

UNIVERSIDADE DE SÃO PAULO
FACULDADE DE FILOSOFIA, CIÊNCIAS E LETRAS DE RIBEIRÃO PRETO
PROGRAMA DE PÓS-GRADUAÇÃO EM ENTOMOLOGIA

“Looking for the missing link: do eggs act as an alternative source of communication in social systems?”

“A busca pelo elo perdido: os ovos atuam como veículos alternativos de comunicação em sistemas sociais?”

Rafael Carvalho da Silva

Tese apresentada à Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto da Universidade de São Paulo, como parte das exigências para obtenção do título de Doutor em Ciências, obtido no Programa de Pós-Graduação em Entomologia

Ribeirão Preto - SP

(2022)

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Orientador: Prof. Dr. Fabio Santos do Nascimento

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Ficha catalográfica

**Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto da Universidade de
São Paulo**

da Silva, Rafael Carvalho

Looking for the missing link: do eggs act as an alternative source of communication in social systems?
Ribeirão Preto, 2022. 436 p.

A busca pelo elo perdido: os ovos atuam como veículos alternativos de comunicação em sistemas sociais?
Ribeirão Preto, 2022. 436 p.

Thesis presented to Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto of USP, in partial fulfillment of the requirements for the degree of Doctor of Science, Area: Entomology

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Orientador: Fábio Santos do Nascimento

1 – Chemical communication. 2 – Juvenile hormone. 3 – Social conflicts. 4 – Conflict resolution. 5 – Brood. 6 – Egg-marking cues.

1 – Comunicação química. 2 – Hormônio juvenil. 3 – Conflitos sociais. 4 – Resolução de conflitos. 5 – Prole. 6 – Pistas de marcação de ovos.

Nome: da Silva, Rafael Carvalho

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Aprovado em: _____

Banca examinadora

Prof (a). Dr (a): _____

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Parecer: _____

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Prof (a). Dr (a): _____

Instituição: _____

Parecer: _____

Assinatura e: _____

Ribeirão Preto, _____ de _____ de 2022

*Dedico esse trabalho à minha sobrinha Ana
Livia Carvalho da Silva Urano.
Entenda que independente do nosso histórico,
nossos sonhos podem eventualmente se tornar
realidade.*

Agradecimentos

A realização do presente trabalho não seria possível sem o suporte que recebi de inúmeras pessoas, logo, deixo aqui meus sinceros agradecimentos...

Ao meu orientador Prof. Dr. Fabio Nascimento, pela oportunidade de realizar não apenas meu mestrado, mas também meu doutorado no Lab CEIS. Agradeço por fornecer um espaço que me permitiu criar novas conexões e viver experiências maravilhosas.

À minha co-orientadora Dr. Cintia A. Oi, por todo suporte, principalmente durante os piores meses da pandemia. Agradeço por todas as discussões, reuniões e sugestões. Além disso, agradeço por ter me recebido tão bem durante os meses que realizei meu estágio em Leuven. Sua orientação foi fundamental para o desenvolvimento do presente trabalho.

À Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Código de financiamento 001 e à Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) – Código de financiamento 2018/22461-3 - por fomentarem o presente trabalho. Também à FAPESP – Código de financiamento 2019/27552-0 – por fomentar minha Bolsa Estágio de Pesquisa no Exterior (BEPE), “O parasitismo regula expressão neurogenômica diferencial em fêmeas e machos de vespas do papel *Polistes*?”. Também agradeço à FAPESP – Código de financiamento 2018/10996-0 – por fomentar parte de minha visita à Katholieke Universiteit Leuven (KU Leuven).

Às instituições de pesquisa que me receberam durante os meus anos enquanto doutorando. Agradeço aos funcionários que lidaram com todas as questões burocráticas que permitiram que minhas visitas fossem possíveis. Obrigado Universidade de São Paulo (USP), Katholieke Universiteit Leuven (KU Leuven) e University of Rochester (U of R).

Aos membros de minha banca avaliadora de relatório pelo PPG em Entomologia, Prof. Dr. Klaus Hartfelder e Prof. Dr. William Fernando Antonialli-Junior. As dadas ao longo dos últimos anos foram importantes para o desenvolvimento do presente trabalho.

À Renata e a Vera por todo suporte associado à pós-graduação. Obrigado pela dedicação e todo cuidado direcionado aos alunos.

À Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto – SP e ao Programa de Pós-Graduação em Entomologia por toda estrutura oferecida aos longos dos meus anos enquanto pós-graduando.

Aos meus pais, Maria Madalena e Edimilson, aos meus irmãos, Cássia e Rodolfo e à minha sobrinha, Ana Livia. Todo suporte foi fundamental para que eu cumprisse mais essa etapa de minha vida. Um agradecimento especial à minha mãe e irmã, obrigado por todas as conversas, palavras de motivação e companhia (mesmo que virtual).

Aos meus avós, João e Vitalina, e também ao meu tio João Paulo, por terem contribuído para minha criação.

Ao Allan, pelo companheirismo, paciência e todo suporte emocional. Agradeço aqui pelos bons momentos que tivemos ao longo dos últimos anos.

À Clara, pelo tremendo suporte e parceria.

Aos meus amigos de Ipuã Matheus, Wesley, Lorrayne e Mariely, pelos bons momentos e todos os domingos de açaí. A companhia de vocês foi fundamental ao longo dos últimos anos.

À Cris, pela paciência ao ensinar sobre o processo de identificação de hidrocarbonetos durante a fase inicial do meu treinamento.

À Prof. Dr. Flória, pela confiança, paciência, treinamento e bons momentos durante o tempo que morei em Rochester.

A todos os amigos que fiz durante meus anos em Ribeirão. Lembrarei com muito carinho de todos os bons momentos, pausas para café e idas à cantina. Agradeço à Jaque (querida), Amanda, Amalia, Nanda, João Robazzi, Jeff, Pri, Helena, Viviana, Wafa, Lívia, Dieguito (São Paulo), Paty, Lohan, Tianfei, Simone, Robin, Ana Luisa, Isamara e Drielly. Um agradecimento especial à Jaque (sentirei muita falta dos nossos momentos reflexivos).

A todos os membros do Laboratory of Socioecology and Social Evolution. Obrigado por proporcionarem um ambiente agradável e por todas as discussões. Agradeço ao Prof. Tom Wenseleers, Cintia, Ricardo, Fabio, Helena, Viviana, Sarah, An, Ian, Clint, Chu, Piet, Luis, Peter e Chris.

A todos os membros e amigos do Trop Bio Lab. pelas valiosas discussões e por me receberem tão bem. Agradeço ao Prof. Al, Hannah, Elsie, Maria, Cheyenne, Fede, Shailee, Maggie, Belle, Joe, Katie and Natasha. Embora não seja um membro formal, agradeço também ao Emiliano, um grande amigo que fiz em Rochester.

A todos os professores que tive ao longo de todas as anos de minha formação. Profissão essa que tem o potencial de transformar vidas. Agradeço por tudo que me foi ensinado e espero que em algum momento, vocês recebam o valor e reconhecimento que merecem.

ABSTRACT

DA SILVA, R. C. - **Looking for the missing link: do eggs act as an alternative source of communication in social systems?** 2022. Tese (Doutorado em Ciências). Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, 2022.

Eusocial insects are known for expressing three main features (1) overlapping of generations, (2) cooperative brood care, and (3) division of reproductive labor. Queens are responsible for performing reproductive tasks and workers engage in others, such as foraging and defense. Even though social insect colonies seem to be cohesive, social conflicts can occur. One conflict is over reproduction. Workers can try to increase their fitness by producing male-destined eggs. To avoid this, policing is a mechanism in which reproductive workers are attacked and their eggs are removed. Besides, nests can also get usurped by unrelated females, which dump eggs to benefit from the care provided by resident individuals. Alien brood can thrive if not detected or removed while females perform cell screening. The ability to discriminate chemical compounds over eggs allows such conflicts to be resolved. Queens usually produce specific chemical compounds, known as queen pheromones, that directly reflect their presence and fertility. These pheromones avoid workers to become reproductive and maintain social cohesion. Queen pheromones can be non-volatile substances, implying that workers must be in direct contact with the queen to perceive them. However, in colonies with thousands of individuals, alternative strategies to spread queen scent have evolved. For example, eggs can carry queen signals and play an important role to promote cohesion. Eggs are coated with chemical substances that carry important information, such as maternity and nest identity. In my Ph.D. thesis, I investigate the roles that eggs display in societies of Vespidae wasps. Vespidae is a promising study group because it comprises species that express a full range of social behavior, from solitary, primitively eusocial, and highly eusocial species. Studying the roles eggs display in this group may give us important insights into the evolution of alternative strategies of communication. I used an integrative approach consisting of a literature review, observation of natural history, correlative chemical data, and experimental studies. My main findings include that (1) brood in general (eggs + larvae) possess chemical compounds that can be used to resolve social conflicts; (2) egg-marking compounds probably derive from secretions released by the *Dufour's* gland, a gland that is part of the reproductive system of hymenopteran females; (3) egg-marking cues and the secretions of the exocrine gland reflect female caste; (4) juvenile hormone, JH, in females are correlated with expression of chemical substances in the cuticle, gland secretions and hence eggs; (5) egg-marking compounds carry information that allows conflicts over nest usurpation to be resolved; (6) wasps possess cognitive abilities, such as learning and memory, that are fundamental to process scents. My thesis expanded the knowledge regarding the chemical communication in wasp societies by showing that eggs act as alternative sources of communication and are used to resolve conflicts. Although often overlooked, immature-adult communication is fundamental for the maintenance of social cohesion in wasps expressing different levels of sociality.

Keywords: Chemical communication. Juvenile hormone. Social conflicts. Conflict resolution. Brood. Egg-marking cues.

RESUMO

DA SILVA, R. C. - **Looking for the missing link: do eggs act as an alternative source of communication in social systems?** 2022. Tese (Doutorado em Ciências). Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, 2022.

Insetos eussociais expressam três características (1) sobreposição de gerações, (2) cuidado cooperativo da prole e (3) divisão de trabalho reprodutivo. Rainhas realizam tarefas reprodutivas e operárias engajam em forrageamento e defesa. Embora vivam em coesão, conflitos sociais também existem. Um dos conflitos está relacionado à reprodução. Operárias tentam aumentar sua aptidão produzindo ovos de machos. Por sua vez, policiamento é um mecanismo onde operárias reprodutivas são agredidas pela rainha e demais operárias e seus ovos são destruídos. Ninhos podem ser usurpados por fêmeas não-relacionadas, as quais colocam ovos e se beneficiam pelos cuidados providos pelas fêmeas residentes. A prole não-relacionada pode ter sucesso se não for detectada enquanto as fêmeas checam células. Perceber e processar compostos químicos é o que permite esses conflitos serem resolvidos. Rainhas produzem compostos químicos que refletem sua presença e fertilidade. Esses feromônios previnem as operárias de se tornarem reprodutivas e mantêm coesão social. Feromônios de rainhas são geralmente de baixa volatilidade, sugerindo que operárias devem estar em contato direto com a rainha para percebê-los. Todavia, em colônias compostas por milhares de indivíduos estratégias alternativas de disseminação desses compostos químicos evoluíram. Por exemplo, ovos carregam compostos de rainhas e desempenham papel importante na promoção da coesão. Ovos são recobertos por compostos químicos que refletem maternidade e identidade do ninho. Portanto, em minha tese de doutorado investiguei os possíveis papéis que ovos desempenham em sociedades de vespas Vespidae. Vespidae se destaca como um grupo promissor, pois compreende espécies que expressam diferentes níveis de comportamento social, de solitárias, a primitivamente e altamente eussociais. Dessa forma, estudar quais os papéis os ovos podem ter nesse grupo pode nos revelar informações importantes acerca da evolução de estratégias alternativas de comunicação. Para isso, adotei uma abordagem integrativa que consistiu em conduzir uma revisão de literatura, estudar história natural, investigar dados químicos de forma correlativa e realizar estudos experimentais. Meus principais achados incluem (1) no geral, a prole em vespas sociais (ovos + larvas) são recobertos por compostos químicos que podem ser utilizados para resolver conflitos sociais; (2) compostos de marcação de ovos se originam a partir da glândula de *Dufour*, a qual faz parte do sistema reprodutivos das fêmeas de hymenópteros; (3) compostos de marcação de ovos e o conteúdo da glândula exócrina refletem a casta das fêmeas; (4) os níveis de hormônio juvenil (HJ) estão correlacionados com compostos químicos encontrados sob a superfície corporal, nas secreções glandulares e consequentemente nos compostos de marcação de ovos; (5) compostos de marcação de ovos carregam informações que permitem a resolução de conflitos uma vez que ninhos são usurpados; (6) vespas possuem habilidades cognitivas, como aprendizado e memória, as quais são fundamentais para o processamento de aromas. Minha tese expande o conhecimento acerca da comunicação química em sociedades de vespas, demonstro que os ovos atuam como recursos alternativos de comunicação e são usados para resolução de conflitos. Embora negligenciada, a comunicação entre imaturos e adultos parece ser fundamental para a manutenção da coesão social em sociedades de vespas que expressão diferentes níveis de socialidade.

Palavras-chave: Comunicação química. Hormônio juvenil. Conflitos sociais. Resolução de conflitos. Prole. Pistas de marcação de ovos.

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GENERAL INTRODUCTION



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Eusociality and Social conflicts

The evolution of eusociality is considered one example of the major transitions in evolution (Smith & Szthmary 1997, adapted from Endler & Hölldobler 2006), whereby an evolution towards a greater complexity was achieved. Genes form a genome, cells are organized to form a multicellular organism, and individuals start to live in societies. Particularly, eusocial insects express three main features (1) overlapping of generations, (2) cooperative care of the brood, and (3) division of the reproductive labor (Wilson 2000).

Two different castes of females are present in eusocial insect societies, a fertile one, which is represented by the female that is responsible for reproducing, namely the queen, and another caste, namely the workers, which is represented by females that refrain from reproducing and are responsible for performing other tasks (Oster & Wilson 1978; Peeters & Tsuji 1993). Eusociality has evolved at least 22 times across the animal kingdom, being nine times among the insects of the order Hymenoptera (Ross et al. 2013). The factors that contribute to the evolution and maintenance of cooperation in social insect colonies still intrigue ethologists and evolutionary biologists (Endler et al. 2006; Nowak et al. 2010).

Although there is a remarkable division of reproductive labor between the queen and workers, social conflicts can occur. In some species, for example, workers can reproduce, leading to a conflict over male production with the queen, as workers produce haploid eggs (Alexander 1974; Bourke 1988; Woyciechowski & Lomnicki 1989). The attempts to invest in self-reproduction are usually prevented in social insect colonies by direct aggression towards fertile workers (physical intimidation) (Keller & Nonacs 1993) and destruction of worker-laid eggs (differential oophagy - policing) (Peeters & Tsuji 1993; Ratnieks et al. 1996; Visscher 1996; Foster & Ratnieks 2001). The act of directly preventing a given female to reproduce within these societies is known as “policing” and it was first described by Ratnieks & Visscher (1989) in honeybees. The inspection of eggs is advantageous in the presence of a fertile queen and it brings benefits from the genetic point of view. The presence of reproducing worker and the accumulation of worker-laid eggs can potentially compromise the colony functionality, once the reproducing workers are less efficient in other tasks and male overproduction represent more resource consumption (Alexander 1974; Bourke 1988; Keller & Nonacs 1993). However, under queen-less conditions, workers switch off their strategy and instead of policing they

engage in egg-laying, which produces the last batch of males in the colony (Miller & Ratnieks 2001; there may be exceptions regarding the change in strategy, see also Châline et al. 2004). Policing behavior occurs due to the ability of females to detect specific chemical compounds over the worker-laid eggs or over the body surface of reproductive workers (Wenseleers et al. 2020a). Females possess an accurate ability to detect – possibly due to their learning and discrimination skills - different chemical cues (Oi et al. 2015b; Châline et al. 2005). Egg-maternity recognition occur based on the different proportions of chemical compounds present over the surface of the eggs (Oi et al. 2016a,b; Bonckaert et al. 2012; Liebig 2010; Smith et al. 2009; Martin et al. 2005; D’Ettorre et al. 2004; Endler et al. 2004;). Intriguingly, eggs can either drive or represent mechanisms by which conflicts are solved within social insect colonies (Wenseleers et al. 2020). The scope for conflict resolution implies that females express cognitive abilities that allow them to perceive different stimuli of the environment. Even though social insects use different modes to communicate, they still rely mostly on the use of chemical communication (Leonhardt et al. 2016).

Chemical communication

Communication through chemical compounds has been proposed as being the most ancient used by several organisms (Karlson & Lüscher 1959). Different modes of communication are used by eusocial insects, which help them to coordinate their division of labor (Ozaki et al. 2005). Among the modes of communication, chemical communication is one of the most important (Blum 1996; Monnin 2006). Chemical compounds mediate interactions involving a few or thousands of individuals (Symonds & Elgar 2008) and the compounds that allow individuals from the same species to communicate are known as pheromones (Law & Regnier 1971). Two major types of pheromones, releasers and primers, have been described, they are classified based on how prolonged their effects are. Releaser pheromones represent chemical substances that cause an immediate behavior modification in the receivers. Examples of releasers pheromones are sex, aggregation, alarm and trail pheromones (Wyatt 2003). Primer pheromones, on the other hand, are represented by chemical compounds that have a prolonged effect over the receiver’s physiology, for example, the queen pheromones in honeybees can trigger reproductive physiological effects on workers (e.g. preventing the workers from activating their ovaries) (Wyatt 2003; Le Conte & Hefetz 2008). Overall, pheromones are considered components of a true communication, and under such

circumstances, the individual who sends a signal and the one that receives benefit from the signal existence (Freeberg et al. 2021). Pheromones evolved from chemical cues, which are merely chemical substances produced by individuals, which can be correlated with certain physiological features, and can also trigger a reaction in receivers, yet not shaped by evolution (Freeberg et al. 2021). The ability to communicate through chemical compounds allows social insects to organize themselves in different tasks, to recognize nestmates over non-nestmates, to attract or interact with sexual partners, to access the caste of each individual, and also to evaluate how healthy an organism is (Kocher & Grozinger 2011; da Silva et al. 2021a,b; da Silva et al. 2022) (Figure 1). Therefore, considering their complex social environment and how useful chemical compounds are, social insects are interesting models to study the evolution of chemical communication system (Kocher & Grozinger 2011).

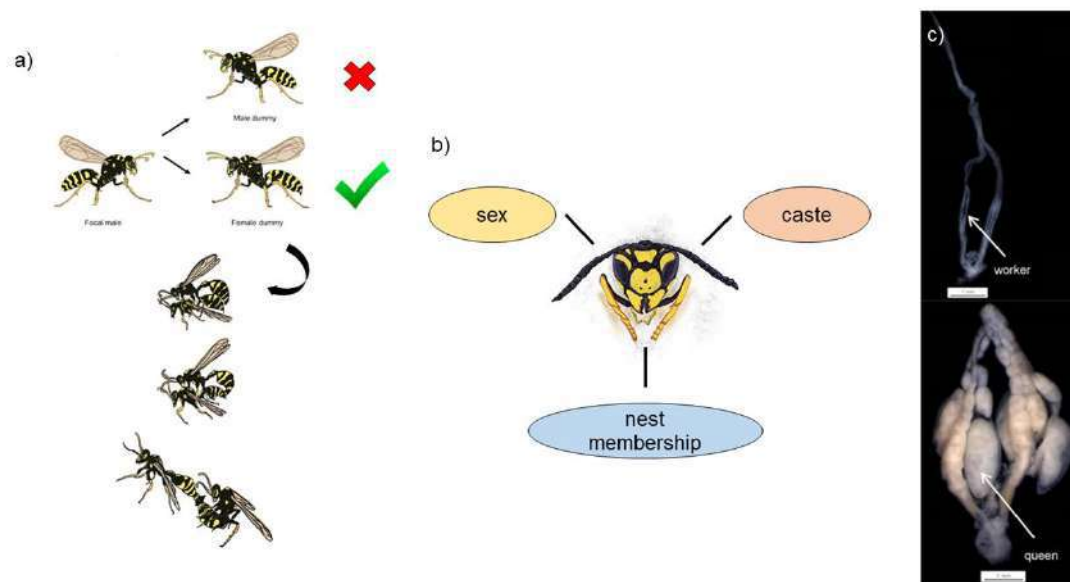


Figure 1: Examples of how pheromones can be used in social insects. a) Sexual interactions: in *Polistes dominula*, cuticular hydrocarbons (CHCs) differ quantitatively between females and males. Males distinguish chemical differences between sexes, and behave differently, repel males and mate with females. During courtship behavior, males approach the female, will touch their body consistently, and then will try to grasp the body and mount onto them (da Silva et al. 2021a). b) In *Vespula germanica*, cuticular hydrocarbons (CHCs) reflect sex, caste and nest membership traits (da Silva et al. 2021b). c) In Epiponini swarm-founding wasps, cuticular hydrocarbons (CHCs) reflect caste and can be used as fertility cues, as there is a correlation between CHCs and ovary activation. Upper workers with thread-like ovaries, below queens with activated ovaries (da Silva et al. 2022).

In a social environment, the chemical compounds act as the proximal factors that allow the regulation of the division of reproductive labor. An important set of chemical compounds are the queen pheromones (Kocher & Grozinger 2011; Oi et al. 2015a). Queen pheromones are compounds produced by the queen or reproductive females of

social insects, and have been widely demonstrated to play key functions in the modulation of the reproductive division of labor (Van Oystaeyen et al. 2014; Oi et al. 2015a,b; Oi et al. 2016; Holman 2018). Two hypotheses have been proposed regarding the function of queen pheromones in social insect. The first hypothesis suggests that these chemicals could be directly used as suppressors of the physiological state of workers, which consequently prevents those females from reproducing, queen control hypothesis (Conte & Hefetz 2008; Oi et al. 2015a). The second hypothesis suggests that these compounds serve as signals that inform the presence of a fertile queen, acting as honest signals, honest fertility hypothesis (Keller & Nonacs 1993; West-Eberhard 2003; Monnin 2006; Oi et al. 2015a). Honest signals are stable through evolution when they represent an honest index, which assumes the idea that the signal is costly and cannot be faked, probably intrinsically connected to the physiology of who is emitting the information. The cost of producing and maintaining the signal assure that only high-quality individuals can produce them, which results in a mutual benefit for both involved parts (Oster & Wilson 1978). Workers benefit from responding to an honest signal once the signals directly reflect queen's quality, her health and reproductive potential, in this way the interests of workers will be align with those of the queen. Ultimately, workers refrain from reproducing and will primarily engage in non-reproductive tasks that benefit the colony as a whole (Oi et al. 2015a).

Two main classes of queen pheromones are pointed as bioactive, volatile compounds, for example, the compounds from the mandibular gland of honeybees (Butler et al. 1963; Hoover et al. 2003; Matsuura et al. 2010; Tan et al. 2015) and the non-volatile compounds, such as some cuticular hydrocarbons of ants, wasps and bumblebees (Holman 2010; Van Oystaeyen et al. 2014; Oi et al. 2016a,b). Phylogenetic analysis including the latter indicates a strong correlation between non-volatile saturated hydrocarbons and females' fertility. In addition, these hydrocarbons seem to represent a conserved class of chemical compounds, being common among 60 different species of social insects that evolved eusociality independently (Van Oystaeyen et al. 2014).

Because of the central role of hydrocarbons in the communication of social insects, I focused on this class of chemical compounds to study other interactions they potentially mediate. CHCs are produced by specialized cells known as oenocytes, and they are transported to the insect body surface by proteins denominated lipophorins (Makki et al. 2014). According to the literature, hydrocarbons can be also produced and released by exocrine glands (e.g. cephalic glands, *Dufour's* gland, etc.) (Orlova et al.

2022; Derstine et al. 2021; Bonckaert et al. 2012; Čahlíková et al. 2004; Martin et al. 2022). Chemical compounds, such as hydrocarbons, do not exclusively occur over the body surface of social insects, but also are present over surface of the nests (Sguarizi-Antonio et al. 2022; Soares et al. 2021).

CHCs that work as queen pheromones likely evolved from pre-existing cues already present in solitary ancestors (Kather & Martin 2015; Oi et al. 2015a; Oi et al. 2016a). Three different hypotheses have been proposed indicating the likely scenarios in which queen pheromones may have evolved from pre-existing chemical cues (Oi et al. 2015a). Queen pheromones may have evolved from pre-existing sexual pheromones used by solitary insects, from chemical cues produced by females as a by-product of their ovary activation, and lastly, from compounds released during the process of egg-laying, oviposition deterring pheromones (Oi et al. 2015a). For example, in the solitary female wasps from *Trypoxylon* sp. genus and solitary female wasps of *Monobia quadridens* express over their cuticle three linear alkanes, *n*-C27, *n*-C28 and *n*-C29, that have been previously identified as queen pheromones in a highly eusocial wasp species (*Vespula vulgaris*). These hydrocarbons can be express as a by-product of their ovary activation or can be used to mediate sexual interactions in these species (da Silva *unpublished data*).

Alternative strategies of chemical communication

Chemical compounds used by social insects possess different volatility properties. For instance, CHCs are usually non-volatile, which requires individuals to touch each other with their antennae to perceive the cues or signals (Ozaki & Wada-Katsumata 2010). Low volatility implies that chemical transmission can be limited in bigger colonies where a single queen cannot interact with all workers (Endler et al. 2004). Indirect ways of communication have been proposed to exist in different social systems (Endler et al. 2004). For instance, the mandibular queen pheromone in honeybees can be disseminated in the hive through trophallaxis (Seely 1979; Naumann et al. 1991), females may release pheromones stored in their *Dufour's* gland during egg-laying, and eggs possibly work as spreaders of queen scent in the colony (Oi et al. 2015b; Bonckaert et al. 2012; Martin et al. 2004; Martin et al. 2002; Hölldobler & Carlin 1989; Brian & Rigby 1978). An additional way is when the queens spread their scents by constantly rubbing their abdomen over the nest surface, which leads to the release of compounds (Bhadra et al. 2007). In fact, the nest surface of wasps and the wax present in the hive of bees are usually

enriched by chemical substances (Nunes et al. 2010; Sguarizi-Antonio et al. 2021; Soares et al. 2021). The strategy of spreading their scents across the colony is especially useful in highly eusocial insects. These alternative strategies allow queens to increase their chances of reaching indirectly individuals (Oi et al. 2015b; Endler et al. 2004; Hölldobler 1989; Brian & Rigby 1978). However, even in primitively eusocial insects, where individuals interact directly with each other, queens also mark their nests and eggs with chemical compounds (Tannure-Nascimento et al. 2009; Dapporto et al. 2007). Egg marking cues or signals hence may contribute to the process of conflict resolution in insect societies. Interestingly, egg-marking behavior has probably evolved as a by-product of reproduction or as a direct strategy to confer egg protection (Oi et al. 2015a). Overall, queens produce CHCs and egg-marking compounds that are tightly linked to their fertility. Production of chemical compounds and the control of fertility are traits that vary depending on their hormonal levels.

Juvenile hormone as a social regulator

Juvenile hormones (JH) are acyclic sesquiterpenoids that control several physiological aspects in insects (Huang 2020; see Noriega 2014; Hartfelder 2000). JHs are lipophilic molecules, and their titers are primarily regulated by the biosynthesis in a pair of glands located near the brain, named *Corpora allata* (CA). Although at least eight different forms have already been identified, the JH III isoform is the most commonly found in insects (see Noriega 2014). JHs were the first described as the hormones maintaining juvenile features in the larvae stage during metamorphosis. Later, JHs became known for their pleiotropic effects, responsible for regulating several processes, such as immature development, reproduction, aggressive behavior, behavioral maturation, caste determination, diapause, stress response, dispersal and flight activities, and many other polyphenisms in several insect species (see Hartfelder 2000; Goodman et al. 2012, see Jindra et al. 2015).

In social insects, in addition to the roles mentioned above, JH may be associated with the production of chemical compounds, and hence chemical expression that is caste-linked (Oi et al. 2021a,b; Oi et al. 2020). Related to the pleiotropic effects of JH, the hormonal pleiotropy hypothesis suggests that the production of queen pheromones and quality (queen fertility) are under a similar endocrine control (Oliveira et al 2017). This is consistent with the honest fertility hypothesis where low-quality females would not be

able to fake the production of queen pheromones, since this would require them to upregulate the production of hormones, which in turn would lead to affecting other traits, such as ovary activation (Holman 2012). Recently, there is increasing evidence showing that JH is directly associated with the regulation of reproduction and production of queen-characteristic signals (Oliveira et al., 2017; Oi et al. 2020; Oi et al. 2021a,b; Ferreira et al. 2022). For example, in the highly eusocial wasp *V. vulgaris*, queens were shown to have almost 300 more JH titers in their hemolymph compared to workers (Oliveira et al. 2017). This correlation supports that JH acts as gonadotropic in this species. Experimental evidence has shown that the topical application of JH analogue (methoprene) in newly emerged workers leads to them to acquire a queen-like chemical composition (Oliveira et al. 2017; Oi et al. 2021a).

Up to this moment several hymenopteran species have been used in studies that aimed to find out how JH affects their lives, which includes species ranging from solitary to highly eusocial ones (Table I), using empirical or correlational studies. Methoprene is the most used JH analogue in Hymenoptera (Table I). The mode of JH manipulation can be through the topical application (most often in the abdominal tagma), but injection and oral are also used. The majority of the studies adopted a single application, but there are a few in which the authors treated the same individuals several times over a week or two (Table I). Studies using the anti-JH effect (using precocene I, II, and III) are less frequent. Precocene triggers opposite effects as those provoked by pure JH or JH analogue in insects. For example, precocene can prevent ovary activation, having an anti-gonadotropic effect, or delay task transitioning, having an anti-behavioral maturation effect. Although our knowledge has advanced regarding the roles of JH in social insects, determining whether or not JH circulating levels ultimately affect other components, for example chemical expression in exocrine glands is still lacking. A group of social insects that has been neglected over the past years is the Vespidae wasps. Vespidae is a promising group to be used in studies investigating social conflicts, alternative strategies of communication (Oi et al. 2021c). Furthermore, this group of wasps comprises species that express the full range of social complexity (Taylor et al. 2018).

Table 1: Review table including Hymenoptera species that have been submitted to experiments to manipulate their JH circulating levels.

Group	Species	Family	Sub-family	Social organization	Reference	Method
Wasp	<i>Polybia occidentalis</i>	Vespidae	Polistinae	Swarm-founding	O'Donnell & Jeanne 1993 / Prato et al. 2021 / Prato et al. 2022	Topically
Wasp	<i>Ropalidia marginata</i>	Vespidae	Polistinae	Primitively eusocial	Agrahari & Gadagkar 2003	Topically
Wasp	<i>Polistes dominula</i>	Vespidae	Polistinae	Primitively eusocial	Shorter & Tibbetts et al 2009	Topically
Wasp	<i>Polistes metricus</i>	Vespidae	Polistinae	Primitively eusocial	Tibbetts & Sheenan 2012	Topically
Wasp	<i>Polistes canadensis</i>	Vespidae	Polistinae	Primitively eusocial	Giray et al. 2005	Topically
Wasp	<i>Vespula vulgaris</i>	Vespidae	Vespinae	Highly eusocial	Oliveira et al. 2017	Topically
Wasp	<i>Synoecca surinama</i>	Vespidae	Polistinae	Swarm-founding	Kelstrup et al 2014	Topically
Wasp	<i>Polistes fuscatus</i>	Vespidae	Polistinae	Primitively eusocial	Walton et al. 2020	Topically
Wasp	<i>Polistes annularis</i>	Vespidae	Polistinae	Primitively eusocial	Barth et al. 1975	Topically
Wasp	<i>Eupelmus vuilletti</i>	Eupelmidae	Eupelminae	Parasitoid	Mathiron et al 2019	Topically/Injection
Wasp	<i>Polistes dominula</i>	Vespidae	Polistinae	Primitively eusocial	Tibbetts & Izzo 2009	Topically
Wasp	<i>Polistes dominula</i>	Vespidae	Polistinae	Primitively eusocial	Tibbetts et al. 2013a	Topically
Wasp	<i>Euodynerus foraminatus</i>	Vespidae	Eumeninae	Solitary	Tibbetts et al. 2013b	Topically
Wasp	<i>Polistes dominula</i>	Vespidae	Polistinae	Primitively eusocial	Tibbetts & Banan 2010	Topically
Wasp	<i>Mischocyttarus consimilis</i>	Vespidae	Polistinae	Primitively eusocial	Neves et al. 2020	Topically
Wasp	<i>Mischocyttarus consimilis</i>	Vespidae	Polistinae	Primitively eusocial	Montagna et al. 2015	Topically
Wasp	<i>Polistes metricus</i>	Vespidae	Polistinae	Primitively eusocial	Bohm 1972	Topically
Wasp	<i>Vespula vulgaris</i>	Vespidae	Vespinae	Highly eusocial	Oi et al. 2020	Topically

Wasp	<i>Polistes gallicus</i>	Vespidae	Polistinae	Primitively eusocial	Röseler et al. 1984	Injection
Wasp	<i>Polistes lanio</i>	Vespidae	Polistinae	Primitively eusocial	Southon et al. 2020	Topically
Wasp	<i>Vespula vulgaris</i>	Vespidae	Vespinae	Highly eusocial	Oi et al. 2021b	Topically
Wasp	<i>Mischocyttarus metathoracicus</i>	Vespidae	Polistinae	Primitively eusocial	Oi et al. 2021a	Topically
Wasp	<i>Mischocyttarus cassununga</i>	Vespidae	Polistinae	Primitively eusocial	Oi et al. 2021a	Topically
Wasp	<i>Polistes satan</i>	Vespidae	Polistinae	Primitively eusocial	Oi et al. 2021a	Topically
Wasp	<i>Polistes dominula</i>	Vespidae	Polistinae	Primitively eusocial	Oi et al. 2021a	Topically
Wasp	<i>Mischocyttarus cerberus</i>	Vespidae	Polistinae	Primitively eusocial	Ferreira et al. 2022	Topically
Wasp	<i>Mischocyttarus cassununga</i>	Vespidae	Polistinae	Primitively eusocial	Ferreira et al. 2022	Topically
Wasp	<i>Polybia occidentalis</i>	Vespidae	Polistinae	Swarm-founding	Prato et al. 2022	Topically
Ant	<i>Lasius niger</i>	Formicidae	Formicinae	Formicoid clade	Pamminger et al. 2016a	Topically
Ant	<i>Lasius niger</i>	Formicidae	Formicinae	Formicoid clade	Pamminger et al. 2016b	Topically
Ant	<i>Lasius niger</i>	Formicinae	Formicinae	Formicoid clade	Holman 2012	Topically
Ant	<i>Myrmecaria eumenoides</i>	Formicidae	Myrmicinae	Formicoid clade	Lengyel et al. 2007	Topically
Ant	<i>Acromyrmex octospinosus</i>	Formicidae	Myrmicinae	Formicoid clade	Norman & Hughes 2016	Topically
Ant	<i>Dinoponera quadriceps</i>	Formicidae	Ponerinae	Poneroid clade	Norman et al. 2019	Topically
Ant	<i>Ectatomma tuberculatum</i>	Formicidae	Ectatomminae	Formicoid clade	Azevedo et al. 2016	Topically
Ant	<i>Pogonomyrmex sp.</i>	Formicidae	Myrmicinae	Formicoid clade	Cahan et al. 2011	Topically
Ant	<i>Harpegnathos saltator</i>	Formicidae	Ponerinae	Poneroid clade	Penick et al. 2012	Topically
Ant	<i>Pheidole bicarinata</i>	Formicidae	Myrmicinae	Formicoid clade	Wheeler & Nijhout 1983	Topically
Ant	<i>Solenopsis invicta</i>	Formicidae	Myrmicinae	Formicoid clade	Burns et al. 2002	Topically
Ant	<i>Cardiocondyla obscurior</i>	Formicidae	Myrmicinae	Formicoid clade	Schrempf & Heinze 2006	Topically
Ant	<i>Solenopsis invicta</i>	Formicidae	Myrmicinae	Formicoid clade	Azizi et al. 2009	Topically
Ant	<i>Solenopsis invicta</i>	Formicidae	Myrmicinae	Formicoid clade	Burns et al. 2007	Topically

Ant	<i>Harpegnathos saltator</i>	Formicidae	Ponerinae	Formicoid clade	Penick & Liebig 2017	Topically
Ant	<i>Harpegnathos saltator</i>	Formicidae	Ponerinae	Formicoid clade	Penick & Liebig 2012	Topically
Bee	<i>Nomia melanderi</i>	Halictidae	Nomiinae	Solitary	Kapheim & Makenna 2017	Topically
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Rutz et al. 1976	Injection
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Chang et al. 2015	Topically
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Robinson & Ratnieks 1987	Topically/orally
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Robinson 1987a	Topically
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Robinson 1987b	Topically
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Schulz et al. 2002	Topically/orally
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Sasagawa et al. 1989	Topically/Injection
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Jaycox et al. 1974	Injection
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Whitfield et al. 2006	Orally
Bee	<i>Apis mellifera</i>	Apidae	Apinae	Highly eusocial	Huang et al. 2018	Topically
Bee	<i>Lasioglossum zephyrum</i>	Halictidae	Halictinae	Primitively eusocial	Bell 1973	Topically
Bee	<i>Bombus terrestris</i>	Apidae	Apinae	Primitively eusocial	Bortolotti et al. 2001	Topically
Bee	<i>Bombus terrestris</i>	Apidae	Apinae	Primitively eusocial	Shpigler et al. 2014	Topically
Bee	<i>Bombus terrestris</i>	Apidae	Apinae	Primitively eusocial	Pandey et al. 2020	Topically
Bee	<i>Bombus impatiens</i>	Apidae	Apinae	Primitively eusocial	Cameron & Robinson 1990	Topically/Injection

Vespidae: biological aspects and social conflicts

Vespid is a group composed by wasps that express the full spectrum of social lifestyle, from solitary to highly eusocial (Piekarski et al. 2018; Taylor et al. 2018). Eusociality has evolved independently twice in this clade, in the Stenogastrinae and Polistinae + Vespinae branches (Piekarski et al. 2018). Polistinae is composed by primitively eusocial and swarm-founding wasps, whereas Vespinae encompasses highly eusocial species (O'Donnell 2020; Sumner & Cini 2020; Jeanne 2020; Gadagkar 2019; Yamane & Yamane 2020).

Polistes and *Mischocyttarus* genus belong to Polistinae and are classified as primitively eusocial species, which means that there are no apparent morphological differences between reproducing and non-reproducing females (O'Donnell 2020). Despite the lack of apparent morphological traits, females express a key feature, all of them are totipotent, retain the capacity to switch between reproductive and non-reproductive states (Ratnieks et al. 2006). Nests are started by a single or coalition of female foundresses. In the latter case, females will compete to become the reproductive, and usually the most aggressive get the chance to monopolize reproduction, whereas the others will behave as subordinate individuals (O'Donnell 2020; Sumner & Cini 2020). *Polistes* and *Mischocyttarus* wasps build nests that are deprived of a protective envelope (Wensel 2020), which increases the chances of unrelated individuals to access them (O'Donnell 2020).

In the primitively eusocial species, females face at least two types of social conflicts, over reproduction and nest parasitism. Along nest ontogeny, subordinates or workers that emerge from the nest can attempt to reproduce in the presence of the main egg layer (Miyano 1983; Tsuchida et al. 2003). In the case of worker egg-laying, the main egg layer usually is able to detect the eggs and eat them (Tsuchida et al. 2020). This implies the existence of cues that allow proper recognition. The second potential conflict is linked to females raising unrelated brood once their nests are attacked by usurpers or social parasites (Cervo 2006). In both cases, eggs can play a role in conflict resolution, as they are coated with chemical substances that allow egg discrimination. For instance, the main egg layers, which are more fertile, lay eggs that reflect their fertility, and allow the discrimination of eggs laid by other females. It is expected that egg-marking cues are species-specific, hence females can detect and discriminate their eggs over the ones laid by nest usurpers.

Vespine wasps are represented by four different genera - *Vespula*, *Dolichovespula*, *Vespa* and *Provespa* - and nest founding is usually performed by a single female the queen (Yamane & Yamane 2020). There is a pronounced morphological variation between queens and workers, with queens being bigger. Workers usually have the same size, although late workers can express a similar size as the virgin queens (Greene 1991; Yamane & Yamane 2020). Due to the larger size of their nests, the mechanism that ensures reproductive monopoly involves release of chemical compounds that signal the queen's presence (Van Oystaeyen et al. 2014; Oi et al. 2016a,b; Yamane & Yamane 2020). However, even under queen-right conditions, workers are able to activate their ovaries and they try to invest in their own reproduction (Wenseleers et al. 2020a,b). Workers are not inseminated, however, they capable to lay male destined eggs and this can lead to a conflict over male production with the queen.

Worker-laid eggs in social wasps usually get destroyed either by the queen or other workers (Wenseleers et al. 2020a,b). Eggs are perceived due to egg maternity compounds (Oi et al. 2015b). In fact, queens of *V. vulgaris* release high levels of branched hydrocarbon (3-MeC29) during egg-laying (Oi et al. 2016b ; Oi et al. 2015b) compared to worker-laid eggs (Oi et al. 2016b ; Oi et al. 2015b), which are perceived by queens and workers. Some worker-laid eggs can escape the policing process and adult males can emerge from them, although in low percentage (Wenseleers et al. 2007; Wenseleers et al., 2005). Worker-laid eggs may succeed because they are not perceived (e.g. in bigger colonies policing may be diluted compared to smaller colonies). Workers of *V. vulgaris* treated with JH analogue methoprene acquire a queen-like profile and lay eggs that are less destroyed as they are chemically similar to those laid by queens (Oliveira et al. 2017; Oi et al. 2020; Oi et al. 2021b). In this scenario, their eggs have higher chances to succeed.

Eggs are important components of the social life in Vespidae wasps, as they potentially help to solve conflicts. Considering that there still exist some gaps of knowledge regarding the roles eggs can display in Vespidae, I conducted an integrative study using Polistinae and Vespinae wasps to investigate how eggs can contribute for keeping the social cohesion within their colonies.

Aims and thesis organization

Chemical communication through hydrocarbons plays a fundamental role in social insect colonies, not only to signal fertility but it is also used during sexual interactions, species recognition, and in brood detection. Besides that, the production of these hydrocarbons is potentially affected by the JH levels that females have. Even though it has been demonstrated to be the case for some social species, there is still a lack of comparative studies on Vespidae wasps, which express different degrees of social behavior. Wasps use chemical compounds for different functions. Studying chemical communication and different levels of social organization in wasps can provide insights into how conflicts are resolved from an evolutionary perspective.

In this thesis, my main goal was to investigate the chemical communication dynamics in social wasps and how their eggs can potentially be used as fundamental tools to solve conflicts. I explored if egg-marking compounds potentially derive from *Dufour's* gland secretions and I analyzed if egg-marking cues are caste-related. Also, I aimed to address whether egg-marking cues are differently produced depending on their JH levels. In addition, I tested if compounds could help females to deal with nest usurpation. Finally, I also investigated for the very first time whether a Neotropical social wasp is capable of learning and memorizing chemical scents. Therefore, my main hypothesis was that eggs may convey chemical information and thus contribute to the maintenance of social cohesion in wasp societies. I predicted that (1) eggs would be coated with similar compounds that have been previously reported to exist over the body of social insects, (2) eggs would carry information concerning egg maternity origin, being queen-laid and worker-laid, which influence policing, (3) females would correctly recognize eggs from different species, (4) the *Dufour's* gland is the most likely source of egg-marking compounds, (5) egg-marking cues would be affected by JH levels, and (6) wasps are able to learn and memorize chemical scents, once these abilities may be key for the maintenance of social behavior and for the resolution of several social conflicts. To accomplish the overall goal of my work, chemical compounds used to mark eggs were identified and compared across different castes of wasps of different species. To this end, I organized my thesis into chapters formatted as manuscripts to be submitted to different scientific journals. I used wasp species that express different levels of social behavior and I conducted several approaches, from literature review, description of natural history, and correlative and experimental studies. More details about the biology of the study wasps

are supplied within each chapter. Below, I presented the main aims of the different chapters:

Chapter 1: Brood as sources of communication in wasp societies

Eggs carry information that reflects maternity and nest specificity. To cover in details the roles that not only eggs but also larvae may display within wasp societies, I conducted a mini-review to synthesize the current literature available regarding the importance of brood in wasp societies.

Chapter 2: Notes on brood morphology and development of the Neotropical eusocial wasp *Mischocyttarus cerberus* (Hymenoptera, Vespidae, Polistinae)

Given that *Mischocyttarus cerberus* was a key model species in my thesis, I reported biological knowledge about the brood, with an important description of number of larval instars, description of morphological features, and how the developmental stages vary according to different moments across the year. The information generated here was fundamental for the execution of the experiments to manipulate the eggs across the nests (Chapter 6).

Chapter 3: Chemical resemblance in egg surface composition and Dufour's gland in two Polistinae wasps

It has been hypothesized that egg marking compounds would reflect the chemical content of the Dufour's gland, an accessory exocrine gland associated to the reproductive apparatus system in Hymenoptera females. In this chapter, I studied whether egg marking is a phenomenon present in primitively eusocial wasps. The main aims were to investigate the source of egg compounds, the level of the chemical similarity between CHCs, egg marking cues, and Dufour's gland content in two species of primitively eusocial wasps. In other societies, egg marking compounds have been reported to reflect the CHCs composition of their mothers. Comparing two related species of Polistinae wasps can provide insights if these cues are conserved across the species.

Chapter 4: Hydrocarbon signatures of egg maternity and Dufour's gland in Vespine wasps

In highly eusocial Vespine wasps, usually the queen is morphologically larger than workers and the colonies have hundreds of individuals. This makes almost impossible for the queen to directly interact with the workers, and suppress worker reproduction. Under this scenario, queens are expected to release compounds over their eggs and nest material, that may indirectly inform their fertility and presence within the nest. In this chapter, I examined the CHCs, egg marking compounds and the Dufour's

gland content in four species of Vespine wasps. This allowed me to explore the hypothesis of a common strategy used by queens of different highly eusocial species to mark their eggs. This work was conducted during my PhD sandwich at the University of Leuven.

Chapter 5: Juvenile hormone modulates hydrocarbon expression and reproduction in the German wasp *Vespula germanica*

JH is a pleiotropic hormone in the highly eusocial wasp *V. vulgaris*. In fact, JH acts as a gonadotropic hormone and it has been also implied to be correlated to produce queen pheromones (Oliveira et al. 2017; Oi et al. 2020; Oi et al. 2021b). This suggests that JH may maintain these queen signals honest, whether this hormone has acquired similar functions in other Vespinae wasps is a topic that remains unexplored. The aim of this chapter was to test whether JH would be responsible for controlling the expression of hydrocarbons and reproduction in *Vespula germanica*. This would provide insights of the conserved function of JH in *Vespula*. This work was also conducted during my PhD sandwich at the University of Leuven.

Chapter 6: Tiny but socially valuable: eggs work as sources of communication in *Mischocyttarus* societies

Given that eggs of *Mischocyttarus* primitively eusocial wasps are coated with chemical compounds (hydrocarbons) (Ferreira et al. 2022), the next step was to test if they would actively work as a source of information. In this chapter, I tested whether females are able to recognize their eggs when confronted with eggs from different nests and different species. This was an experimental work that allow me to show that most of the alien eggs were efficiently removed, and this provided insights into the mechanisms that help to avoid nest parasitism.

Chapter 7: You learn it and you learn it well: Cognitive abilities vary according to behavioral caste, age and sex in a primitively eusocial wasp

In the previous chapters, I demonstrated that eggs are coated with similar hydrocarbons that have been described to play several communicative functions in wasp societies. Additionally, I also empirically demonstrated that females are indeed able to perceive and take different decisions upon egg origin. This implies that females are likely able to learn and memorize scents, having some implications in cognitive abilities. Although the experiments of this chapter are not correlated with the recognition of hydrocarbon cues, in this chapter I aimed to understand how *Mischocyttarus* wasps cope with learning scents that may be important for their lives, to find food, or to locate their nests. I conducted a set of experiments that demonstrate that wasps are able to learn and

memorize scents upon repeated presentation. The main aim of this chapter was to study the learning and memory abilities of wasps according to their behavioral caste, age, and sex. The individuals were shown to be able to associate scents upon repetitive exposure and hence memorize them, these abilities to learn and retain memory are fundamental during evolution, possibly influencing the division of labor and conflict resolution.

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CHAPTER 1

Brood as sources of communication in wasp societies



Credit: The author

To be submitted to Insectes Sociaux

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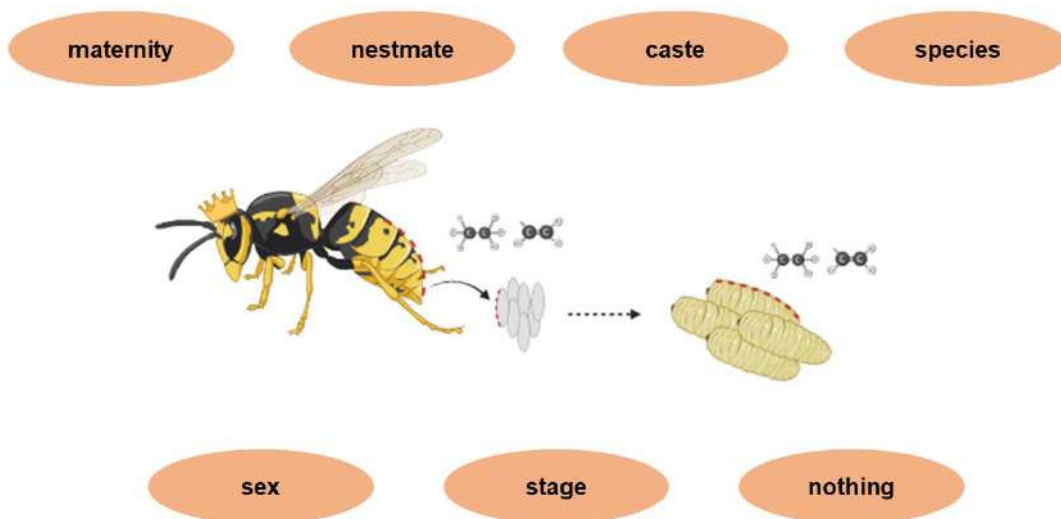
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Graphical abstract



Summarization of the roles that brood (eggs and larvae in this case) could potentially display within wasp societies. The figure was generated in BioRender (free trial).

Abstract

The Vespidae family represent a key group to understand the evolution of social behavior in social insects. The main reason is that species express a spectrum of social behaviors within this group, from solitary to highly eusocial. This social complexity could only evolve with a complex communication system, in which chemical communication is the most used one. Chemical communication provides information about the individual identity, colony identity, sex, and caste, and it helps to solve intracolony conflicts. The brood, eggs, and larvae were shown to be involved in chemical communication. For example, eggs are covered with chemical substances that provide information about egg maternity and the queen's fertility. We reviewed the current information regarding the brood roles in wasps, comprising the available literature on several wasp species and we synthesized the ideas of how the brood may be involved in conflict resolution.

Keywords: Vespidae, brood, eggs, larvae, chemical communication

Introduction

Vespidae wasps represent a valuable group to study the evolution of social behavior. The main reason is that within this group, there are organisms expressing the full spectrum of social behaviors, including solitary, presocial, primitively eusocial and highly eusocial species (Hunt 2007). Colonies of social insects have been described often as cooperative entities (Heinze 2010). One of the explanations for cooperation is the high relatedness within a colony and kin selection (Hamilton 1964). Even if the majority of the females within a colony do not lay eggs, they are still favored by raising their relatives, because this increases their indirect fitness (Hamilton 1964). Relatedness cannot explain alone the cooperation in social insects and other ecological factors were pointed to drive cooperation. For example, cooperation can emerge to monopolize a long-lasting food resource, then individuals would not disperse and protect their resources together. Individuals can also cooperate for future chances to inherit the nest. However, individuals that cooperate in the latter scenario may balance their level of help according to their opportunities to reproduce (Korb 2010).

In social wasps, workers are not completely sterile. They can retain functional ovaries capable to lay male eggs, leading to a conflict over male production with the queen. Besides direct reproduction, there are other ways to increase their fitness. Females can provide care for their siblings, they can replace the queen in case she dies, and also, they can leave their original nest to start their own (Korb 2010). To ensure cooperation, as females do not necessarily cooperate voluntarily, coercion events may occur to limit

the chances of direct reproduction (Wenseleers & Ratnieks 2006; Wenseleers et al. 2020; Oi et al. 2021). Regardless of the social organization, primitively eusocial or highly eusocial, due to coercion, females may forego reproduction because of the chances of being aggressed by other females or by having their eggs policed (= destroyed by their nestmates). Therefore, given the low chances of successfully reproducing, females will cooperate and help to raise their relatives (Wenseleers and Ratnieks 2006; Wenseleers et al. 2020; Oi et al. 2021). Another type of coercion is policing, and worker reproduction is reduced in situations where policing effectiveness is high (Wenseleers & Ratnieks 2006).

The complex communication system in social insects in general contribute for intracolony conflict resolution. Eusocial wasps rely on visual or chemical cues/signals during interactions. For example, females use chemical cues to detect parasite brood (Cervo et al. 2008), to recognize dominance (Tannure-Nascimento et al. 2008), and to recognize individual facial marks (Sheehan & Tibbetts 2011). Chemical compounds, being cues or signals, can be used in different contexts, for example, to avoid female aggressiveness (Bhadra et al. 2010), to prevent worker reproduction (Van Oystaeyen et al. 2014), and to recognize nestmates (Cini et al. 2019). A combination of modes of communication is common, for example, females prioritize facial marking over chemical cues to recognize nestmates over intruders (Baracchi et al. 2015).

Chemical communication is the most used mode of communication. Besides volatile compounds used frequently in wasps as alarm pheromones (Jeanne 1981; Fortunato et al. 2004; Bruschini et al. 2006), non-volatile compounds as hydrocarbons are often used (Van Oystaeyen et al. 2014; Oi et al. 2016; Cini et al. 2019). On the external surface, these hydrocarbons form a waxy layer that primarily has mechanical functions, once it prevents them from desiccating and also functions as a barrier against microorganisms' infections (Gibbs 1998; Gibbs & Rajpurohit 2010; Drijfhout et al. 2013). In insects, hydrocarbons are produced in specialized cells known as oenocytes, which are transported to the external surface through specialized proteins called lipophorins. In social insects, besides protection, cuticular hydrocarbons acquired a secondary communicative function (Drijfhout et al. 2013). Cuticular hydrocarbons (CHCs) carry information that mediates intraspecific interactions, reflecting sex identity and hence in mating recognition (Derstine et al. 2019; da Silva et al. 2021a,b). CHCs also vary between colonies of the same species, representing proximal cues that enable

nestmate recognition (Ruther et al. 2002; Cini et al. 2009; Cini et al. 2019; Gamboa et al. 1996) and specific cuticular hydrocarbons also act as queen pheromones (Van Oystaeyen et al. 2014). Even though hydrocarbons in general play a fundamental role in mediating adult-adult interactions, less attention has been given to the putative roles that hydrocarbons covering brood may display. Although brood do not engage physically in interactions, they are fundamental to composing the next generation of individuals, and they can help to stabilize cooperation, providing cues that impact colony functionality.

We synthesized the current knowledge available in the literature regarding the importance of brood in wasp societies. We focused primarily on eusocial species from the Vespidae family. Specifically, we aimed to address four questions (1) Do brood play a role in promoting conflicts and conflict resolution? (2) How brood play a role mediating parasitism? (3) What is the potential source of chemical compounds that are found over brood in wasp societies? (4) Is brood scent regulated by juvenile hormone? Lastly, we also present future directions and gaps that can be addressed in the future.

(1) *Do brood play a role in promoting conflicts and conflict resolution?*

In colonies in which the queen mates with multiple partners and the different paternal lineages will consist of females that do not fully share the same genetic information, the interests of the queen and workers are not fully aligned. Workers will benefit by investing in their own reproduction rather than providing care for the queen's brood. From the colony perspective, reproductive workers can be costly, once these individuals do not engage in performing worker-related tasks. This is the case for *Vespula atropilosa*, workers under queenless conditions were less engaged in foraging and construction tasks (Landort et al. 1977; Wenseleers et al. 2004). Strategies to avoid worker reproduction have evolved in some wasps' species. In small societies, like primitively eusocial wasps, the use of aggression is used to coerce reproductive workers, as all the females can have direct contact with each other. In bigger societies, such as those from *Vespula* genus, coercion in the form of policing is used in combination with spreading chemical signals (Wenseleers et al. 2020; see Table 1).

Brood display key roles within social insect colonies (Orlova et al. 2020; Schultner & Pulliainen 2020; Oi et al. 2020; Oi et al. 2015). The fact that both eggs and larvae are covered by chemical compounds implies that they participate in the chemical communication system. So far, studies involving wasps lack experiments testing which information brood may convey (Table 1).

Table 1: Review of the published literature investigating the roles of brood (eggs and larvae) in wasp societies. Those studies report direct interaction of the brood or chemical characterization of compounds from eggs and larvae. The main findings of the type of information relevant for this review are included.

Level of conflict	Type of conflict	Background	Potential way of resolving	Evidence	References
Intracolony	Over male parentage	Workers try to increase their fitness by laying eggs in queen-right conditions	Queens and policing workers rely on visual/chemical information to selectively destroy worker-laid eggs	Strong support - existence of egg-marking compounds linked to caste + correlational + behavioral data	Oi et al. 2020 / Wenseleers et al. 2005a / Wenseleers et al. 2005b / Kovacs & Goodisman 2007 / Saigo & Tsuchida 2004 / Tsuchida et al. 2020 / Cotoneschi et al. 2009 / the present work, Chapter 4
Intracolony	Linked to breeding role	Subordinate / worker females attempt to reproduce instead of providing care for the existent brood	Foundresses/dominant females engage in cell screening and are able to distinguish their own eggs in comparison with others	Correlational support - egg-marking compounds linked to female breeding role +	Dapporto et al. 2010 / Dapporto et al. 2007

Intraspecific	Related to caste fate	Females can try to lay eggs in nests of unrelated individuals from the same species (either worker or gyne-destine)	Resident females express the ability to recognize natal over alien eggs. However, females distinguish eggs based on caste fate. Worker-like not destroyed and gyne-like destroyed	Experimental support - females do recognize their own eggs over alien ones. Females kept worker-destine eggs	Lorenzi & Filippone 2000
Intraspecific	Linked to nestmate recognition	In high density populational areas wasps mistakenly lay eggs in unrelated nests	All the females engage in cell screening and are able to distinguish their own natal eggs in comparison with other from the same species but from a different nest	Correlational support - chemical cues covering brood that reflect nest identity	Cotoneschi et al. 2007 / Kudô et al. 2016 / Turillazzi et al. 2007 / Lorenzi & Filippone 2000 / Chapter 6
Intraspecific	Linked to kin recognition	Nests started by multiple totipotent females can results in females sharing reproduction	Reproduction is shared at a certain extent among related females. Females tolerate kin over non-kin brood	Correlational support - chemical cues covering brood linked to kin structure	Klahn & Gamboa 1983 / Panek & Gamboa 2000

Interspecific	Linked to different species attempting nest usurpation	Primitively eusocial nests non attended can be usurped by females from different species	Resident females should express cognitive abilities that allow egg cognition against different species	Experimental + correlational support - chemical cues covering brood linked to species / egg recognition indeed exists	Wright et al. 2020 / Ferreira et al. 2022 / Chapter 4 and 7

Interspecific	Actual parasites dumping eggs in host nests	Primitively eusocial nests non attended can be usurped by social parasite species	Resident females should express cognitive abilities that allow egg cognition against parasites (not always). Parasite eggs can be chemically insignificant or similar to host eggs	Experimental + correlational support - chemical cues covering social parasites brood have / do not have information	Elia et al. 2018 / Cervo et al. 2008 / Martin et al. 2008 /

In primitively eusocial species such as *Mischocyttarus cerberus*, a high rate of females has active ovaries along the nest ontogeny (Figure 1) (da Silva et al. 2020). Those females expressing reproductive potential can engage in two different strategies (1) attempt to reproduce under queen-right conditions or (2) remain in the hierarchical line and reproduce upon the queen's death or disappearance (Korb 2010).

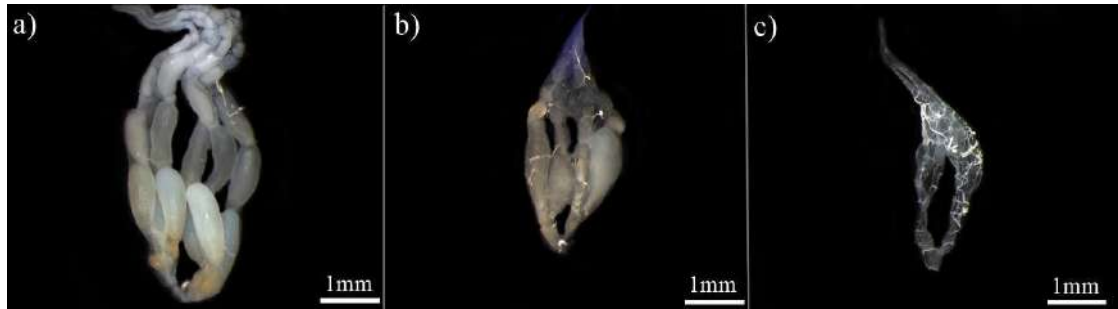


Figure 1: Different degrees of ovary activation expressed by females of *Mischocyttarus cerberus*. a) activated ovaries with apparent and mature oocytes located at the base of the ovary; b) ovaries expressing an intermediate level of activation, it is visible the presence of one oocyte nearly mature and few oocytes undergoing development; c) inactivated ovaries, with no visible oocytes are detected and the ovarioles express this thread-like shape. Ovary description was adapted from Beani et al. 2011.

The queen reproductive monopoly in *M. cerberus* is maintained because the queen checks the cells following the process of egg-laying (Figure 2). We suggest that this behavior is fundamental for the queen to maintain her reproductive dominance through the chemical recognition of her eggs. In fact, these females consistently check cells more often than other females within the nest (Chapter 6). Checking cells probably works as a way to directly associated and memorize the chemical cues that cover their eggs. The queen also coerces other females in the nest (da Silva et al. 2020) and performs differential oophagy toward eggs laid by other females. Curiously, subordinate females still invest in activating their ovaries even though they seem to be unlikely to reproductively succeed. An alternative explanation is that subordinates wait for an opportunity to lay eggs, and their reproductive chances may vary along with the nest ontogeny, being higher in later stages of colony development.

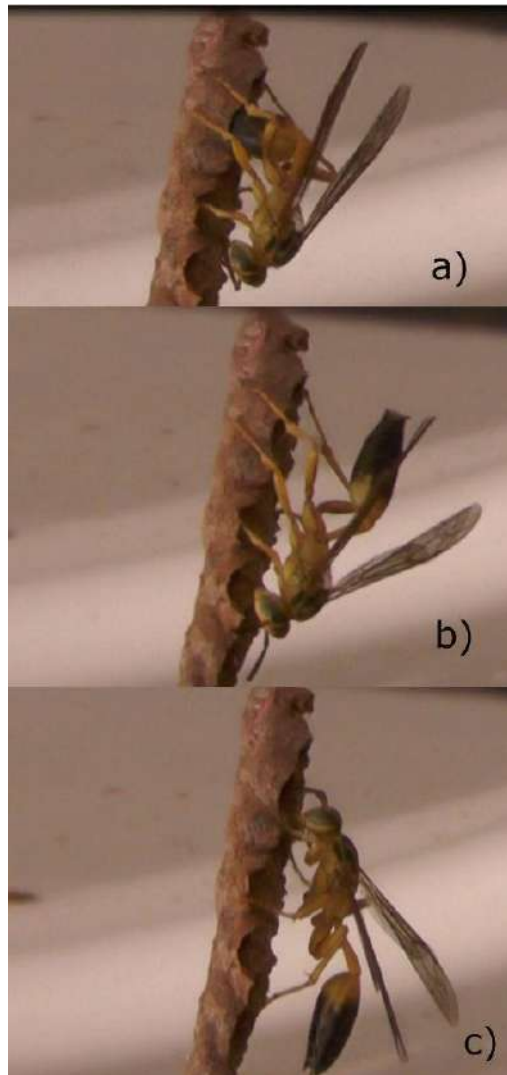


Figure 2: *Mischocyttarus cerberus* during egg-laying. a) Female inserts its abdomen within a cell and release an egg. b) Female removes its abdomen from the cell. c) Female turns around and insert its head inside the cell. It is likely that during the last process this female is touching the eggs with its antennae.

Nests of *M. cerberus* are usually started by a single or a coalition of females (Miller et al. 2018; da Silva et al. 2020) (Figure 3). However, towards the end of the nest ontogeny, the number of cells is significantly higher if compared with the number during the pre-emergence stage (Figure 3). It is reasonable that the queen is more effective in policing during the initial stages of the nest ontogeny. However, as the nest start to enlarge and the number of females within the nest increase it is likely that the process of cell screening takes more time and the efficiency of queen policing decreases. This hypothesis still needs further testing. However, under this scenario if a given female is capable to maintain their reproductive status along the nest ontogeny, they can still gain direct benefits by investing in their own reproduction. In fact, *M. cerberus* females seem to be able to rely on the chemical compounds covering eggs' surfaces to recognize their origin

(Chapter 6). So far only evidence of egg recognition at an intracolony and interspecific level has been reported. Future experiments testing whether queens are capable of detecting their eggs over subordinate eggs will be important to attest if this ability has emerged early in the intermediate stages of social behavior.

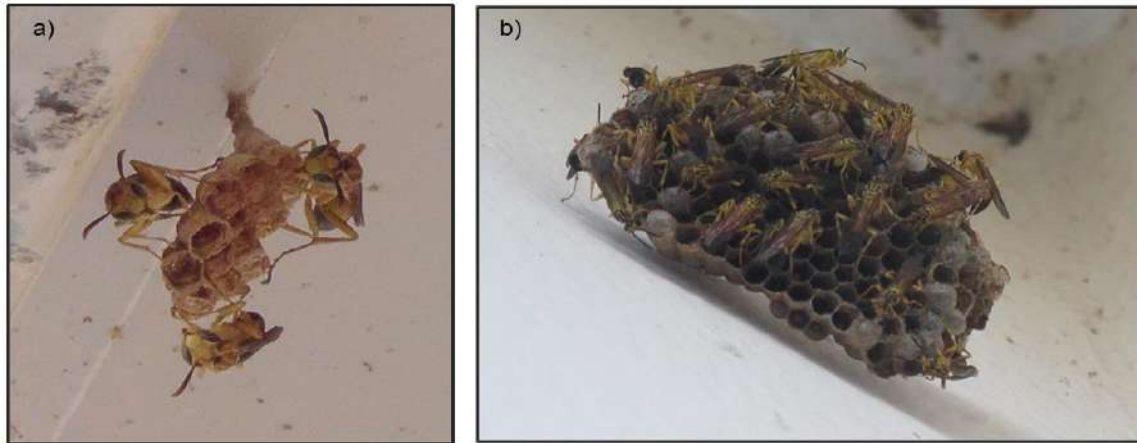


Figure 3: Different nest ontogeny stages in *Mischocyttarus cerberus*. a) Pre-worker emergence nest started by a coalition of three females; b) Post-worker emergence nest full of cells and individuals.

In the primitively eusocial species *Polistes dominula*, females have the ability to directly assess the queen's quality by her reproductive performance (Liebig et al. 2005). The experimental removal of eggs triggers ovary activation in subordinate females and hence egg-laying behavior (Liebig et al. 2005). Intriguingly, these results suggest that not only the presence of brood is used as direct evidence of queen quality, but also workers perceive and react to these cues (Liebig et al. 2005). Besides visual cues, *P. dominula* rely on chemical cues found over the egg surface to take different decisions (e.g. keep or remove a given egg depending on their egg maternity). Even though subordinate females are able to reproduce in these societies, there is evidence that the egg-marking cues released by the queen contain specific cues that differ from eggs laid by subordinate individuals (Dapporto et al. 2007). The chemical compounds covering the egg surface potentially work as the proximal factors that allow egg recognition (Dapporto et al. 2007). It is worth mentioning that the success of egg policing in these societies is directly associated with chemical recognition (Dapporto et al. 2010). One important factor to be taken into consideration is that females differ in cognitive abilities and the olfactory responsiveness may be associated with situations they are confronted with (Wright et al. 2019). In addition to eggs, larvae can potentially drive conflicts in *P. dominula*, once male and female larvae are chemically distinct (Cotoneschi et al. 2009). Adult wasps may be selective and bias their care toward females if they are able to perceive the chemical sex

variation (Cotoneschi et al. 2009). In *Polistes chinensis antennalis*, subordinate females and workers can reproduce even under queen-right conditions (Saigo & Tsuchida et al. 2004; Tsuchida et al. 2020). However, as expected, queen-laid eggs have a higher chance to survive than eggs laid by any other females. The recognition process in this case was demonstrated to be driven by the hydrocarbons that cover the eggs (Tsuchida et al. 2020). Intriguingly, females of the species *Polistes carolina* do not provide extra care for their larvae over the ones of their sisters (Strassmann & Queller 2000). In a situation where several females share the reproduction the presence of cues that reflect kin or nestmate information but do not provide individual information, represents a constrain over brood recognition (Strassmann & Queller 2000).

In highly eusocial species, queen-right and queen-less conditions are decisive for eggs to be either accepted or removed in *Vespa crabro* (Foster et al. 2002). Queen-laid eggs are more likely to survive under queen-right conditions, whereas worker-laid eggs are more likely to be destroyed. Under the queen-less condition, the likelihood of survivorship is flipped. Under queen-right conditions, it is possible that workers are favored to work, while the ones attempting direct reproduction will be more likely to fail (Foster et al. 2002). Genetic data demonstrated an absence of worker-male sons in *V. crabro* colonies (Foster et al. 2002). Worker-laid and queen-laid eggs in *V. crabro* are chemically distinct (Chapter 4). In queen-right conditions, workers potentially detect these chemical cues over queen-laid eggs and invest in raising brood and taking care of the nest. Under queen-less conditions, policing may be relaxed, and workers may change their strategy. Instead of investing energy to perform colony-related tasks or policing, they switch for investing in self-reproduction. In *Vespula maculifrons* and *Vespula squamosa*, a similar phenomenon occurs, in which worker-laid eggs seem to be uncommon (Kovacs & Goodisman 2007). In these polyandrous species, other factors may prevent worker reproduction rather than policing, for example, workers responding to queen's fertility signals (Kovacs & Goodisman 2007). Still, we lack empirical evidence in those species. Contrarily to that, in *Dolichovespula sylvestris*, worker reproduction is common and 50% of the males produced are worker' sons (Wenseleers et al. 2005a). Also, in *Vespula rufa* policing rates occur at low levels, as most males were shown to be worker's sons (Wenseleers et al. 2005b). Policing may occur at low rates in these two species due to the absence of chemical cues that allow the recognition of egg maternity.

The most studied species regarding policing behavior is the *Vespula vulgaris*. Non-reproducing workers are capable to detect queen-laid over worker-laid eggs. Once they are given the option, they will almost exclusively remove worker-laid eggs (Foster & Ratnieks 2001). Policing rates is effective in *V. vulgaris*, and genotyping analysis revealed that the adult males are usually queen' sons (Foster & Ratnieks 2001). The policing rates is likely effective because queen-laid and worker-laid eggs are coated with different scents (Bonckaert et al. 2012; Oi et al. 2015). Higher amounts of longer-chained alkenes and methylated alkanes are detected over the surface of queen-laid eggs, while worker-laid eggs are primarily represented by shorter-chained alkanes (Bonckaert et al. 2012). The methyl alkane 3-MeC29 is overexpressed over the surface of queen-laid eggs (Oi et al. 2015). Worker-laid eggs topically treated with a synthetic version of the 3-MeC29 are less removed than the control coated with solvent. This result implies that 3-MeC29 acts as an egg-marking maternity signal (Oi et al. 2015).

(2) How brood play a role mediating parasitism?

As eggs are coated with hydrocarbons and also larvae produce their own chemical cues, they can be used females to avoid nest usurpation. For example, *P. dominula* larvae possess chemical cues that are aligned with their nest identity (Cotoneschi et al. 2007). In regions where *P. dominula* is invasive, they may be more tolerant when confronted with alien brood (Wright et al. 2019). In a non-native range female usually gathers with other females to start new nests and they are not necessarily related (Liebert et al. 2008; Field & Leadbeater 2016). Females of *Polistes metricus*, which is a native species in the area where *P. dominula* is an invasive one, usually start their nests alone and are less permissive when confronted with *P. dominula* eggs (Wright et al. 2019). Females of *Polistes biglumis* not only have the ability to recognize their own eggs over alien ones, but they seem to have evolved the ability to distinguish eggs' fate, whether it is a worker-destined or gyne-destined (Lorenzi & Filippone 2000). Worker-destined eggs have a higher chance to be accepted if compared with gyne-destined eggs. From the collective perspective, if nest usurpation events are common among females from the same species, females that have cognitive capacity may be favored to recognize their brood. Having the capacity to selectively destroy alien eggs based on their fate may be highly advantageous (Lorenzi & Filippone 2000). Females may not invest much of their time checking cells and destroying all alien eggs, as they can keep the ones that will turn out into workers, representing an additional workforce to the colony.

In *Mischocyttarus* and *Polistes* wasps, nests can be attacked by several enemies, either parasitoid wasps or other *Mischocyttarus* and *Polistes* females (da Silva et al. 2019; Montagna et al. 2012; Cervo et al. 2008). If a given female invests in usurpation strategies, they can fail to achieve reproductive success when the host females have cognitive skills that can avoid the usurpation events. However, in some species females have lost the ability to build their own nests, and rather the only way for them to achieve reproductive success is by behaving as social parasites (Elia et al. 2018; Cervo et al. 2008; Cervo 2006). Under these circumstances, parasite females will enter host nests and leave their eggs to be raised by host females (Cervo 2006). Two main hypotheses are suggested to explain why host females raise alien eggs, brood parasites may go unnoticed because they are chemically insignificant to the host, or alternatively, brood parasites match the cues produced by the host (Cervo et al. 2008; Cervo 2006). Alternatively, social parasites brood may succeed by releasing producing chemical compounds that have appraising effects over the host (Elia et al. 2018). Larvae and pupae of the social parasite *Polistes atrimandibularis* express high levels of an alkene (9-nonacosene), which is able to reduce aggressiveness in foundresses females (Elia et al. 2018).

Females of *M. consimilis* can behave as social parasites and usurp nests of *M. cerberus* (Montagna et al. 2012). The presence of these unique profiles associated with *M. consimilis* brood could probably represent a mechanism by which *M. cerberus* resident females deal with nest usurpation. Intriguingly, along with nest ontogeny, both resident and invader females interact and produce offspring (Montagna et al. 2012). Eggs from both species are highly chemical divergent. In fact, eggs of *M. consimilis* are covered with less hydrocarbons (n = 15) than eggs of *M. cerberus* (n = 41) (Chapter 6). Eggs of *M. consimilis* are mostly covered by linear alkanes (Montagna et al. 2012), whereas eggs laid by *M. cerberus* are covered by linear and branched alkanes, as well as by alkenes (Chapter 6). *M. consimilis* may succeed reproductively because they lay eggs that go unnoticed and lack chemical cues that allow interspecific egg recognition.

The smell of the brood cannot completely prevent parasitism, in *P. dominula* (host species) and *Polistes sulcifer* (social parasite), parasite brood develops quicker than the host, which may reflect how well brood parasite is able to manipulate the care provided by female hosts in their benefit (Cervo et al. 2004). In addition to that, brood parasites are able to evade recognition by the host females, the main reason for that relies on the fact that the parasite brood seems to have evolved a similar chemical profile

expressed by the host brood (Cervo et al. 2004). In a different system, which includes *Vespa dybowskii* (parasite species) and both *V. crabro* and *V. simillima* (host species), the eggs laid by the parasites probably succeed and are not removed because they are chemical transparent (Martin et al. 2008). In this case, the eggs laid by the parasite species are barely coated with methyl-branched compounds, whereas the eggs laid by the host species are greatly covered by this group of hydrocarbons (26 – 41%) (Martin et al. 2008). Thus, if egg recognition is primarily driven by methyl-alkanes in the host species, it is possible that parasite eggs are favored by carrying only small proportions of them (Martin et al. 2008).

In addition to driving interactions between different species (host-parasite interactions), chemical cues covering the brood convey information allowing intraspecific detection. *Polistes fuscatus* females can recognize their own larvae over larvae from different nests. On the other hand, they fail to perform in the same way when paired with larvae from their sister's nests (Panek & Gamboa 2000; Klahn & Gamboa 1983). These results suggest that larvae are covered in chemical compounds that allow recognition to occur at the colony level, but not at a kin level (Panek & Gamboa 2000). Brood nestmate recognition potentially occurs in *Parischnogaster mellyi*, because brood carries chemical cues that reflect their nest of origin (Turillazzi et al. 2008). In the swarm-founding wasp *Polybia paulista*, chemical cues covering the brood surface convey nest identity information (Kudô et al. 2016). Females when confronted with alien larvae and their own, tend to display more licking behavior towards their nestmate larvae (Kudô et al. 2016).

Although hardly explored, parasite brood may evade detection upon indirect acquisition of colonial chemical compounds. In ants, it has been demonstrated that the liquid that is exchanged during trophallaxis is enriched by several components, including hydrocarbons (Leboeuf et al. 2016). Thus, although we do not have evidence demonstrating that the liquid released by wasp females also contain chemical cues, the work performed by Kudô et al (2016) indeed shows that female wasps lick their brood and during this act, brood can potentially acquire chemical cues.

(3) *What is the potential source of chemical compounds that are found over brood in wasp societies?*

Besides the larvae and the pupae being able to produce their own chemical compounds, other exogenous sources may contribute to the overall brood smell. During the larvae's growth, probably several glands play a role in producing chemical substances that are important for chemical recognition. Another potential source from where brood may acquire indirectly chemical compounds is the nest material (Sguarizi-Antonio et al. 2022, Soares et al. 2021). Studies targeting larval stages of wasps focused on studying their morphological features have reported that as the larvae molt and grow, they will be in closer contact with the nest material (da Silva et al 2020). The nest material is composed of woody fibers, plant hairs, mud, and secretions that are released by cephalic glands (Jeanne 1975; Wenzel 1991). The chemical composition of nest material is composed by several hydrocarbons (Soares et al. 2021; Sguarizi-Antonio et al. 2022; Silva et al. 2016). In fact, in *Protopolybia exigua* the chemical composition of brood and nest material overlaps. Interestingly, the cephalic secretions in ants are full of several components, including hydrocarbons (Leboeuf et al. 2016). Thus, although it is still necessary a further investigation is to uncover if cephalic secretions released by social wasps are also enriched with hydrocarbons. It is reasonable to suggest that while macerating nest material or while feeding the larvae, social wasp females release chemical compounds that are integrated into the nest surface. Hence, those compounds are indirectly transferred to their brood, either during nest construction, or directly contact the larvae during trophallaxis.

The most likely source of compounds that cover the eggs is the accessory gland that is part of the female reproductive apparatus, namely *Dufour's* gland (Figure 4). The *Dufour's* gland is an exocrine gland that displays distinct functions across Hymenoptera (Mitra 2013). One of these functions includes releasing compounds that help the communicative process in social insect colonies (Mitra 2013). During the process of egg laying, the *Dufour's* gland releases chemical compounds that help the egg to remain attached to the wall surface and that cover the eggs (Mitra 2013). Hydrocarbons usually present in the *Dufour's* gland are also detected over the surface of eggs in wasps belonging to different social levels (from primitively eusocial to highly eusocial wasps) (Ferreira et al. 2022; Chapter 3, 4; and 5 Bonckaert et al. 2012). In Stenogastrinae wasps, females also use the *Dufour's* gland as a reservoir of a gelatinous substance (pap) that is

secreted over the eggs after the process of oviposition (Turillazzi & Pardi 1982). In two *Mischocyttarus* species, *M. cerberus* and *Mischocyttarus cassununga*, a great overlap exists between *Dufour's* gland content and egg-marking compounds (Ferreira et al. 2022). In these societies, egg marking regardless of the existence of a complex social environment – eggs are coated with chemical cues when the females in the absence (Ferreira et al. 2022) or presence of nestmates (Chapter 3 and 6). Similarly, in post-worker emergent nests of *Mischocyttarus metathoracicus* and *Polistes versicolor*, egg marking cues are more similar to the *Dufour's* gland content when compared to females' CHCs (Chapter 3). A next step will be to track whether the *Dufour's* gland content reflect nestmate information in Neotropical social wasps.

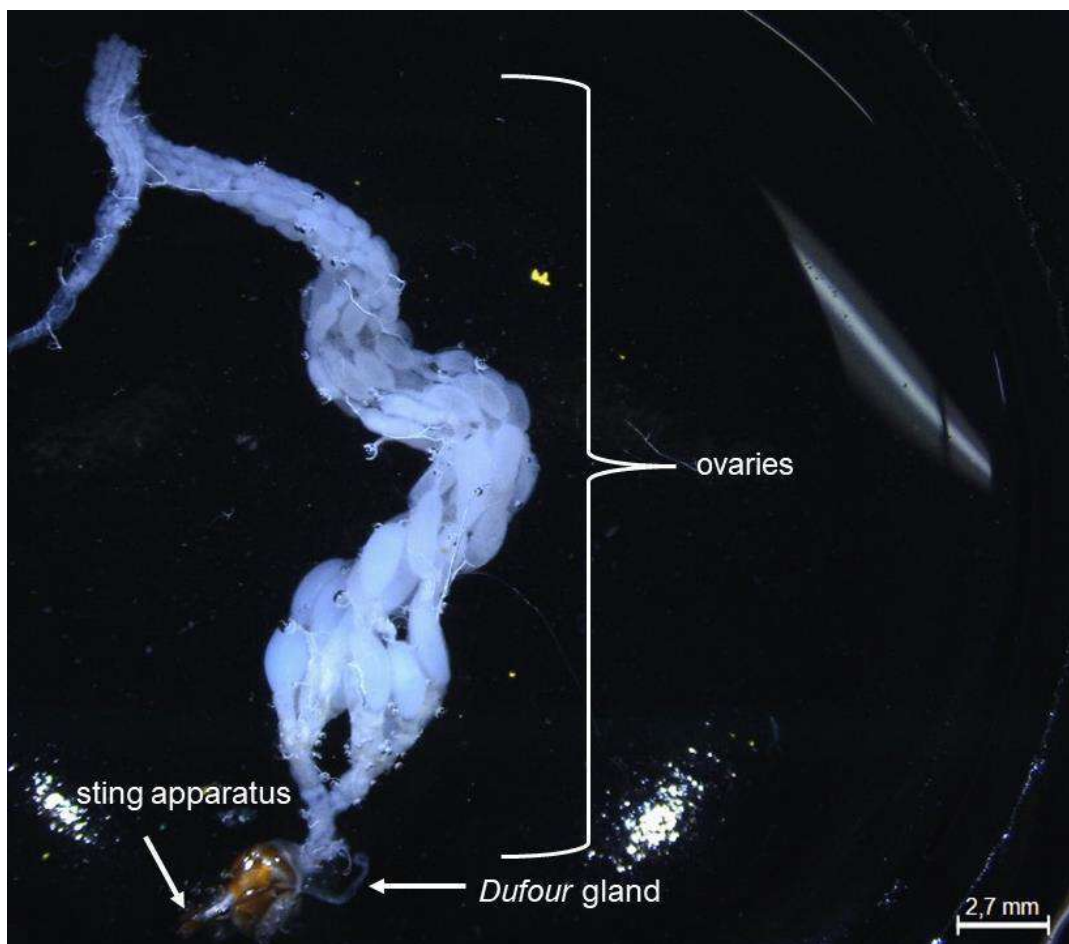


Figure 4: The reproductive apparatus of a *Dolichovespula saxonica* queen. In evidence it is displayed the ovaries (several ovarioles with oocytes), the *Dufour's* gland is located at the base of the ovaries and attached to the sting apparatus.

(4) Is brood scent regulated by juvenile hormone?

Juvenile hormone (JH) regulates several functions in social insects, such as behavior maturation and physiological processes (Huang 2020). JH titers are known to affect ovary activation levels and hence chemical expression in adult females (Barth et al. 1975; Agrahari & Gadagkar 2003; Tibbets & Sheehan 2012; Giray et al. 2005; Walton et al. 2020; Oi et al. 2021b; Neves et al. 2020; Ferreira et al. 2022). Establishing possible connections between JH and brood is a theme that still requires further investigation. Other than displaying its primary function (molting control), JH can affect the brood in other ways. For instance, in societies of the wasp *Mischocyttarus consimilis*, JH is probably linked to determining the larvae's fate (Montagna et al. 2015; Neves et al. 2020). For example, third instar larvae of *M. consimilis* when exposed to topical treatments of JH analog emerged with bigger body size proportions, they do not leave the nest frequently, are less attacked by other females, and express cuticular hydrocarbons that differ from those females treated in different instars (Montagna et al. 2015; Neves et al. 2020). Primitively eusocial females are not morphological distinct, and this indicates that some caste bias may exist, and it is probably a by-product of JH levels. Manipulating JH levels in foundresses of two *Mischocyttarus* species (*M. cerberus* and *M. cassunuga*) ultimately affects their *Dufour's* gland content and the layer of compounds that are deposited over their egg surface (Ferreira et al. 2022). The fact that different JH levels trigger the modification of chemical compounds within *Dufour's* gland and over egg surface suggest that females potentially inform their presence (or fertility) even in primitively eusocial species. In the highly eusocial wasp *V. vulgaris*, JH levels are essential for a female to lay more eggs (Oliveira et al. 2017). Manipulation of JH in workers was shown that the surface of eggs carried chemical information that prevented them from being policed (Oi et al. 2020), probably affecting the *Dufour's* gland. Workers of the species *Vespula germanica* express not only different CHCs following topical treatments, but they also express different chemical compounds within their *Dufour's* gland and hence a variation in their egg-marking compounds (Chapter 5). Overall, these studies allow us to suggest that at least to a certain extent, the proportion of compounds that is found covering the brood (eggs and larvae) is linked to different JH levels.

Concluding remarks

The present review highlights information that suggests that brood are essential components within wasp societies. Although brood are coated with exogenous chemical cues or if they actively produce their own, the cues covering brood surfaces carry enough information that allows several conflicts to be solved. Internal conflicts, involving females within the same nest, and external conflicts, such as nest usurpation by parasites, can be mediated by the brood. Besides the brood role to keep nest cohesion, studies using brood remain poorly investigated. One reason that may limit experiments using wasp brood is that is challenging to manipulate them. Eggs and larvae are fragile, and the use of forceps may cause their destruction. A possible approach is the use of artificial cells prepared with waxed paper (Chapter 6). Performing such experiments would allow the advance of brood manipulation in wasps. Another important aspect that can be assessed is which specific chemical cues allow egg recognition to happen. Studies usually report correlative evidence and demonstrate that several compounds can differ between brood from different nests. However, the recognition process does not necessarily mean the use of all of them, being restricted to specific compounds. Although there is support for the *Dufour's* gland to be the main source of compounds that cover eggs, the next steps can aim to investigate if wasp females transfer hydrocarbons through their trophallaxis, which can be incorporated into the eggs and larvae. There is still a lack of studies integrating chemical and cognitive ecology to understand the brood roles in wasp societies .

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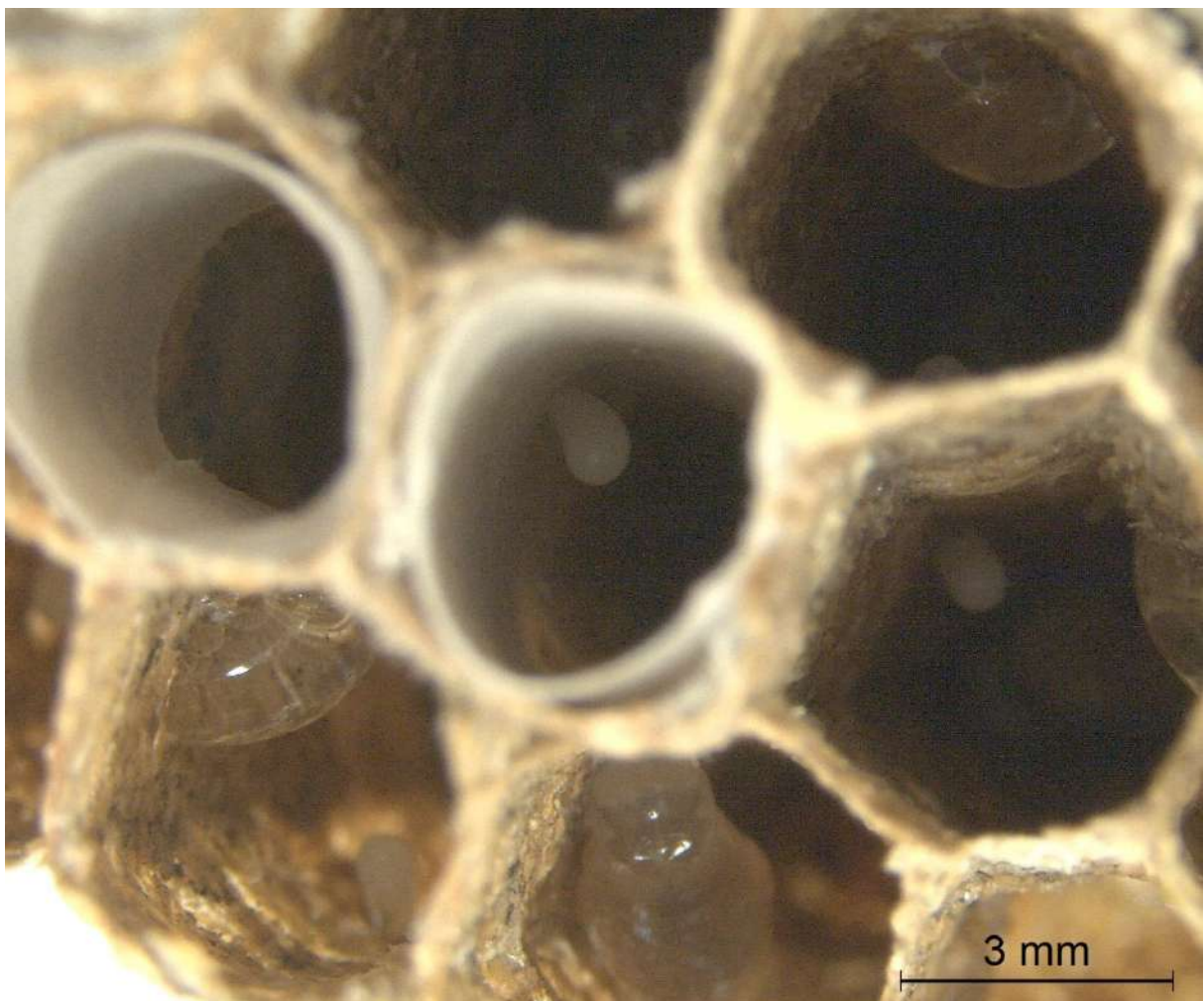
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CHAPTER 2

*Notes on brood morphology and
development of the neotropical eusocial
wasp *Mischocyttarus cerberus*
(Hymenoptera, Vespidae, Polistinae)*



Credit: The author

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Abstract

Mischocyttarus cerberus stands out among the most investigated species of the eusocial paper wasp, in Brazil. While the adult characteristics were relatively well reported in the earlier studies, very meager information was available regarding their immature stages. This study provides a description of the immature morphology of the general brood of *M. cerberus*, by studying the number of instars and analyzing the degree of influence exerted by some of the environmental factors on the individuals in the immature phases. This work involves a detailed study of 72 wasp colonies from Rio Claro and Ribeirão Preto. Using the larvae drawn from 41 nests, the number of instars was calculated; besides, the degree to which a few environmental factors could affect the immature brood development was assessed in 31 nests. Eggs showed patterns similar in terms of form and size to that of the species described earlier. The two ventral lobes, characteristic of the *Mischocyttarus* larvae, were fully developed only in the fifth instar. Based on the head measurements, we found that *M. cerberus* also express five larval instars, which is in agreement with reports published earlier for the most part of social wasps. Besides, larvae took longer than eggs and pupae to develop. From the results of our study, we concluded that *M. cerberus* showed the typical developmental pattern in the immature stages of the genus.

Key words: Larval instars, larval development, brood description, *Mischocyttarini*

Introduction

The paper wasp *Mischocyttarus cerberus* is widely distributed across Brazil (Richards, 1978; Oliveira et al., 2017). One or a few inseminated females (foundresses or queens) initiate new nests, which give rise to generations of other females (workers and future queens) and males, as the cycle of the colony progresses. New colonies are established throughout the year (Giannotti, 1998a). Similar to other independent-founding wasps, no clear morphological caste differences are observed (see Jeanne, 1980). However, the nestmates establish a reproductive-based division of labor depending upon dominance-subordination interactions. Normally, only one queen exists per colony (Poltronieri & Rodrigues, 1976; Giannotti, 1998a). It lays most of the eggs and is the most aggressive female, often displays aggressive behaviors toward their nestmates (Noda et al., 2001). The adult wasps are also known to be capable of defending their nests against ants (Togni & Giannotti, 2007; Togni & Giannotti, 2008).

One common aspect of the biological and ecological studies described prior was that they focused only on the adult wasps, which seems to be the general pattern adopted in the research of eusocial insects (Giannotti, 1998; Togni & Giannotti, 2007; Togni & Giannotti, 2008). However, paper wasp colonies include substantial numbers of immature brood, like eggs, larvae and pupae. These immature stages are observed in the nest in the most part of the colony cycle and the adults often exhibit interactions with them. A considerable duration of individuals' lives is spent in the immature stages (Giannotti & Fieri, 1991; Giannotti & Machado, 1994; Giannotti 1995; Prezoto & Gobbi, 2005; Solis et al., 2012; Cecílio et al., 2015; Rocha & Giannotti, 2016). The considerable presence of interspecific variation in the larval morphology implies its taxonomical significance (Nelson, 1982; Kojima, 1998; Carpenter et al., 2000). Larvae of *Mischocyttarus* wasps were first described by having the first abdominal sternite with one, two or three lobes projected forward, besides their first abdominal spiracle is twice as big the remaining and mandibles have a single elongated tooth (Richards, 1978). Kojima (1998) was the first to study larvae of *M. cerberus*, however he studied only material coming from two nests and his notes regarded only to morphological aspects. Despite of that, there is still a lack of detailed information regarding the immature stages of *M. cerberus* up to this moment.

Thus, we used laboratory and field observations of the paper wasp *M. cerberus* to describe (i) the general external morphology of the eggs, larvae and pupae, (ii) the

number of larval instars and (iii) the duration of the immature stage in relation to temperature and nest phase variation.

Material and Methods

Study location and wasp collection

During the years of 1991-1993 and 2017, we examined a total of 72 *M. cerberus* field colonies located in the municipalities of Rio Claro (22°24' S; 47°33' W, at elevation 612 m) and Ribeirão Preto (21°05' S, 47°50' W, at elevation 531 m), São Paulo state, Southwest Brazil. To assess the general external morphology and determine the number of larval instars, 41 field nests were collected, from which 177 eggs, 259 larvae, 31 pre-pupae (correspond to the individual in transition between fifth instar larvae and pupae) and 69 pupae were sampled. These immature individuals were preserved in 70% ethanol. To describe the duration of each immature stage, field observations were performed on a total of 31 naturally established colonies, out of which we followed the development of 404 eggs, 232 larvae and 284 pupae.

The general external morphology of immature stages

The eggs, larvae, pre-pupae and pupae were carefully studied under a binocular stereomicroscope (Leica MZ125). The immature stages were described based on the terminology used in the previous studies (Kojima, 1998; Cecílio et al., 2015; Rocha & Giannotti, 2016).

The external morphometry of the immature stages

Each immature individual was carefully removed from its cell and measured under a stereomicroscope. For each egg, we measured the maximum width, whereas for each larva, pre-pupa and pupa, we measured the maximum width of the head capsule. After measuring all samples, mean values were calculated and pair-wise comparisons were carried to check whether the groups were different or not.

The number of larval instars

The number of larval instars was determined depending upon a visual analysis of the data on head width, plotted in a frequency-distribution graph. Distinct peaks corresponding to distinct size frequency distribution peaks were categorized as instars.

To validate our method, the head width data of the larvae were then tested according to Dyar's rule (Dyar, 1890), which suggested that the larval head grew in geometrical progression, increasing its maximum width in the ratio of 1.44 at each ecdysis (Parra & Haddad, 1989).

Duration of the immature stages in relation to temperature and nest phase variations

This part of the study was performed in Rio Claro. The climate classification of the area is mesothermic according to Köppen (1948), which means that there are two well defined seasons along the year, a rainy (from October to March) and a dry (from April to September) season. The eggs, larvae and pupae present in each nest were mapped during regular visits (at 2- to 10-day intervals) under natural conditions. Thus, the overall duration (in days) of each immature stage was assessed during the months of the year when the investigations were done. The months were grouped as follows: December – February; March – May; June – August, and September – November. In the discussion, we explored the manner in which the results differed with respect whether the study period was cold and dry or rainy and sunny. Besides that, duration of the immature stages was calculated based on the colonial stages of development (pre- and post-worker emergence).

Statistical analyses

The cephalic capsule width was compared using a linear model (LM). In our model, we used the cephalic capsule width as the response variable and the *M. cerberus* life stages as the explanatory variable. We used a normal model, because it best fitted our hypothesis (Weights AIC: Poisson < 0.0001; Normal = 0.999). Posteriorly, we used the Tukey's test for a post-hoc analysis with p correction, employing false rate discovery (fdr). Besides that, the developmental time for each phase (egg, larvae and pupae) was compared based on the different month groups throughout the year using the Kruskal-Wallis test. Brood development time according to nest phase (pre and post-worker emergence) were compared through Mann-Whitney U test. Statistical analyses were performed using the R and PAST version 3.20 software.

Results

The general external morphology of the immature stages

The eggs showed slight curvature, narrow at the base, fixed onto one of the nest cell wall angles and projecting into the nest cell lumen at a roughly 45° angle and coated with an adhesive secretion (Fig 1a). The vermiform larvae are soft-bodied, having sclerotized pale brown cephalic capsules, which became even darker in color through the molting cycle. The thoracic and abdominal segments are whitish, in numbers of 3 and 10, respectively (Fig 1d). Larvae are fixed by their distal end in the nest cell, until the third instar (Fig 1b); from the fourth instar onwards they become free. The fifth instar larvae has two abdominal lobes, covered by small bristles (Fig 1). The abdominal lobes are observed as small protuberances since the third instar, and they achieve full development only in the fifth instar (Fig 1d). Thus, only the last instar expresses the typical aspect of the *Mischocyttarus* larvae, with clearly evident abdominal lobes, prominently projected forward. The diameter of the first spiracular atrium (sited between the second and third thoracic segments) is almost twice the diameter of the rest of the atria (Fig 1d). The transversal anal slot is located in the last (anal) segment (Fig 1d). The head is composed of the cephalic capsule and mouth parts, which are more highly sclerotized in the last larval instar (Fig 1c). The cephalic capsule is brown in color compared to the rest of the larval body.

The pre-pupa or pharate pupa is categorized as the late period of the fifth larval instar and characterized by the elongated body of the last-instar larva (Fig 1e). Through the transparent pre-pupal cuticle the reddish-brown compound eyes of the pupa can be observed to be fully developed (Fig 1e). During the pre-pupal phase the abdominal lobes are projected rearward rather than forward. Finally, in the pupal stage, the appendages remain free from the body and the wings are not fully distended until this stage is complete (Fig 1e). At the beginning, the pupa is whitish in color with reddish-brown compound eyes, and gradually its body turns to be yellow and black. Besides, the dark pigmentation appears to develop faster than the yellow pigmentation along the body.

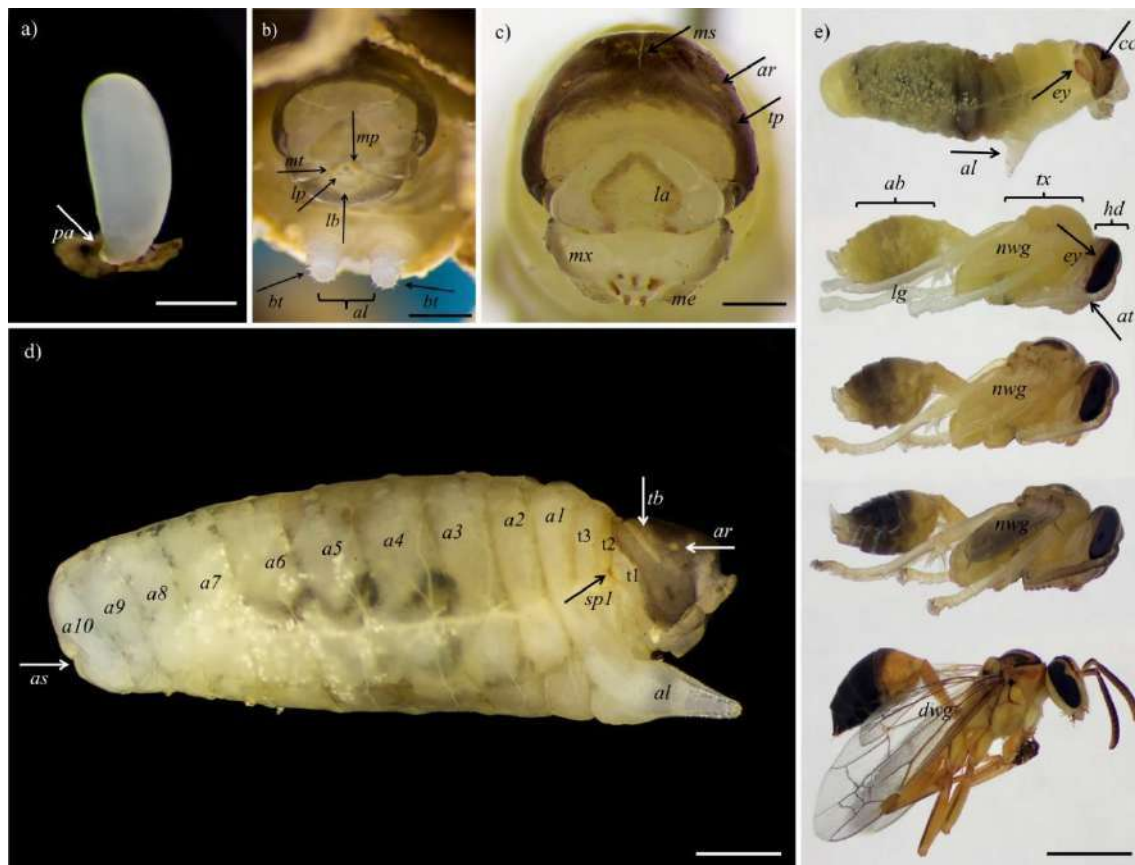


Figure 1: a) Example of one *M. cerberus* egg attached to a piece of nest material – white bar represents 0.5 mm; b) Frontal view of one fifth-instar larvae with its abdominal lobes in evidence – black bar corresponds to 1.0 mm; c) Frontal view of one fifth-instar larvae cephalic capsule – black bar represents 0.5 mm; d) Lateral view of one fifth-instar larvae – white bar represents 0.5 mm; e) Lateral view from pre-pupae with elongated body of fifth-instar larvae to a fully developed pupae before its emergence – black bar corresponds to 5.0 mm. a1 to a10 – abdominal segments from 1 to 10; ab – abdomen; al – abdominal lobes; ar – antennal ring; as – abdominal slot; at – antenna; bt – bristles; cc – cephalic capsule; dwg – developed wings; ey – compound eyes; hd – head; la – labrum; lb – labium; lg – legs; lp – labial papilla; me – mentum; mp – maxillary papilla; ms – median suture; mt – mandible tooth; mx – maxilla; nwg – non-developed wings; pa – point of attachment; sp1 – spiracle 1; t1 to t3 – thoracic segments from 1 to 3; tb – temporal band; tp – tentorial pit; tx – thorax.

The external morphometry of the immature stages

The linear model analysis revealed that the groups of eggs, larvae, pre-pupae and pupae differed in their width ($F = 3365$; $p < 0.0001$). Generally, the head width increases progressively, as the wasps develop from one instar to the other (Table 1).

Five larval instars were determined by the visual inspection of the distribution-graph indicating the measurements of the head width (Fig 2). Supporting these findings, the five larval instars proposed expressed significant differences based on the average of their head width when compared ($F = 3365$; $p < 0.0001$). Finally, our data analyzed larval average growth rate according to Dyar's rule, we observed mean growth ratio among the

instars = 1.44 (1.39 between L1 and L2, 1.40 between L2 and L3, 1.43 between L3 and L4 and 1.52 between L4 and L5).

Table 1 – Descriptive statistics of the maximum width (mm) of the eggs and the cephalic capsules of the larvae (L1 – L5), pre-pupae (PP) and the pupae (P) of *Mischocyttarus cerberus*. All classes differed statistically from each other ($p < 0.05$).

Groups	N	Mean	Stand. dev	Median	Min	Max
Eggs	177	0.496	0.053	0.496	0.372	0.622
Larvae 1	49	0.452	0.041	0.465	0.346	0.558
Larvae 2	38	0.644	0.04	0.637	0.589	0.745
Larvae 3	34	0.897	0.07	0.893	0.757	1.024
Larvae 4	72	1.441	0.212	1.359	1.05	1.749
Larvae 5	66	1.895	0.099	1.884	1.756	2.148
Pre-pupae	31	1.97	0.084	1.984	1.769	2.139
Pupae	69	2.438	0.155	2.48	1.718	2.666

Duration of the immature stages in relation to monthly temperature and nest phase variations

The overall duration of each brood stage is presented in Table 2. From the Kruskal-Wallis test it is clear that the eggs ($H = 74.68$, $p < 0.001$), larvae ($H = 719.28$, $p < 0.001$) and pupae ($H = 24.37$, $p < 0.001$) take different times to develop throughout the year. The sum of the mean values of the developmental times (eggs + larvae + pupae) are similar for the warmer and rainier months (from September to May), however, they are longer for the coldest and drier ones (from June to August) (Table 2). The mean period of incubation of the eggs in the preworker emergence stage of the colonies of *M. cerberus* was significantly longer than in the post-emergence stage (MannWhiney test, $U = 2072.5$, $p = 0.05$). The respective times of duration of the egg incubation were 13.7 ± 4.4 (9-22, $n = 17$) and 11.6 ± 3.9 (7-28, $n = 191$) days. On the other hand, there was not significant difference between the larval period in the pre and the post-worker emergence stages in colonies (Mann-Whiney test, $U = 879.0$, $p = 0.68$). The respective times of duration of the larval periods were 30.2 ± 9.7 (16-48, $n = 15$) and 30.5 ± 11.9 (19-93, $n = 111$) days. The mean of pupal period in the pre-worker emergence was significantly longer than in the post-worker emergence (Mann-Whiney test, $U = 1284.5$, $p = 0.001$). The respective time of duration of the pupae was 24.2 ± 4.6 (16-33, $n = 15$) and 19.6 ± 4.5 (9-36, $n = 111$) days.

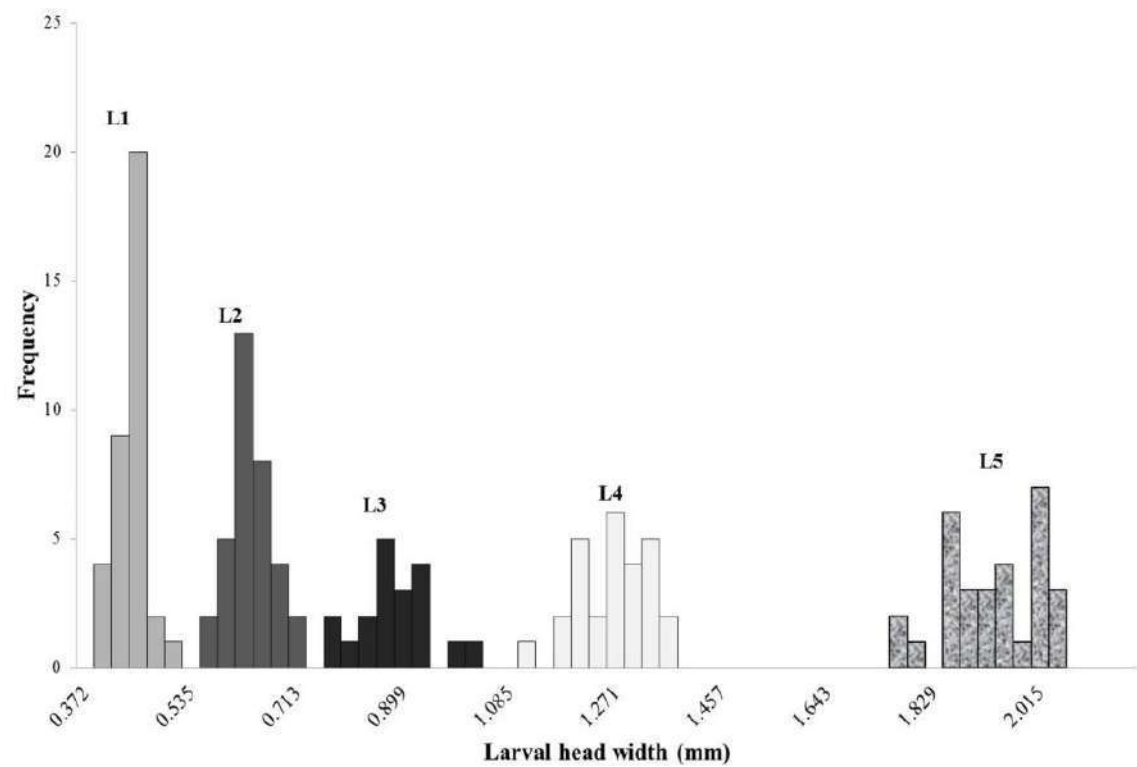


Figure 2: Frequency-distribution of the maximum widths of head capsules of *M. cerberus* larvae. L1: first instar; L2: second instar; L3: third instar; L4: fourth instar and L5: fifth instar.

Table 2 - Average duration (in days) of the immature stages of *Mischocyttarus cerberus* according to the months of study.

Average duration in days of immature stages				
Months	egg	larvae	pupae	sum on mean values
(September – November)				
		rainfall average 102.0 mm		
		temperature average 20.0°C (10.2°C - 30.0°C)		
	11.3± 3.4 (n = 100)	29.2±9.0 (n = 45)	19.6±3.6 (n = 29)	60.1 days
(December – February)				
		rainfall average 175.0 mm		
		temperature average 20.9°C (13.4°C - 28.1°C)		
	10.6±2.4 (n = 233)	30.4±6.2 (n = 144)	19.5±2.9 (n = 169)	60.5 days
(March - May)				
		rainfall average 190,1 mm		
		average temperature 19.9°C (11.8°C - 27.5°C)		
	13.5±4.0 (n = 60)	34.4±9.4 (n = 37)	20.0±3.9 (n = 82)	67.9 days
(June – August)				
		rainfall average 13.3 mm		
		temperature average 18.2°C (7.0°C - 29.3°C)		
	20.9±3.5 (n = 20)	69.7±19.0 (n = 7)	30.3±4.0 (n = 4)	120.9 days
Mean total Duration	11.7±3.7	31.9±10.5	19.8±3.5	

Discussion

Morphology of the Immature stages The *M. cerberus* eggs are similar in appearance to those described earlier for the wasps from the same genus (Giannotti & Silva, 1993; Cecilio et al., 2015; Rocha & Giannotti, 2016). As observed for *M. drewseni* (Giannotti & Trevisoli, 1993), only the last larval instar expressed the features of the *Mischocyttarus* larvae (Wheeler & Wheeler, 1979), in which the abdominal lobes were fully evident and prominently projected forward. From the findings of several researchers, these structures may be involved in different functions. One hypothesis suggests that they could be used as sensorial structures, based on the number of bristles covering them (Rocha & Giannotti, 2016). A second hypothesis proposes that they could play a role when the larvae are ingesting food, functioning as a mean to hold the solid food (Reid, 1942; Wheeler and Wheeler, 1979). A third hypothesis proposes that these lobes could assist during the process of saliva transference (larvae – adult), by pumping the larval saliva into the adults when they solicit it (Jeanne, 1972), in a behavior described as “lobe erection” (Hunt, 1988). Finally, according to Giannotti & Silva (1993), these lobes may help the larvae to sustain themselves inside the cells, preventing them from falling. The pattern of the cuticle changing from a lighter color to a blackish one during the pupal stage of development appears to be the general rule when compared to the species analyzed earlier (Giannotti & Silva, 1993; Rocha & Giannotti, 2016).

Determination of the morphometry of the immature brood and instars

Our findings concerning determination of the number of instars corresponded to previously published results for most of the *Mischocyttarus* species, including *M. cassununga* (Giannotti & Silva, 1993), *M. drewseni* (Giannotti & Trevisoli 1993), *M. latior* (Cecílio et al., 2014) and *M. nomurae* (Rocha & Giannotti, 2016). A similar pattern has also been identified for other social wasps from different genera, such as *Agelaia* (Giannotti, 1998b), *Brachygastra* (Machado et al., 1988), *Polistes* (Giannotti, 1995; Prezoto & Gobbi, 2005), *Polybia* (Solis et al., 2012) and *Protopolybia* (Silveira, 1994). In fact, the presence of five instars has been proposed as a pattern number for the larvae of Polistinae and Vespinae, whereas for the Stenogastrinae the number may range from three to five (Kojima, 1998). On the other hand, our results differed from the findings of Silva (1984) and Raposo-Filho (1981), who determined only four instars for *M. extinctus* and *M. atramentarius*. Some authors proposed that the number of larval instars might vary in accordance to the biotic and abiotic factors, such as the environmental temperature, hereditary traits or even nutritional frequency (Parra & Haddad, 1989). Like in *M. cerberus*, it

was verified that in *Polistes lanio* (Giannotti, 1995) the eggs are wider than the larvae of the first instar. On the other hand, these findings differed from the results reported for the other *Mischocyttarus*, such as *M. cassununga* (Giannotti & Fieri, 1991), *M. drewseni* (Giannotti & Trevisoli, 1993) and *M. latior* (Cecílio et al., 2015), which have eggs and first larvae instar of similar sizes. Besides that, the head width dimensions of fifth larval instars and pre-pupae were statistically different, which is supported by the findings of Rocha and Giannotti (2016). A larger pre-pupal head size might be required for providing sufficient space for the head of the pupa growing below it.

Duration of the immature stages in relation to monthly temperature and nest phase variations

Comparing with the data published earlier on the *Mischocyttarus* spp., we noticed that the larval stage is the one that takes more time to develop (Jeanne, 1972; Litte, 1977, 1979, 1981; Dantas-de-Araujo, 1980; Raposo-Filho, 1981; Silva, 1984; Giannotti & Fieri, 1991; Michelutti et al., 2014; Cecilio et al., 2015). This is perhaps because larval development is affected by many more variables than only temperature, such as food availability, colony cycle and genetic factors (Silva, 1984; Giannotti & Trevisoli, 1993; Giannotti & Machado, 1994; Cecilio et al., 2015). On the other hand, the egg and pupal stages tend to be affected more by temperature throughout their developmental cycle. In other words, these two stages do not exhibit any dependence on the food provided by the foragers (Cecilio et al., 2015). The average values of brood development did not differ in most of the studied months (except from June to August), which means that studies involving brood should be avoided during the dry and cold months, because they seem to be more sensible during this period. Eggs and pupae seem to require more time to develop in pre-worker emergence nests rather than in post-worker nests, which contradicts with what was previously found in other species of the same genus, where eggs develop faster in pre-worker emergence (*M. latior*: Cecílio et al., 2015). This fact might be important for colony survival, taking into consideration that as fast as the brood develop, more adult females would be in the nest to help nest-foundress and less time the foundress would be alone (especially in the cases where only one foundress start the nest) (Cecílio et al., 2015). On the other hand, it is possible to believe that it is not a problem for *M. cerberus* because cases of nest foundress association are also common (Noda et al., 2001).

In conclusion, the present study confirmed the presence of five larval instars in *M. cerberus*, which reinforces the concept of five instars as being the standard for the Polistinae larvae. We also added more details to the early description given for the mature larvae, by Kojima

(1998). It is our hope that our data will prove useful for further studies which may involve different approaches. Considering that different larval stages were morphologically identified here, chemical analyses of the cuticle appears to be a promising field, not fully explored yet, which can be used to confirm whether the different instars exhibit specific hydrocarbon patterns, so far the only study performed up to this moment was carried by Michelutti et al. (2017). This could add another function for these chemical substances, widely used in adult-adult communication. Finally, we believe that further studies relating to the differences in types and pattern of the bristles found on the abdominal lobes are required, to clarify whether they may be used as possible taxonomic characters for the *Mischocyttarus* wasps.

Author's Contribution

RCS, ARS e EG planed, designed and executed experimental work, RCS, DSA and EG conducted data analyses, RCS, ARS, FSN wrote the manuscript.

Acknowledgments

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001 (RCS and ARS) and Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP under grant D.S.A. [proc. nº 2015/17358-0]), RCS [2018/22461-3] and FSN [2018/10996 – 0]

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CHAPTER 3

Chemical resemblance in egg surface composition and Dufour's gland in two Polistinae wasps



Credit: The author

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Abstract

Chemical communication plays a major role on regulating social dynamics in colonies of social insects. The most studied class of chemical compounds are the cuticular hydrocarbons (CHCs), compounds with high molecular weight that cover the body of insects. CHCs are used in nestmate recognition and to signal reproductive status. CHCs are non-volatile compounds with high molecular weight and therefore, they are used in alternative strategies of communication. Brood, as larvae and eggs, are thought to be important sources of chemical compounds in the colonies, as for example, CHCs and egg surface compounds are highly similar in some social insects' species. It has been also shown that the main source of egg compounds is the *Dufour's* gland, an accessory reproductive gland present in several Hymenoptera females. The comparison of CHCs, eggs surface and the *Dufour* gland content is yet not investigated for some wasp species, which could provide correlational evidence of the origins of egg compounds. Thus, in the present work, we studied whether egg surface compounds were more similar to CHCs or *Dufour's* gland secretions in two Neotropical primitively eusocial wasp species, one belonging to the genus *Polistes* (*Polistes versicolor*) and the other to *Mischocyttarus* (*Mischocyttarus metathoracicus*). As expected, a higher chemical similarity was found among samples of eggs and *Dufour's* gland secretions in both studied species, reinforcing the hypothesis that this gland is the main source of egg surface compounds.

Keywords: cuticular hydrocarbons; *Dufour* gland; egg surface compounds; *Mischocyttarus metathoracicus*; *Polistes versicolor*

Introduction

Social insects are best known for possessing three main features (1) division of reproductive labour, which is represented by one or a few individuals being responsible for reproduction, while the remaining massive of them engage in non-reproductive tasks, (2) all individuals cooperate to care of the young individuals, and (3) there is overlap of generations (Oster and Wilson 1978). The cohesion within colonies of social insects is thought to exist due to the existence of well-sophisticated modes of communication, which regulates social interactions (see Leonhardt et al. 2016). The communication throughout chemical compounds, however, probably represents the most common form of communication in social insects (Leonhardt et al. 2016). In the past years, the identification of chemical compounds and pheromones provided knowledge that chemical compounds are likely involved in communicative processes in social insects colonies (Schultner and Pulliainen 2020; Oliveira et al. 2021; Oliveira et al. 2020; Holman 2018; Van Oystaeyen et al. 2014; Derstine et al. 2021; Nunes et al. 2016; Nunes et al. 2011; da Silva et al. 2021; Oi et al. 2020; da Silva et al. 2020).

Chemical compounds covering the insect body, namely cuticular hydrocarbons (CHCs), are one of the most important compounds used in chemical communication in social insects. CHCs are used in nestmate recognition and also to signal reproductive condition (e.g. queen pheromones and fertility cues) (Van Oystaeyen et al. 2014; Oi et al. 2016; Holman 2016; Oi et al. 2015b). However, due to their chemical proprieties, such as low volatility, it has been questioned how these chemical compounds are spread in the colony, especially how these compounds reach to all individuals if they are not in direct contact with each other (Endler et al. 2004). One of the hypotheses is that brood could be used to carry such cues/signals in the colony (Schultner and Pulliainen 2020; Orlova et al. 2020; Oi et al. 2015a; Endler et al. 2004). For example, eggs in social colonies can carry information related to the presence of the queen, hence they can play a role as alternative sources of communication in colonies social insects. The chemical composition found over eggs and body surface of queens and egg-layers are highly similar in composition (Dapporto et al. 2007; Tsuchida et al. 2020; Bonckaert et al. 2012). However, the chemical compounds present in the egg surface likely originate from the *Dufour's* gland, an accessory reproductive gland, which is connected to the ovipositor and sting apparatus of several Hymenoptera females, and this gland can release compounds that coat the eggs (Mitra et al. 2011). In the past years, it has been assumed that *Dufour's* gland works as a reservoir of chemical fertility signals which are deposited onto the eggs during the process of oviposition (Dani et al. 1996; Mitra and Gadagkar 2011; Mitra et al. 2011).

An intriguing case of which roles the *Dufour's* gland content display within a society has been well documented in colonies of the primitively eusocial wasp *Ropalidia marginata* (Bhadra et al. 2010; Mitra et al. 2011; Mitra and Gadagkar 2011; Mitra and Gadagkar 2012). Queens of *R. marginata* are not aggressive toward their workers (Gadagkar 2001), but rather they maintain their reign by spreading their pheromones when they rubby their abdomen in the nest surface (Bhadra et al. 2007), thus queens keep their reproductive monopoly by using chemical compounds (Bhadra et al. 2010; Mitra et al. 2011; Mitra and Gadagkar 2011; Mitra and Gadagkar 2012). Experiments have demonstrated that queen *Dufour's* gland extracts are able to mimic their presence, besides queens and workers can be distinguished based on the composition of their glands (Bhadra et al. 2010). In fact, *Dufour's* gland composition is highly correlated with the ovarian conditions expressed by queens, reinforcing that these chemical compounds signal fertility in *R. marginata* (Mitra and Gadagkar 2011). The chemical content of *Dufour's* gland in *R. marginata* also match those find over the cuticular surface of females (Mitra and Gadagkar 2012) and they do not carry information that may be associated with the process of nestmate recognition (Mitra et al. 2011). Besides *R. marginata*, a few other primitively eusocial wasps were explored and *Dufour's* gland content may play a role in nestmate recognition in *Polistes dominula* (Dani et al. 1996 a,b). Recently, it was experimentally demonstrated that the chemical secretions of *Dufour's* gland may be under influence of circulating levels juvenile hormone in foundresses females of *Mischocyttarus* wasps (Ferreira et al. 2022).

Even though some correlational analyses have been conducted regarding the chemical composition of cuticular surface, eggs' surface and *Dufour's* gland content for some species of primitively eusocial wasps, a direct comparison of CHCs, eggs' surface and the *Dufour's* gland content is yet not investigated for several of them. Thus, in the present work we studied whether egg surface compounds were more similar to CHCs or the *Dufour's* gland secretions in two primitively eusocial species of wasps, one belonging to the genus *Polistes* (*Polistes versicolor*) and the other to *Mischocyttarus* (*Mischocyttarus metathoracicus*). We characterize chemical egg surfaces of *P. versicolor* and *M. metathoracicus* in order to check the chemical resemblance of their compounds. We hypothesized that *Dufour's* gland is a source of egg-marking compounds. Thus, we predicted that a stronger chemical similarity exist between samples of eggs and *Dufour's* gland for both species. Samples were also compared among females displaying distinct fertility conditions.

Material and Methods

Study area and sampling methods

Colonies of *M. metathoracicus* and *P. versicolor* were sampled in the area of Universidade de São Paulo (USP) – Campus of Ribeirão Preto – SP in 2019 (21°10'39"S; 47°48'37"W, 531 m elevation) (between the months March to June, and between November and December (da Silva et al. 2019). Upon collection, all the nests were in post-worker emergence phase. The number of females per nest ranged from six to 20 (*M. metathoracicus*) and from three to 20 (*P. versicolor*) (Table 1). Prior to phase classification, the colonies were observed for two consecutive days (ca. 60 min per day). Nests were classified as being post-worker emergent due to the presence of newly emerged wasps and meconium within the cells. Once nests were located, they were collected with the aid of an entomological net and plastic boxes. Following sampling, boxes containing the nests and individuals were taken to the Laboratório de Comportamento e Ecologia de Insetos Sociais (USP – Ribeirão Preto), where they were frozen in -20°C. Each female was individualized in a glass vial to extract their CHCs. The females were washed with hexane (95% purity, Makron Fine Chemicals) using 1 ml for *M. metathoracicus* or 2 ml for *P. versicolor* for 1 minute. After that, the bodies were taken out of the glass vials and stored again until being dissected and their *Dufour's* gland sampled. All females were dissected under a binocular stereomicroscope (Leica M125 C). Ovaries were coded as activated (with apparent oocytes) and non-activated (not visible oocytes) (Figure 1). Following ovary dissections, the *Dufour's* gland was removed with the aid of tweezers. The *Dufour's* gland was extracted in a glass vial with hexane using 50 µl of hexane for 1 min. Finally, from the nests, the eggs were also sampled, placed individually in glass vials, and washed in hexane using 50 µl of hexane for 1 min to check the chemical composition of their surfaces.

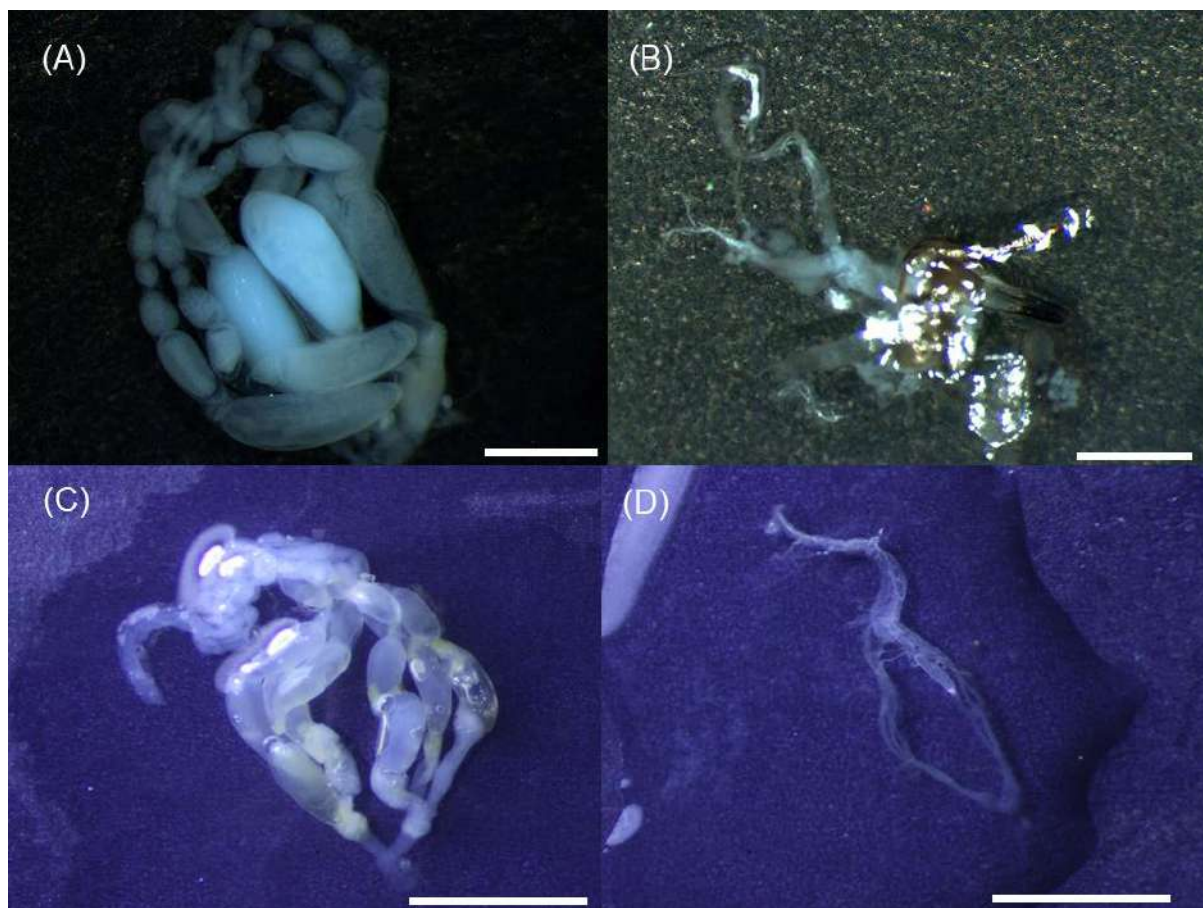


Figure 1: Examples of ovary activation condition used to classify females as with “activated ovaries” (A and C) and “without activated ovaries” (B and D). A and B = *Mischocyttarus metathoracicus*; C and D = *Polistes versicolor*. White bars in A and B corresponds to 1mm, and white bars in C and D corresponds to 5mm.

The glass vial containing the compounds were dried under a fume hood and prepared for chemical analyses. The glass vials containing the chemical compounds were resuspended in 150 μl of hexane (Macron Fine Chemicals 95% purity) for CHC, while the *Dufour's* gland content and the egg surfaces were resuspended in 50 μl of hexane (Macron Fine Chemicals 95% purity). All *P. versicolor* samples were analysed in a system of gas chromatography coupled with a mass spectrometer (GC-MS; Shimadzu, model QP2010 Plus) equipped with a Rxi-1ms column (thickness 0.25 μm ; length 30 m; diameter 0.25 mm) and helium as carrier gas (pressure 57.6 kPa; total flow 50.0 ml/min; column flow 1.11 ml/min; linear velocity 38 cm/sec; purge flow 5.0 ml/min; split ratio -1.0). In the gas chromatograph, 1 μl of sample was injected using splitless injection. The injector temperature was set to 250 $^{\circ}\text{C}$ and all samples were run in the spitless mode. The oven temperature was initially set to 40 $^{\circ}\text{C}$ and held for 2 minutes. Then the temperature increased by 20 $^{\circ}\text{C}/\text{min}$ until 120 $^{\circ}\text{C}$. In the following step, the temperature was increased by 10 $^{\circ}\text{C}/\text{min}$ until 200 $^{\circ}\text{C}$, and subsequently by 7 $^{\circ}\text{C}/\text{min}$ until 250 $^{\circ}\text{C}$. Lastly, the temperature increased 5 $^{\circ}\text{C}/\text{min}$ until 320 $^{\circ}\text{C}$ and it was kept for 4 minutes. All *M. metathoracicus*

samples were analysed in a system of gas chromatography coupled with a mass spectrometer (Thermo Fisher Trace 1300 ISQ). In the gas chromatograph, 1 µl of sample was injected using splitless injection and separated onto a Restek MXT-5 column (30 m, 0.25 mm of diameter and 0.25 µm thickness) with helium as carrier gas (constant flow of 0.9 mL min⁻¹). The injection temperature was 320° C. Initially, the temperature was held at 40° C for 2 min, then increased to 120° C with a rate of 20° C/min. This was followed by an increase in rate of 10° C/min until 200 °C, then 7° C/min to reach 250° C and a last increase of 5° C/min to reach 350° C, which was held for 4 minutes. Electron impact ionization at 70eV was used during mass spectrometry at a temperature of 300° C. A solution of linear alkane leaders (Sulpeco) from n-C7 to n-C40 was used as references to calculate cubic spline interpolated retention indexes. Chromatogram peaks were identified based on their mass spectrometric fragmentation patterns and also in previously published references (Oi *et al.* 2021a). Total ion chromatogram peaks were integrated using R version 4.0.2 using a customized script (available upon request).

Table 1: Total number of nests and samples of each category sampled in our study for both species.

Species	Nest	Cuticular	Eggs	Dufour's gland
<i>Mischocyttarus metathoracicus</i>	1	10	4	2
<i>Mischocyttarus metathoracicus</i>	2	19	2	9
<i>Mischocyttarus metathoracicus</i>	3	10	3	2
<i>Mischocyttarus metathoracicus</i>	4	6	1	1
<i>Mischocyttarus metathoracicus</i>	5	6	2	3
<i>Polistes versicolor</i>	2	3	5	3
<i>Polistes versicolor</i>	3	3	0	3
<i>Polistes versicolor</i>	4	3	5	3
<i>Polistes versicolor</i>	5	14	6	13
<i>Polistes versicolor</i>	6	20	6	20

Statistical analysis

To check whether eggs were chemically similar to CHCs or *Dufour's* gland secretion, and the reproductive condition of the females influenced their chemical composition, the compounds were log2-transformed using relative peak areas and compared by ANOVA followed by Tukey test with FDR correction. A heatmap using the mean relative abundance was done to visualise the hydrocarbon composition of the three different group of samples (CHCs x eggs x *Dufour's* gland). For that, we used row z scores calculated per group. Clustering was based on a

UPGMA hierarchical clustering using Euclidean distance as the distance metric. All the analysis were performed using R (version 4.1.2) (Team 2013).

Results

Mischocyttarus metathoracicus

A total of 39 compounds were found after analysing samples of CHCs, eggs and *Dufour's* gland of *M. metathoracicus* (Figure 2A), which were represented by linear alkanes, alkenes, methyl and dimethyl-alkanes, and unknown compounds. The chemical comparison among different groups of samples (CHCs x eggs x *Dufour's* gland) demonstrated that almost all compounds were significantly different, with exception of three compounds (3-MeC27, 7-MeC27 and 15-;13-MeC31) (Figure 2A/Table 2). A complete description of the chemical composition is available in the supplementary material Table S1 and S2. Based on the heatmap, a higher chemical similarity was observed between samples of eggs and *Dufour's* gland, while samples of CHCs formed a different cluster (Figure 2A). The three groups of samples differed in two levels, qualitatively and quantitatively (Figure 2A). According to the post hoc Tukey test, a total of 28 compounds differed significantly between samples of CHCs and eggs, a total of 33 compounds differed significantly between samples of CHCs and *Dufour's* gland, and only 12 were statistically different between samples of eggs and *Dufour's* gland (Table 2). A high rate of females with activated ovaries was seen in all the study nests (pooling the five nests = 83.33% with activated ovaries x 16.67% with non-activated ovaries). When the females were grouped based on their fertility status, none of the compounds present over their cuticular surface differed significantly. Overall, the results revealed that hydrocarbons vary significantly among groups of samples, however, there is a high chemical resemblance between samples of eggs and *Dufour's* gland, strengthening the hypothesis that this gland is likely the main source of compounds that cover eggs. Additionally, females do not differ in their CHCs according to their fertility status, thus these cues may be aligned with factors that were not covered in this work.

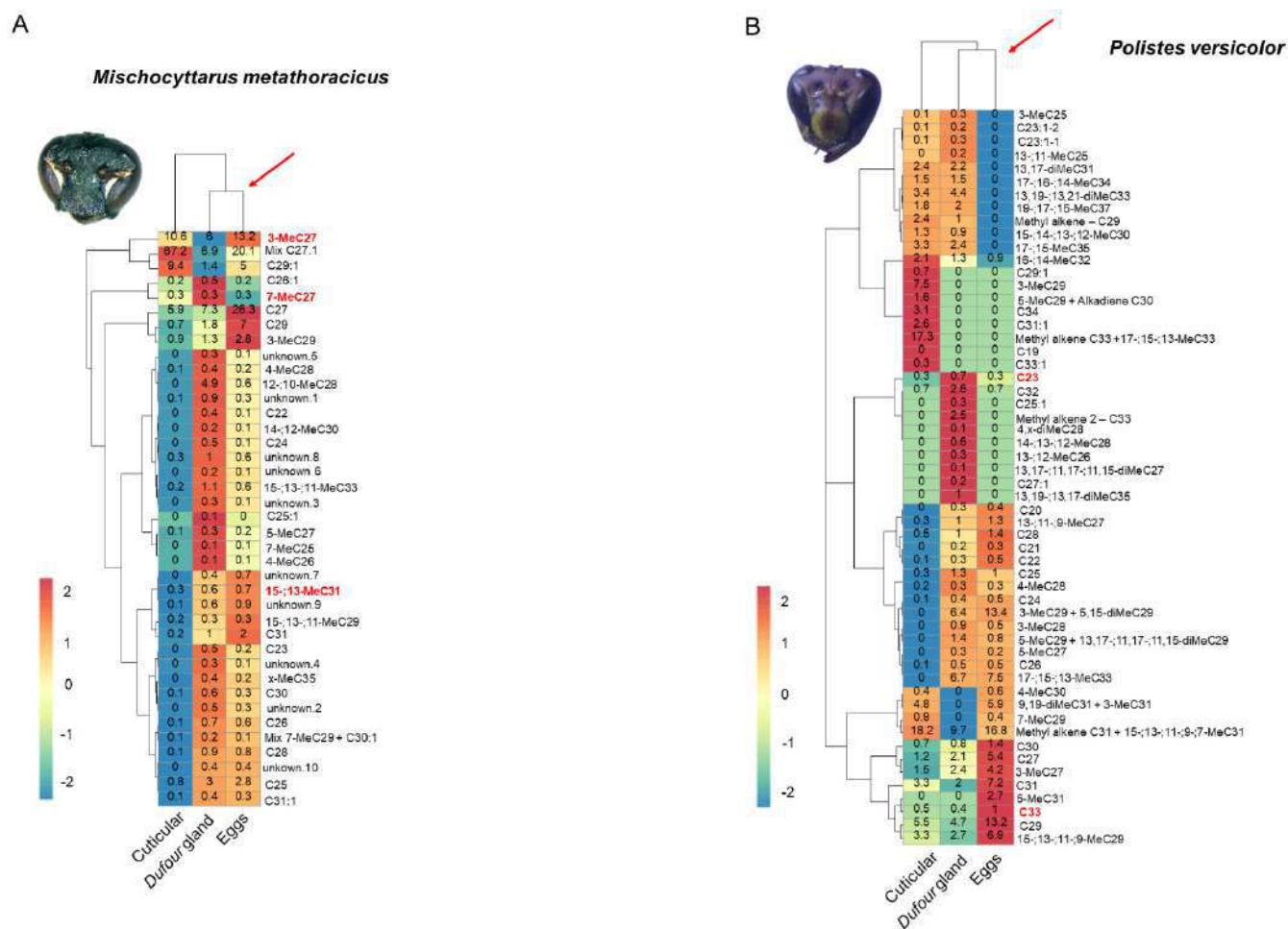


Figure 2: Heatmaps representing the differences in relative abundance of compounds (log-transformed) in the chemical profile of the cuticle (CHCs), egg surface and in *Dufour's* gland secretion for both study species, (A) *Mischocyttarus metathoracicus* and (B) *Polistes versicolor*. Colours represent the mean fold difference in relative abundance of each hydrocarbon found for each of the three groups of samples. The number represents the relative abundances. Compounds were clustered based on a UPGMA clustering using Euclidean distance and the distance metric.

Table 2: Post hoc Tukey test results based on the pairwise comparisons ran using samples of CHCs, eggs and *Dufour's* gland in *Mischocyttarus metathoracicus*, indicating the p values of each comparison per compound.

Compounds	Cuticular – <i>Dufour's</i> gland	Cuticular - Eggs	Eggs – <i>Dufour's</i> gland
C22	< 0.001	< 0.001	< 0.001
C23	< 0.001	< 0.001	1
C24	< 0.001	< 0.001	0.002
C25	< 0.001	< 0.001	1
C25:1	< 0.001	1	< 0.001
C26	< 0.001	< 0.001	1
C26:1	< 0.001	1	< 0.001
C27	1	< 0.001	< 0.002
C28	< 0.001	< 0.001	1
C29	< 0.001	< 0.001	< 0.001
C29:1	< 0.001	0.081	< 0.001

C30	< 0.001	< 0.001	1
C31	< 0.001	< 0.001	1
C31:1	< 0.001	< 0.001	1
Mixture + C27:1	< 0.001	0.015	0.406
7-MeC29 + C30:1	< 0.001	0.003	1
unknown 1	< 0.001	< 0.001	0.283
unknown 2	< 0.001	< 0.001	1
unknown 3	< 0.001	< 0.001	1
unknown 4	< 0.001	< 0.001	0.552
unknown 5	< 0.001	< 0.001	0.028
unknown 6	< 0.001	< 0.001	0.676
unknown 7	< 0.001	< 0.001	1
unknown 8	< 0.001	< 0.001	1
unknown 9	< 0.001	< 0.001	1
x-MeC35	< 0.001	< 0.001	0.6
12-;10-MeC28	< 0.001	< 0.001	< 0.001
14-;12-MeC30	< 0.001	< 0.001	0.952
15-;13-;11-MeC29	0.316	0.051	1
15-;13-;11-MeC33	< 0.001	0.018	1
15-;13-MeC31	0.519	0.406	1
3-MeC27	0.605	1	0.463
3-MeC29	0.047	< 0.001	< 0.001
4-MeC26	< 0.001	0.297	0.037
4-MeC28	< 0.001	< 0.001	0.008
5-MeC27	< 0.001	1	1
7-MeC25	< 0.001	0.614	0.106
7-MeC27	1	1	1

Polistes versicolor

A total of 56 compounds were found after analysing samples of CHCs, eggs and *Dufour's* gland of *P. versicolor* (Figure 2B), which were represented by linear alkanes, alkenes, methyl and dimethyl-alkanes, alkadiene, and methyl-alkenes. The chemical comparison among different groups of samples (CHCs x eggs x *Dufour's* gland) demonstrated that almost all compounds were significantly different, with exception of two of them (C23 and C33) (Figure 2B/Table 3). A complete description of the chemical composition of *P. versicolor* is available in the supplementary material Table S3 and S4. According to the heatmap UPGMA cluster analysis, a higher chemical convergence was observed between samples of eggs and *Dufour* gland, while samples of CHCs formed a different cluster (Figure 2B). As in *M. metathoracicus*, the three groups of samples of *P. versicolor* also varied quantitatively and qualitatively (Figure 2B). According to the post hoc Tukey test, a total of 41 compounds differed significantly between samples of CHCs and eggs, a total of 42 compounds differed significantly between samples of CHCs and *Dufour's* gland, and 33 compounds were statistically different between samples of

eggs and *Dufour's* gland (Table 3). Unlike we saw for *M. metathoracicus*, the rate of females with activated and non-activated ovaries was similar when pooling all the nests (females with activated ovaries = 51.48% x females without activated ovaries = 48.52%). When the females were grouped based on their fertility status, a single compound differed significantly between females (C23 – estimate: -1.737; SE: 0.424; t.ratio: -4.096; p value = 0.013). Overall, these results suggest that hydrocarbons vary significantly among groups of samples, however, there is a higher chemical similarity between samples of eggs and *Dufour's* gland, suggesting that in *P. versicolor* this gland is also the main source of compounds that cover eggs. Additionally, the chemical variation between females with different fertility status was seen to be subtle.

Table 3: Post hoc Tukey test results based on pairwise comparisons ran using samples of CHCs, eggs and *Dufour's* gland in *Polistes versicolor*, indicating the p values of each comparison per compound.

Compounds	Cuticular - <i>Dufour's</i> gland	Cuticular - Eggs	<i>Dufour's</i> gland - Eggs
C23:1-1	< 0.001	< 0.001	< 0.001
C23:1-2	< 0.001	< 0.001	< 0.001
C25:1	< 0.001	1	< 0.001
C27:1	< 0.001	1	< 0.001
C29:1	< 0.001	< 0.001	1
C31:1	< 0.001	< 0.001	1
C33:1	< 0.001	< 0.001	1
Methyl alkene C29	< 0.001	< 0.001	< 0.001
Methyl alkene C33 + 17-;15-;13-MeC33	< 0.001	< 0.001	1
Methyl alkene C31 + 15-;13-;11-;9-;7-MeC31	< 0.001	1	0.019
Methyl alkene C33 - 2	< 0.001	1	< 0.001
C19	< 0.001	< 0.001	1
C20	< 0.001	< 0.001	1
C21	< 0.001	< 0.001	0.686
C22	< 0.001	< 0.001	1
C23	0.688	1	1
C24	< 0.001	< 0.001	1
C25	< 0.001	< 0.001	1
C26	< 0.001	< 0.001	1
C27	0.343	< 0.001	0.021
C28	< 0.001	< 0.001	1
C29	1	< 0.001	< 0.001
C30	1	< 0.001	0.004
C31	0.048	< 0.001	< 0.001
C32	< 0.001	1	< 0.001
C33	1	0.221	0.137
C34	< 0.001	< 0.001	1
13-;11-;9-MeC27	< 0.001	< 0.001	1
13-;11-MeC25	< 0.001	< 0.001	< 0.001

13-;12-MeC26	< 0.001	1	< 0.001
13,17-;11,17-;11,15-diMeC27	< 0.001	1	< 0.001
13,17-diMeC31	1	< 0.001	< 0.001
13,19-;13,21-diMeC33	1	< 0.001	< 0.001
13,19-;13,17-diMeC35	< 0.001	1	< 0.001
14-;13-;12-MeC28	< 0.001	1	< 0.001
15-;13-;11-;9-MeC29	1	0.016	< 0.001
15-;14-;13-;12-MeC30	0.862	< 0.001	< 0.001
16-;14-MeC32	0.087	< 0.001	1
17-;15-;13-MeC33	< 0.001	< 0.001	1
17-;15-MeC35	0.521	< 0.001	< 0.001
17-;16-;14-MeC34	1	< 0.001	< 0.001
19-;17-;15-MeC37	1	< 0.001	< 0.001
3-MeC25	< 0.001	< 0.001	< 0.001
3-MeC27	< 0.001	< 0.001	< 0.001
3-MeC28	< 0.001	< 0.001	0.002
3-MeC29	< 0.001	< 0.001	1
3-MeC29 + 5,15-diMeC29	< 0.001	< 0.001	< 0.001
4-MeC28	0.001	0.27	1
4-MeC30	< 0.001	0.066	< 0.001
4,x-diMeC28	< 0.001	1	< 0.001
5-MeC27	< 0.001	< 0.001	1
5-MeC29 + 13,17-;11,17-;11,15-diMeC29	< 0.001	< 0.001	0.124
5,MeC29 + Alkadiene C30	< 0.001	< 0.001	1
5-MeC31	1	< 0.001	< 0.001
7-MeC29	< 0.001	< 0.001	< 0.001
9,19-diMeC31 + 3-MeC31	< 0.001	0.288	< 0.001

Discussion

Our results revealed that a higher chemical similarity exists among the eggs and the *Dufour's* gland in *Mischocyttarus metathoracicus* and *Polistes versicolor*, which corroborates our initial hypothesis. These findings support that the *Dufour's* gland likely is the main source of compounds that are used to mark the eggs. Additionally, we also confirmed that CHCs may also work as fertility cues in societies *P. versicolor*. However, the variation of CHCs concerning fertility status was restricted to subtle quantitative variation of a single compound, one linear alkane (n-C23). Comparing with other species, in the highly eusocial wasp *Vespula vulgaris*, a methyl-alkane (3-MeC29) signals egg maternity and is likely responsible to protect queen-laid eggs to be eaten by the workers (Oi et al. 2015a). Whether the hydrocarbons we identified for the primitively eusocial wasps also conceive egg maternity information is yet to be investigated.

In *P. fuscatus*, the *Dufour's* gland extracts from subordinate females are found in the surface of their eggs, which shown to induce dominant females to eat them more often when compared to the eggs treated with the solvent only (Downing 1991). Releasing chemical compounds in the surface of eggs has been proposed to act as a strategy for queens to distinguish between eggs laid by them and unrelated ones and then maximize their fitness throughout differential oophagy (Liebig et al. 2005). The act of destroying eggs in these societies is known as policing, which is a way of socially coercing individuals - reproductive females that lay unfertilized eggs have their eggs removed -, and this behaviour is either performed by the queen toward reproductive workers, but also among other workers (Wenseleers et al. 2020; Ratnieks and Wenseleers 2005). It was also previously demonstrated that *Dufour's* gland act as a reservoir of compounds that are linked with fertility in the primitively eusocial wasp *R. marginata*, thus these compounds act as honest signals of fertility (Mitra and Gadagkar 2011; Mitra et al. 2011). Interestingly when comparing social wasps, in which sociality evolved separately (Piekarski 2018): the currently under study from the genus *Mischocyttarus* and *Polistes*, and those from the genus *Parischnogaster* and *Liostenogaster* (Stenogastrinae wasps), we noticed that these species share a similar chemical composition in their *Dufour's* gland. Among the compounds present in their *Dufour's* gland, we found especially linear alkanes (Keegans et al. 1993). In the primitively eusocial bee *B. impatiens*, *Dufour's* gland content is caste and physiological-dependent, and workers can detect chemical differences when presented to the *Dufour's* gland composition from workers with different social and reproductive status (Derstine et al 2021). Additionally, the surface of eggs of the primitively eusocial ant *Dinoponera quadricaps*, allow nurse workers to discriminate egg maternity between nestmate and non-nestmate, and several branched and linear alkanes seem to be the proximal cues that allow discrimination to occur (Tannure-Nascimento et al. 2009).

Regarding the CHCs differences, in *M. metathoracicus* we found less compounds than previously reported in another work (n = 46 compounds) (Oi et al. 2021). The difference between the current data and the one presented by Oi et al. (2021) can be related to the fact that here the females analysed were not treated with any other compound, while the former treated them with either acetone, methoprene and precocene. Here, we found no difference between the CHCs of females bearing different fertility status. This result is in line with the data presented by Oi et al. (2021), once almost all the females treated in their work expressed higher rates of ovary activation and did not differ based on their CHCs. In a previous report, *P. versicolor* females expressing different fertility status were found to differ significantly based on their linear alkanes

(Brito et al. 2017). Here, we reported one single linear alkane, namely C23, varied significantly between *P. versicolor* females with different fertility status. The lack of strong chemical variation between females of both study species may be related to the fact that in these primitively eusocial societies, the most part of the conflicts are resolved through different pathways, such as aggression, but not through chemical communication (Oi et al. 2019; da Silva et al. 2020). In fact, CHCs have been extensively proposed to function as merely cues rather than signals in primitively eusocial societies (Oi et al. 2019; Izzo et al. 2010; Sledge et al. 2001). In highly eusocial societies of *V. vulgaris*, on the other hand, a set of CHCs act as queen pheromones (Van Oystaeyen et al. 2014; Oi et al. 2022). Interestingly, the compounds that were previously reported to act as queen pheromones in *V. vulgaris* were also found in our samples. The presence of these chemical cues in primitively eusocial wasp species reinforce that the full-fledged queen pheromone signals (reported to exist in societies of *V. vulgaris*) evolved from cues that were likely present in their ancestors (Oi et al. 2015b).

The high rate of females with activated ovaries in post-worker emergence nests of *M. metathoracicus* was previously for other *Mischocyttarus* species, namely *M. cerberus* (da Silva et al. 2020) and *M. cassununga* (Murakami et al. 2009). In fact, *M. cerberus* females engaged in different tasks (reproductive and non-reproductive ones) have activated ovaries along with nest ontogeny, and interestingly, a high rate of them is inseminated regardless of nest ontogeny (da Silva et al. 2020). Furthermore, the percentage of *P. versicolor* with and without activated ovaries reported here is similar to what was reported for another population of the same species (Brito et al. 2017). For both species, the presence of several females ready to lay eggs may bring either benefits or represent a cost for the society. Among the benefits, more females with activated ovaries suggest that in the absence of the original queen (e.g. in case of death), a new female could rapidly raise as the principal egg-layer and replace it (Deshpande et al. 2006; Murakami et al. 2009). On the other side, more fertile females within a nest may represent a higher existence of reproductive conflicts, once several of the fertile females – other than the queen – may try to gain fitness directly (by producing their own brood), rather than indirectly (raising the brood of the queen) (Tsuchida et al. 2020). Future research should address this question.

In summary, the results of our work uncovered that indeed the chemical composition of the cuticular surface (CHCs), the *Dufour's* gland content and the egg-marking compounds vary in both studied species. However, a higher chemical convergence was found between the chemical composition of eggs and the *Dufour's* gland content for both species, suggesting that this gland is indeed the main source of the egg-marking cues. Besides, we also demonstrated that

CHCs may not play a strong role on informing fertility status in both species, but rather these chemical cues may be associated with other factors not covered in the present work. Lastly, we confirmed for another *Mischocyttarus* species that it is not unusual to find several females with activated ovaries within their societies. Future work including more information, such as behavioural data, will be useful to understand whether hydrocarbons are used to confer egg maternity and to carry information other than fertility status.

Competing interests

The authors declare no competing or financial interests.

Acknowledgements

This study was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. Funding was provided from Bilateral grant FWO-FAPESP to CAO and FSN (process: 2018/10996-0 FAPESP and FWO: GOF8319N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Author contribution

This study was conceptualized and designed by RCS. Data collection and chemical analysis were performed by RCS. Statistical analyses were performed by RCS and CAO. The first draft was written by RCS and CAO. All authors read and approved the final manuscript version.

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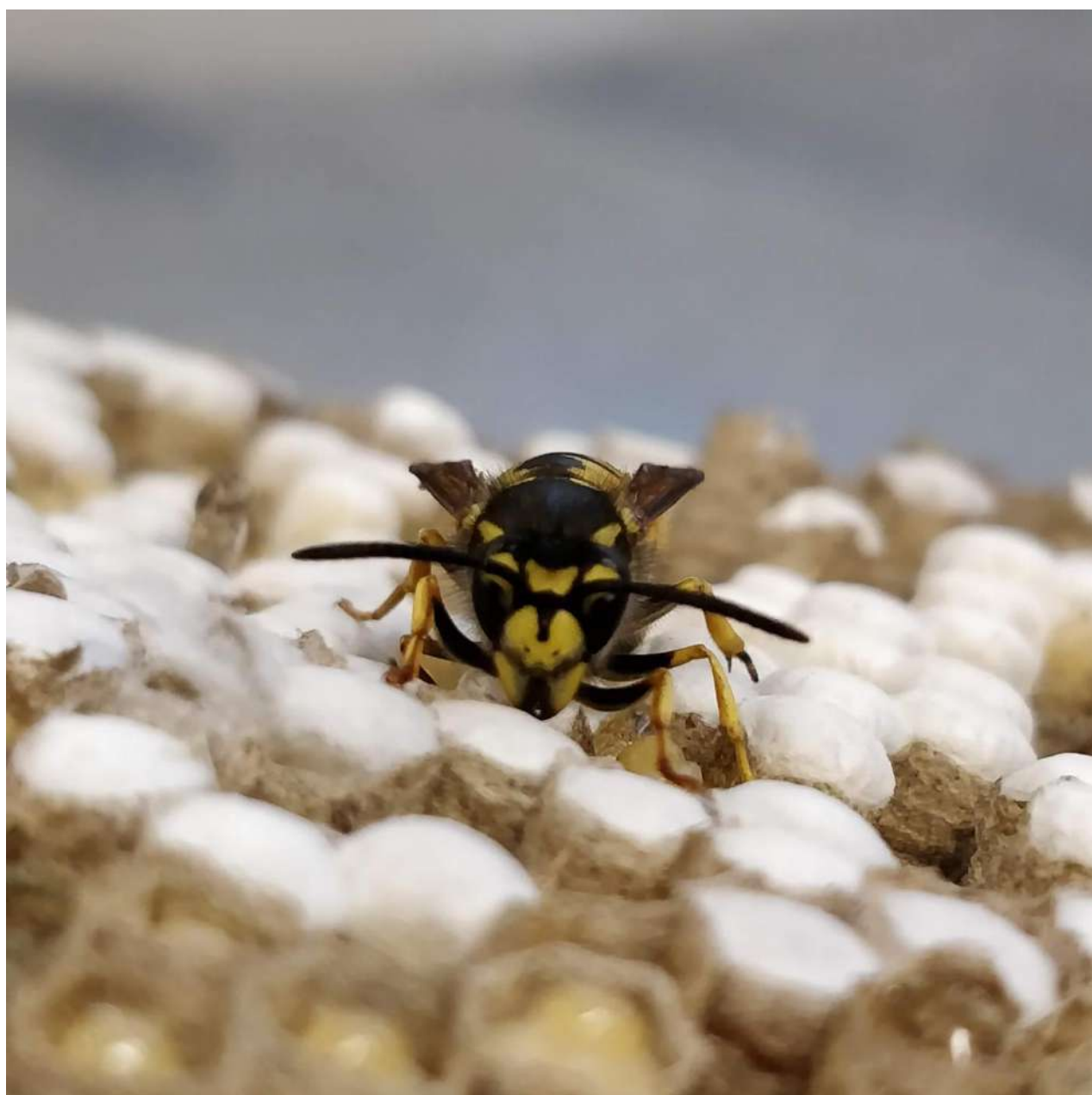
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CHAPTER 4

Hydrocarbon signatures of egg maternity and Dufour's gland in Vespine wasps



Credit: Cintia A. Oi

In prep. To be submitted to *The Science of Nature*

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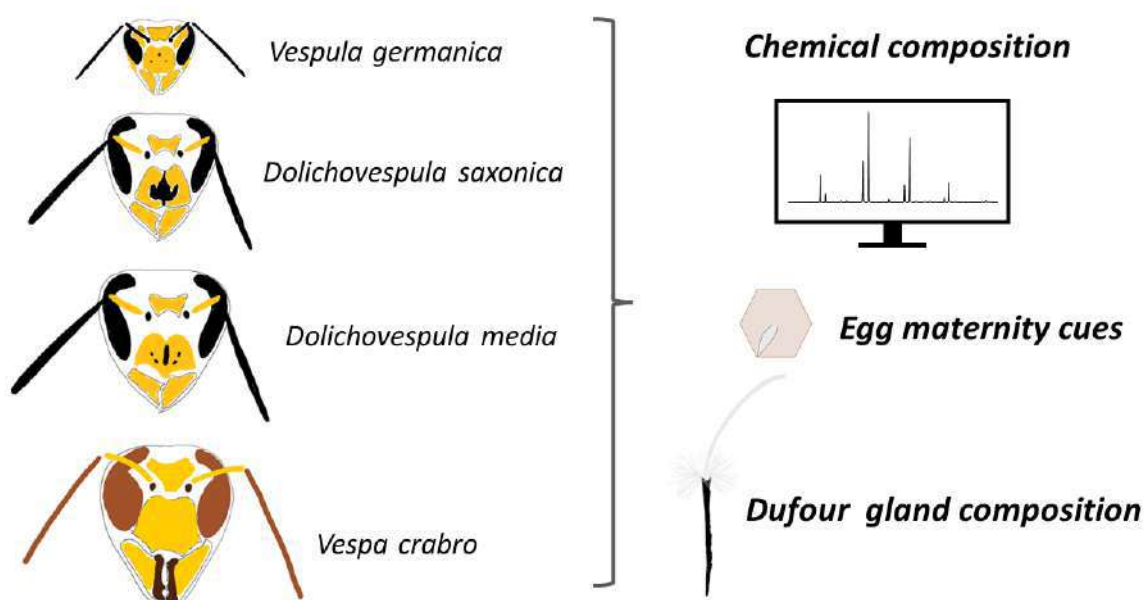
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Graphical abstract



Highlights

- Hydrocarbon signatures vary according to fertility status in four species of Vespine wasps
- Eggs are coated with compounds that have been previously described to play several roles in the communication process
- *Dufour's* gland is likely the main reservoir of egg-marking chemical compounds
- Egg marking cues are species-specific, not conserved

Abstract

Cuticular hydrocarbons (CHCs) are often used in the chemical communication among social insects. CHCs can be used in nestmate recognition and as queen pheromones, the latter allows the regulation of the reproductive division of labor. In the common wasp *Vespula vulgaris*, CHCs and egg-marking hydrocarbons are caste-specific. It was shown that some specific hydrocarbons act as queen pheromones and as egg maternity signals. If these compounds are conserved among other Vespinae wasps remains still unknown. We collected queens, virgin queens, reproductive workers, and workers belonging to four different species of Vespinae wasps, *Dolichovespula media*, *Dolichovespula saxonica*, *Vespa crabro*, and *Vespula germanica*. We characterized cuticular hydrocarbons, egg surface, and *Dufour's* gland composition and we found that chemical compounds are caste-specific in the four species. We also detected quantitative and qualitative differences in the cuticle, eggs, and *Dufour's* gland. Some specific hydrocarbons that were shown to be overproduced in the cuticle of queens, were also present in higher quantities in queen-laid eggs and in their *Dufour's* gland. These hydrocarbons can be indicated as putative fertility signals that regulate the division of reproductive labor in other Vespine wasps. This is in line with the fact that in related wasp species, *V. vulgaris* and *D. saxonica*, hydrocarbons were shown to be conserved queen signals. We present new correlative evidence that queen chemical compounds are found not only over the body surface but also in other sources, such as the *Dufour's* gland and eggs.

Keywords: cuticular hydrocarbons, egg surface, *Dufour's* gland, Vespine wasps, fertility cues

Introduction

Social insects live in complex societies, leading them to be referred as superorganisms (Strassmann and Queller 2010; Boomsma and Gawne 2017). One or few individuals reproduce (queens), whereas the remaining majority engage in other high-cost tasks (workers). A high level of coordination and task partitioning exists among females in social insects (Wenseleers et al. 2020a). Even in such cooperative circumstances, conflicts emerge among females (queen versus workers, workers versus workers, see Ratnieks et al. 2006), as individuals are not clones and express intermediate or low relatedness levels (Hamilton 1964). In some species, workers can retain the capacity to activate their ovaries and lay unfertilized eggs (male destined) (Foster and Ratnieks 2000; Barron et al. 2001; Foster and Ratnieks 2001; Tsuchida et al. 2003; see Toth et al. 2004). However, these worker-laid eggs are perceived and often destroyed by their nestmates, a behavior also referred to as policing (Foster et al. 2002; Foster and Ratnieks 2001; Saigo and Tsuchida 2004; Liebig et al. 2005; Wenseleers et al. 2005; Oi et al. 2015b). Policing behavior results in worker-laid eggs being destroyed or in the reproductive workers being directly attacked by other workers or the queen (Ratnieks et al. 2006; Wenseleers and Ratnieks 2006; Wenseleers et al. 2020b). Policing has evolved

as a mechanism to regulate the reproductive division of labor. Reproductive workers do not go unnoticed in their colonies because they produce certain fertility cues, which distinguish them from sterile nestmates (Smith et al. 2008; Smith et al. 2012; Oi et al. 2021b). Reproductive workers would benefit by not being detected, however, fertility cues are probably produced as by-products of their ovary activation (Oi et al. 2015a; Wenseleers et al. 2020b).

In honeybees, in which policing behavior was firstly described (Ratnieks and Visscher 1989), esters derived from the *Dufour's* gland - an accessory gland of the reproductive system in Hymenoptera females (Mitra 2013) - were identified as the main cues driving policing behavior. Queen-laid eggs have higher proportions of these esters when compared with worker-laid eggs (Katzav-Gozansky et al. 1997). Empirical evidence, however, suggests that neither esters nor hydrocarbons work as signals allowing policing (e. g. Katzav-Gonzansky et al. 2001; Martin et al. 2002). In ants, queens also release queen characteristic compounds on eggs (see review Schultner and Pulliainen 2020). Hydrocarbons that cover the egg's surface are the molecules that allow policing behavior (Schultner and Pulliainen 2020). A study integrating chemical data and electroantennography sensibility in workers of *Pachycondyla inversa*, revealed that a dimethyl hydrocarbon (3,11-diMeC27) acts as a fertility signal. This compound is present in higher proportions in the cuticular surface of mature queens and reproductive workers (d'Ettorre et al. 2004). The proportion of 3,11-diMeC27 has positively correlated with total egg length and the antennae of workers were highly sensitive to this hydrocarbon. Worker-laid eggs coated with 3,11-diMeC27 are more accepted than non-treated control ones (d'Ettorre et al. 2004; van Zweden et al. 2009). In the ant *Camponotus floridanus*, the cuticular hydrocarbons (CHCs) and compounds covering egg surface are caste specific (Endler et al. 2004). Queen CHCs may be involved in egg protection in *C. floridanus* colonies, as the transference of these chemicals onto worker-laid eggs prevented them to be destroyed by workers (Endler et al. 2004). In the primitively eusocial ant *Dinoponera quadriceps*, the presence of several branched and linear alkanes on the egg's surface allows nurses to discriminate maternity information, allowing the distinction between nestmate and non-nestmate (Tannure-Nascimento et al. 2009). In social wasps *Polistes dominula*, subordinate individuals are able to lay eggs, however, their eggs do not chemically match those laid by queens, and consequently, they are policed (Dapporto et al. 2007). In colonies of *Polistes chinensis antennalis*, workers

reproduce under queen-right conditions, however, their eggs are often destroyed. Worker-laid eggs are detected and destroyed as a consequence of being distinct from the queen-laid eggs (Tsuchida et al. 2020). In the common wasp *Vespula vulgaris*, methyl alkanes are present in higher concentrations over the queen-laid eggs, whereas worker-laid eggs have a higher proportion of long-chain alkenes (Bonckaert et al. 2012). In fact, the methyl alkane 3-MeC29 reflect queen maternity and drive egg policing (Oi et al. 2015b).

Egg-maternity cues probably derive from *Dufour's* gland secretions. Considering that this gland is associated to the sting apparatus in females of several Hymenoptera species (Apocrita) (Mitra 2013), a key function of this gland is to release chemical compounds that cover the eggs during the process of oviposition (Abdalla and Cruz-Landim 2001). The *Dufour's* gland is an exocrine gland that evolved more than 200 million years ago. This gland displays several roles across the Hymenoptera (Mitra 2013). These compounds are used during nest building, as cues for nest recognition, nestmate recognition, fertility signalling, and so on (Mitra 2013).

Considering that CHCs and egg-marking compounds are often produced in different amounts by females bearing different fertility status and that *Dufour's* gland is the likely source of egg-marking compounds, in the present study, our main goal was to investigate these chemical variations in four species of Vespine wasps. For that, different groups of females were used in our study: queens, virgin queens, workers and reproductive workers. Three different sources of chemical compounds were investigated: CHCs, egg-marking cues and *Dufour's* gland content. We hypothesized that female's fertility (= ovary activation) would be correlated with chemical similarity among females of the four studied species. Thus, among our predictions we have (1) that queens and reproductive workers would chemically resemble each other when compared with virgin queens and workers; (2) a higher chemical resemblance between *Dufour's* gland and egg-marking compounds exist in the four species. This would reinforce the possible role of *Dufour's* gland in egg-marking. A chemical similarity between egg-marking compounds in the four species would indicate a conserved strategy linking fertility and egg maternity. Our results contribute to understand the dynamics of chemical communication in highly eusocial wasps, as we identified putative queen and egg marking pheromones.

Material and Methods

Study site and nest sampling

We collected nests of the four Vespinae species, *Dolichovespula saxonica*, *Dolichovespula media*, *Vespa crabro*, and *Vespula germanica* between July and September 2019 in the vicinity of Leuven - Belgium (50° 52' 46" N; 4° 42' 3" E, 41 m elevation). Nests were found hanging under the roof, in tree branches, inside birdhouses, or in the ground. We collected colonies, kept them in plastic boxes, and they were transported to the laboratory, where samples were collected. The first step was to anesthetize the nests with CO₂. Once all the wasps were anesthetized, the queen, workers, and virgin queens (if present) of each nest were frozen in -20°C until chemical analyses (Figure S1). After that, we sampled queen-laid eggs from the newest comb. We removed the eggs from their cell wall with the aid of surgical scissors and tweezers. To avoid eggs being destroyed during their removal, a tiny piece of the nest where the eggs were attached was removed together. To collect worker-laid eggs, we settled ca. of 10 to 20 workers in a wooden box provided with water, sugar syrup, sugar paste (Apifonda), and pieces of mealworms (*Tenebrio molitor*), together with a comb from their original nests without eggs. The wooden box consisted of two main parts, the first one where the comb was hung with pieces of iron (reproductive area), which was kept covered with a plastic lid and a piece of thick black plastic. The first part was covered with black plastic to keep the area under dark conditions and recreate the dark interior of their nests. The second part consisted of the foraging area, where tubes containing sugar syrup and water were placed. We covered the foraging area with a plastic lid. We placed a small plastic tube between the first and second boxes, which allowed workers to go from foraging arena to the comb area. This procedure was adapted from Oi et al. (2015b). We checked the combs for the presence of worker-laid eggs after one week (we kept workers under these conditions for maximum two weeks). We collected and analyzed a total of 154 samples of CHCs, 169 samples of eggs, and 118 samples of the *Dufour's* gland (Table 1).

Table 1: Number of samples analyzed per species.

Species	Nests	Cuticular hydrocarbons			
		Queens	Virgin queens	Reproductive workers	Workers
<i>Dolichovespula saxonica</i>	6	4	4	5	17
<i>Dolichovespula media</i>	6	5	10	7	29
<i>Vespa crabro</i>	10	8	-	-	35
<i>Vespula germanica</i>	10	4	-	6	20
Species	Nests	Eggs			
		Queens	Workers		
<i>Dolichovespula saxonica</i>	5	12	15		
<i>Dolichovespula media</i>	6	24	21		
<i>Vespa crabro</i>	9	38	14		
<i>Vespula germanica</i>	6	27	18		
Species	Nests	Dufour's gland			
		Queens	Virgin queens	Reproductive workers	Workers
<i>Dolichovespula saxonica</i>	4	2	2	3	12
<i>Dolichovespula media</i>	5	5	5	7	27
<i>Vespa crabro</i>	10	8	-	-	16
<i>Vespula germanica</i>	10	8	-	6	17

CHCs analysis

For CHC extraction, we placed queens, virgin queens, reproductive workers and workers in individual glass vials and covered with pentane (HPLC grade, Sigma-Aldrich) for one minute. After that, all the extracts were dried under a fume hood. After CHC extraction, we dissected wasps under a Leica MZ125 stereomicroscope to sample their *Dufour's* gland. We dissected the *Dufour's* gland and placed in glass inserts filled with 50 µl of pentane (HPLC grade, Sigma-Aldrich). We dried the extracts under a fume hood and the glass vials were kept frozen. We extracted eggs in 50 µl of pentane (HPLC grade, Sigma-Aldrich) for 1 minute. Subsequently, the liquid content was transferred to another vial and evaporated. We added a total of 150 µl, 50 µl, and 50 µl of hexane to cuticle, egg, and *Dufour's* gland samples, respectively. We analyzed all the samples in a Gas Chromatography coupled with Mass Spectrometer (GC-MS) (Thermo Fisher Trace 1300 ISQ) system. In the GC-MS system, we injected 1 µl of each sample by using a splitless mode, and the chemical compounds were separated in a Restek MXT-5 column (30 m, 0.25 mm of diameter, and 0.25 µm of thickness), with helium as a carrier gas (constant flow of 0.9 mL min⁻¹). We used GC-MS parameters adapted from Oi et al. (2021c). The injector temperature was kept at 320 °C. Initially, the oven temperature was set at 40 °C

for 2 minutes, then increased to 120 °C with a rate of 20 °C/minute. Next, the temperature increased to 200°C at a rate of 10°C/minute, then 7°C/minute until 250 °C. Finally, the temperature increased at a rate of 5 °C/minute until 350 °C, which was held for 4 minutes. Electron impact ionization at 70 eV was adopted during mass spectrometry at a temperature of 300 °C. To help identify the chromatograms and to calculate cubic spline interpolated retention indexes (Messadi et al., 1990), linear alkane ladders (Supelco) from *n*-C7 to *n*-C40 were used. Hydrocarbons were identified based on the expected mass spectrometric fragmentation patterns (Carlson et al., 1998) and retention indexes by the NIST 2014 retention index database (Linstrom and Mallard, 2016; Pherobase El-Sayed, 2016). Chromatograms were integrated using R version 4.0.2.

Statistical analysis

For the first analysis, in which we aimed to test whether chemical cues would consistently vary according to females' fertility status across the four study species, we transformed the peak area of each compound from the three types of samples (CHCs, eggs, and *Dufour's* gland) into relative abundances (%) and we compared them in PERMANOVA tests (9999 permutations) to check whether they were different among caste. We used the package *vegan* (Oksanen et al. 2008). The data corresponding to CHCs, eggs and *Dufour's* gland were plotted in a principal component analysis (PCA) graph to visualize data distribution and group formation. For that, we used the package *vegan* (Oksanen et al. 2008) and *ggplot2* (Wickham et al. 2016). To check which compounds contributed the most to group differentiation, we used a percentage similarity test (SIMPER) by adopting a Bray-Curtis index with the package *vegan* (Oksanen et al. 2008). To understand whether *Dufour's* gland would be the main source of egg-marking compounds, we explored the overlap among samples of cuticle, eggs and *Dufour's* gland, using queens and reproductive workers (we did not have samples of reproductive workers for *V. crabro*, but we present a heatmap and related analysis in the supplementary material). To check whether eggs were chemically similar to CHCs or *Dufour's* gland secretion the compounds were log2-transformed using relative abundances and compared by ANOVA followed by Tukey test with FDR correction. A heatmap using the mean relative abundance was done to visualize the hydrocarbon composition of the three different group of samples (CHCs x eggs x *Dufour's* gland). For that, we used row z scores calculated per group. Clustering was based on a UPGMA hierarchical clustering using Euclidean distance as the distance metric. We inspected the chemical differences

of the previously published queen pheromones in *V. vulgaris* and *D. saxonica* (Van Oystaeyen et al. 2014; Oi et al. 2016) in our samples. We used a similar approach to indicate the fertility cues in the study species. Besides, to check if egg-marking compounds are species-specific or if there exist similarity among the chemical compounds released by queens and reproductive workers of Vespinae species we also run a PERMANOVA test (9999 permutations), followed by a PCA plot and finally a SIMPER analysis in egg-marking compounds data for queen-laid and worker-laid eggs. For the second analysis, the PERMANOVA test was used to verify whether samples were similar according to their species. The PCA was used to visualise whether samples would group together (chemical similarity among compounds released during oviposition) or if they would group separately (existence of a species-specific egg-marking). The SIMPER was used to highlight which chemical compounds would be specific to females (species-specific). Considering that in the second analysis we used samples of queens and reproductive workers, we used samples from all species but *V. crabro*. All the statistical analyses were performed using RStudio (version 1.4.1717, R core team 2021).

Results

Dolichovespula saxonica

The CHCs analysis of *D. saxonica* revealed a total of 45 compounds, which ranged from *n*-C23 to C33:1. The most representative class of CHCs was methyl-alkanes 44.44%, followed by dimethyl-alkanes 22.22%, then linear alkanes 17.77%, alkenes 11.11%, and unknown compounds 4.44% (Table S1). Overall, we found that the proportion of linear alkanes was higher in queens and reproductive workers, whereas virgin queens were most represented by alkenes, and workers did not express any class in a higher proportion when compared to queens and virgin queens (Figure 1). According to the permutation analysis, overall, all groups (queens, virgin queens, reproductive workers, and sterile workers) were statistically different based on their CHCs (Table 2). However, based on the post-hoc permutation analysis, only three pairs were statistically different (queens x workers / virgin queens x workers / reproductive workers x workers) (Table 2). The PCA of relative abundances explained 86.79% of the total variation, PC1 represented 72.62% and PC2 represented 14.17% (Figure S1a). Based on the SIMPER analysis, the most representative compounds that contributed to group differentiation

included two linear alkanes, two alkenes, two methyl-alkanes, and two dimethyl-alkanes (Table S4).

The chemical analysis of *D. saxonica* eggs revealed a total of 54 compounds, which ranged from *n*-C20 to *n*-C33. The most representative class of hydrocarbons was methyl-alkanes 38.88%, followed by linear alkanes 22.22%, then alkenes 20.37%, and dimethyl-alkanes 18.51% (Table S2). Overall, the proportion of methyl-alkanes was higher in queen-laid eggs, whereas worker-laid eggs were best represented by linear alkanes and alkenes (Figure 2). According to the permutation analysis, queen-laid and worker-laid eggs of *D. saxonica* were not different based on their hydrocarbons (Table 2). The PCA of relative abundances explained 72.29% of the total variation, PC1 represented 48.90% and PC2 represented 23.39% (Figure S1b). Among the five most representative compounds that contributed to group differentiation according to SIMPER, only 3-MeC29 was statistically different, and the average was higher in queen-laid eggs (Table S4).

The *Dufour*'s gland analysis of *D. saxonica* revealed a total of 49 compounds, which ranged from *n*-C23 to *n*-C35. The most representative class of CHCs was methyl-alkanes 38.77%, followed by linear alkanes 22.44%, then alkenes 20.40%, and dimethyl-alkanes 18.36 (Table S3). Overall, the proportion of methyl-alkanes was higher in the queen *Dufour*'s gland if compared with reproductive worker and worker samples, but not if compared to virgin queen samples. Virgin queen *Dufour*'s gland samples were most represented by alkenes, whereas reproductive worker and worker *Dufour*'s gland samples had a higher proportion of linear alkanes (Figure 3). According to the permutation analysis, overall, all groups (queens, virgin queens, reproductive workers, and workers) were statistically different based on the chemical compounds found in their *Dufour*'s glands (Table 2). However, based on the post-hoc permutation analysis, neither of the pairs was statistically different. The PCA of relative abundances explained 73.84% of the total variation, PC1 represented 45.12% and PC2 represented 28.72% (Figure S1c). Based on the SIMPER analysis, the most representative compounds that contributed to group differentiation included three linear alkanes, two alkenes, and two methyl-alkanes (Table S4).

Dolichovespula media

The CHCs analysis of *D. media* revealed a total of 45 compounds, which ranged from *n*-C18 to 17-;15-;13-;11-MeC35. The most representative class was methyl-alkanes 46.66%, followed by linear alkanes 31.11%, then alkenes 15.55%, and dimethyl-alkanes 6.66% (Table S5). In *D. media*, the proportion of linear alkanes was higher in queens, and the proportion of alkenes was higher in virgin queens. Reproductive workers, and workers, on the other hand, were best represented by methyl-alkanes (Figure 1). According to the permutation analysis, the global and pair-wise comparisons were statistically different (Table 2). The PCA of relative abundances explained 79.35% of the total variation, PC1 represented 57.33% and PC2 represented 22.02% (Figure S2a). Based on the SIMPER analysis, the most representative compounds that contributed to group differentiation included three linear alkanes, one alkene, and three methyl-alkanes (Table S8).

Twenty-five compounds were detected in eggs of *D. media*, which ranged from C21:1 to 15-;13-;11-;9-MeC31. Among the identified hydrocarbons, methyl-alkanes were the most representative class with 44.00%, followed by alkenes with 28.00%, then linear alkanes 20.00%, and dimethyl-alkanes 8.00% (Table S6). As it was found for eggs of *D. saxonica*, the queen-laid eggs were represented by a higher proportion of methyl-alkanes, whereas worker-laid eggs were most represented by linear alkanes and alkenes (Figure 2). The permutation analysis revealed that queen-laid and worker-laid eggs are chemically distinct based on their hydrocarbons (Table 2). The PCA of relative abundances explained 69.79% of the total variation, PC1 represented 48.81% and PC2 represented 20.98% (Figure S2b). According to the SIMPER analysis, two linear alkanes, and three methyl-alkanes were the most important to promote group differentiation (Table S8).

A total of 37 compounds were identified in *Dufour*'s gland samples of *D. media*, which ranged from C21:1 to 17-;15-;13-;11-MeC35. Methyl-alkanes were the most representative class in *Dufour*'s gland samples of *D. media* with 40.54%, followed by alkenes with 27.02%, then linear alkanes 24.32%, and dimethyl-alkanes 8.10% (Table S7). Overall, queen *Dufour*'s glands had a higher proportion of methyl-alkanes, virgin queen *Dufour*'s glands were more represented by linear alkanes and alkenes, and worker *Dufour*'s glands did not have a higher proportion of any compound class when compared to queens and virgin queens (Figure 3). The global permutation analysis revealed that *Dufour*'s gland samples are chemically different, which was consistent with the pairwise

comparisons, with exception of the pair queen x worker, which had a marginal p -value ($p = 0.053$) (Table 2). The PCA of relative abundances explained 64.95% of the total variation, PC1 represented 36.44% and PC2 represented 28.51% (Figure S2c). Based on the SIMPER analysis, the most representative compounds that contributed to group differentiation included two alkenes, three methyl-alkanes, one dimethyl-alkanes, and one mixture containing a linear alkane and one alkene (Table S8).

Vespa crabro

A total of 33 peaks were detected in the CHC samples of *V. crabro*, which ranged from C21:1 to 3-MeC29. Methyl-alkanes were the most representative class, with 42.42% of the identified compounds, followed by linear alkanes 27.27%, alkenes, and unknown compounds either represented 12.12% of the identified compounds, and lastly dimethyl-alkanes represented 6.06% (Table S9). In *V. crabro*, the proportion of linear alkanes was higher in queens, whereas workers were best represented by alkenes (Figure 1). According to the permutation analysis, queens, and workers of *V. crabro* are statistically different based on their CHC (Table 2). The PCA of relative abundances explained 96.21% of the total variation, PC1 represented 92.80% and PC2 represented 3.41% (Figure S3a). Based on the SIMPER analysis, the most representative compounds that contributed to group differentiation included two linear alkanes, two alkenes, and one methyl-alkane (Table S12).

The chemical analysis of *V. crabro* eggs revealed 37 compounds, which ranged from *n*-C18 to 15-;13-;11-;9-MeC29. The most representative class of hydrocarbons was methyl-alkanes with 48.64%, followed by linear alkanes 32.43%, then alkenes 13.51%, and finally, dimethyl-alkanes and unknown compounds represented 2.70% (Table S10). Overall, the proportion of alkenes was higher in queen-laid eggs, and the proportion of linear alkanes was higher in worker-laid eggs (Figure 2). The permutation analysis indicated that queen-laid and worker-laid eggs are chemically distinct (Table 2). The PCA of relative abundances explained 92.60% of the total variation, PC1 represented 64.90% and PC2 represented 27.70% (Figure S3b). According to the SIMPER analysis, three linear alkanes, and two alkenes were the most important for promoting group differentiation (Table S12).

A total of 53 compounds were identified in *Dufour's* gland samples of *V. crabro*, which ranged from *n*-C21 to *n*-C35. Methyl-alkane was the most representative class in

the samples with 54.71%, followed by linear alkanes 26.41%, then dimethyl-alkanes 11.32%, and alkenes 7.54% (Table S11). Linear alkanes were found in higher proportions in queen *Dufour*'s gland samples, and alkenes were the class that best represented worker *Dufour*'s glands (Figure 3). Based on the permutation analysis, queen *Dufour*'s gland and worker *Dufour*'s gland samples were chemically distinct (Table 2). The PCA of relative abundances explained 89.64% of the total variation, PC1 represented 72.45% and PC2 represented 17.19% (Figure S3c). Based on the SIMPER analysis, the most representative compounds that contributed for group differentiation included two alkanes, one alkene, and two methyl-alkanes (Table S12).

Vespula germanica

A total of 31 compounds were found in the CHC samples of *V. germanica*, which ranged from *n*-C22 to 7,x-diMeC33. The most representative class of CHCs was methyl-alkanes 51.61%, followed by linear alkanes 25.80%, then dimethyl-alkanes 12.90%, and alkenes 9.67 % (Table S13). Lastly, the proportion of linear alkanes was higher in queens of *V. germanica*, and the proportion of methyl-alkanes was higher in reproductive workers and workers (Figure 1). According to the permutation analysis, queens, and workers of *V. germanica* are statistically different based on their CHC (Table 2). The PCA of relative abundances explained 96.06% of the total variation, PC1 represented 82.94% and PC2 represented 13.12% (Figure S4a). Based on the SIMPER analysis, the most representative compounds that contributed for group differentiation included three linear alkanes, and two methyl-alkanes (Table 16).

The chemical analysis of *V. germanica* eggs revealed a total of 27 compounds, which ranged from *n*-C21 to *n*-C31. The most representative class of hydrocarbons was methyl-alkanes with 44.44%, followed by linear alkanes 33.33%, and both dimethyl-alkanes and alkenes represented 11.11% (Table S14). Queen-laid eggs were best represented by methyl-alkanes, whereas worker-laid eggs were more represented by linear alkanes (Figure 2). According to the permutation analysis, queen-laid and worker-laid eggs are not different (Table 2). The PCA of relative abundances explained 71.25% of the total variation, PC1 represented 42.01% and PC2 represented 29.24% (Figure S4b). According to the SIMPER analysis, only 3-MeC27 was statistically different among the five most important compounds, which was found in a higher proportion in queen-laid eggs (Table S16).

A total of 23 compounds were identified in the *Dufour*'s gland samples of *V. germanica*, which ranged from *n*-C23 to 13,17-diMeC33. Methyl-alkanes were the most representative class in *Dufour*'s gland samples of *V. germanica* with 56.52%, followed by linear alkanes 30.43%, alkenes 8.69%, and dimethyl-alkanes 4.34% (Table S15). Queen *Dufour*'s gland samples were best represented by linear alkanes, whereas methyl-alkanes were found in higher proportions in worker *Dufour*'s gland samples (Figure 3). According to the permutation analysis, the *Dufour*'s gland content of queens and workers was statistically different (Table 2). The PCA of relative abundances explained 81.83% of the total variation, PC1 represented 64.03% and PC2 represented 17.80% (Figure S4c). Based on the SIMPER analysis, the most representative compounds that contributed to group differentiation included one alkane, three methyl-alkanes, and a mixture containing a linear and a dimethyl-alkane (Table S16).

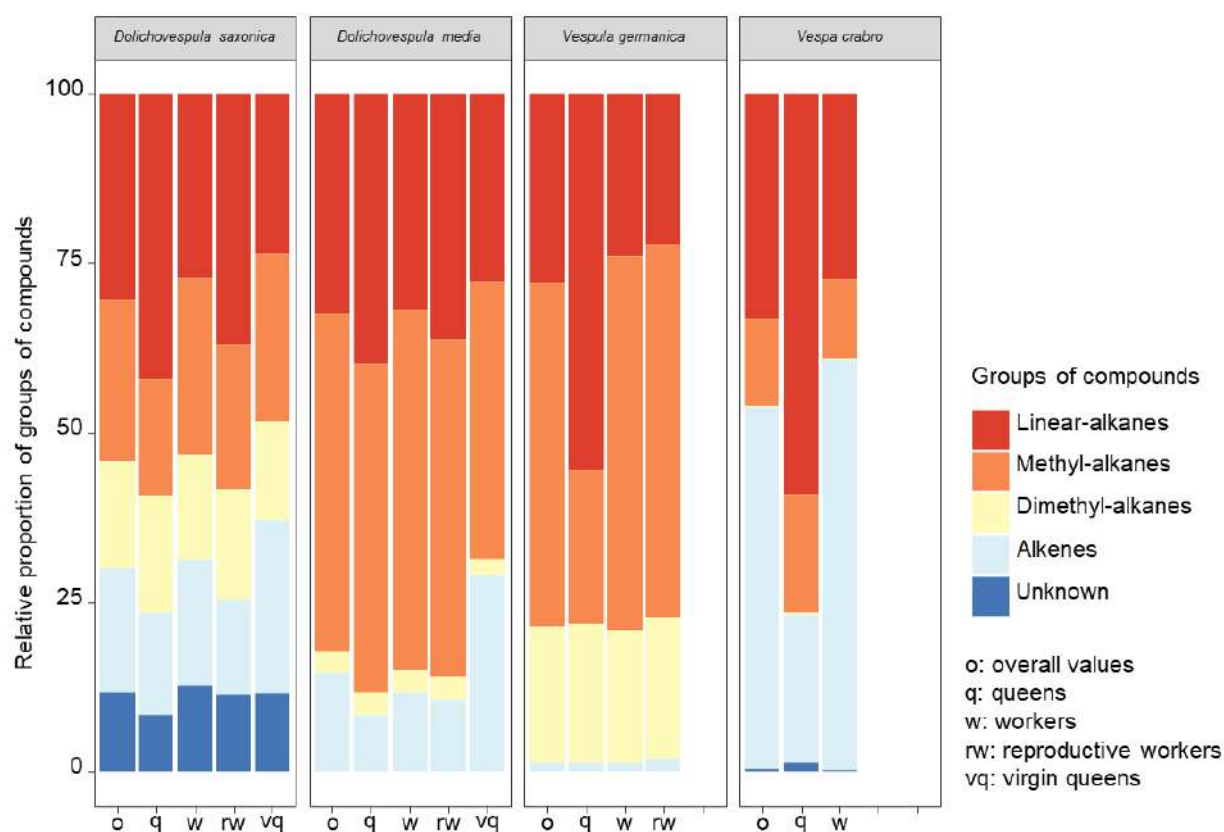


Figure 1: Queens (q), virgin queens (vq), reproductive workers (rw) and sterile workers (w) expressed different proportions of cuticular hydrocarbons (CHCs). Schematic representation of CHC classes identified in *Dolichovespula saxonica*, *Dolichovespula media*, *Vespa germanica* and *Vespa crabro*, linear alkanes, methyl alkanes, dimethyl-alkanes, alkenes and unknown compounds. Each bar plot represents the relative proportion of groups and the overall proportion of the species.

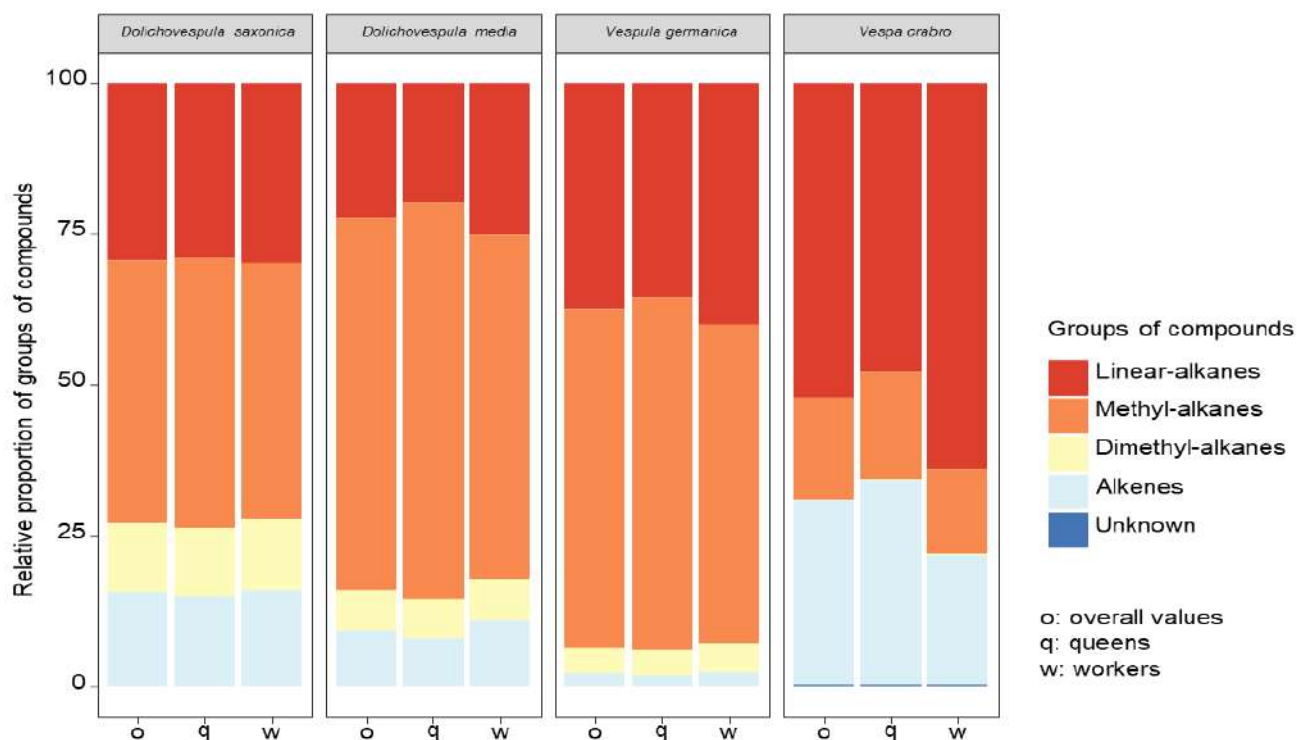


Figure 2: Queen-laid eggs (q) and worker-laid eggs (w) expressed different proportions of hydrocarbons in their surface of *Dolichovespula saxonica*, *Dolichovespula media*, *Vespula germanica* and *Vespa crabro*. Each bar plot represents the relative proportion of groups of compounds found in queen-laid, and worker-laid eggs, and the overall proportion (o) of each species of linear alkanes, methyl alkanes, dimethyl-alkanes, alkenes and unknown compounds.

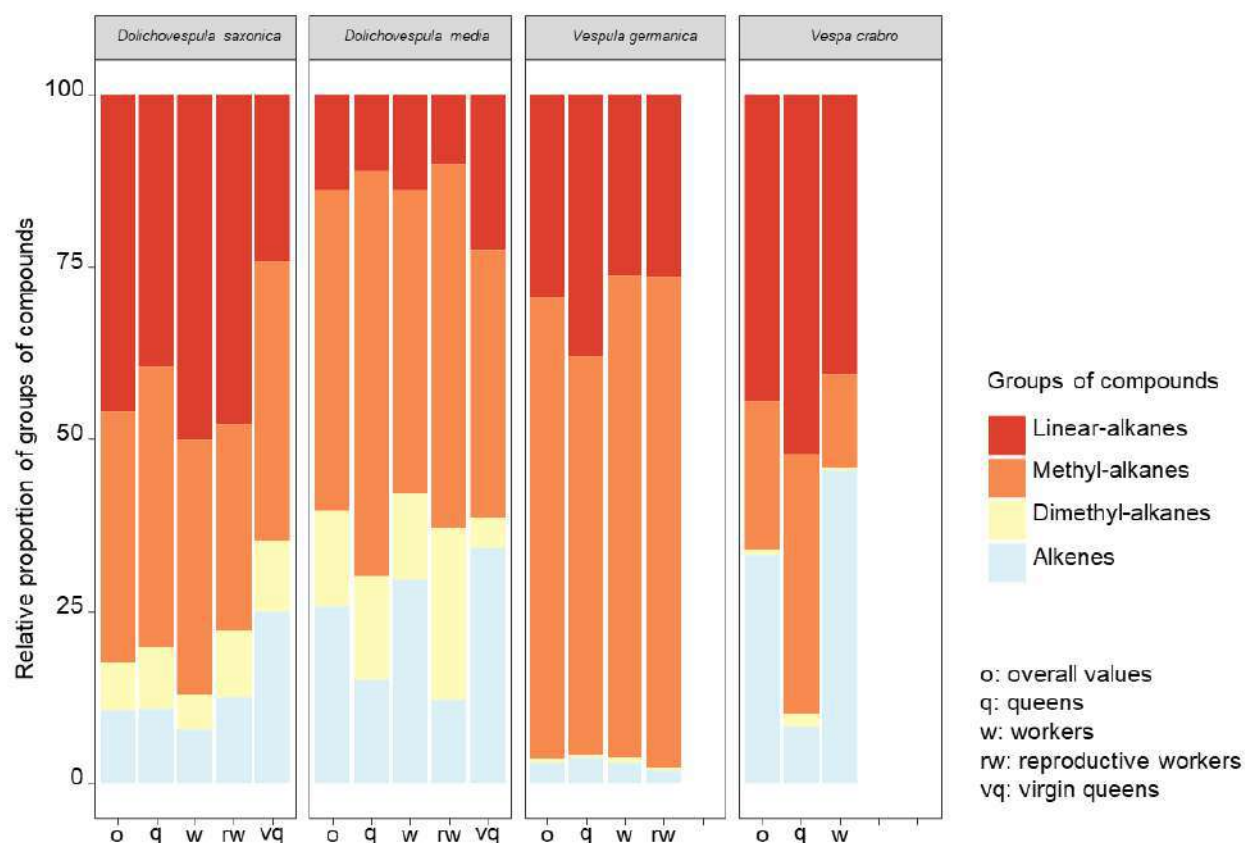


Figure 3: The *Dufour's* gland of queens (q), virgin queens (vq), reproductive workers (rw) and sterile workers (w) express different proportions of hydrocarbons. Schematic representation of hydrocarbon classes linear alkanes, methyl alkanes, dimethyl-alkanes, alkenes and unknown compounds, identified in samples of *Dolichovespula saxonica*, *Dolichovespula media*, *Vespula germanica* and *Vespa crabro*. Each bar plot represents the relative proportion of groups of compounds found in samples of workers, virgin queens, queens, and the overall proportion (o) of the species.

Table 2: Permutation analysis (PERMANOVA) per species and group of samples (CHCs, eggs, and *Dufour* gland). Significance levels * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

<i>Dolichovespula saxonica</i> - CHCs				
	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
all groups	8.707	0.501	<0.001	***
queens x virgin queens	6.802	0.531	0.474	n.s
queens x reproductive workers	1.707	0.196	0.948	n.s
queens x workers	11.579	0.378	<0.01	**
virgin queens x reproductive workers	21.890	0.757	0.054	n.s
virgin queens x workers	9.661	0.337	<0.01	**
reproductive workers x workers	7.701	0.278	<0.01	**
<i>Dolichovespula media</i> - CHCs				
	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
all groups	25.297	0.617	<0.001	***
queens x virgin queens	48.090	0.787	<0.01	**

queens x reproductive workers	21.478	0.682	<0.05	*
queens x workers	28.622	0.472	<0.01	**
virgin queens x reproductive workers	23.454	0.609	<0.01	**
virgin queens x workers	35.727	0.491	<0.01	**
reproductive workers x workers	2.341	0.064	0.498	n.s

<i>Vespa crabro</i> - CHCs				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
queens x workers	139.600	0.772	<0.001	***

<i>Vespula germanica</i> - CHCs				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
all groups	31.368	0.699	<0.001	***
queens x reproductive workers	50.147	0.862	<0.05	*
queens x workers	61.269	0.735	<0.01	**
reproductive workers x workers	0.772	0.031	1.000	n.s

<i>Dolichovespula saxonica</i> - eggs				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
queens x workers	1.843	0.068	0.131	n.s

<i>Dolichovespula media</i> - eggs				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
queens x workers	5.507	0.113	<0.001	***

<i>Vespa crabro</i> - eggs				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
queens x workers	10.207	0.169	<0.001	***

<i>Vespula germanica</i> - eggs				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
queens x workers	1.701	0.038	0.156	n.s

<i>Dolichovespula saxonica</i> - Dufour gland				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
all groups	3.141	0.385	<0.001	***
queens x virgin queens	6.722	0.770	1.000	n.s
queens x reproductive workers	1.139	0.275	1.000	n.s
queens x workers	4.998	0.294	0.066	n.s
virgin queens x reproductive workers	2.067	0.407	1.000	n.s
virgin queens x workers	2.648	0.180	0.318	n.s
reproductive workers x workers	2.870	0.180	0.180	n.s

<i>Dolichovespula media</i> - Dufour gland				

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
all groups	4.860	0.267	<0.001	***
queens x virgin queens	6.668	0.454	<0.05	*
queens x reproductive workers	1.609	0.138	1.000	n.s

queens x workers	3.266	0.098	0.060	n.s
virgin queens x reproductive workers	8.637	0.463	<0.01	**
virgin queens x workers	6.395	0.175	<0.01	**
reproductive workers x workers	4.586	0.125	<0.05	*
<i>Vespa crabro</i> - Dufour gland				
	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
queens x workers	40.890	0.650	<0.001	***
<i>Vespula germanica</i> - Dufour gland				
	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Sig. Level
all groups	2.790	0.166	<0.01	**
queens x reproductive workers	4.942	0.291	<0.01	**
queens x workers	4.346	0.158	<0.01	**
reproductive workers x workers	0.222	0.010	1.000	n.s

What are the fertility cues in each species?

Several hydrocarbons differed significantly when we compared all the queen and reproductive worker samples (CHCs, eggs and *Dufour's* gland) (Figure 4, Table S20, Table S21 and Table S22). The heatmap UPGMA cluster analysis revealed that for the three species samples clustered primarily based on their group (CHCs, eggs or *Dufour's* gland) regardless of their caste. Secondly, samples of *D. saxonica* formed a cluster including the CHCs and a separate one that included eggs and *Dufour's* gland (Figure 4a). Samples of *D. media* and *V. germanica*, on the other hand, formed a cluster including *Dufour's* gland and another one including both CHCs and eggs (Figure 4b, 4c). In summary, these results indicate that each source (CHCs, eggs and *Dufour's* gland) has its own characteristic chemical composition for the three species, once samples did not clustered based on their correspondent caste. Additionally, it is possible that the correspondence between sources naturally differ among species. In *D. saxonica*, the linear alkanes n-C29 and n-C31 stand out as putative queen pheromones, once they are highly produced by both queens and reproductive workers and their levels do not differ between the two groups ($p > 0.05$). The methyl alkanes 3-MeC27 and 3-MeC29 are overproduced in eggs and in *Dufour's* gland content by queens and reproductive workers ($p > 0.05$). In *D. media*, the only CHCs previously identified as queen pheromone is the alkane n-C28, which was not different between queens and reproductive workers ($p > 0.05$). The eggs of *D. media* have higher levels of 3-MeC27 and 3-MeC29. Neither of them differed statistically between queen and reproductive workers ($p > 0.05$). However, *Dufour's*

gland samples did not have similar levels of 3-MeC27 and 3-MeC29 as in eggs. In *V. germanica*, the putative queen pheromone is n-C27. We found high levels of 3-MeC27 covering the surface of eggs and *Dufour's* gland content. Neither n-C27 nor 3-MeC27 differed between queens and reproductive workers ($p > 0.05$).

Is Dufour's gland the main source of egg compounds in Vespinae wasps?

Our data suggest that indeed the chemical compounds that cover the surface of eggs are more similar to the chemical composition of *Dufour's* gland in the species *D. saxonica*. However, for *D. media* and *V. germanica*, we found a different pattern, with the chemical composition of eggs being chemically closer to those found over the body surface of females (CHCs) (Figure 4).

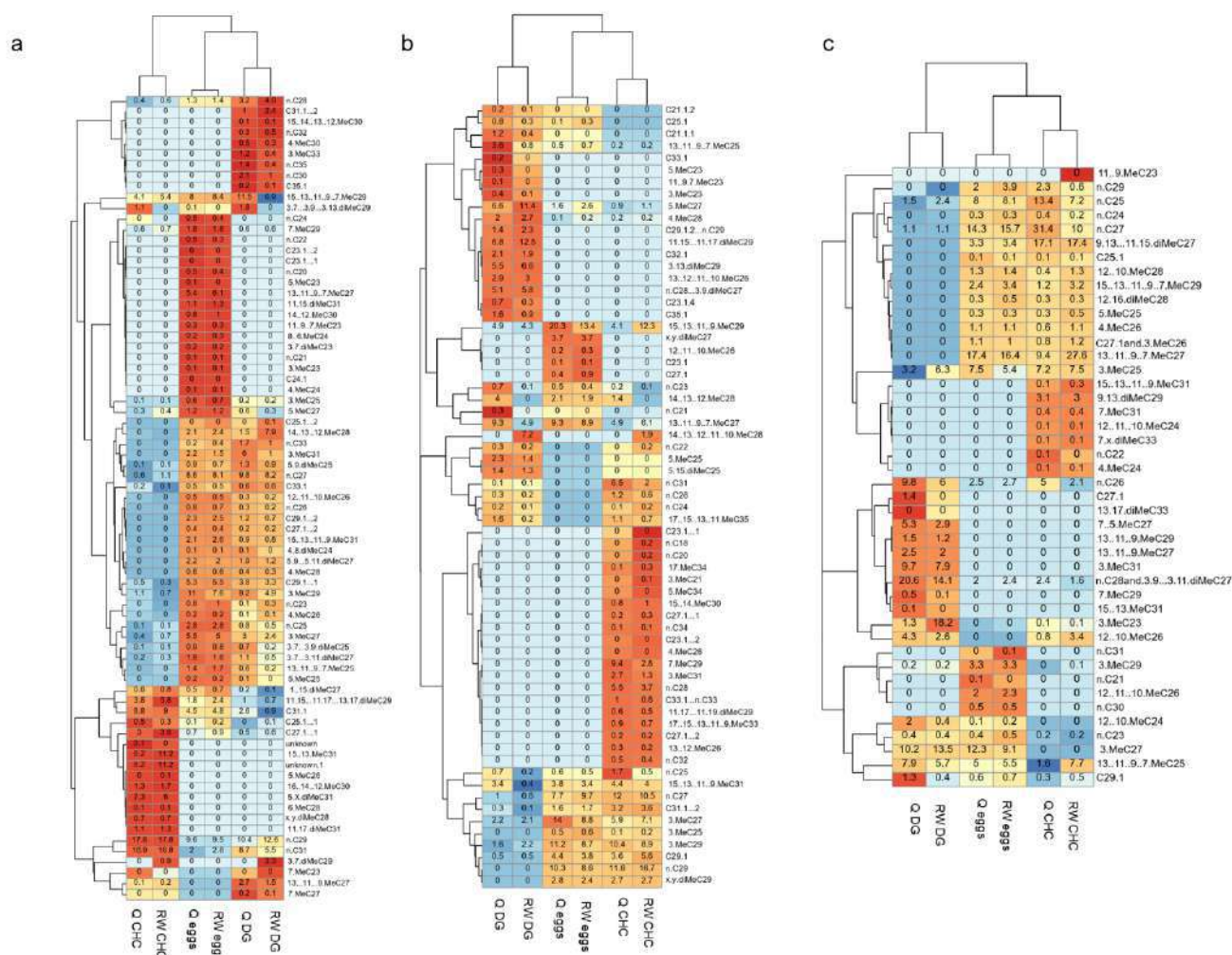


Figure 4: Heatmaps representing the differences in relative abundance of compounds (log-transformed) in the chemical profile of the cuticle (CHCs), egg surface (eggs) and in *Dufour's* gland (DG) secretion for the three species (a) *Dolichovespula saxonica*, (b) *Dolichovespula media* and (c) *Vespula germanica*. Colours represent the mean fold difference in relative abundance of each hydrocarbon found for each of the three groups of samples. Compounds were clustered based on a UPGMA clustering using Euclidean distance as the distance metric. Q = queen; RW = reproductive worker; Q eggs = queen-laid eggs, RW eggs = reproductive worker-laid eggs.

Are egg-marking cues species-specific?

According to the PERMANOVA analysis, egg-marking cues varied significantly among queen-laid eggs from different species ($p = 0.006$ among the six different pairs) and among worker-laid eggs from different species ($p = 0.006$ among the six different pairs). The PCA analysis revealed that the combination of the first two PCs explained a total of 80.58% of the overall variation among egg hydrocarbons found over queen-laid eggs (Figure 5a), and a total of 62.79% of the overall variation was detected among egg hydrocarbons found over worker-laid eggs (Figure 5b). In both cases (queen-laid and worker-laid eggs) samples clustered primarily according to their species (Figure

5a and 5b). According to the SIMPER analysis, the top five compounds from each pairwise comparison based on queen-laid egg samples included three linear alkanes (n-C25, n-C27 and n-C29), four alkenes (C29:1, C29:1 – 1, C29:1 – 3 and C31:1), and five methyl-alkanes (3-MeC25, 13-;11-;9-;7-MeC27, 3-MeC27, 15-;13-;11-;9-;7-MeC29 and 3-MeC29). Whereas the top five compounds from each pairwise comparison based on worker-laid egg samples included three linear alkanes (n-C25, n-C27 and n-C29), three alkenes (C29:1 – 1, C29:1 – 3 and C31:1) and three methyl-alkanes (13-;11-;9-;7-MeC27, 15-;13-;11-;9-;7-MeC29 and 3-MeC27) (Table S24). Interestingly, a certain chemical convergence was detected between queen-laid and worker-laid eggs from different species. Eggs laid by *D. media* females were represented by 3-MeC27 and 15-;13-;11-;9-;7-MeC29; eggs laid by *D. saxonica* females were represented by C29:1 1 and C31:1; eggs laid by *V. germanica* females were represented by n-C27 and 13-;11-;9-;7-MeC27; eggs laid *V. crabro* females were represented by n-C25 and C25:1 - 3. The fact that these hydrocarbons were conserved between queen-laid and worker-laid eggs from each species indicates that they could potentially be species-specific. The egg-marking cues from *V. crabro* were the most divergent for both queen-laid and worker-laid eggs (Figure 5). Even though being statistically different, the egg-marking cues from *D. media* and *D. saxonica* were the closer (Figure 5).

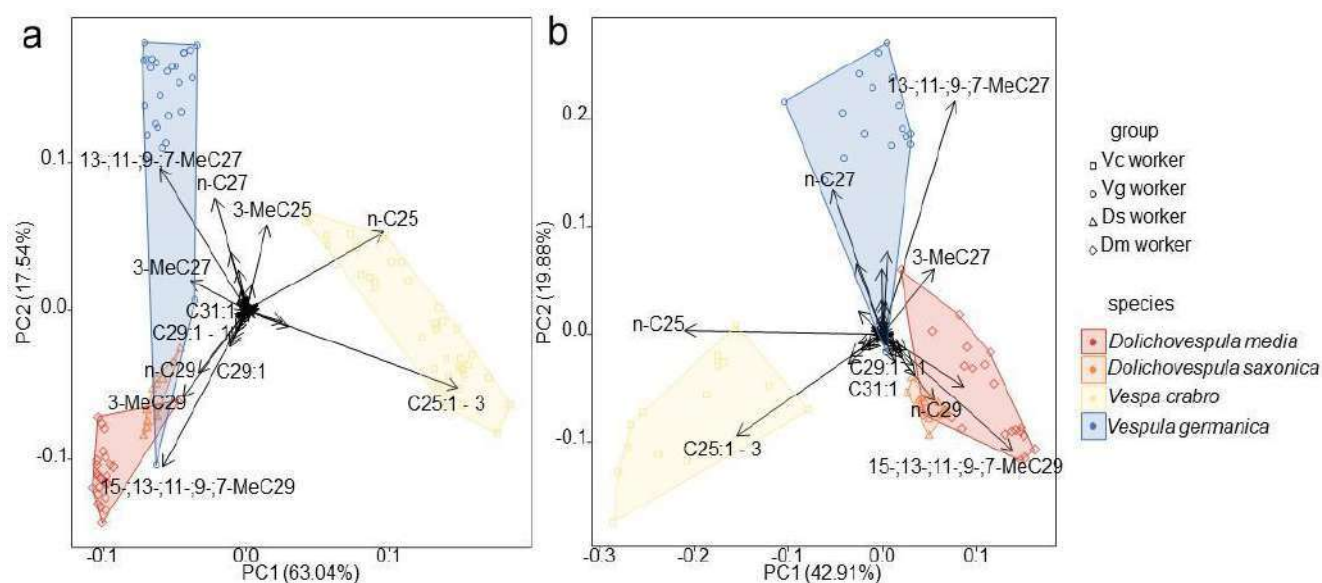


Figure 5: Principal component analysis (PCA) plots based on the chemical information identified in the surface of (a) queen-laid and (b) worker-laid eggs. Compounds represent the top five hydrocarbons highlighted by the SIMPER analysis (the ones the most likely explain the variation among samples from different species). Vc = *Vespa crabro*, Vg = *Vespa germanica*, Ds = *Dolichovespula saxonica* and Dm = *Dolichovespula media*.

Discussion

Our results demonstrate that the chemical composition of cuticular hydrocarbons (CHCs), egg surface, and *Dufour's* gland differs according to caste in the four Vespinae wasps, *D. saxonica*, *D. media*, *V. germanica* and *V. crabro*. The variation was found to be more pronounced across overall comparisons, being CHCs different between queens and workers. Moreover, for egg samples a significant difference was found in the permutations across two species *D. media* and *V. crabro*, whereas for the other two species *D. saxonica* and *V. germanica*, only a subtle variation was detected. In the eggs, the most representative compounds, based on SIMPER analysis, were for *D. saxonica* the 3-MeC29, which was found in higher proportions in queen-laid eggs; while for *V. germanica* it was the compound 3-MeC27. Although we present correlative evidence for these methylated compounds, these results indicate that queen-laid and worker-laid eggs in the four study species possibly contain information that may help workers to discriminate their maternity, in a similar way as in the common wasp *V. vulgaris* (Oi et al. 2015b). For *Dufour's* gland samples, the majority of the pairwise comparisons were statistically different based on the overall chemical composition. In *D. saxonica*, variation was driven by specific compounds, queens had higher proportions of 15-;13-;11-;9-MeC29, and *n*-C31, and virgin queens had a higher proportion of an alkene C27:1. We also found that the chemical composition vary primarily according to their sources, CHCs, eggs and *Dufour's* gland rather than caste. In samples of *D. saxonica* we detected that a higher chemical resemblance between eggs and *Dufour's* gland. In samples of *D. media* and *V. germanica* although there is an overlap among compounds of eggs and *Dufour's* gland, a higher chemical resemblance was detected between samples of CHCs and eggs. The queen-linked egg-maternity compounds 3-MeC27 and 3-MeC29 in *V. vulgaris* potentially reflect fertility/maternity status in the species explored here. In *D. saxonica* and *D. media*, we found that the same methylated hydrocarbons are overexpressed in queen and reproductive worker samples (egg + *Dufour's* gland samples). In *V. germanica*, we detected the 3-MeC27 in similar proportions in egg and *Dufour's* gland of queen and reproductive worker samples. Finally, we found that the compounds covering the eggs differed between species, for both queen-laid and worker-laid eggs. These results suggest that in addition to carry information regarding egg maternity (queen-laid or worker-laid), the compounds released in the eggs during oviposition also carry species-specific information.

The CHCs that were most specific to queens based on PCA and SIMPER analysis were *n*-C29, *n*-C31, and 5,x-diMeC31 for *D. saxonica*; 3-MeC29, 7-MeC29, and *n*-C31 for *D. media*; *n*-C25, *n*-C27, and 3-MeC27 for *V. crabro*; and *n*-C25, *n*-C26, and *n*-C27 for *V. germanica*. Among these compounds, *n*-C25, *n*-C26, *n*-C27, 3-MeC27, *n*-C29, 3-MeC29, *n*-C31 were previously spotted to be queen-specific in Vespinae wasps (Butts et al. 1990; Van Oystaeyen et al. 2014; Oi et al. 2016; van Zweden et al. 2014; Derstine et al. 2018; da Silva et al. 2021). Among the species studied here, at least for *D. saxonica*, a blend of CHCs were already demonstrated to play a role over worker reproduction (Oi et al. 2016). In *D. saxonica* one or more components of the blend (*n*-C29, 3-MeC29, *n*-C30, *n*-C31, and 3-MeC31) prevented worker reproduction (Oi et al. 2016). The correlation among certain CHCs and castes is linked to the fact that these chemical molecules are overproduced as a consequence of female fertility (=ovary activation) in social insects (Izzo et al. 2010; Oi et al. 2015a; Holman 2018; Honorio et al. 2019). Here, we show that the chemical variation is not only restricted to CHCs in *D. saxonica*, *D. media*, *V. crabro*, and *V. germanica*, but rather extended to other sources (e.g. *Dufour's* gland and hence eggs). Our results are in line with a previous report showing that queens of *V. germanica* chemically differ from virgin queens and workers (da Silva et al., 2021). Additionally, we demonstrate here that chemical compounds also differ between queens and reproductive workers (CHCs, eggs, and *Dufour's* gland). The overproduction of certain CHCs is common in queens of Polistinae wasps. For instance, in the swarm-founding species *Synoecca septentrionalis*, the linear alkanes *n*-C25, *n*-C29, and *n*-C31 were found in higher proportions over the cuticular surface of queens (Santos et al. 2018). The linear alkane *n*-C29 was one of the compounds found exclusively in samples of queens in *Polybia sericea* (Soares et al. 2021), whereas in the sister species *Polybia micans*, the linear alkane *n*-C25 was one of the two CHCs detected in higher proportion in queens (Kelstrup et al. 2014). In the primitively eusocial wasps *Polistes*, some of the CHCs that we reported here also reflect dominance or fertility status of dominant females (=queens or alpha females). In *Polistes satan*, *n*-C25, 3-MeC27, *n*-C29, and *n*-C31 are overexpressed over the body surface of dominant females when compared with either subordinate and worker females (Oi et al. 2019; Tannure-Nascimento et al. 2008). Queens of *Polistes metricus* show higher proportions of *n*-C27, and *n*-C29 when compared to workers and males (Layton et al. 1994). Altogether, all the information provided above suggests that linear alkanes and 3-methyl alkanes are the ones that reflect

fertility in queens of several species of Vespidae, and can potentially work as putative fertility signals.

Hydrocarbon signatures of egg maternity were characterized in the common wasp *V. vulgaris* and the hydrocarbon 3-MeC29 signals egg maternity and drive egg policing (Oi et al. 2015b). The same compound was identified in higher proportions in the egg surface and in the *Dufour's* gland of queens in three out of the four species *D. saxonica*, *D. media*, and *V. germanica*. In *V. crabro*, however, 3-MeC29 was found only in a higher proportion in CHC and *Dufour's* gland. Queens that live in big colonies can potentially use egg-marking as an alternative strategy of communication, by advertising their presence without requiring direct physical contact with the workers. This was shown for some ant species such as *Myrmica rubra* (Brian and Rigby 1978), *Aphaenosgaster cockerelli* (Hölldobler and Carlin 1989), and *Camponotus floridanus* (Endler et al. 2004), but could also be applied for Vespinae wasps. In the relatively small nests of *Polistes* wasps, females use the same strategy to selectively detect and destroy eggs based on their egg maternity (queen-laid/worker-laid) (Liebig et al. 2005). For instance, a chemical correspondence is present between cuticular and egg surface in *P. dominula*. Chemical compounds, however, vary according to female social status, meaning that even though females other than the queen can reproduce, they fail to make their eggs go unnoticed in the colonies (Dapporto et al. 2007). In colonies of the primitively eusocial ant *Dinoponera quadriceps*, the hydrocarbons covering eggs' surface allow nurses to discriminate them according to nest origin, and one alkene (C27:1) together with two methyl-alkanes (15-;13-;11-MeC29, and 3-MeC27) were spotted as recognition cues (Tannure-Nascimento et al. 2009). In addition to possibly containing information that reflects maternity, we found out that eggs also carry information that are specific to their species. The specificity between hydrocarbons and species is not only restricted to the body surface in Vespinae wasps (Derstine et al. 2018), but it is also extended to other components, as eggs and *Dufour* gland. We did not find a chemical similarity among chemical compounds covering the egg surface of queens from different species, implying in the non-existence of a specific compound responsible for informing egg maternity. We hypothesize that different hydrocarbons in each species may display egg maternity cues, and that this variation may be advantageous to avoid social parasites.

According to our results, the *Dufour's* gland could potentially work as the main source of chemical compounds that cover the surface of eggs (egg-marking pheromones)

in *D. saxonica*, as we found out a great overlap between samples of eggs and *Dufour's* gland samples. For the other two species *V. germanica* and *D. media*, *Dufour's* gland can potentially work as the source that releases at least part of the egg-marking compounds, as we detected a slight overlap between some compounds among the two groups of samples. The lack of a higher similarity between *Dufour's* gland and eggs can be explained by the fact that *Dufour's* gland is a reservoir of chemical compounds that have functions other than egg-marking. For example, the *Dufour's* gland of *Ropalidia marginata* queens contains queen signals, which reduce aggressive levels among potential queens (Bhadra et al. 2010; Mitra et al. 2011). In the primitively eusocial bee *Bombus impatiens*, *Dufour's* gland content changes according to caste and female physiological status, eliciting electroantennography responses in workers (Derstine et al. 2021). In *P. dominula*, the *Dufour's* gland is also involved with nestmate recognition. In *P. dominula* indeed CHCs and egg-marking cues are highly chemically similar (Dapporto et al. 2007), and the results we encountered for *D. media* and *V. germanica* follow this pattern. Lastly, the fact that the chemical composition of *Dufour's* gland and eggs do not fully match is not surprising, eggs can also acquire compounds through the direct contact that females establish with them. For instance, queens touch the eggs with their antennae from time to time (personal observation), besides, it is possible that during the egg screening process queens release chemical compounds from their cephalic glands, which could be integrated into the eggs' surface. In fact, in trophallactic fluids exchanged by ants of the species *Camponotus floridanus*, several chemical molecules have been detected (LeBoeuf et al. 2016), among them several long-chain hydrocarbons. We still lack evidence if this is also the case of Vespinae wasps. Further research should consider checking how much cephalic fluids released by queens of Vespinae match the chemical composition of their eggs upon oviposition. It is more reasonable to expect that the *Dufour's gland* is responsible for carrying out queen pheromones to be spread across colonies, however, it would not be surprising whether the other exocrine glands also release queen pheromones, especially if we consider that in *Apis mellifera* queen pheromones are located in the mandibular gland (Slessor et al. 1988, 2005).

Overall, chemical quantitative variation was detected across samples in the four study Vespinae species. It means that females from different castes express a similar chemical composition of CHCs, hydrocarbons deposited in their eggs, and also *Dufour* gland content, but their proportions are not the same. The only exceptions were for CHC

samples of *D. saxonica*, and *V. germanica* and also for *Dufour* gland samples of *V. crabro*, in which females from different castes differed either quantitatively or qualitatively. In conclusion, our results reinforce the hypothesis that hydrocarbons must play a central role in the chemical communication system in Vespinae wasps, once they reflect caste. Additionally, we demonstrate that the chemical variation associated to caste exist across different components – cuticular surface, eggs’ surface, and *Dufour*’s gland content. These differences likely contribute synergically to the communication between castes within the same nest and between females from different nests. The CHCs found in higher proportions over the cuticular surface of queens may convey information about their fertility status, and workers may perceive them when they touch their bodies. The connection between *Dufour*’s gland composition and eggs’ surface suggest that this gland is potentially used by queens to mark their eggs, and spread their scents across the colonies. We also suggest that the chemical complexity found over the eggs may derive from a combination of sources. Further research is necessary to determine empirically whether one or more of the hydrocarbons present in higher quantities in queen samples (CHCs and egg-marking compounds) act indeed as queen signals in *D. saxonica*, *D. media*, *V. crabro*, and *V. germanica*. Given that the methyl alkanes 3-MeC27 and 3-MeC29 were overall linked to fertility/maternity, testing their potential effect driving policing in other Vespinae societies will allow us to discover if or not there is a conserved queen maternity signal across social wasps. Lastly, it will be important to address in the future whether cephalic glands also contribute for the formation of the chemical surface of eggs.

Acknowledgments

This study was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. Funding was provided from Bilateral grant FWO-FAPESP to CAO, FSN and TW (process numbers: 2018/10996-0 and 2021/05598-8 FAPESP and FWO: GOF8319N, FWO: GOF6622N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Funding

This study was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. Funding was provided from Bilateral grant FWO-FAPESP to CAO, FSN and TW (process: 2018/10996-0 and 2021/05598-8 FAPESP and FWO: GOF8319N, FWO: GOF6622N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author contributions

Rafael Carvalho da Silva and Cintia Akemi Oi contributed to the study conception and design. Material preparation, data collection and analysis were performed by Rafael Carvalho da Silva and Cintia Akemi Oi. Cintia Akemi Oi, Tom Wenseleers and Fabio Santos do Nascimento were responsible for getting funding. Rafael Carvalho da Silva and Cintia Akemi Oi were responsible for conducting the investigation. Cintia Akemi Oi, Tom Wenseleers and Fabio Santos do Nascimento were responsible for project administration. Rafael Carvalho da Silva wrote the first draft of the manuscript and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript version.

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CHAPTER 5

*Juvenile hormone modulates hydrocarbon expression and reproduction in the German wasp *Vespula germanica**



Credit: Cintia A. Oi

Accepted for publication in *Frontiers in Ecology and Evolution*

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Abstract

Juvenile hormone (JH) affects multiple physiological traits in insects. In social insects, besides development, JH has been demonstrated to influence caste determination and production of chemical compounds. In social wasps, JH triggers behavioural maturation, gonadotropic effects and hydrocarbons modulation. Here, we investigated whether JH displays the same function in fertility and fertility cue production in females of the German wasp *Vespula germanica*, previously shown in the related species *Vespula vulgaris*. By experimentally treating workers with JH-analogue, an anti-JH, and acetone solvent control, we tested whether JH modulates the cuticular chemical expression (CHCs), the *Dufour's* gland chemical composition, and hence the compounds found over egg's surface. Additionally, we explored whether JH has a gonadotropic effect in workers. Workers treated with the JH-analogue acquired a chemical profile that were intermediate between the queen and other treated workers. Interestingly, the same pattern was also seen in the *Dufour's* glands and eggs, although more subtle. Furthermore, workers treated with the JH-analogue were more fertile when compared to the controls, supporting the fact that JH acts as a gonadotropic hormone. Our results indicate a similar function of JH in societies of related wasp species *V. germanica* and *V. vulgaris*.

Introduction

Juvenile hormone (JH) represents a family of acyclic sesquiterpenoids that are responsible for controlling several physiological traits in insects, from development to sexual maturation (Noriega, 2014; Huang, 2020). JH was primary known to maintain juvenile features in larval stage during metamorphosis, but later JH became known for its pleiotropic effects, responsible for regulating immature development, reproduction, aggressive behaviour, behavioural maturation, caste determination, diapause, stress response, dispersal and flight activities, and many other polyphenisms (Hartfelder 2000; Goodman et al. 2012, Jindra et al. 2015). For instance, in solitary insects such as the *Bombyx mori*, JH plays a role controlling metamorphosis (Kamimura and Kiuchi, 1998; Zhang et al., 2017). In the fruit flies *Drosophila melanogaster*, JH controls reproductive

traits (Raushenbach et al., 2004; Yamamoto et al., 2013), and in cockroaches, JH likely influence aggressive behaviour (Kou et al., 2008). In eusocial insects as the model honeybee such *Apis mellifera*, JH has acquired a role to directly regulate the age polyethism in workers (Robinson, 1987), whereas in the primitively eusocial bee *Bombus terrestris*, higher JH affects aggressiveness and dominance rank in females (Pandey et al., 2020). In ant societies, JH displays a variety of roles depending on the species, from reproductive maturation to caste determination. In the ants *Harpegnathos saltator* and *Cardiocondyla obscurior*, JH seems to be linked with caste determination, as higher doses of JH induce larvae to become reproductive adults (Schrempf and Heinze, 2006; Penick et al., 2012). In societies of the primitively eusocial ant *Dinoponera quadriceps*, JH function may have been remodelled during the evolution of the species, instead of triggering gonadotropic effects (increase ovary activity in females), it inhibits reproduction in high-rank workers, as treated workers show a decreased number of vitellogenic eggs and overall smaller ovarioles (Norman et al., 2019). In contrary to the general gonadotropic effect in insects, JH negatively impacts reproduction in some species of ants (Holman et al., 2012; Pamminger et al., 2016a,b; Azevedo et al., 2016; Norman et al., 2019).

In wasps, JH acquired multiple functions in the species, which varied among the different levels of sociality. In primitively eusocial species, JH display a gonadotropic effect in females - in *Polistes annularis* (Barth et al., 1975), *Ropalidia marginata* (Agrahari and Gadagkar, 2003), *Polistes metricus* (Tibbetts and Sheehan, 2012), *Polistes canadensis* (Giray et al., 2005), *Polistes fuscatus* (Walton et al., 2020) and *Polistes dominula* (Oi et al., 2021b); JH regulates behaviour (onset of foraging and aggressive acts) – in *Polistes canadensis* (Giray et al., 2005) and *P. dominula* (Shorter and Tibbetts, 2009; Tibbetts and Izzo, 2009; Tibbetts et al., 2013); and JH affects the production of chemical compounds – in *Mischocyttarus consimilis* (Neves et al., 2020), *P. dominula* (Oi et al., 2021b), *Polistes satan* (Oi et al., 2021b), *Mischocyttarus cassununga* (Ferreira et al., 2022; Oi et al., 2021b) and *Mischocyttarus cerberus* (Ferreira et al., 2022). In swarm-founding species, JH has been reported to control behavioural maturation in *Polybia occidentalis* (Prato et al., 2021), ovary activation and chemical expression of CHCs in *P. occidentalis* (Prato et al., 2021) and *Synoeca surinama* (Kelstrup et al., 2014). In highly eusocial wasps, JH effects have been well studied so far in a single species, namely *Vespula vulgaris*, and one of the roles is being associated with regulating

reproductive traits in females, leading to modification of certain cuticular compounds over the cuticle (Oliveira et al., 2017; Oi et al., 2020; Oi et al., 2021a). By treating workers topically with a JH analogue (methoprene), studies in the past have supported that in addition to the regulation of CHC production, JH may be directly responsible for increasing the proportion of queen pheromones in *V. vulgaris* (the compounds n-C27, n-C28, n-C29 and 3-MeC29) (Oliveira et al., 2017; Oi et al., 2021a). Furthermore, in *V. vulgaris*, increasing JH levels may be decisive for reproductive workers to succeed (Oi et al., 2020), as workers treated with methoprene lay eggs that chemically resemble those laid by queens, and in doing so, their eggs were less policed (Oi et al., 2020).

The *Dufour's* gland is the main source of egg-maternity cues in social insects, as this gland is associated to the sting apparatus in females of several Hymenoptera (Apocrita) (Mitra 2013). This gland may have acquired other roles across the evolution of hymenopteran species (Mitra 2013) and one of the key functions of this gland is to release chemical compounds that cover the eggs during oviposition (Abdalla and Cruz-Landim 2001). Besides that, *Dufour's* gland compounds are used during nest building, as cues for nest recognition, nestmate recognition, fertility signalling, brood cell lining, and as sexual pheromones (Mitra 2013). Given the existing evidence that *V. vulgaris* workers treated with methoprene lay eggs that chemically resemble those laid by the queens (Oi et al., 2020), it is likely that increasing JH levels have cascade effects, that not only trigger cuticle chemical modification (Oi et al. 2021a), but also trigger modification in other chemical reservoirs, such as the *Dufour's* gland. Hence, the chemical modification in the eggs laid by methoprene-treated workers in *V. vulgaris* may represent a modification in the *Dufour's* gland composition.

Here, we evaluated whether JH is responsible for controlling chemical expression and reproduction in the German wasp *Vespula germanica*. Firstly, we experimentally manipulated the levels of JH in workers by treating them with either JH analogue methoprene, the anti-JH precocene, or with the solvent-only acetone as a control. We sampled their CHCs, eggs, and *Dufour's* glands to investigate their chemical composition and their level of chemical similarity. Then, treated workers were compared with fertile queens to identify putative fertility cues (chemical cues associated with their reproductive state). Lastly, we estimated fertility by counting the number of oocytes in the ovaries of treated workers. Considering that JH acts as a pleiotropic hormone, regulating fertility and fertility-signalling in the sister species *V. vulgaris* (Oi et al., 2021),

our hypothesis was that JH effects would be conserved in *V. germanica*. Because workers have lower JH levels when compared to queens in *V. vulgaris* (Oliveira et al., 2017), we expected that CHCs, eggs, and *Dufour's* glands from methoprene-treated workers would chemically resemble those from fertile queens, and the opposite would be seen for the samples from solvent and precocene-treated workers. Similarly, we expected that methoprene-treated workers to be more fertile compared to precocene and solvent treated workers.

Material and Methods

Study Site and Nest Sampling. Thirteen nests of *V. germanica* were collected between August and September 2019 in the surroundings of Leuven - Belgium (50° 52' 46" N; 4° 42' 3" E, 41 m elevation). Nests were collected from ground or attics, then they were kept in plastic boxes, and taken to the Laboratory of Socioecology and Social Evolution at the University of Leuven - Belgium.

Experimental Setup. Once in the lab, the wasp nest was sedated with CO₂ and the combs containing pupae were maintained in plastic boxes for 24 - 48 h to sample newly emerged workers. Queens were sampled and stored in the freezer until further analysis. Eggs present in the original combs coming from the field were sampled and categorized as queen-laid eggs in the further analysis. Under queen right conditions, worker-laid eggs are efficiently removed by policing workers (Bonckaert et al., 2008). A total of 5 queen-laid eggs were sampled and stored in the freezer until further analysis. Newly emerged workers (0 days old) were topically treated on their abdomen with either 5 µl JH analogue methoprene (20 µg/µl) (Sigma-Aldrich), 5 µl anti-JH precocene (15 µg/µl) (Sigma-Aldrich), or 5 µl of the solvent acetone (Sigma-Aldrich) as control. Those concentrations and single topical application were shown to be effective for the sister species *V. vulgaris* (Oliveira et al., 2017; Oi et al., 2020; Oi et al., 2021). After being treated, the workers (ca. 20 individuals) were settled in experimental wooden boxes corresponding to their treatments. Wooden boxes consisted of two parts (similar from Oi et al., 2021). The first part (nest box) contained a comb in which the eggs were removed (to allow workers to lay eggs) ranged with a metal wire. The second part (foraging box) contained falcon tubes with sugar syrup, sugar paste (Apifonda), and pieces of mealworm. The nest and foraging boxes were connected by a hole (Supplemental Information Figure S1). The experiments were kept in a climate room, under controlled conditions for a week (12-hour cycle, 28°C). After a week, the wasps were sedated, and the females were individualized in glass

vials kept in a freezer -20°C for chemical extractions and dissections. The combs were stored in the freezer (-20°C), to keep the worker-laid eggs preserved until being further chemically analysed. The queens and queen-laid eggs used in this chapter were previously used in the Chapter 4.

Chemical Extraction and Analyses. We individualized queens and workers in glass vials, and we filled them with 2 ml (queens) or 1 ml (workers) of pentane (Acros organics, HPLC) to extract CHCs. After 1 minute in contact with the solvent, the wasps were removed from the glass vials, and they were all preserved again in the freezer until *Dufour's* gland dissections. To sample the *Dufour's* gland, the abdominal tagma of each female was dissected under a stereomicroscope. The female was pinned in a Petri dish containing a saline solution, a small incision was made on each side of the terminal part of their abdomen. The abdomen was exposed to sample the *Dufour's* gland. Once the *Dufour's* gland was located, we used tweezers to sample it and put it in a glass insert filled with 50 µl of pentane. Once in the glass insert, the *Dufour's* gland was smashed with the aid of the tweezers. Queen-laid and worker-laid eggs (from each of the three treatments) were individualized in glass inserts. All the eggs were washed with 50 µl of pentane for a minute, after that, all the eggs were removed from the solution. Each sample correspond to one sampled egg. After the extraction procedure, all the samples were let dry under the fume hood at room temperature. Glass vials containing CHCs were refilled with 1000 µl (queens) and 200 µl (workers) of hexane (HiPerSolv CHROMANORM, HPLC). Glass vials containing chemical extracts from eggs and *Dufour's* gland were refilled with 50 µl of hexane. All the samples were analysed in a system of Gas Chromatography coupled with a Mass Spectrometry (GC-MS) (Thermo Fisher Scientific Trace 1300 connected to a Thermo Fisher Scientific ISQ mass spectrometer). In the GC, we used a column of 30 meters with a diameter of 0.25 mm and a 0.25 µm film was used (Restek MXT-5). From each sample, 1 µl was injected at a temperature of 320°C using a split-lees injection mode (similar conditions used by Oi et al., 2021). The initial temperature was set to 40°C and kept for 2 minutes. Then, the temperature was increased to 120°C with an increased rate of 20°C per minute. After that, the temperature increased to 200°C with a rate of 10°C per minute, and with a rate of 7°C per minute until 250°C. Finally, the last increase of temperature consisted of 5°C per minute until 350°C, which was held for 4 minutes. The GC-MS parameters used in our work were based on previous published studies (Oi et al., 2020; Oi et al., 2021a). We used helium as carrier gas under

a constant flow rate, and it was kept under a constant flow rate of 0.9 ml per minute. The temperature of the MS electric ionization and MS transfer line was kept at 300°C. To identify the hydrocarbons and calculate retention indexes, samples of external alkane ladders (Sulpeco) ranging from n-C7 to n-C40 were run. Ion chromatograms were integrated using R studio Version 1.4.1717 (R version 4.1.0) with a script provided at Supplementary material. After integration, we extracted the peak area which was converted in relative abundances to be used in the statistical analysis. We performed multivariate and univariate analyses to check whether the dependent variables (chemical compounds) were affected according to the different treatments. Groups of females (queens, methoprene, precocene and acetone) belonging to the three types of samples (CHCs, eggs, and *Dufour's* gland) were compared using a PERMANOVA test (9999 permutations) to check whether they varied according to their chemical composition. For that, we used the package *vegan* (Oksanen et al., 2008) in R. The data corresponding to CHCs, eggs, and *Dufour's* gland were plotted using a principal component analysis (PCA) to visualize data distribution and group formation. To check which compounds contributed the most to group differentiation, a percentage similarity test (SIMPER) using a Bray-Curtis index was performed with the package *vegan* (Oksanen et al., 2008). To check the level of similarity among samples of CHCs, eggs and *Dufour's* gland from the four groups of females, the differences in compound abundancy were analysed by using ANOVA on the log-transformed relative peak areas per compound. The ANOVA test was followed by a Tukey post hoc test with Bonferroni corrections to compare the abundance of compounds between groups of samples per group of females. For that, the function *contrast* from the package *lsmeans* (Bates et al., 2015) was used. To observe clustering based on their chemical information the function *pheatmap* from the package *pheatmap* (Kolde, 2015) was used and UPGMA was utilized as clustering method using 1-Pearson correlation for the distance matrix (adapted from Oi et al. 2021a).

Dissections. Workers were dissected in ringer solution under a stereomicroscope (Leica, model: MSV266). The total number of oocytes was counted and was used as a proxy for investigating the effects of treatments over the females' reproduction. We included the measurements of head size as a proxy of size for the individuals. We measured head width at their widest part from the head frontal view. Head measurements were conducted using the software Image J. We ran a Spearman correlation test to evaluate if head width and number of oocytes were correlated. Head width and number of oocytes were not

significantly correlated ($\rho = -0.036$; $p\text{-value} = 0.770$), thus head width was not included as a factor in the following analysis. To analyse the effects of the treatments on the reproductive traits of females, data were analysed by using a generalized linear mixed model with Poisson distribution, compared to by the `glmer` function from the `lme4` (Bates et al., 2015) package. As we checked overdispersion in our data, using the function `dispersion_glmer` from `blmeco` package (Korner-Nievergelt et al 2015), we fitted a negative binomial model that gave the best AIC value. The model was fitted with the total number of counted oocytes as a fixed effect, and nest origin as a random factor. For pairwise comparison among the treatments, we used the function `emmeans` adopting *fdr* correction, for that, (Bates et al., 2015). All analyses and graphics were done in R studio version 1.4.1717 (R version 4.1.0).

Results

The number of samples that were included in chemical analyses were: CHCs – four queens, 25 workers treated with acetone, 21 workers treated with methoprene and 25 workers treated with precocene; Eggs – 27 queen-laid eggs, 20 eggs laid by workers treated with acetone, 23 eggs laid by workers treated with methoprene and 24 eggs laid by workers treated with precocene; *Dufour's* gland – 8 samples for queens, 25 samples for workers treated with acetone, 15 samples for workers treated with methoprene and 24 samples for workers treated with precocene. Some samples of CHCs and *Dufour's* gland were removed due to the quality of the chromatograms.

CHCs. A total of 31 chemical compounds were detected in the samples (Table S1). The permutation analysis showed that the CHCs from different groups of females were statistically different (F value = 27.000, $p < 0.001^{***}$) (Table 1). The post-doc permutation analysis showed that the CHCs differed significantly when the groups were compared in pairs (Table 1). According to the SIMPER analysis, among the ten first compounds, several differed between the pairs of females (Table S4). However, the most contrasting variation was detected between the castes, queens versus all the groups of treated workers (Figure 1A, S2). Looking at the ten first compounds highlighted by SIMPER analyses, workers treated with methoprene were the most different group if compared with workers treated with acetone or precocene. Interestingly, the pattern also exists including or excluding non-treated workers (Supplementary material – Figure S2). A total of four and three compounds were statistical different in the pairs “acetone x

methoprene” and “methoprene x precocene”, respectively. On the other hand, none of the first ten compounds differed between workers treated with acetone and precocene.

Eggs. A total of 27 chemical compounds were detected in the surface of eggs (Table S2). The permutation analysis indicated that the hydrocarbons covering the eggs from different groups were statistically different (F value = 3.432, $p < 0.001^{***}$) (Table 1). The SIMPER analysis showed that linear, methylated and dimethylated compounds were responsible for group differentiation (Table S4). The hydrocarbons n-C25 and 3-MeC25 were seen to be abundant over the surface of queen-laid eggs, which make them putative queen egg-marking compounds (Table S2). Overall, the chemical composition of eggs laid by the different groups of females overlapped in the PCA analyses (Figure S3), thus the chemical variation in eggs laid by different groups of females is subtle and restricted to certain compounds.

Dufour’s gland. A total of 23 chemical compounds were detected in samples of *Dufour’s* glands (Table S3). The permutation analysis showed that the hydrocarbons found in the *Dufour’s* gland of females were statistically different (F value = 5.322, $p < 0.001^{***}$) (Table 1). The post-hoc permutation analysis revealed that in fact almost all the six pairs were statistically different ($p < 0.05^*$) (Table 1). Hydrocarbons from the four classes of compounds detected in samples of *Dufour’s* gland (linear, methylated, dimethylated alkanes and alkenes) were found to contribute for group differentiation (Table S4). The variation among females for the *Dufour’s* gland is restricted to specific chemical compounds (high overlap among samples) as shown for the eggs (Figure S4).

Similarity among samples. Samples were primarily clustered based on their original groups regardless of female category, however a higher similarity was detected between CHCs and egg-marking cues (Figure 1B). CHC and egg samples clustered together in the same upper branch, whereas *Dufour’s* gland samples clustered in a different branch. Pairwise comparison per compound showed that several compounds were statistically different among samples (Table S5).

Effects on Reproduction. A total of 66 workers (acetone = 23; methoprene = 18; precocene = 25) of *V. germanica* were dissected. Two pairwise comparisons were significantly different. Methoprene treated workers had more oocytes in their ovaries and were significantly different from either acetone treated workers (z ratio = -2.487, $p = 0.019^*$) and precocene treated workers (z ratio = 3.782, $p < 0.001^{***}$). Precocene treated

workers and acetone treated workers did not have different numbers of oocytes in their ovaries (z ratio = 1.402, $p = 0.161$).

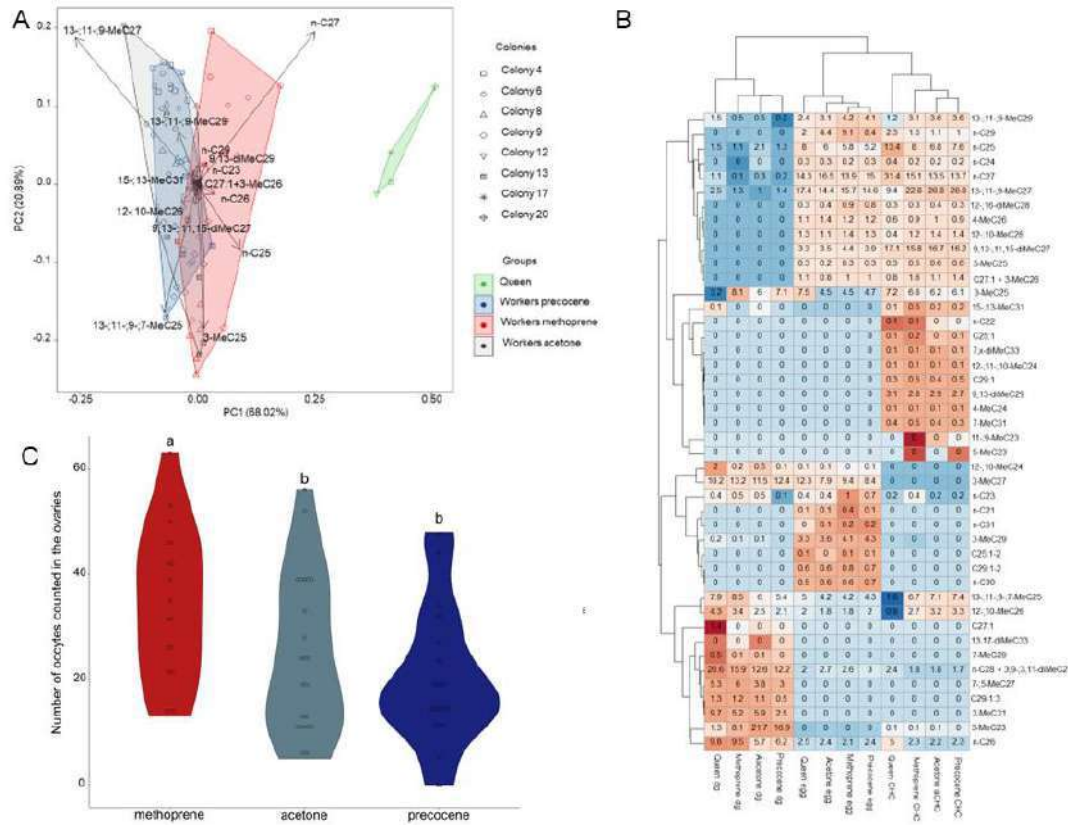


Figure 1: (A) Principal component analysis (PCA) showing cuticular hydrocarbons (CHCs) differences in *Vespa germanica*. The symbols indicate the origin of the colonies and colours correspond to groups of females, queens or treated workers. (B) Heatmap based on the chemical compounds of the different groups of samples, cuticle CHC, eggs or *Dufour's* gland (dg) for all the groups of females (queens, workers treated with methoprene, workers treated with acetone and workers treated with precocene). Numbers in the heatmap represent the log-transformed relative peak areas per compound and the background colours represent the z-scores. (C) The total number of oocytes in the ovaries of *Vespa germanica* workers was greater in methoprene treated workers compared to acetone and precocene treated workers. Different letters represent statistic differences among treated workers.

Table 1: Permutation analysis (PERMANOVA) represented by group of samples in *Vespa germanica*: cuticular hydrocarbons (CHC), eggs, and *Dufour's* gland.

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Significance level
All groups (CHC)	27	0.532	< 0.001	***
Pair wise CHC samples				
queens x workers acetone	74.687	0.734	0.006	**
queens x workers methoprene	33.897	0.595	0.006	**
queens x workers precocene	111.026	0.804	0.006	**
workers acetone x workers methoprene	8.663	0.164	0.006	**
workers acetone x workers precocene	0.921	0.018	1	n.s.
workers methoprene x workers precocene	8.217	0.157	0.006	**

	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Significance level
All groups (eggs)	3.432	0.102	< 0.001	***
Pair wise egg samples				
queens x workers acetone	4.53	0.091	0.048	*
queens x workers methoprene	6.529	0.119	0.006	**
queens x workers precocene	7.094	0.126	0.006	**
workers acetone x workers methoprene	0.836	0.02	1	n.s.
workers acetone x workers precocene	0.523	0.012	1	n.s.
workers methoprene x workers precocene	0.37	0.008	1	n.s.
	<i>F</i> value	<i>R</i> ²	<i>p</i> value	Significance level
All groups (<i>Dufour's</i> gland)	5.322	0.19	< 0.001	***
Pair wise <i>Dufour's</i> gland samples				
queens x workers acetone	10.77	0.257	0.006	**
queens x workers methoprene	4.407	0.173	0.006	**
queens x workers precocene	7.725	0.204	0.006	**
workers acetone x workers methoprene	6.877	0.153	0.012	**
workers acetone x workers precocene	0.787	0.016	1	n.s.
workers methoprene x workers precocene	4.51	0.108	0.042	*

Discussion

Our initial hypothesis that JH has a conserved function underlying chemical modulation and reproduction in *Vespula* wasps was corroborated. CHCs varied according to caste as queens showed to be different from workers. Furthermore, we showed that workers treated with the JH analogue methoprene expressed chemical profiles that were intermediate between queens and the other two worker groups (acetone and precocene treated workers). We detected a subtle colony effect over the CHC dataset, which could be due to the fact that CHCs also play a role in nestmate recognition. We also demonstrated a higher chemical similarity between CHC and egg samples, meaning the same compounds are present in the two sources. Additionally, workers treated with methoprene had more developed oocytes in their ovaries compared to workers from the other two groups. The chemical changes were more pronounced in the CHC samples, whereas the variation for egg and *Dufour's* gland samples were more subtle. These results provide additional support for the hypothesis that JH has pleiotropic properties, being responsible for regulating several processes in social wasps, such as ovary activation, behavioural maturation, oviposition and the modulation of chemical compounds (Oliveira et al., 2017; Oi et al., 2021; Prato et al., 2021). JH not only modulates the production of CHCs, as it has been previously demonstrated for wasp species (Oliveira et al., 2017; Oi

et al., 2021a; Oi et al., 2021b; Prato et al., 2021), but can potentially modulates other components, such as the *Dufour's* gland composition.

Our results are in line with previous reports of chemical composition in *V. germanica* (queens, workers, virgin queens, and males), that CHCs vary in quantity, and are probably important to mediate intranidal interactions (da Silva et al., 2021). One key hydrocarbon that has been reported to be queen-characteristic was the linear alkane n-C27, which was also found in higher proportions in our queen samples, and can potentially be a candidate for the queen pheromone in *V. germanica* (da Silva et al., 2021). This compound was also higher in the methoprene treated workers. Previously, the linear alkane n-C27 has been found to be overexpressed in the cuticle of queens of four other Vespine species, *Vespula squamosa*, *Vespula pensylvanica*, *Vespula alascensis*, and *Dolichovespula maculata* (Derstine et al., 2018) and to act as a queen pheromone in *V. vulgaris* (Van Ostaeyen et al., 2014). Empirical evidence is still lacking to confirm if this compound possibly works as a conserved queen signal in *V. germanica* or other Vespine wasps.

Policing behaviour is an effective mechanism against worker reproduction of the German wasp *V. germanica* (Bonckaert et al., 2008). Our results showed that eggs laid by methoprene treated workers chemically resembled more the ones laid by queens. Although not significant, methoprene treated workers overexpressed the hydrocarbons 3-MeC25, n-C25 and 3-MeC27 on their eggs, compounds found to be also queen characteristic. In the sister species, *V. vulgaris*, two methylated hydrocarbons, namely 3-MeC27 and 3-MeC29, are also deposited in higher proportions in queen-laid eggs (Oi et al., 2015). Policing behavioural assays confirmed that 3-MeC29, besides working as a queen pheromone (Van Oystaeyen et al., 2014), also works as an egg maternity signal in *V. vulgaris* (Oi et al., 2015). Behavioural assays are needed to certify whether one or a combination of 3-MeC25, n-C25 and 3-MeC27 play a role as queen egg-maternity compounds in *V. germanica*. The higher abundance of these compounds in eggs of methoprene treated workers may be an indication of high fertility. Although the *Dufour's* gland has been hypothesized as the main source of egg-marking cues (Mitra, 2013), here we show that egg samples were more chemically similar to CHC samples. Some compounds still overlap between *Dufour's* gland and eggs, however the chemical composition of eggs may change after oviposition due to their direct interaction with the

nest or other components (e.g. when the eggs are licked by females, when females touch them with their antennae or even from the contact with the paper cell).

Besides regulating chemical production, here we also report that JH has likely conserved gonadotropic effects in *V. germanica*, similar to its sister species *V. vulgaris* (Oliveira et al., 2017; Oi et al., 2020; Oi et al., 2021b). JH is the responsible for regulating reproductive traits in primitively and swarm-founding wasp species (Tibbetts and Sheehan, 2012; Walton et al., 2020; Kelstrup et al., 2014; Prato et al., 2021) and in highly eusocial species. Altogether, it is possible that JH has gonadotropic conserved function across the lineage of wasps. However, this hypothesis still must be considered with caution because comparative data is needed, which also requires including the inspection of JH circulating levels in females accordingly. Furthermore, given its pleiotropic roles, females are affected by JH along their nest ontogeny (Kelstrup et al., 2015; Oi et al., 2021b), and future experimental design need to take this into consideration.

In conclusion, our results strengthen the hormonal pleiotropy hypothesis, as we show that both traits, chemical production and reproduction, are under a shared endocrine control in *V. germanica*. JH may be responsible for controlling the chemical production of other sources, such as the chemical composition of *Dufour's* gland which are posteriorly deposited on the surface of eggs. The hydrocarbons that are found over the eggs may work as cues to allow policing in *V. germanica*. Future research is necessary to confirm whether the queen-characteristic compounds that we highlighted in our results indeed act as queen pheromones or egg-marking pheromones in *V. germanica* and other *Vespinae* wasps.

Funding

This study was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. Funding was provided from Bilateral grant FWO-FAPESP to CAO, FSN and TW (process: 2018/10996-0; 2021/05598-8 FAPESP and FWO: GOF8319N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author contributions

Rafael Carvalho da Silva and Cintia Akemi Oi contributed to the study conception and design. Material preparation, data collection and analysis were performed by Rafael Carvalho da Silva and Cintia Akemi Oi. The first draft of the manuscript was written by Rafael Carvalho da Silva and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript version.

Acknowledgements

We would like to thank An Vandoren for running the samples and Clint Varnemen to help with the experiments. We thank the two reviewers for their helpful comments in the earlier version of the present work.

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Data Availability Statement

The datasets for this study are available as supplementary material. Please see the [Data Availability section of the Author guidelines](#) for more details.

CHAPTER 6

Tiny but socially valuable: eggs work as sources of communication in Mischocyttarus societies



Credit: The author

In prep. To be submitted to *Behavioral Ecology and Sociobiology*

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Abstract

Chemical compounds play a major role in the recognition processes in social insects, and one class of compounds namely hydrocarbons cover the adult body, but also the surface of their eggs. The ability to discriminate between friends from foes minimizes the exploitation of resources. We investigated whether females of *Mischocyttarus cerberus*, which is often attacked by other wasp species, can discriminate their own eggs over the eggs of foes. We experimentally collected eggs from post-worker emergent nests and we offered their eggs to other nests to test the policing behavior in *M. cerberus*. Overall, our results show that the females of *M. cerberus* can discriminate eggs according to their origin and most of the removed eggs were policed within the first hour of the experiment, revealing that females have accurate discrimination skills. We discuss that chemical cues present over the surface of eggs may be important for them to be accepted or removed, and these cues may be important to avoid parasitism. Additionally, dominant females (= queens) are the most likely individuals to remove the eggs. Altogether, our results reinforce that the nestmate recognition ability is not restricted to recognizing adult relatives, but it is also extended to recognizing brood in *M. cerberus*.

Keywords: egg discrimination; alternative strategies; chemical communication; egg-marking pheromones

Introduction

Social insects have evolved abilities to recognize and accept adult nestmates over non-nestmates (van Zweden & d’Ettorre 2010; d’Ettorre & Lenoir 2010; Mora-Kepfer 2014). Contrarily, whether adult females have the same abilities to recognize and discriminate brood remain poorly investigated (Panek & Gamboa 2000; Gamboa 2004). The ability to discriminate individuals is a potential mechanism used by social insects to minimize the exploitation of resources by unrelated conspecific usurpers or social parasites (Fletcher & Michener 1987; Lorenzi & Filippone 2000). In such a context, the thin layer full of chemical compounds that cover the insect body has been proposed to be the main vehicle of information, allowing the communication process to occur (Howard & Blomquist 2005). Cuticular hydrocarbons (CHC) contribute to the recognition process among individuals, being composed by linear alkanes, branched alkanes and unsaturated ones (Howard & Blomquist 2005). A higher chemical similarity exists among individuals from the same colony compared with non-nestmates (Gamboa 2004; Turillazzi et al. 2008). Members of a given colony learn the chemical templates early in their adult life (Gamboa et al. 1986a). Evidence of nestmate recognition based on CHCs has been shown in ants (Tannure-Nascimento et al. 2009; Bos et al. 2010; Bos & d’Ettorre 2012; Larsen et al. 2014), bees (Nunes et al. 2008; Nunes et al. 2011; Nascimento & Nascimento 2012; Jones et al. 2012), termites (Bagnères et al. 1991; Yusuf et al. 2010), and wasps (Gamboa et al. 1986b; Cini et al. 2009; Cappa et al. 2020). Nestmate recognition in this context corresponds to the perception of cues in the CHC profile and comparison with the chemical template of the evaluator (see Bos & d’Ettorre 2012).

Besides covering the insect body surface, hydrocarbons occur over the surface of brood (eggs, larvae, and pupae) as well (ants: Endler et al. 2004; see Schultner & Pulliainen 2020; bees: Starkey et al. 2019; Orlova et al. 2020; wasps: Cotoneschi et al. 2007; Cervo et al. 2008; Cotoneschi et al. 2009; Oi et al. 2020), suggesting their possible role in mediating communication between adult-immature individuals. Among social insects, it is relatively well known how ants (see Schultner & Pulliainen 2020), bees (Free et al. 1983; Starkey et al. 2019; Orlova et al. 2020) and a few wasp species (Klahn & Gamboa 1983; Panek & Gamboa 2000; Strassmann et al. 2000; Cotoneschi et al. 2009) use these chemical cues to regulate adult-immature interactions. Overall, ants seem to be influenced by several factors when dealing with brood, which allow them to recognize and discriminate colony origin, maternity, developmental stage, sex, and caste (see

Schultner & Pulliainen 2020). In colonies of the bumblebee *Bombus impatiens*, larvae play a role in regulating worker reproduction and behavior, their presence reduce egg laying rates and worker aggression (Starkey et al. 2019; Orlova et al. 2020). In colonies of social wasps, such as *Vespula vulgaris*, the hydrocarbons covering the eggs' surface mediate policing (= egg destruction behavior), as queen-laid and worker-laid eggs are chemically different (Bonckaert et al. 2012; Oi et al. 2015).

However, concerning wasps, most of the available literature on policing behavior or brood detection correspond to species from temperate areas, except for *Parischnogaster mellyi* (Turillazzi et al. 2008) and *Polybia paulista* (Kudô et al. 2016), which are both from tropical areas. *Mischocyttarus* is one of the most diverse genera of Neotropical social wasps and they represent good models to investigate aspects of policing behavior. *Mischocyttarus* wasps are primitively eusocial species, which means that females from different castes are not easily morphologically distinguished from each other, but instead they behave differently (O'Donnell 2020, Giannotti 1999). The nests start by one or a few females (Miller et al. 2018), and following nest foundation there is the establishment of a linear hierarchy of dominance, which is kept along nest ontogeny – nest ontogeny comprises pre-worker emergence, post-worker emergence and decline (Noda et al. 2001). *Mischocyttarus* wasps build stelocytarus gymnodomous nests, which means that they are often sustained by a single pedicel and they lack a protective envelope, like in *Polistes* paper wasps (Noll et al. 2020). The fact that their nests are deprived of a protective envelope, make them ideal to perform manipulations, to directly observe adult interactions and how adults interact with their brood. However, the lack of envelope also facilitates unrelated individuals to access their nest content. Nests of *Mischocyttarus* are often attacked by parasitoid wasps (Somavilla et al. 2015; da Silva et al. 2019a), usurped by other wasps – *Mischocyttarus* and *Polistes* (Prezoto & Nascimento 1999; Pinto et al. 2004; de Souza et al. 2012; Montagna et al. 2012), attacked by ants (Clouse 1995), and also receive drifting females from other conspecific nests (Giannotti 1999).

Given that resident females of *Mischocyttarus* are exposed to such environmental pressures - lack of a protective envelope, usurpation by conspecifics and heterospecific individuals - having cognitive abilities linked to nestmate recognition may help them dealing with nest usurpation. If a given resident female is not able to recognize and discriminate its own brood from non-kin brood, the costs of raising unrelated

individuals can be high. Being that said, the goal of the present study was to investigate whether females of *Mischocyttarus cerberus* species are able to recognize their own eggs over alien eggs coming from intraspecific and interspecific nests. We studied wasps that occur in an anthropic area, where in the past, we reported the occurrence of six different species belonging to the *Mischocyttarus* genus (da Silva et al. 2019b). Nests are often found close to each other, which may facilitate parasitism and usurpation to take place (da Silva et al. 2019b). Thus, we hypothesized *M. cerberus* females display egg recognition based on their origin. We predicted that when confronted with options, females would destroy alien eggs belonging to different colonies or species. In addition, females would destroy more alien eggs coming from interspecific nests compared with eggs coming from intraspecific alien nests. We suggest that the recognition process is mediated by chemical cues (hydrocarbons) that cover the eggs' surfaces. Thus, the higher accuracy in brood discrimination between species relies on the fact that a higher chemical variation is present between different species, but not within the same species. Lastly, we suggest that dominant females (=queens) may have a key role on such a recognition process. This is so far the first effort to experimentally investigate the capacity of *Mischocyttarus* females to discriminate brood. Our results show that interspecific eggs and intraspecific eggs do not go unnoticed in nests of *M. cerberus*. Similarly, the capacity to recognize and remove undesirable eggs was reported before for *Polistes* and now for *Mischocyttarus*.

Material and Methods

Study area and collection

Nests in the post-worker emergence phase of *Mischocyttarus cerberus* and *Mischocyttarus montei* were studied in the area of the campus of the University of São Paulo (USP) – Campus of Ribeirão Preto - (21°10'39"S; 47° 48' 37"W, 531 m elevation) between February and May 2021 (da Silva et al. 2019b).

Experimental setup

(I) Egg recognition assays

We used artificial paper cells made by waxed paper that were inserted in the natural cells to sample fresh laid eggs. A piece of the waxed paper was inserted inside an

empty cell from an abandoned nest to shape it, then drops of white glue were used to keep the artificial cell stable, and then they were left to dry. Artificial cells were inserted in either empty cells or in cells that had eggs (the eggs were removed with forceps before the insertion of the artificial cells). Nests were monitored daily for the presence of newly laid eggs. Artificial cells containing a *M. cerberus* egg were moved to a different cell when the experiment was settled to avoid any bias concerning egg localization. A random cell containing a *M. cerberus* egg was selected and then the egg was replaced by the artificial cell containing an egg of *M. montei* (Figure S1). Eggs used in the experiments came from nests that were at least 100m apart from each other.

The procedure of settling natal eggs against experimental eggs was performed at the same time, and it was repeated several times in different nests of *M. cerberus* (Experiment I n = 34 nests; Experiment II n = 16 nests). Considering that we were interested to investigate whether egg policing would occur right after eggs being placed in the nests, simulating natural conditions, after preparing each nest with both a control and an experimental egg, we waited for one hour and then all the nests were checked to evaluate whether egg removal had occurred or not. For eggs that were not removed in the first hour of experiment, we additionally followed them for a week to track egg's survivorship.

(II) Egg marking hydrocarbons

After performing the egg discrimination assays, eggs from *M. cerberus* (either control and experimental nests) and *M. montei* were collected to investigate if they differ based on their egg-marking hydrocarbons. Eggs' chemical profiles were determined via GC/MS analysis. Sample preparation and analysis were conducted in using similar methods as Oi et al. (2020).

(III) Analyzing checking cells frequency

We analysed data from 14 post-worker emergent nests of *M. cerberus*. Each nest was observed for four hours, and females were divided into three different groups (I) alpha females (= queens), (II) beta females (= the most likely to become queens), and (III) other subordinate females (= including all the other females that were not from the first and second groups). The group assignment was done by studying their dominance hierarchy interactions, and this methodology was reported by da Silva et al. (2020). The

total number of times each female inserted their heads inside a cell during the observation period was recorded. After recording the total number of times females inserted their heads inside the cells, the proportion of checking cell behaviour was calculated and later used in the statistical analysis.

Data analysis

To access whether the likelihood of eggs being in the nests after an hour of experiment was correlated to their origin, we fitted a generalized linear mixed model with binomial errors and with logit link function using *glmer*. For the chemical analyses, peak areas of each chemical compound were transformed in relative amounts, then a permutation analysis (PERMANOVA) was run to verify whether eggs from different groups were chemically distinct based on their hydrocarbons. We used the *adonis* function from the *vegan* package and adopted 999 permutations. A principal component analysis (PCA) was performed with the *prcomp* function of the stats package (Team RC 2013). We run a multivariate similarity analysis (SIMPER) using the Bray-Curtis distance and adopting 999 permutations to check how much each of the components (CHC) most contributed to the observed variation between eggs from different groups. To uncover whether the frequency of checking cells varied among females from different groups, data was analysed by using a generalized linear mixed model, fitted by the *glmer* function from the *afex* package (Singmann et al. 2016). All analysis was performed using R (version 4.0.2).

Results

(I) Egg recognition assays

In the first experiment, eggs of *M. cerberus* were significantly more tolerated after one hour in the nests than the interspecific experimental ones of *M. montei* (Fig. 1A) (ANOVA: LR Chisq = 31.355, $p < 0.001$) (Figure 1a). The likelihood of eggs to survive for a week differed significantly according to their origin (Chisq= 36.9; Df = 1; $p < 0.001$) (Figure 1a). In the second experiment using only intraspecific nests, control eggs of *M. cerberus* were more tolerated after one hour than the experimental ones from other *M. cerberus* nests (ANOVA: LR Chisq = 13.809; $p < 0.001$) (Figure 1b). The likelihood of eggs to survive for a week differed significantly according to their origin in the second

experiment as well (Chisq= 14.0; Df = 1; $p < 0.001$) (Figure 1b). In both experiments, control eggs survived longer than the experimental ones (see Table S1).

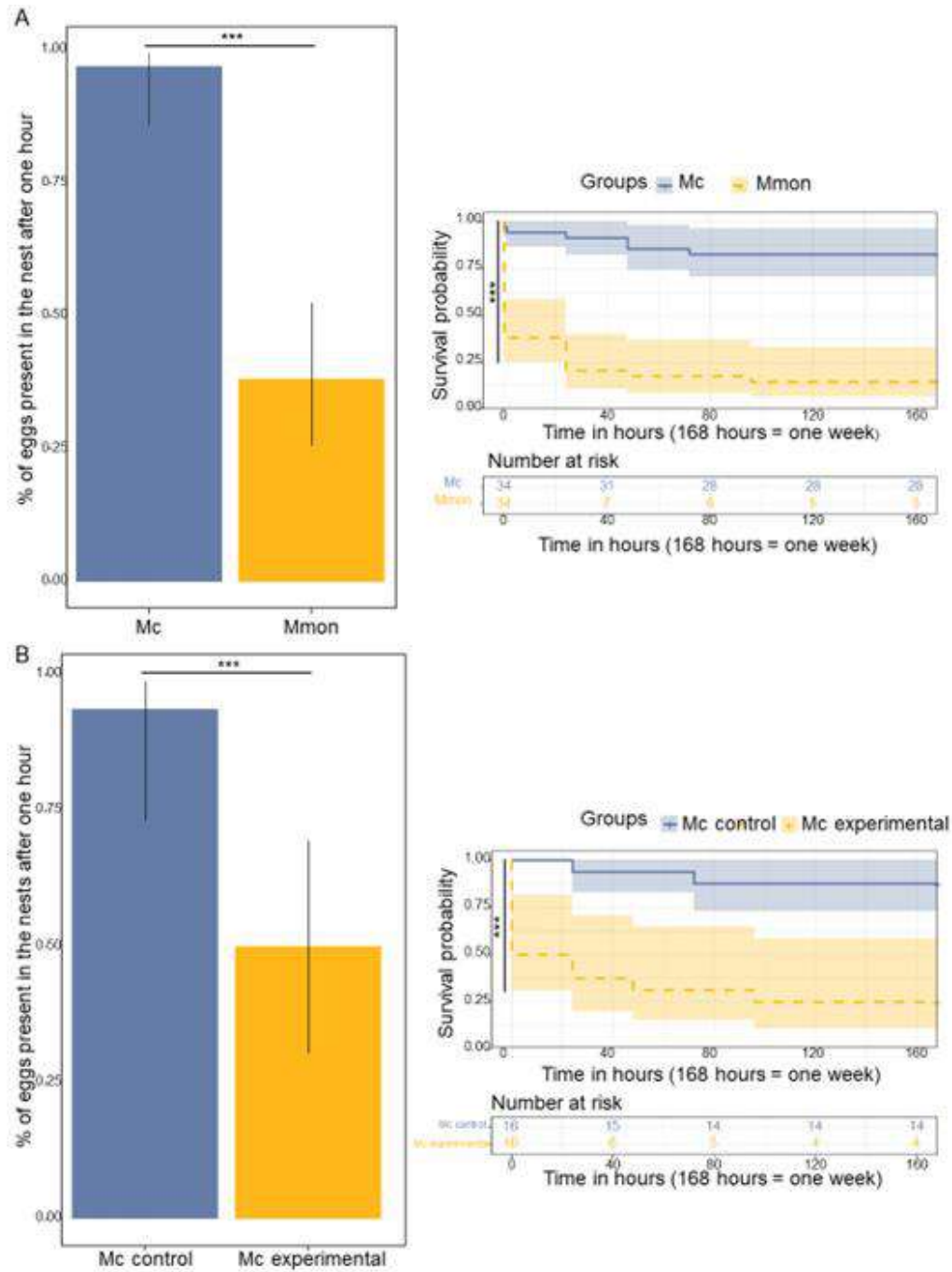


Figure 1: a) A greater proportion of *Mischocyttarus cerberus* control eggs were present in the nests after an hour. Survivorship plot of eggs from Experiment 1. b) A greater proportion of *Mischocyttarus cerberus* control eggs were present in the nests after an hour. Survivorship plot of eggs from Experiment 2. The blue line represents the survivorship rate of control eggs, whereas the yellow line represents the survivorship rate of experimental eggs.

(II) Egg marking hydrocarbons in *Mischocyttarus cerberus* and *Mischocyttarus montei*

Eggs belonging to different groups differed based on their hydrocarbons (PERMANOVA, $R^2 = 0.455$; $F = 15.889$; $p < 0.001$) (Table 1A). The post hoc permutations analysis demonstrated that not all pairs of groups are indeed significantly different (Table 1B). The only pairwise permutations that differed statistically were the ones composed of a combination including experimental eggs from Experiment 1 (*M. montei*) and any other group of eggs (Table 1B). Principal component analysis (PCA) revealed that the experimental eggs from Experiment 1 (*M. montei*) were the most different according to their chemical composition (Figure 2a; Table S2). The most important compounds that contributed to group differentiation included linear, methyl, and dimethyl-alkanes (Fig. 2b; Table 2).

Table 1: (A) Global permutations (PERMANOVA) using all the groups of eggs collected in Experiment 1 and Experiment 2 (control and experimental eggs from both phases). (B) PERMANOVA pairwise contrasts between the groups of eggs collected in Experiment 1 and Experiment 2.

(A) Global PERMANOVA				
	R2	F value	p value	Significance level
eggs data\$group	0.455	15.889	< 0.001	***
Residual	0.544			
Total	1			
(B) Pairwise PERMANOVA				
pairs	R2	F value	p value	Significance level
Mc control exp. 1 x Mc experimental exp. 2	0.106	3.941	0.186	n.s.
Mc control exp. 1 x Mc control exp. 2	0.043	1.268	1	n.s.
Mc control exp. 1 x Mmon exp. 1	0.541	40.171	< 0.01	**
Mc experimental exp. 2 x Mc control exp. 2	0.119	3.12	0.252	n.s.
Mc experimental exp. 2 x Mmon exp. 1	0.403	19.64	< 0.01	**
Mc control exp. 2 x Mmon exp. 1	0.482	22.37	< 0.01	**

Table 2: SIMPER analysis showing the five most important compounds that contributed for group separation (pairs of groups). Average group 1 = *Mischocyttarus cerberus* control from Experiment 1 (n = 20 eggs); Average group 2 = *Mischocyttarus montei* from Experiment 1 (n = 16 eggs); Average group 3 = *Mischocyttarus cerberus* control from Experiment 2 (n = 10 eggs); Average group 4 = *Mischocyttarus cerberus* experimental from Experiment 2 (n = 15 eggs). Sig. level = significance level.

Groups	Compound	Average	SD	Ratio	Average group 1	Average group 2	p value	Sig. level
Mc control exp. 1 x Mmon exp. 1	11,15-; 11,17-diMeC31	0.042	0.019	2.246	12.772	4.493	0.001	***
	15-; 13-; 11-MeC31	0.032	0.020	1.625	10.451	15.333	0.001	***
	3-MeC29	0.031	0.013	2.368	13.253	7.072	0.001	***
	3-MeC27	0.028	0.006	4.755	0.711	6.361	0.001	***
	n-C27	0.024	0.011	2.223	0.873	5.707	0.001	***
Groups	Compound	Average	SD	Ratio	Average group 1	Average group 3	p value	Sig. level
Mc control exp. 1 x Mc control exp. 2	11,15-; 11,17-diMeC31	0.023	0.017	1.325	12.772	13.361	1.000	n.s.
	15-; 13-; 11-MeC31	0.022	0.019	1.179	10.451	13.304	0.888	n.s.
	3-MeC29	0.014	0.011	1.339	13.252	12.979	0.999	n.s.
	n-C29	0.011	0.008	1.302	7.076	5.445	0.918	n.s.
	17-; 15-MeC33	0.008	0.006	1.380	5.829	5.994	0.960	n.s.
Groups	Compound	Average	SD	Ratio	Average group 1	Average group 4	p value	Sig. level
Mc control exp. 1 x Mc experimental exp. 2	11,15-; 11,17-diMeC31	0.030	0.019	1.616	12.772	8.671	0.480	n.s.
	15-; 13-; 11-MeC31	0.023	0.016	1.416	10.451	13.321	0.860	n.s.
	3-MeC29	0.014	0.010	1.351	13.253	13.560	1.000	n.s.
	n-C29	0.010	0.007	1.443	7.077	7.679	0.995	n.s.
	17-; 15-MeC33	0.008	0.006	1.408	5.830	4.835	0.935	n.s.
Groups	Compound	Average	SD	Ratio	Average group 2	Average group 3	p value	Sig. level
Mmon exp. 1 x Mc control exp. 2	11,15-; 11,17-diMeC31	0.046	0.022	2.066	13.361	4.493	0.001	***

	3-MeC29	0.030	0.014	2.174	12.979	7.072	0.001	***
	3-MeC27	0.029	0.006	4.958	0.600	6.361	0.001	***
	15-; 13-; 11-MeC31	0.028	0.017	1.663	13.304	15.333	0.152	n.s.
	n-C27	0.025	0.011	2.296	0.715	5.707	0.001	***
Groups	Compound	Average	SD	Ratio	Average group 1	Average group 4	<i>p</i> value	Sig. level
Mmon exp. 1 x Mc experimental exp. 2	3-MeC29	0.033	0.013	2.553	13.560	7.072	0.001	***
	3-MeC27	0.027	0.006	4.568	0.937	6.361	0.001	***
	15-; 13-; 11-MeC31	0.026	0.018	1.481	13.321	15.333	0.262	n.s.
	11,15-; 11,17-diMeC31	0.025	0.022	1.142	8.671	4.493	0.997	n.s.
	n-C27	0.024	0.011	2.218	0.883	5.707	0.001	***
Groups	Compound	Average	SD	Ratio	Average group 3	Average group 4	<i>p</i> value	Sig. level
Mc control exp. 2 x Mc experimental exp. 2	11,15-; 11,17-diMeC31	0.034	0.021	1.624	8.671	13.361	0.031	*
	15-; 13-; 11-MeC31	0.021	0.016	1.294	13.321	13.304	0.932	n.s.
	3-MeC29	0.014	0.011	1.328	13.560	12.979	0.998	n.s.
	n-C29	0.013	0.008	1.634	7.679	5.445	0.627	n.s.
	4-MeC30	0.010	0.006	1.490	2.093	3.573	0.009	**

(III) Frequency of checking cells

The proportion of events in which females checked cells varied significantly among the groups ($\chi^2 = 25.378$, Df = 2, $p < 0.001$). The post hoc pairwise tests revealed that indeed groups were significantly different from each other (dominant x beta: t.ratio = 3.407, $p < 0.01$; dominant x subordinates: t.ratio = 4.760, $p < 0.001$), with exception for the pair beta x subordinates (t.ratio = 0.082, $p > 0.05$) (Figure 1d). Dominant females checked cells more frequently than the other two groups of females.

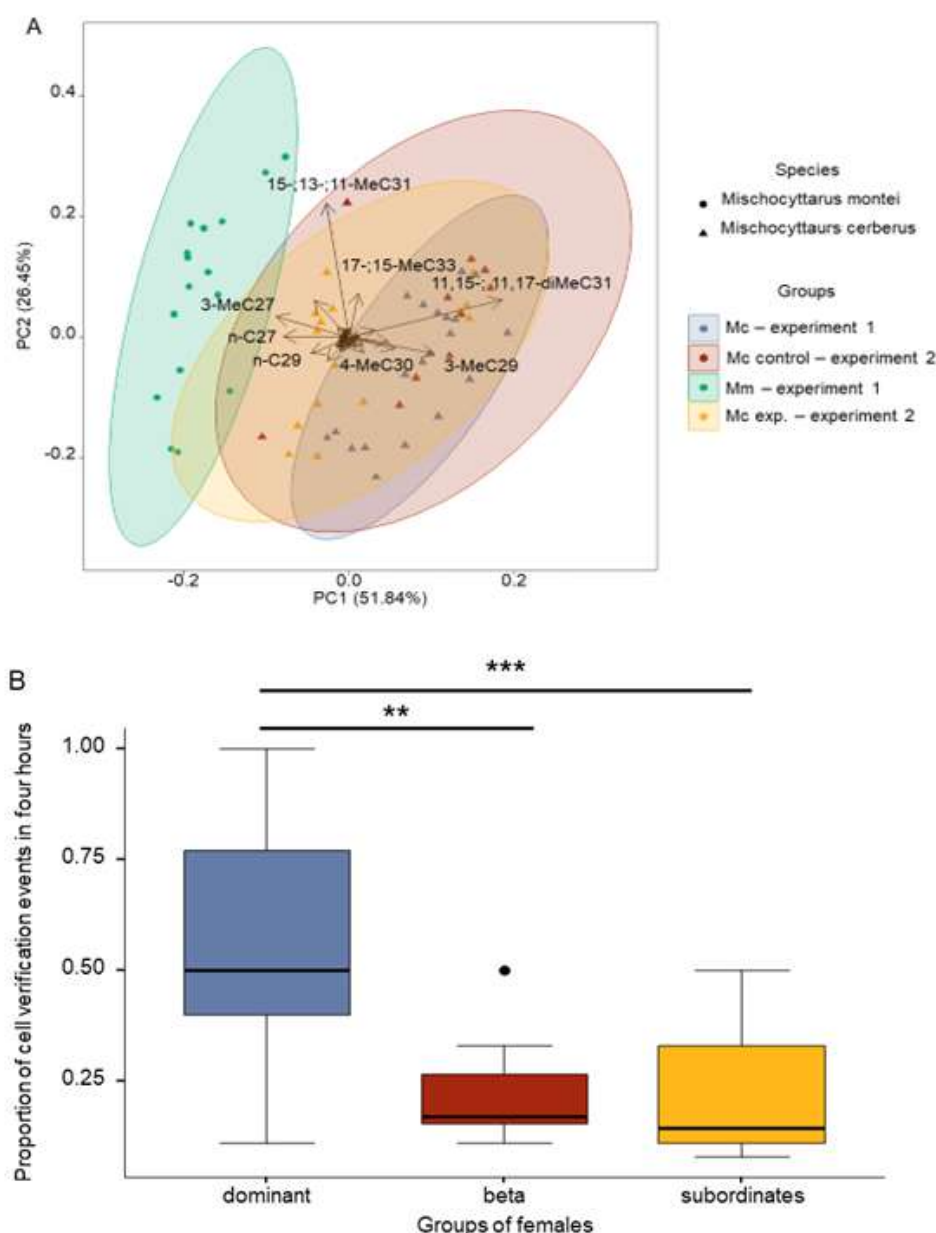


Figure 2: a) Principal component analysis (PCA) showing the ordination of the four studied groups of eggs based on their hydrocarbons. Chemical compounds in evidence represent the most important to promote group separation according to SIMPER analysis. Mc = *Mischocyttarus cerberus* and Mm = *Mischocyttarus*

montei. b) Proportion of cell verification events performed by females during four hours of observation. Alpha = 13 females, beta = 7 females, subordinates = 26 females. The proportion of cell verification varied significantly among groups of females ($\chi^2 = 25.378$, Df = 2, $p < 0.001$). The post hoc pairwise tests revealed that indeed groups were significantly different from each other (dominant x beta: t.ratio = 3.407, $p < 0.01$; dominant x subordinates: t.ratio = 4.760, $p < 0.001$), with exception for the pair beta x subordinates (t.ratio = 0.082, $p > 0.05$).

Discussion

The ability to correctly recognize a nestmate over a non-nestmate is important to maintain the social integrity in social insects, once it prevents their nests to be usurped by other individuals (adults or brood). Here, we empirically demonstrated that females of *Mischocyttarus* wasps have the capacity to recognize and destroy eggs at two different levels, intra and interspecifically. We confirmed our initial hypothesis that *M. cerberus* females would correctly recognize eggs based on their origin. We found that females destroy alien eggs more frequently than their own. The recognition abilities worked similarly when they were confronted either with interspecific and intraspecific eggs. Furthermore, we detected quantitative variations on the hydrocarbons covering the eggs, suggesting that females likely rely on the chemical cues to make decisions. A more pronounced chemical variation was detected between eggs from different species (*M. cerberus* x *M. montei*), although a slight dissimilarity was also detected among eggs from different *M. cerberus* nests. Lastly, we demonstrated that alpha females (= queens) are the ones that check cells more often within their nests, indicating that they are likely responsible for removing eggs. Taking into consideration that *M. cerberus* can have their nests usurped by other *Mischocyttarus* or *Polistes* species, egg recognition skills potentially help females to remove unrelated brood from their nests.

The survivorship results of the eggs suggest that females perform eggs' destruction shortly after being placed (= laid), and this is true for intra and interspecific eggs. However, some alien eggs escaped policing and were reported to be in the nests after a week. We believe that there are two possible explanations, firstly, eggs may escape being removed because after a while in the nest, they indirectly acquire some chemical cues throughout the interaction that females maintain with them (grooming) or from the nest material; or alternatively, it is possible that not all the females have accurate discrimination skills, then these nests would be more susceptible to usurpers. Although these two explanations are speculative in our case, previously published studies demonstrated that these may be the case for other species of social insects. For example, as previously demonstrated for two termite species (*Reticulitermes santonensis* and *R.*

lucifugus grassei) allogrooming behavior (grooming towards another individual) is a way in which cuticular compounds can be transferred passively among individuals (Vauchot et al. 1998). In ant species, allogrooming helps them to spread CHCs stored in their glands that they received from different individuals (Lenoir et al. 2001). Trophallaxis is also a route of disseminating hydrocarbons among nestmates (LeBoeuf et al. 2016). In *Polistes metricus*, females do not perform a high frequency of egg removal when confronted with their own and alien eggs (Wright et al. 2019). In this case, there seems to be an effect of olfactory responsiveness of each female, the most responsive females are more likely to reject alien eggs, whereas the contrary is true for the less responsive ones (Wright et al. 2019). Future research should address questions related to chemical cues transference between adult-immature individuals, and also check whether females of *M. cerberus* (especially queens) have a similar olfactory responsiveness, which probably would help us understand whether all females have similar discriminatory skills.

As demonstrated previously for other social insects, the hydrocarbons covering eggs' surfaces are likely the proximal factors that allow *M. cerberus* females to recognize their eggs over alien ones. Here we could not explore how *M. cerberus* females would behave if confronted with eggs of *Mischocyttarus consimilis* or *Mischocyttarus cassununga*, the two species that were already reported to interact with *M. cerberus* (usurpation interactions) (Pinto et al. 2004; Montagna et al. 2012; personal observation). However, the accurate ability to eliminate eggs from other *M. cerberus* and *M. montei* nests suggest that they may be able to associate specific chemical cues of their brood and react properly. Egg marking chemical cues are useful not only to prevent nests from being usurped in social wasps (Lorenzi & Filippone 2000), but they are also the main route to resolve internal queen-worker reproductive conflicts (see Wenseelers et al. 2020a; Wenseelers et al. 2020b; Oi et al. 2020). Although the queen is the main responsible for reproduction in the colony, workers in some cases are not fully sterile and try to invest in direct fitness by laying their own eggs (male-destined eggs), however, reproductive workers can represent a cost for the whole colony since they do not perform the same amount of work as the remaining sterile ones (Wenseelers et al. 2004). Under such circumstances even though workers can activate their ovaries and even lay some eggs, these eggs are effectively removed by their nestmates (Foster & Ratnieks 2001; Wenseeler et al. 2005; Liebig et al. 2005). The cues that allow such recognition are the chemical compounds that cover them (Oi et al. 2015; Oi et al. 2020), as queen-laid and

worker-laid eggs are chemically different. For example, in the social wasp *V. vulgaris* a methylated hydrocarbon (3-MeC29) is more abundant over queen-laid eggs, and experiments have shown that the topical application of these hydrocarbon over worker-laid eggs let them to be less removed (Oi et al. 2015). In *Polistes dominula* the chemical composition of subordinate eggs does not match the same that are laid by queens, then this variation may help queens to recognize and destroy undesirable eggs in order to increase their fitness (Dapporto et al. 2007). The fact that not only queens have activated ovaries and are inseminated in colonies of *M. cerberus* (da Silva et al. 2020b) raise the possibility that reproductive conflicts may exist among females. Beta females and the other subordinate females may attempt to invest in their own reproduction. If *M. cerberus* females rely on such egg marking chemical cues, this can help reproductive conflicts to be solved.

In *Polistes biglumis*, females express the same ability to recognize their own eggs when confronted with other from unrelated females. However, they behave differently depending on the eggs' fate, reproductive-destined eggs are removed whereas worker-destined eggs receive care (Lorenzi & Filippone 2000). In this case, the differential responses exhibited by *P. biglumis* females seem to be a result of the different fitness return that females may have from raising alien brood. Caring for worker-destined eggs means receiving help with nest maintenance when these adult females emerge, while caring for reproductive-destined eggs does not mean receiving any help (Lorenzi & Filippone 2000). We cannot assure that eggs' fate was a determinant factor that contributed for some alien eggs to be tolerated for a longer time in our experiments. Future experiments should address worker-destined eggs or male-destined eggs would be removed at different rates in *M. cerberus* colonies.

Although we were not able to correctly assign which female is responsible for scanning the nest to remove alien eggs, we believe that this task is probably performed more often by females responsible for reproduction, the dominant ones (= queens) in *M. cerberus*. Our data demonstrate the proportion of checking cell events from different groups in a limited time (4 hours of observation), however, we were already able to see a trend for dominant females to check cells more often. Females of *M. cerberus* probably check cells for different reasons. Dominant females stay on the nest and dedicate their time to reproductive tasks, which includes laying eggs and checking them right after oviposition (personal observation / see Figure S2), additionally, they also display the

brood attending behavior, and they frequently perform aggressive acts toward other females (da Silva et al. 2020b). The remaining females however, often put their heads inside a cell when they are feeding larvae, for example forager females perform this right after returning from the field (personal observation). In social wasps belonging to different social levels, from primitively to highly eusocial, it is well established that policing behavior is performed not only by the queen, but also by other workers (Saigo & Tsuchida 2004; Wenseelers et al. 2005). Thus, even though we believe that dominant females are the ones responsible to realize such a task, the likely involvement of other females in egg screening behavior is not dismissible. The successful use of artificial cells to collect eggs used here will allow more studies addressing questions related to policing behavior in *Polistine* wasps.

The hydrocarbons found covering the egg's surface likely work as the proximal cues that allow discrimination of brood. The majority of the hydrocarbons covering the eggs originate from the *Dufour's* gland (Ferreira et al. 2022), but secretions released by cephalic glands during the egg licking behavior may also exist. Thus, whether parasitism is costly and frequent in *M. cerberus* nests, it is possible that hydrocarbons of these glands may have been selected to carry information that match specifically species and nest origin. Our results demonstrate the ability to recognize brood in *M. cerberus*. Future experiments should also address whether the removal rates of eggs coming from *M. cassununga* and *M. consimilis* nests are consistent with the data that we present here for *M. montei*.

In conclusion, the results of our work reinforce that in social wasps, nestmate recognition skills are not limited to interacting with adult individuals, but also brood as eggs. This ability may be useful and may bring benefits to individuals in a nest at multiple levels. Perceiving the presence of intra or interspecific alien brood, and queens to distinguish their own eggs over other subordinate females. Additionally, we conclude that hydrocarbons are likely the proximate cues that allow egg recognition to occur in *M. cerberus*. Finally, we report that the process of egg recognition and hence removal may be performed by the dominant females, since they are the ones that seem to be more engaged in checking cell behavior. Several aspects of egg discrimination remain unsolved for *Mischocyttarus* wasps and some questions should be addressed in future experiments.

Acknowledgments

We would like to thank the funding provided by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. Funding was also provided from Bilateral grant FWO-FAPESP to CAO, FSN and TW (process: 2018/10996-0 FAPESP and FWO: GOF8319N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Funding

This study was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. Funding was provided from Bilateral grant FWO-FAPESP to CAO, FSN and TW (process: 2018/10996-0 FAPESP and FWO: GOF8319N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Data availability

The data that supports the findings of this study are available in the supplementary material of this manuscript.

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CHAPTER 7

*You learn it and you learn it well:
Cognitive abilities vary according to
behavioural caste, age and sex in a
primitively eusocial wasp*



Credit: The author

In prep. To be submitted to *iScience*

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Abstract

Learning and memory are cognitive skills that have been widely investigated through the proboscis extension reflex (PER) protocol in the model system *Apis mellifera*. New adapted versions of PER arose in a way to accommodate new model organisms such as ants and wasps. Wasps are key organisms for the maintenance of the environment. However, they still get less attention when compared to bees. In this way, using wasps in cognitive studies stands out as a promising strategy for conserving these insects. Here we present for the first time a new model organism to study learning and memory skills under a PER-adapted protocol belonging to the social wasp genus *Mischocyttarus*. Individuals from *Mischocyttarus cerberus* species (queens, foragers, males, newly emerged females and newly emerged males) were conditioned in absolute conditioning to associate two types of an olfactory stimulus, one with biological relevance and another with no apparently biological relevance, with a sucrose reward. Additionally, after the conditioning phase, all conditioned individuals were tested for memory retention and generalization to a new odorant. We hypothesized that learning and memory skills would vary according to the different behavioral castes, age, and sex of the tested individuals. We predicted that older individuals would perform better than the younger ones at the learning and memory trials irrespective of their sex. Our data revealed that *M. cerberus* individuals indeed are able to learn olfactory stimuli. Besides that, we also found out that individuals are able to learn and memorize scents irrespective of their biological relevance. Interestingly, the only group that did not demonstrate the ability to learn the association between the stimuli was the one including newly emerged females. As predicted, the cognitive skills in individuals of *M. cerberus* may be influenced by their behavioral caste, age and sex. Future studies should address whether brain structures undergo any modification that could explain the cognitive variability observed in our study.

Keywords: associative learning; *Mischocyttarus cerberus*; memory acquisition; olfactory cues; social wasps; cognitive skills

Introduction

Associative learning assays have gained huge attention since Pavlov (1927) conducted experiments with dogs, which have been adapted for many other vertebrates and invertebrates (Guerrieri & d’Ettorre 2009). Since then, several studies on this topic have been performed using social insects as models, especially the honey bee *Apis mellifera* (Châline et al. 2005; Giurfa 2015). Other species of social insects have been occasionally used as well (Laloi et al. 1999; Laloi et al. 2004; Guerrieri & d’Ettorre 2009; Piqueret et al. 2019; Wright et al. 2019; Gong et al. 2019). Nevertheless, there is still a variety of social insect species with unknown information regarding their learning and memory skills, also taking into consideration their evolutionary trajectories (Papaj & Alcinda 2012).

In honeybees, the cognitive abilities, such as learning and memory, were studied under the proboscis extension reflex (PER) paradigm (Takeda et al. 1961; Bitterman et al. 1983; Châline et al. 2005; Giurfa & Sandoz 2012). The PER protocol allows accessing information that ranges from the behavioral to the molecular level of these bees (Giurfa & Sandoz 2012). When you touch a honey bee’s antennae with sucrose solution, the bee reacts with the innate response of extending its proboscis. Thus, the PER protocol consists in presenting a given odorant (the conditioned stimulus – CS) to a harnessed bee, followed by a presentation of sucrose solution (the unconditioned stimulus – US) to its antennae and mouthparts. After some trials, the bees learn to associate both stimuli (US and CS) and hence start extending the proboscis under the presence of the odorant alone, anticipating the sucrose reward (Takeda et al. 1961; Bitterman et al. 1983; Giurfa & Sandoz 2012).

Alternatively, the PER protocol has been adapted to ants and wasps (Guerrieri & d’Ettorre 2009; Perez et al. 2013; Wright et al. 2019; Gong et al. 2019; Mattiacci et al. 2021). Restrained ants and wasps are also able to respond to sucrose solution if they are touched in their antennae in a similar way as honey bees do. However, they extend their maxilla-labium mouthparts (“tongue”) (Guerrieri & d’Ettorre 2009; Piqueret et al. 2019; Wright et al. 2019; Gong et al. 2019), also termed as maxilla-labium response, or MaLER (Guerrieri and d’Ettorre 2009). Yet, only a few species have been explored under this protocol. For instance, ants of the species *Camponotus aethiops* are able not only to learn an odor stimulus, but are also able to discriminate between different odors when one is

paired with sucrose (sugar reward) and the other one is paired with quinine (aversive stimuli) (Guerrieri & d'Ettore 2009).

Concerning social wasps, conditioning assays using different groups of *Vespa velutina* - virgin queens, males, and workers - showed that they are able to learn a different set of olfactory stimuli if they are paired with sucrose solution. Besides that, virgin queens and males retain memory even after 30 days of experimental conditioning (Gong et al. 2019). Also, the level of responsiveness that *Polistes* paper wasp females express during conditioning assays is tightly associated with the likelihood of these females accepting or not alien eggs in their nests (Wright et al. 2019). Although relevant, these are so far the only information available for the non-bee model organisms that aimed to explore the cognitive skills of individuals through PER-adapted protocols. Consequently, an enormous pathway of knowledge is yet to be fulfilled. Considering the plethora of ecosystem services that wasps provide to the environment and society (Brock et al. 2021), together with the fact that are not receiving the same attention from researchers as other insect groups (Sumner et al. 2018), and that wasps populations have declined across the past years (Outhwaite et al. 2019; 2020), using wasps in cognitive studies stand out as a promising strategy for promoting the conservation these organisms. Additionally, uncovering wasp cognitive abilities can bring some insights about how these organisms may deal with social interactions that require this set of skills.

One of the most speciose genera of Brazilian social wasps is *Mischocyttarus*, which comprises 144 species (Somavilla et al. 2021), and even though they occur almost exclusively in the Neotropical area, a few information that covers their biological aspects have been reported across the years (O'Donnell 2020). *Mischocyttarus cerberus* is a Neotropical primitively eusocial wasp, as females belonging to different castes do not differ based on external morphological terms, but instead, they vary behaviorally and chemically (Gianotti 1999; da Silva et al. 2020). Colonial cycles are asynchronous throughout the year, and nests are usually started by a single female, but associative foundations also occur (consisting of a few females) (Miller et al. 2018; da Silva et al. 2019). Nests of *M. cerberus* are deprived from an envelope and often experience usurpation by unrelated species (da Silva et al. 2019; Pinto et al. 2004; Montagna et al. 2012).

The younger (or newly emerged) individuals of this species have black eyes, and after about a week, they go through a process of depigmentation and become green (Togni

& Giannotti 2010). Males are easily distinguished from females because they have an extra antennomere, which is bent and also, they have lighter faces (Togni & Giannotti 2010; da Silva personal observation). During the first week, newly emerged females remain mostly immobile in the nest and do not perform any task. By the second week, they start foraging for resources (Giannotti 1999; da Silva personal observation). Males usually stay in the nests for only a short period of time (Giannotti 1999; Togni & Giannotti 2006). Considering that individuals of *M. cerberus* experience a variety of contexts throughout their lives, which differ according to their age, caste, and sex, it is plausible to believe that they also have distinct cognitive abilities.

Here we present for the first time a new model organism to study learning and memory skills under a PER-adapted protocol, belonging to the wasp genus *Mischocyttarus*. By using an absolute conditioning protocol, we tested the ability of individuals to learn and memorize odors with and without apparent biological relevance. We hypothesized that the learning and memory skills would vary according to the behavioral castes, ages, and sex of individuals. We expected that older individuals would be able to learn and memorize odors irrespective of their sex more successfully than the younger ones, because individuals may suffer neurologically changes due to brain plasticity as they age, as suggested recently for the related wasp species *Polistes fuscatus* (Jernigan et al. 2021). The results of our work represent an important addition to the field of cognitive neurosciences of social insects, and will likely contribute to new studies involving social wasps to be performed in the future.

Results

Experiment I - Do individuals learn and memorize an odour that is biologically relevant?

We trained *M. cerberus* foragers in an absolute conditioning protocol in two different situations. One group was trained by pairing the conditioned stimulus (CS+) with the unconditioned stimulus (US), i.e., paired group, whereas a second group was trained with both stimuli in an unpaired fashion. Wasps from the paired group were able to learn the association between CS+ and US across trials (Fig. 1), as a significant trial effect was found (ANOVA - $\chi^2 = 21.656$, $Df = 1$, $p < 0.001$). In contrast, wasps from the unpaired group did not present higher rates of MaLER across trials ($\chi^2 = 0.232$, $Df = 1$, $p = 0.629$; Fig. 1), indicating that individuals from this species can indeed perform associative learning between a CS+ and US, and did not respond randomly when both

stimuli were paired in the previous group. These results are reflected by the memory tests, performed one hour after conditioning. A significant difference was found between condition (Chisq = 7.559; DF = 1; $p = 0.005$), odor presented (Chisq = 9.140; DF = 1; $p = 0.002$) and the interaction between condition and odor presented (Chisq = 6.537; DF = 1; $p = 0.010$). In the memory test, foragers from the paired group responded more frequently when presented to Linalool than to the new odor (NOd; Geraniol) (odds.ratio = 387.195; $p = 0.013$; Fig. 1). These results indicate that these females did not generalize their response toward the odors, but instead they consistently performed MaLER toward the conditioned odor. As expected, females from the unpaired did not perform differently in the memory tests (odds.ratio = 1.000; $p = 1.000$), also presenting low levels of responses when presented to the conditioned odor and the new one (Fig. 1).

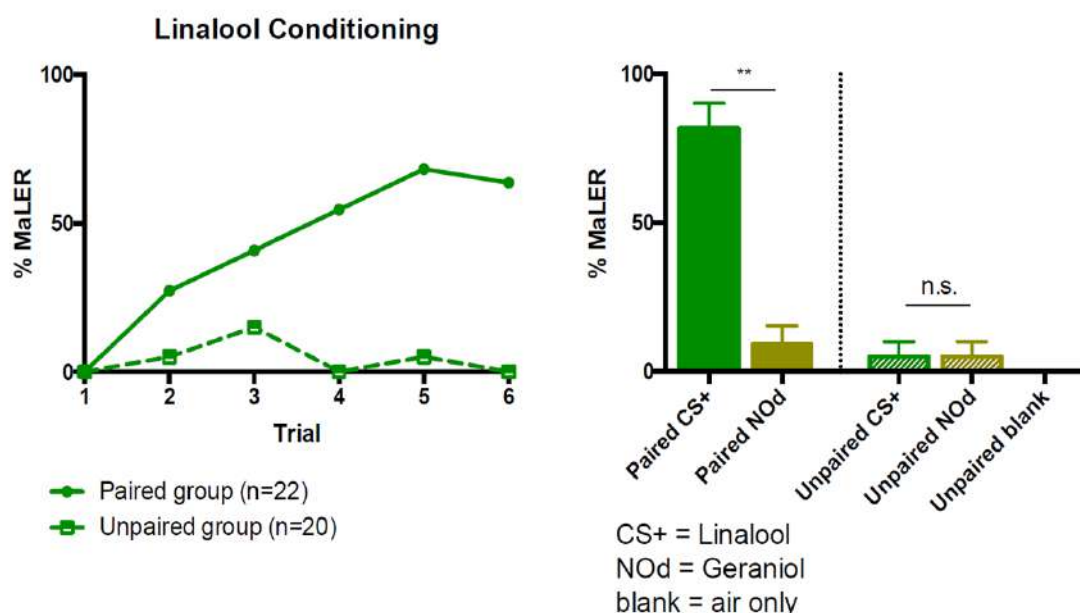


Figure 1: The left panel shows the learning acquisition curves for the two groups of *Mischocyttarus cerberus* foragers, under six trials of absolute conditioning. The paired group that received a subsequent and overlapping presentation of CS+ (Linalool) and US (sucrose solution), and the unpaired group were presented with both stimuli separately. The right panel represents memory retention and generalisation performances of the two groups of foragers towards the CS+ and a new odor (NOd) (Geraniol) one hour after conditioning, in the absence of US. Significant discrimination between CS+ and NOd was detected only in memory assays that included foragers that received both CS+ and US in a paired fashion (odds.ratio = 387.195; z.ratio = 3.023; $p = 0.013$). Considering that during the conditioning assays of unpaired foragers we used a clean glass that released air only to present together with the US, in the memory assays these foragers were presented again with the clean glass vial. However, as expected, none of the females performed the maxilla-labium extension response (MaLER).

To test whether the different groups of *M. cerberus* perform differently in learning and memory experiments, we trained foragers, queens, newly emerged females,

males and newly emerged males in an absolute conditioning protocol. Individuals were trained by receiving both CS+ with unconditioned stimuli US in a paired situation. Only the newly emerged females were not able to learn the association between CS+ and US across trials (ANOVA (trial) - $\text{Chisq} = -3.552$, $\text{Df} = 1$, $p = 1.000$), while all of the other groups were successful in performing this task (ANOVA (trial) - $\text{Chisq} = 22.709$, $\text{Df} = 1$, $p < 0.001$); Fig. 2. One hour after conditioning, individuals from the five groups were tested for memory and generalization to a novel odor (NOd). Again, only newly emerged females were not able to perform the task, responding similarly to the CS+ and to the NOd (T test - odds.ratio = 2.100, $p = 0.999$), with low levels of MaLER. Individuals from the other groups consistently responded more to the CS+ than to the NOd. The ANOVA test showed that the factors “group” ($\text{Chisq} = 35.977$; $\text{DF} = 4$; $p < 0.001$) and “odour presented” ($\text{Chisq} = 26.367$; $\text{DF} = 1$; $p < 0.001$) were significant. Looking at the results of the post hoc pairwise test three groups “foragers”, “males” and “newly emerged males” indeed demonstrated the lower levels of generalization during the memory tests, as their responses toward CS+ and the NOd were statistically different (foragers: odds.ratio = 45.000; $p = 0.001$ / males: odds.ratio = 10.625; $p = 0.043$ / newly emerged males: odds.ratio = 21.533; $p = 0.005$) (Figure 2). Queens, on the other hand, although demonstrating the capacity to associate stimuli during the conditioning phase, generalized their response at a higher frequency during the memory test (odds.ratio = 9.000; $p = 0.078$) (Figure 2).

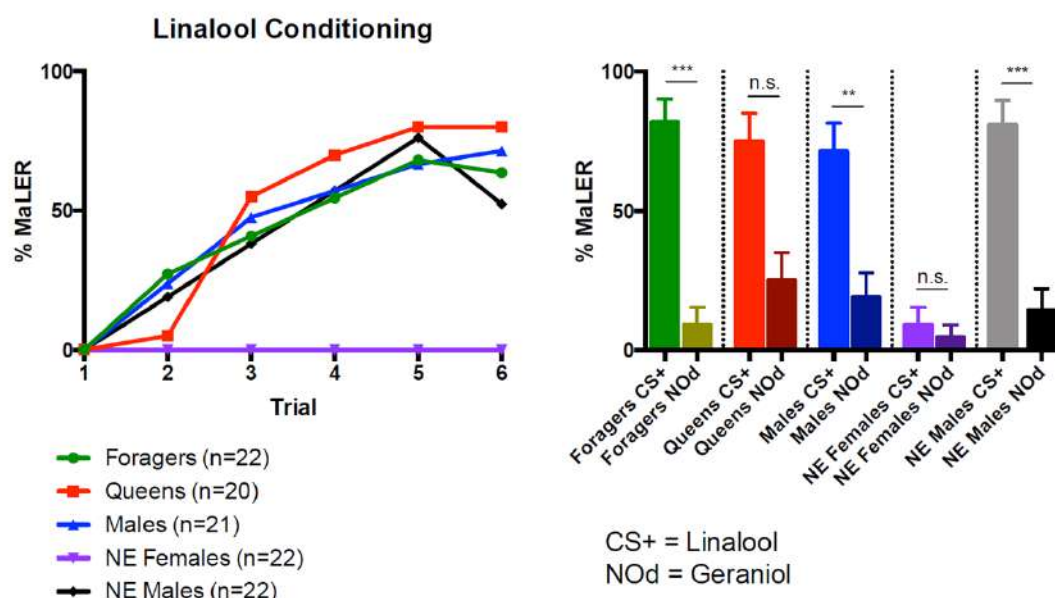


Figure 2: The left panel shows the learning acquisition curves for the five groups of *Mischocyttarus cerberus* wasps - foragers, queens, males, newly-emerged females (NE females), and newly-emerged males (NE males). The five groups of wasps received both conditioned stimuli (Linalool; CS+) and unconditioned stimuli (sucrose solution; US) in a paired fashion under six trials of absolute conditioning. The right panel represents memory retention and generalisation performances of the five groups wasps towards the CS+ and a new odor (Geraniol; NOD) one hour after conditioning assays, in the absence of US. Significant discrimination between CS+ and NOD was detected for almost all groups of wasps that received both CS+ and US in a paired fashion (foragers: pairwise, odds.ratio = 45.000; $p = 0.001$ / males: pairwise, odds.ratio = 10.625; $p = 0.043$; newly-emerged males: pairwise, odds.ratio = 21.533; $p = 0.005$). Although queens have demonstrated a strong ability to associate CS+ to the US during the conditioning experiment, they generalised more during the memory test (queens: pairwise, odds.ratio = 9.000; $p = 0.078$). The low responsiveness of newly-emerged females in the memory tests is related to the fact that during conditioning they did not learn to associate CS+ with the US.

Experiment II - Do individuals learn and memorize an odor that is not biologically relevant?

In this experiment we trained *M. cerberus* foragers, newly emerged females and newly emerged males in an absolute conditioning protocol. Individuals were trained to associate the US to a CS+ that is not biologically relevant for the species (Nonanal). Individuals belonging to the forager and newly emerged male groups were able to associate the CS+ to the US along with the six trials (ANOVA (trial) - $\text{Chisq} = 20.014$, $\text{Df} = 1$, $p < 0.001$), while newly emerged females were not able to learn across trials (ANOVA (trial) - $\text{Chisq} = 0.000$, $\text{Df} = 1$, $p = 0.992$); Fig. 3). One hour after conditioning, individuals belonging to the three groups were tested for memory and generalization to a novel odor (NOD), which is also not biologically relevant for the species (1-Hexanol). As expected from the conditioning results, individuals belonging to forager and newly emerged male groups responded more to the CS+ than to the NOD (Figure 3). According to the ANOVA test, the factor group ($\text{Chisq} = 11.531$, $\text{Df} = 2$, $p = 0.003$) was statistically different. The results of the post hoc pairwise tests unveil that actually none of the pairs including foragers and newly emerged males (Nonanal vs 1-Hexanol) were statistically different (T test foragers - odds.ratio = 11.000, $p = 0.064$ / T test newly emerged males - odds.ratio = 3.777, $p = 0.521$). These results indicate that although foragers and newly-emerged males were able to learn the stimuli during the conditioning phase, they were less successful in the memory tests. In other words, although foragers and newly emerged males performed correctly MaLER at a higher rate toward the CS+, however, they also generalized more. Newly emerged females had low levels of responses during the memory tests, with no differences between the responses to CS+ and NOD (T test - odds.ratio = 2.100, $p = 0.991$).

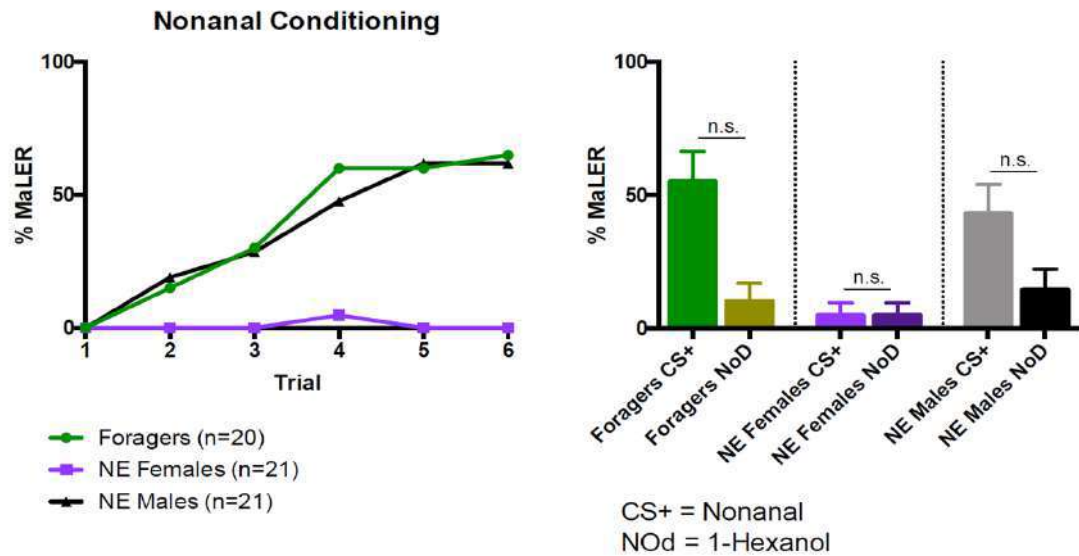


Figure 3: The left panel shows the learning acquisition curves for the three groups of *Mischocyttarus cerberus* wasps - foragers, newly-emerged females (NE females), and newly-emerged males (NE males). The three groups of wasps received both conditioned stimuli (Nonanal; CS+) and unconditioned stimuli (sucrose solution; US) in a paired fashion in six absolute conditioning trials. The right panel represents memory retention and generalisation performances of the three groups wasps towards the CS+ and a new odor (1-Hexanol; NOd) one hour after conditioning, in the absence of US. Even though foragers and newly emerged males responded more consistently toward CS+ rather than toward the NOd, a significant discrimination between CS+ and NOd was not detected in any of the three groups. As seen in the experiment 1, the low responsiveness of newly-emerged females in the memory assays towards the CS+ is related to the fact that during conditioning these females were not able to learn the association between the CS+ with the US. The lack of significant variation between the responses performed by foragers and newly-emerged males toward CS+ and NOd in the memory assays indicates a higher level of generalisation by these individuals in Experiment 2, in comparison with Experiment 1.

Discussion

This is so far the first study to explore the cognitive skills of the primitively eusocial wasp *M. cerberus*. By using an adapted version of the well-established PER protocol, namely MaLER (Guerrieri and d’Ettorre 2009), our study revealed that *M. cerberus* wasps are able to learn olfactory stimuli if it is paired with a rewarding sugar solution. The learning skills of *M. cerberus* were present irrespective of biological relevance that the olfactory stimuli may have for them, as wasps were capable to learn the odor in Experiment 1 (Linalool) and Experiment 2 (Nonanal). Additionally, during the memory retention tests *M. cerberus* built a stable memory towards the odors that they learned, as they expressed MaLER more frequently towards the CS+ than to the NOd. Foragers showed a better performance in the memory test when compared with all the other groups. Interestingly, newly-emerged females represented the only group that was not able to associate the CS+ to the US during conditioning and hence did not acquire

memory. That being said, our hypothesis was corroborated, as we confirmed that the cognitive skills varied among castes, sex, and age in *M. cerberus* wasps.

Even though four out of the five tested groups demonstrated the ability to associate CS+ when paired with US, queens demonstrated to be better at this task, once they overall did better from trial four to six, which likely suggests that they have better olfactory skills than the other individuals. On the other hand, although queens were seen to have acquired consolidated memory regarding the CS+, they represented the group that expressed the higher level of generalization in Experiment 1. These results can be a consequence of their age. Queens are usually the older individuals within *M. cerberus* nests: their average life expectancy corresponds to 190 days, whereas workers live for about 14 days, and males stay on the nests for about 11 days (Giannotti 1999). Although we did not have access to the exact age of the wasps used in our experiments, queens were certainly the older tested individuals. That being said, learning abilities probably become better as individuals become older. However, a side effect of that may be a lower accuracy concerning the process of odor discrimination. In fact, this was already reported for older females (foundresses) of *Polistes fuscatus*, which have better facial learning and memory than workers (Tibbetts et al. 2018). This reinforces that the cognitive skills in wasps can be affected by their age.

Another aspect of our work that strengthens the idea that age may play a significant role in the cognitive skills of wasps, is that foragers performed much better than newly-emerged females in both learning acquisition and memory tests. Foragers were able to associate the CS+ to the US in Experiments 1 and 2, while newly-emerged females were not capable of doing the same. Besides that, foragers demonstrated to be able to retain the memory of the conditioned stimuli and generalized at a lower frequency. During the memory tests, newly-emerged females sometimes performed MaLER, but it seemed to occur in a random way. In honeybees, newly-emerged workers are able to learn through associative conditioning if they express higher responsiveness to sucrose. However, their level of acquisition is much inferior to those expressed by foragers (Behrends & Scheiner 2009). Pre-forager and forager workers in *Vespula germanica* kept under lab conditions seems to have similar levels of responsiveness toward carbohydrate and protein resources. However, whether they learn and memorize scents in a similar way is still unknown (Mattiacci et al. 2021). Still, the responsiveness level to sucrose does not explain the newly-emerged females' performance in our experiments, as they were

fully responsive to the 50% sucrose solution that we used in our conditioning assays. An alternative explanation is that newly-emerged females do not have fully developed brain structures that would allow olfactory learning, for instance. Recent work demonstrated that newly-emerged females of *P. fuscatus* have significantly smaller brain volumes when compared with older ones (Jernigan et al. 2021). Future studies should investigate if this is also the case for *M. cerberus*. Thus, an integrative study exploring cognitive skills and brain structure development will be important to clarify the possible connection of these two factors.

Surprisingly, the same variation was not found when looking at the data of newly-emerged and older males. Individuals from both groups expressed similar levels of associative learning, and newly-emerged males performed even better at the memory tests from Experiment 1, as they responded more to the CS+ and generalized less to the NOd. These results become even more interesting whether we look at the learning curves and memory acquisition responses of newly-emerged males and females. Even though brain structures may be affected by the individuals' age, this may not be a general rule. Instead, it seems that there is an age influence that is sex-dependent. The striking cognitive abilities variation between females and males is likely an adaptive trait of the species. As for other social insect species, males of *Mischocyttarus* species do not stay in the nests during their whole life, in contrast to females - around 11 days for *M. cerberus* (Giannotti 1999), 4 days for *M. atramentarius* (Silva 1984), 5 days for *M. drewseni* (Jeanne 1972), and 9 days for *M. extinctus* (Raposo-Filho 1981). Therefore, it is likely that their brain structures develop differently between females and males. A comparative study looking at the brain structures using females and males of different ages is necessary to test this hypothesis.

The fact that *M. cerberus* individuals are able to learn and memorize olfactory stimuli despite their biological relevance is an indication that these skills may be useful for their life in society. Having the ability to learn and memorize scents other than those associated with food, such as the ones correlated with individuals' recognition (eg. cuticular hydrocarbons or CHCs), can be useful to avoid nests being attacked by usurpers and to keep nest cohesion. Although this is merely speculative for *M. cerberus* species, previous research investigated this phenomenon, particularly in a few ant species (Errad 1994; Bos et al. 2010; Bos et al. 2011; Bos & d'Ettorre 2012; d'Ettorre 2013). Ants from the species *Formica selysi* and *Manica rubida* are capable of recognizing familiar

individuals even if separated for a year, probably because they retained memory regarding the recognition cues during their early life (Errad 1994). Experiments using the ant species *C. aethiops* demonstrated that workers can associate a highly diverse set of non-nestmate CHCs when paired with a sucrose solution. However, the conditioning assays still did not prevent ants to behave aggressively towards familiar and unfamiliar nestmates, suggesting that the colony defense is not affected by their appetitive learning skills (Bos et al. 2010). Nevertheless, individuals from the same species also have the ability to learn linear and methyl alkanes whether presented separately and subsequently discriminate between a large number of pairs of them (Bos et al. 2011). Bees of the species *A. mellifera* also have the ability to learn and discriminate a set of different CHCs. In fact, those bees express a high capacity to learn some alkenes, compounds that may be key during the process of nestmate recognition (Châline et al. 2005).

Our work has revealed several interesting factors regarding the cognitive skills of the primitively eusocial wasp *M. cerberus*. In summary, overall individuals have the ability to associate scents irrespective of their biological relevance if paired with a sugary reward. Besides that, they are also capable to retain memory and respond more frequently to the conditioned odor when paired with a new one. Queens had the best learning curves but they were also the ones that expressed the higher levels of generalization. Foragers, on the other hand, expressed lower levels of generalization. Foragers are the individuals responsible for performing the foraging tasks, hence they may be in constant contact with floral resources. Being that said, the fact that we used a floral scent (Linalol) during absolute conditioning in the experiment I and later presented it against another one (Geraniol) during the memory trials likely explains why they performed so well and did not generalize as the individuals from the other groups. The close contact with these floral scents on their daily basis likely makes the process of distinguishing them easier. Although speculative, we believe that if we had used other classes of chemical compounds during conditioning and memory tests, such as cuticular hydrocarbons (CHCs), it is possible that queens would be better at not generalizing scents. Queens of *M. cerberus* are probably the ones responsible for patrolling which eggs are present in their nests, and these eggs are covered by CHCs (da Silva et al. in prep). Thus, the type of role that these females perform within their nests may bias which olfactory stimuli they become better at learning and hence memorizing. Newly-emerged females were not able to associate the CS+ to the US in either of the experiments and hence, they did not acquire

memory. Newly-emerged and older males expressed similar patterns of learning and memory. Altogether, the results of our work clearly demonstrate that age and sex (and the combination of them) are probably two factors that play a role in the development of the cognitive skills in *M. cerberus*. Future research combining brain analyses and cognitive skills are necessary to investigate whether there is a tight connection between brain maturation and the development of learning and memory abilities in females and males. Additionally, it would be interesting to investigate how the learning and memory abilities are used by individuals within their social context, for instance, to regulate nestmate recognition towards adult and immature ones.

Material and Methods

Study site and wasps

Individuals used in the experiments were collected in nests (n = 48) that were located in the area of Universidade de São Paulo (USP) – Campus of Ribeirão Preto - (21°10'39"S; 47° 48' 37"W, 531 m elevation), where nests of different ontogenetic phases are found at the same time across the whole year (da Silva et al. 2019). Only nests in the post-emergence phase were used. Nests were observed according to what has been reported for the species (Giannotti 1999; Noda et al. 2001; da Silva et al. 2020) before the experiments take place. We identified the different castes based on their morphological differences and/or behavior. We used queens (the most aggressive females) (according to da Silva et al. 2020), foragers (females returning from the field with resources), old males (with green eyes), and newly emerged males and females (with black eyes). A total of 180 individuals were used.

Collected wasps were placed in a plastic box, which was taken to the freezer for 2 minutes. After that, each wasp was individually mounted in Eppendorf plastic tubes (0.5ml) with the inferior part removed. In this way, we were able to pass the wasp's head through the hole, whereas all the remaining parts of the body were restrained. Two strips of tape were placed around the wasp's head, preventing them from escaping from the plastic tube. Finally, a piece of cotton was placed in the bottom part of the plastic tube to give support for the wasps, so they were not merely suspended. Once the wasps were mounted, they were kept in a controlled climate room of the Laboratório de Comportamento e Ecologia de Insetos Sociais, under darkness, for two hours. After two hours the experiments were initiated. For honeybees, this interval between being prepared

and the conditioned phase is important to keep individuals hungry and reinforce that all of them would have appetitive motivation (Matsumoto et al. 2012). We determined that two hours were enough after conducting some pilot assays at the beginning of our study.

Olfactory conditioning

In our experiments, we evaluated if the wasps extended or not their maxilla-labium (MaLER) towards the US and CS across six trials (as in Gong et al. 2019), an adapted protocol version of the original PER (Matsumoto et al. 2012). Before starting the conditioning assays all the wasps were touched in their antennae with a toothpick embedded with 50% (v/v) sucrose solution (which triggers MaLER) to check whether they were responsive to US stimuli. Wasps that did not respond were removed from the experiment.

The olfactory stimuli used during the experiments were placed inside glass vials and were presented to the wasps by an automated odour-releasing machine controlled by a microcomputer (Arduino®Uno, Tilburg, North Brabant, The Netherlands) (Aguiar et al. 2018). The harnessed wasp was placed in front of the machine. In this system, a continuous flow of clean air is released towards the wasp's head. An air extractor was placed behind the wasp to prevent odorant accumulation. The air flow could be diverged to the glass vials containing the olfactory stimuli when they were presented to the tested wasps.

We used an absolute conditioning protocol, in which a single odorant is paired with sucrose reward. During the conditioning phase, after the olfactory stimuli were presented to the wasp (4s), and following the odor stimulation a 50% (v/v) sucrose solution (unconditioned stimulus - US) was delivered to the antennae and mouthparts for 3 s, with 1s overlap with the CS+. Each trial lasted 1 min and started with the setting of the wasp in the conditioning device for 26 s, which were followed by the CS-US stimulation (for a total of 6 s); finally, the wasp was left in the setup during another 28 s until it was removed and replaced by the next wasp. The inter trial interval (ITI) was 10 minutes. The procedure was repeated until all wasps were conditioned in 6 trials (Figure x). Wasps that responded to the CS+ in the first trial were removed from the experiment. One hour after conditioning, a retention test was performed in which the CS+ was presented without reward. In such a test, a new odor (NOd) was also presented in order to assess generalization (Figure 4). At the end of the memory test, all the wasps were

tested again to MaLER to check if their mouthparts were not stuck. To avoid killing unnecessarily individuals after being used in the conditioning assays, whenever possible, the individuals were paint-marked with non-toxic ink, to avoid recollecting the same individual, and they were returned to their original nest.

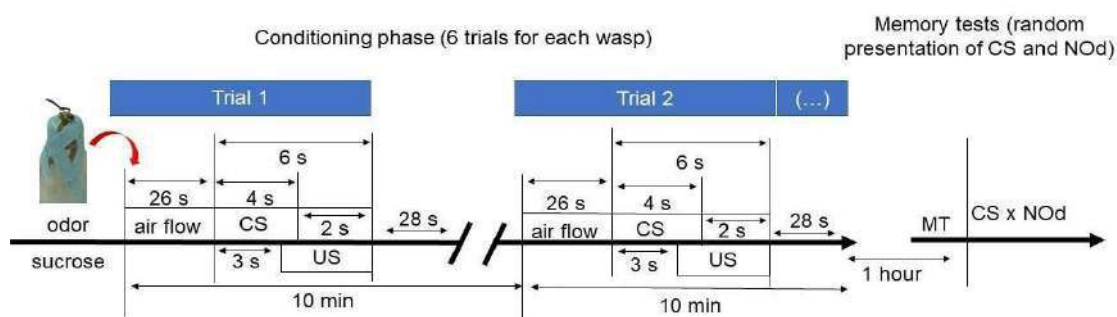


Figure 4: Conditioning procedure used to present the olfactory stimuli (CS+) together with the sucrose solution (US) for the wasps, followed by the memory acquisition scheme. To check whether individuals from *M. cerberus* are able to associate a food resource (sucrose solution) with an odour, and posteriorly if they retain the memory of that, two different experiments were performed and will be presented in the following topics.

Experiment I - Do individuals learn and memorize an odour that is biologically relevant?

In the first experiment, wasps were conditioned with Linalool (CS+), and posteriorly, Geraniol was used as the new odor (NOd). Both olfactory stimuli were chosen because they are likely to have a biological relevance for wasps, as they are naturally found in flowers, where these wasps can collect food resources, such as nectar. Thus, it is expected that wasps are capable of associating the CS+ with the sucrose solution (US) (Gong et al. 2019; Wright et al. 2019). Additionally, both odors were previously used to perform the same type of experiments with another two wasp species (Gong et al. 2019; Wright et al. 2019). In this experiment, five groups of at least 20 individuals were used: (I) queens, (II) foragers, (III) newly-emerged females, (IV) males, and (V) newly-emerged males. As a control, an additional set of 20 foragers were also used in the unpaired conditioned test. In this case, wasps were trained under 12 trials of absolute conditioning, with a 5 minutes ITI. In each trial only the CS or the US was presented to a wasp, in a way that each individual received the same six presentations of CS and six of US, as for the paired group, in the same amount of time. A pseudo randomized order was used for CS and US presentations. To maintain a constant airflow and perform the

experiments as similar as possible for the paired group, these wasps were presented with the airflow diverging from an empty glass vial (blank), whenever the individual was supposed to receive only the US presentation. One hour after conditioning, wasps of the unpaired group went through the memory retention and generalization tests, as for the paired group wasps. During these tests, the individuals were presented to the CS (Linalool), NOd (Geraniol) and to the air from the empty vial (blank). This step was essential to demonstrate that the lack of pairing between the CS and US would result in individuals not learning to associate both stimuli across the six trials, and hence not responding to the CS in the memory assays.

Experiment II - Do individuals learn and memorize an odour that is not biologically relevant?

In order to check whether *M. cerberus* individuals were able to learn and retain memory when presented with odors without apparent biological relevance, i.e., they are not known for being pheromones, cues or attractive traits for this species. Nonanal was used as CS+ (paired with the US), and 1-Hexanol was used as NOd in the second experiment. As in Experiment 1, a total of six trials were performed during the conditioning phase. In this experiment, three groups of at least 20 individuals were used: (I) foragers, (II) newly-emerged females, and (III) newly-emerged males. Queens and males were not used because there was a lack of sufficient available individuals in the study area when the study was performed.

Statistical analysis

In the conditioning and memory retention phases, the responses expressed by wasps toward the olfactory stimuli were coded in a binomial fashion (0 = absence of MaLER and 1 = presence of MaLER). The percentage of wasps per group that expressed MaLER were presented. Wasps' performance was analyzed by using generalized linear mixed models (GLMM). Data concerning MaLER, trial number, condition (paired or unpaired), and group (queen, forager, newly-emerged female, male, and newly-emerged male) were introduced as fixed factors, whereas information concerning the date, nest origin, and wasp code were entered as random factors. For the learning assays, we tested whether the MaLER results would vary according to the interaction between trial and condition (unpaired experiment) and trial and group (Experiment 1 - Linalol / Experiment

2 - Nonanal). A posthoc Tukey test was performed to spot specific differences across trials and groups. In this analysis, we found no differences in learning for queens, foragers, males and newly emerged males in Experiment 1, so these data are presented in a single analysis at the results section. In a similar way, no difference was found in learning between foragers and newly emerged males in Experiment 2, and these data are also presented in a single analysis. For the memory assays, we tested whether the MaLER results would vary according to the interaction between odour (CS = Linalol / Nod = Geraniol) and condition (unpaired experiment), and odour (Experiment 1 – CS+ = Linalol / Nod = Geraniol; Experiment 2 – CS+ = Nonanal / Nod = 1-Hexanol) and group. An ANOVA test was performed in order to check overall statistical differences among different trials and individuals belonging to different groups. All analyses were performed using the software R Studio (version 1.4.1717). For that, the packages *afex* (Singmann et al. 2015) and *lsmeans* (Bates et al. 2015) were used.

Acknowledgments

Competing interests

The authors declare no competing or financial interests.

Author contributions

Funding

This study was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001 and grant 2018/22461-3 São Paulo Research Foundation (FAPESP) to RCS. JMRBVA was funded by the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP; 2019/20408-0). Funding was provided from Bilateral grant FWO-FAPESP to CAO and FSN (process: 2018/10996-0 FAPESP and FWO: GOF8319N), Research Foundation Flanders to CAO (postdoctoral fellowship FWO-12V6318N and research grant FWO-1513219N) and Conselho Nacional de Desenvolvimento Científico e Tecnológico to FSN (307702/2018-9).

Data availability

Supplementary information

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GENERAL CONCLUSION AND FUTURE PERSPECTIVES



Credit: The author

In this thesis, I integrated several methods to investigate chemical ecology aspects that potentially help wasps solving conflicts. More specifically, whether eggs play a role as sources of communication. I combined literature review, chemical characterization, and behavioral experiments to achieve my goal to expand the knowledge of how wasp societies manage to keep social cohesion. Even though I did not perform the comparisons or experiments including all wasp species in the different chapters, my work represents one of the few efforts aimed to explore the roles that brood (mainly eggs) could have. I include in my thesis studies of species from different levels of sociality, from primitively eusocial to highly eusocial species. In primitively eusocial species, egg-marking cues can bring advantages in case the nests get usurped by unrelated females. These nests are deprived of an envelope, which make easier for unrelated individuals to access it. Females that release chemical compounds during egg-laying and are capable to recognize their own eggs may be selected over the females that do not express the same ability. In highly eusocial species, egg-marking cues are potentially important for queens reaching the hundreds or thousands of workers. These nests are bigger than the ones established by primitively eusocial species, which complicates for queens to directly interact with every single worker. Eggs play a role as alternative tools of communication in both primitively and highly eusocial wasp species.

In my thesis, I first presented a mini-review that synthetized the roles that not only eggs, but brood in general display in wasp societies. In fact, brood usually are covered in chemical compounds that directly or indirectly help to maintain the cohesion in wasp colonies. For example, brood possesses chemical cues that are linked to their sex (*P. dominula* - Cotoneschi et al. 2009); that reflect that they are immature and not adult individuals (*P. dominula* - Cotoneschi et al. 2007); linked to their species (*Parischnogaster mellyi* - Turillazzi et al. 2008; *M. metathoracicus*/*P. versicolor* - Chapter 3); that allow parasitism to take place (*P. sulcifer* - Cervo et al. 2008); that reflect female fertility (*M. cassununga* and *M. cerberus* - Ferreira et al. 2022; *V. vulgaris* - Oi et al. 2020); It was clear that the majority of those data were correlational or descriptive. Empirical studies are needed to confirm that the compounds present over brood surface indeed act as signals.

Secondly, I studied the primitively eusocial wasp *M. cerberus* and I presented basic information of brood morphology. By doing this, I showed overall patterns of brood development and how some external factors can affect them. For example, brood

development is affected along the year. In rainy and warmer months, the sum of the mean values of the three different immature categories (eggs + larvae + pupae) were shorter if compared with colder and drier months. In addition to that, immature development is affected by nest ontogeny (pre-worker and post-worker emergence). This chapter was essential to learn how to manipulate wasp brood, which later I used to conduct the egg exchange experiments (Chapter 6).

Thirdly, I explored the variation of chemical compounds that cover eggs in primitively eusocial and highly eusocial species. This is important once it gives insights about egg-marking cues evolution in wasps belonging to different social levels. I detected similar egg-marking cues in eggs laid by females from species expressing the different levels of sociality. It has been demonstrated that hydrocarbons indeed act not only as egg-marking cues but also as maternity signals in a highly eusocial wasp species (Oi et al. 2015). As I demonstrate that primitively eusocial wasps release chemical cues over their eggs, it is likely that egg-marking cues evolved into signals of egg maternity during the evolution of some social species. Egg maternity signals are fundamental for females to discriminate between worker-laid and queen-laid eggs. Solitary wasps also deploy egg-marking during egg laying. However, instead of having social functions, the egg marking compounds work as oviposition deterring pheromones, to mark the places where the females laid eggs and avoid competition with other females (Oi et al. 2015b). Thus, in a hypothetical evolutionary scenario, females that were able to lay eggs and release chemical compounds that reflected their fertility may have been selected over the ones that did not have the same ability. Once sociality evolved, fertile females likely had advantage over the less fertile ones, once their eggs were less likely to be removed. Those compounds that were likely produced and released by a solitary ancestral female, may have been coopted during evolution and became important to help intra and interspecific social conflicts to be solved in eusocial species. Furthermore, I investigated whether eggs were more chemically alike to the cuticular surface of females or to the *Dufour's* gland. By studying the chemical composition of the *Dufour's* gland – a gland hypothesized to be a reservoir of chemical cues released during oviposition – I encountered that many hydrocarbons that are present over the egg surface are stored in the *Dufour's* gland. My results indicated that in both social levels, eggs are covered with hydrocarbons. Many of these egg compounds are similar to the cuticular surface of the females who laid them. In general, there is a chemical correspondence among the sources that I studied (cuticular

hydrocarbons (CHC) / eggs / *Dufour's* gland), however, I detected a trend for a higher chemical similarity between compounds of the *Dufour's* gland and chemical compounds covering the eggs in the two primitively eusocial species, whereas the same pattern was not consistent in the highly eusocial ones. The lack of a fully match between *Dufour's* gland content and egg-marking compounds does not necessarily mean that the gland is not the main reservoir. It is possible that with an increase of social complexity, one or a few compounds are selected to display specific social functions (e.g. inform queen presence). Empirical evidence suggests that a single or a few compounds (hydrocarbons) are usually responsible for mediating specific interactions in social insects. For example, in the common wasp *V. vulgaris* three linear alkanes (n-C27, n-C28 and n-C29) and one methyl alkane (3-MeC29) work as queen pheromones (Van Oystaeyen et al. 2014) and the 3-MeC29 function as egg maternity pheromone (Oi et al. 2015a). A linear alkane, namely n-C25, work as a queen pheromone in the bumblebee *Bombus terrestris*, whereas the n-C27 and 3-MeC29 act as queen pheromones in the ant *Cataglyphis iberica* (Van Oystaeyen et al. 2014). In the Saxon wasp *D. saxonica*, the putative queen pheromone includes at least one compound from the blend including n-C29, 3-MeC29, n-C30, n-C31, and 3-MeC31 (Oi et al. 2016). In the black garden ant *Lasius niger* the hydrocarbon 3-MeC31 act as a primer queen pheromone and negatively impacts worker reproduction (Holman et al. 2010). In addition to act as egg-marking, *Dufour's* gland content may have other functions such as releasing queen compounds (e.g. queen pheromones) and cues used in nestmate recognition (Dani et al. 1996a,b; Mitra 2013).

Juvenile hormone, JH, has been widely studied and it is well known to regulate several aspects of the social insect's life (Hartfelder 2000; Goodman et al. 2012, Jindra et al. 2015; Huang 2020). I focused to understand whether JH would affect the chemical cuticular expression but also the composition of the *Dufour's* gland in wasps. Using a highly eusocial species as model organisms, *V. germanica*, I treated female wasps with JH analogue methoprene and anti-JH analogue precocene. My results showed that the *Dufour's* gland content are affected by JH manipulation. Workers treated with a JH-analogue methoprene represented an intermediate group among queens and the other workers, treated with acetone and anti-JH precocene. Methoprene treatment induced the workers to upregulate compounds in their *Dufour's* gland that were queen-characteristic in *V. germanica*. I also confirm that JH play a role as a gonadotropic hormone in *V. germanica*. Workers treated with JH analogue methoprene exhibit more oocytes in their

ovaries when compared to females treated with acetone or the anti-JH precocene. JH upregulation are correlated to females expressing higher fertility (= ovary activation) and produce chemical fertility compounds (in CHCs and egg-marking cues).

Methoprene treated workers in *V. vulgaris* also upregulate over their body surface queen-characteristic hydrocarbons (Oliveira et al. 2017; Oi et al. 2020; Oi et al. 2021). Methoprene treated workers lay eggs that are less policed, likely because they are coated with queen maternity substances (Oi et al. 2020). These past studies have raised important findings about how JH circulating levels can be linked to females overproducing certain compounds that are potentially associated to their higher fertility. However, it was still unclear how higher JH circulating levels would allow these females laying eggs that also display a queen signature. In my work I demonstrate that JH circulating levels affect the chemical composition of the *Dufour's* gland. Once a female has higher JH levels the same female upregulates the production of chemical compounds within the gland (e.g. fertility linked compounds/queen-characteristic compounds) and hence transfer them to the eggs. Following the chemical characterization of eggs and the connection between JH levels and fertility-linked cues, I confirmed that eggs work act as source of communication in *M. cerberus* societies. Females behaviorally responded when they were confronted with natal eggs and alien eggs coming from different nests. Natal eggs had a higher chance to survive in comparison to alien eggs coming from other species *Mischocyttarus montei* and also from unrelated *M. cerberus* nests. These results revealed recognition ability toward conspecific and heterospecific eggs. Females respond differently probably due to the chemical cues covering those eggs. I detected chemical variation between and within species. As expected, a higher variation exists between species. The ability to recognize their own offspring over unrelated eggs are a key skill to avoid nest usurpation. Although *M. cerberus* females are not able to prevent unrelated females to access their nests (Montagna et al. 2012; da Silva et al. 2019), they may at least limit their chances of achieving reproductive success, once egg removal is efficient. However, a few alien eggs still survived longer than I predicted. A possible explanation is that eggs may passively acquire some chemical compounds from the nest, due to their close contact with nest material or through the interactions with females. Eggs laid by usurper females may succeed if they go unnoticed during the first days, over time the chances to succeed increase if they acquire chemical cues from the social environment. In societies of the ant *Camponotus floridanus*, adult individuals exchange liquids through

trophalaxis that are enriched with several components, including hydrocarbons (LeBoeuf et al. 2016). It is still uncertain if the same process of hydrocarbon exchange occurs in social wasps. If this is the case, alien eggs can potentially acquire chemical compounds from the interaction with resident wasps.

Lastly, I studied whether *M. cerberus* adult individuals were able to learn and memorize a scent that could be biological relevant for them. This chapter was fundamental to confirm that these wasps express learning and memory abilities are important cognitive skills. For example, females may engage and respond accordingly when interact among adult nestmates and non-nestmates, but also with brood. Having the ability to learn and memorize volatile scents suggest that these females may be equally capable of learning other complex scents (e.g. CHCs and egg-marking cues). Although this is expected since chemical communication is the main pathway used by social insects to exchange information, it is still valid that we could formally demonstrate it in controlled experiments.

In general, my research is innovative as it represents one of the few attempts to investigate the roles of brood in wasp species that express different levels of social organization. By integrating my results, I can conclude that eggs are key components of the communication system in wasp societies. Eggs are coated with the same chemical compounds that have been consistently demonstrated to mediate social interactions between adult individuals (Antonialli-Junior et al. 2021). My thesis adds experimental evidence that hydrocarbons are central compounds to solve conflicts in the colonies of social wasps. Additionally, I confirm that the *Dufour's* gland is indeed the most likely source of chemical compounds that are deposited over the eggs. I empirically demonstrate that eggs act as a source of communication within wasp societies, and for example, in *Mischocyttarus* societies, the chemical compounds of the eggs are the putative proximal factors that help females to deal with nest usurpation. The differential expression of hydrocarbons in sources such as body surface and *Dufour's* gland, and hence egg-marking cues (derived from *Dufour's* gland) is potentially linked to the different JH levels that females have. This was demonstrated by hormonal manipulation of females and chemical characterization in samples of CHCs, *Dufour's* gland and egg surface. Lastly, I experimentally documented that wasps are able to learn and memorize scents. Having these cognitive abilities are fundamental for wasps to process and respond accordingly in social interactions.

Although I was able to respond several questions regarding chemical communication and the use of eggs to convey social information in wasps, my thesis leaves some questions to be tackle in the future. For example, (1) are egg-marking cues conserved among species expressing different levels of sociality? This can be tested by characterizing egg and *Dufour's* gland compounds in several species. It is important to include other systems such as solitary and swarm-founding species to comprise the full social behavior range. This would allow to use a phylogenetic framework to check the conservation of the chemical compounds. I hypothesize that the hydrocarbons released over the eggs in social wasps are similar regardless of their social level. Performing a chemical characterization of egg-marking compounds in different species would allow the empirical test of conserved chemical substances. Having this information would allow us to start hypothesizing if they act as merely cues or signals.

A second question is (2) do females from primitively eusocial species with higher JH levels lay eggs that are less likely to be removed? Given that JH is directly linked to increasing fertility, JH levels may impact the likelihood of their eggs being accepted or not. This hypothesis come from the fact that females expressing higher JH levels are more fertile and then fertility compounds would also be present in their eggs. It will be interesting to check the process of egg recognition, if it occurs exclusively through the detection of the chemical compounds that exist over their surface or if wasps also assess spatial information, for example using visual cues (e.g. egg position relative to the cell wall).

The third question is (3) how some parasite eggs manage to survive even when females have ability to discriminate the eggs? Some hypotheses raised are (1) they go unnoticed because they are chemically insignificant, (2) they passively acquire the natal smell after a while in the nest (they get camouflaged), or (3) some females express poor cognitive abilities, which prevent them from recognizing related and unrelated brood. This can be tested by conducting an integrative approach to (1) identify the chemical composition of eggs following oviposition by social parasite species, (2) by studying the chemical composition of eggs in the following days after oviposition, (3) by performing experimental manipulation aiming to exchange the chemical surface of eggs - relevant to reveal which compound or blend of compounds drive recognition - (4) following behavioral experiments where females would be confronted with eggs in different conditions (chemical surface manipulated and not manipulated), the females can be

submitted to learning and memory assays. Learning and memory scores can be correlated with the ability of females to recognize or not eggs. These studies will be important to expand our knowledge about interactions between social species and their social parasites.

Finally, a fourth question is (4) do egg removal rates change according to egg's caste fate in societies of primitively eusocial species? Upon nest usurpation resident females may initially pay a high cost by raising unrelated brood. However, if they are able to selectively destroy and keep eggs based on their fate the costs can decrease. For example, raising alien eggs that are worker-destined will boost the amount of worker force in the nest. On the other hand, raising gyne-destined eggs does not bring any advantage for resident females, as the alien offspring will not provide ant investment for the nest. Females of *Polistes biglumis* express this ability (Lorenzi & Filippone 2000). However, if this is valid for *Mischocyttarus* societies remains elusive. Even though it has not been addressed, the capacity of selectively destroy eggs expressed by *P. bligumis* indicates the existence of egg-marking cues that allow recognition of caste fate. At least three steps can be followed to address it. A way to approach this subject could be (1) investigating whether worker-destined and gyne-destined eggs chemically differ; (2) by presenting alien eggs laid in different moments of nest ontogeny for resident females in different nests. Eggs laid during the initial days of nest ontogeny are worker-destined, whereas those laid towards the end of nest cycle are gyne-destined (Giannotti 1999); (3) to confirm if egg-marking cues indeed allow egg discrimination linked to caste fate it would be important to exchange compounds between worker-destined and gyne-destined eggs, and then present them to adult females.

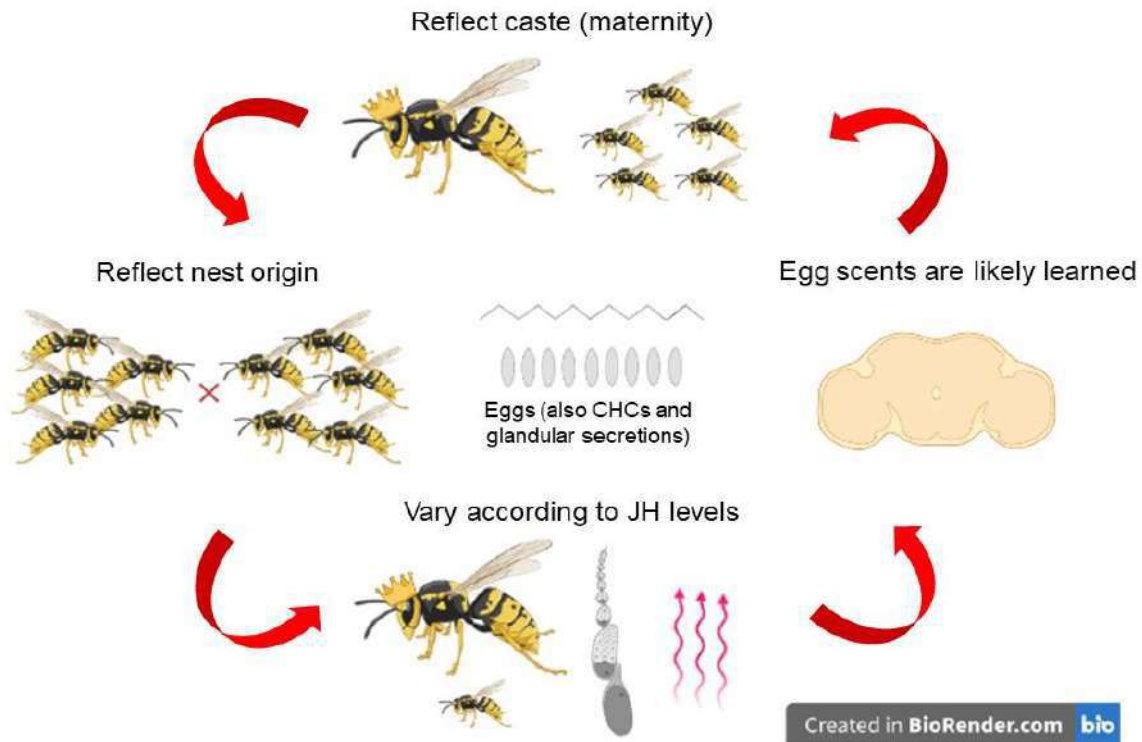


Figure 1: Graphical abstract of the thesis. Eggs are coated with hydrocarbons, chemical compounds that have been extensively demonstrated to mediate several interactions among adult individuals in many social species, including eusocial wasps. These hydrocarbons vary according to caste (= reflect maternity) and species. Once hydrocarbons are linked to caste and species, social conflicts over egg production can potentially be solved. The source of egg compounds is the *Dufour's* gland. The hydrocarbons that cover the eggs are proximal cues that allow females to avoid nest usurpation. Females remove alien eggs and keep their own. The chemical expression is likely associated with the juvenile hormone (JH) levels, which is also responsible to affect ovary activation. Wasps demonstrate abilities to learn and memorize scents, such cognitive skills are fundamental for living in a society. In this way, it could be hypothesized that the combination of egg compounds and the ability to learn may help wasps to deal with different colonial conflicts. The figure was generated in BioRender (free trial). CHCs = cuticular hydrocarbons.

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CONCLUSÃO GERAL E PERSPECTIVAS FUTURAS



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Em minha tese, integrei diversos métodos para investigar aspectos da ecologia química que potencialmente contribuem para que as vespas resolvam conflitos. Mais detalhadamente, explorei se os ovos atuam contribuem para a comunicação. Dentre as abordagens, utilizei revisão de literatura, caracterização química e ensaios comportamentais para expandir o conhecimento acerca de como as vespas mantêm seus ambientes sociais coesos. Embora eu não tenha realizado comparações e experimentos que tenham incluindo as mesmas espécies de vespas ao longo dos diferentes capítulos, meu trabalho representa um dos poucos esforços para se entender quais papéis a prole desempenha (especialmente ovos). Incluí em minha tese estudos envolvendo espécies de vespas que expressam graus distintos de socialidade, de primitivamente à altamente eussociais. Em espécies primitivamente eussociais, compostos de marcação de ovos são vantajosos em casos onde o ninho é invadido por fêmeas não-relacionadas. Os ninhos dessas vespas não possuem um envelope, o que facilita o acesso por indivíduos não-relacionados. Fêmeas que são capazes de liberar e reconhecer os compostos de marcação de ovos podem eventualmente ser selecionadas em detrimento daquelas que não expressam as mesmas habilidades. Em espécies altamente eussociais, compostos de marcação de ovos são potencialmente importantes para que as rainhas espalhem seus odores e atinjam as centenas ou milhares de operárias da colônia. Ninhos dessas espécies são maiores que aqueles construídos por vespas primitivamente eussociais, o que dificulta a rainha interagir diretamente com todas as demais operárias. Ovos atuam como ferramentas alternativas de comunicação tanto em sociedades primitivamente ou altamente eussociais.

Em minha tese, primeiro apresentei uma mini-revisão que sintetizou os papéis que não apenas ovos, mas prole no geral pode desempenhar em sociedades de vespas. A prole é frequentemente recoberta por compostos químicos que diretamente ou indiretamente contribuem para que a coesão social se mantenha nessas sociedades. Por exemplo, a prole é recoberta por compostos químicos que refletem sexo (*P. dominula* - Cotoneschi et al. 2009); por compostos químicos que refletem que são imaturos e não adultos (*P. dominula* - Cotoneschi et al. 2007); por compostos associados à espécie (*Parischnogaster mellyi* - Turillazzi et al. 2008; *M. metathoracicus*/*P. versicolor* - Chapter 3); que permite eventos de parasitismo (*P. sulcifer* - Cervo et al. 2008); que refletem a fertilidade das fêmeas (*M. cassununga* and *M. cerberus* - Ferreira et al. 2022; *V. vulgaris* - Oi et al. 2020). A maioria dos dados reportados na mini-revisão são

provenientes de trabalhos correlacionais ou descritivos. Trabalhos empíricos são necessários para que se confirme se os compostos que recobrem a prole atuam como sinais.

Também estudei aspectos básicos morfológicos da espécie *M. cerberus*. Através desse trabalho demonstrei que como o desenvolvimento pode ser afetado por aspectos externos. Por exemplo, o desenvolvimento dos indivíduos é afetado ao longo do ano. Em meses chuvosos e quentes, a soma dos valores médios de desenvolvimento das três diferentes categorias de imaturos (ovo, larva e pupa) é mais curta se comparado aos meses frios e secos. Além disso, o desenvolvimento dos imaturos é afetado de acordo com a ontogenia colonial (fase de pré-emergência e pós-emergência). Os dados levantados e reportados no segundo capítulo foram fundamentais para que eu aprendesse a manipular imaturos de vespas, o que foi utilizado durante os experimentos de troca de ovos entre ninhos (Capítulo 6).

Também explorei a variação dos compostos químicos que recobrem os ovos de vespas primitivamente e altamente eussociais. As informações reportadas são importantes, uma vez que, apresentam detalhes acerca da evolução de compostos que recobrem os ovos em vespas de diferentes níveis sociais. Encontrei compostos químicos parecidos na superfície de ovos colocados por fêmeas que expressam distintos níveis sociais. Compostos que recobrem os ovos não atuam apenas como pistas, mas também como sinais (Oi et al. 2015). Como demonstrei que vespas primitivamente eussociais liberam compostos químicos sobre seus ovos, é possível que essas pistas químicas se tornaram sinais ao longo da evolução do grupo das vespas sociais. Sinais que refletem a maternidade dos ovos são fundamentais para que as fêmeas detectem entre ovos colocados por operárias daqueles colocados por rainhas. Vespas solitárias também marcam seus ovos com compostos químicos. Contudo, esses compostos não possuem nenhuma função social, mas sim, funcionam como feromônios que mediam interações envolvendo outras fêmeas (Oi et al. 2015b). Logo, em um cenário evolutivo hipotético, fêmeas que eram capazes de colocar ovos e marcá-los com compostos químicos que refletem fertilidade, podem ter sido selecionadas em detrimento daquelas que não tinham a mesma habilidade. Uma vez que a socialidade surgiu, fêmeas férteis provavelmente tiveram vantagem quando comparadas às fêmeas não-férteis, uma vez que seus ovos tinham menos chances de serem removidos. Esses compostos produzidos e liberados por fêmeas solitárias provavelmente foram co-adaptados durante a evolução das espécies e se

tornaram fundamentais para mediar relações intra e interespecíficas, e consequentemente permitem que conflitos sociais sejam resolvidos. Ainda, também investiguei se os ovos são mais quimicamente similares à superfície cuticular das fêmeas ou à glândula de *Dufour*. Ao estudar a composição química da glândula de *Dufour* – glândula que funciona como reservatório químico dos compostos liberados durante a oviposição – encontrei que muitos hidrocarbonetos que estão presentes na superfície dos ovos estão também estocados na glândula de *Dufour*. Meus resultados indicam que em ambos níveis sociais, ovos são recobertos por hidrocarbonetos. Muitos desses compostos químicos que recobrem os ovos são também encontrados na superfície cuticular das fêmeas que os colocaram. No geral, há uma correspondência química entre os diferentes grupos de amostras (hidrocarbonetos cuticulares (HCs) / ovos / glândula de *Dufour*), contudo, pude detectar uma tendência de maior similaridade química entre a glândula de *Dufour* e os ovos nas espécies primitivamente eussociais, ao passo que o mesmo padrão não foi consistente entre as espécies altamente eussociais. A falta de uma correspondência total entre glândula de *Dufour* e ovos não necessariamente implica que a glândula não é o principal reservatório. É possível que com aumento da complexidade social, apenas um ou alguns poucos compostos químicos sejam selecionados e desempenhem papéis sociais específicos (por exemplo, informar a presença da rainha na colônia). Dados empíricos sugerem que um ou poucos compostos químicos (hidrocarbonetos) são frequentemente responsáveis por mediar interações sociais espécies. Por exemplo, em sociedades da espécie *V. vulgaris*, três alcanos lineares (n-C27, n-C28 e n-C29) e um alcano metilado (3-MeC29) atuam como feromônios de rainha (Van Oystaeyen et al. 2014) e o mesmo alcano metilado atua como feromônio reflete maternidade dos ovos (Oi et al. 2015a). O alcano linear n-C25 funciona como feromônio de rainha em *Bombus terrestris*, enquanto que os compostos n-C27 e 3-MeC29 desempenham uma função parecida, mas em sociedades da espécie de formiga *Cataglyphis iberica* (Van Oystaeyen et al. 2014). In sociedades da vespa *D. saxônica*, o potencial feromônio de rainha engloba alguns compostos, como: n-C29, 3-MeC29, n-C30, n-C31, and 3-MeC31 (Oi et al. 2016). Em sociedades da espécie *Lasius niger*, o hidrocarboneto 3-MeC31 atua como feromônio de rainha e impacta negativamente a capacidade das operárias de se reproduzirem (Holman et al. 2010). Logo, além de estocar e liberar compostos de marcação de ovos, é possível que a glândula de *Dufour* também libere substâncias associadas a outros processos sociais, por exemplo, feromônios de rainha e pistas que permite o reconhecimento de companheiras de ninho (Dani et al. 1996a,b; Mitra 2013).

O hormônio juvenil, HJ, tem sido amplamente estudado e é sabido que esse hormônio regula diversos aspectos da vida dos insetos sociais (Hartfelder 2000; Goodman et al. 2012, Jindra et al. 2015; Huang 2020). Em minha tese, investiguei se diferentes níveis de HJ também afetam a composição química da glândula de *Dufour* em vespas sociais. Utilizei uma espécie de vespa altamente eussocial, *V. germanica*, e tratei fêmeas com um hormônio análogo ao HJ (metopreno) e um anti-HJ (precoceno). Meus resultados sugerem que a composição da glândula de *Dufour* é afetada pelos diferentes níveis de HJ. Operárias tratadas com o análogo do HJ representaram um grupo intermediário entre rainhas e as demais operárias tratadas com acetona e precoceno. O tratamento com metopreno induziu a super produção de compostos na glândula de *Dufour* característicos de rainhas em *V. germanica*. Também confirmei que o HJ atua como um hormônio que afeta a ativação ovariana na mesma em *V. germânica*. Operárias tratadas com metopreno exibiram mais oócitos em seus ovários quando comparadas às operárias tratadas com acetona ou precoceno. Logo, o aumento de HJ correlacionou-se com um aumento na fertilidade (= atuação dos ovários) e produção de compostos químicos associados à fertilidade (HCs e compostos de marcação de ovos).

Operárias da espécie *V. vulgaris* quando tratadas com metopreno também aumentam a produção de compostos característicos de rainhas (Oliveira et al. 2017; Oi et al. 2020; Oi et al. 2021). Operárias tratadas com metopreno colocam ovos que são menos policiados, provavelmente porque são recobertos com compostos que se assemelham aos colocados por rainhas (Oi et al. 2020). Estudos realizados no passado reportaram detalhes importantes acerca de como os níveis de HJ podem estar associados às fêmeas aumentarem a produção de compostos que potencialmente refletem uma maior fertilidade. Contudo, não era muito claro como níveis elevados de HJ permitiam que as fêmeas colocassem ovos que fossem quimicamente similares aos colocados por rainhas. Em meu trabalho, demonstrei que diferentes níveis de HJ podem afetar a composição química da glândula de *Dufour*. Uma vez que uma fêmea possui níveis elevados de HJ é possível que a mesma seja capaz de aumentar a produção de determinados compostos na glândula (por exemplo, compostos que refletem fertilidade/característicos de rainhas) e assim transferi-los para seus ovos.

Após realizar a caracterização química de ovos e investigar a conexão entre níveis de HJ e pistas associadas à fertilidade, confirmei que os ovos atuam como um veículo alternativo de comunicação em sociedades de *M. cerberus*. Fêmeas responderam

de forma diferente quando confrontadas com ovos que pertenciam aos seus ninhos em detrimento de ovos que não pertenciam. Ovos que pertenciam ao ninho tiveram uma maior chance de sobreviver se comparados aos ovos que foram transferidos de ninhos não relacionados da espécie *Mischocyttarus montei* e de outros ninhos de *Mischocyttarus cerberus*. Esses resultados demonstram que as fêmeas de *M. cerberus* expressam habilidades de reconhecimento a nível inter e intraespecífico. As fêmeas foram capazes de responder de forma distinta provavelmente por conta dos compostos que recobrem os ovos. Identifiquei variação química entre ovos da mesma espécie e das diferentes espécies. Como esperado, uma maior variação química existe entre ovos colocados por fêmeas de espécies diferentes. A habilidade de reconhecimento a própria prole quando pareadas com uma prole distinta representa uma habilidade chave para que essas fêmeas evitem eventos de usurpação de seus ninhos. Embora as fêmeas de *M. cerberus* não sejam capazes de impedir que indivíduos desconhecidos acessem seus ninhos (Montagna et al. 2012; da Silva et al. 2019, elas podem pelo menos limitar as chances dos invasores de atingirem sucesso reprodutivo, uma vez que são eficazes em remoção de ovos. No entanto, alguns ovos provenientes de ninhos desconhecidos sobreviveram além do esperado. Uma possível explicação é que ao longo do tempo, ovos adquiram compostos químicos de forma passiva, uma vez que podem entrar em contato com o material do ninho ao através das interações que estabelecem com as fêmeas. Logo, ovos colocados por fêmeas que usurpam ninhos podem ter sucesso caso não sejam detectados durante os primeiros (após oviposição), o sucesso de sobrevivência pode aumentar caso entre em contato com compostos químicos que refletem a identidade do ninho. Em sociedades de *Camponotus floridanus*, indivíduos adultos trocam constantemente líquidos através de trofalaxia, os quais são ricos em diversos componentes, como hidrocarbonetos (LeBoeuf et al. 2016). Ainda não se sabe se algo parecido acontece em vespas sociais. Se esse for o caso, ovos colocados por fêmeas que usurpam ninhos podem também adquirir compostos químicos através das interações com fêmeas adultas.

Por fim, também investiguei se indivíduos adultos da espécie *M. cerberus* são capazes de aprender e memorizar um odor que pode ser biologicamente relevante. Esse capítulo foi fundamental para confirmar que essas vespas possuem habilidades cognitivas. Por exemplo, fêmeas podem engajar e responder adequadamente quando interagem com indivíduos adultos (companheiros e não-companheiros de ninho), mas também com imaturos. Ter a capacidade de aprender e memorizar substâncias voláteis

sugere que as fêmeas sejam igualmente capazes de aprender outros odores mais complexos (por exemplo, HC e compostos de marcação de ovos). Embora isso já fosse esperado visto que, a comunicação química é a principal via utilizada por insetos sociais para troca de informações, ainda é válido demonstrar tal habilidade de maneira formal em experimentos controlados.

De forma geral, meu trabalho é inovador e representa uma das poucas tentativas de se investigar o papel da prole em vespas que expressam diferentes graus de organização social. Ao integrar todos os meus resultados, posso concluir que os ovos são componentes fundamentais do sistema de comunicação em sociedades de vespas. Ovos são recobertos com os mesmos compostos químicos que mediam diversas interações entre indivíduos adultos (Antonialli-Juiniór et al. 2021). Minha tese também apresenta dados experimentais que demonstram que os hidrocarbonetos são compostos relevantes para a resolução de conflitos em colônias de vespas sociais. Além disso, confirmei que a glândula de *Dufour* é de fato o potencial reservatório de compostos químicos que são liberados sobre os ovos. Demonstrei de forma empírica que os ovos atuam como um veículo alternativo de comunicação nas sociedades de vespas, e, por exemplo, em sociedades de *Mischocyttarus*, os compostos que recobrem os ovos atuam como fatores proximais que permitem que as fêmeas lidem com usurpação de ninhos. A expressão diferencial de hidrocarbonetos em diferentes fontes, como a superfície corporal e glândula de *Dufour*, e consequentemente, os compostos de marcação de ovos (derivados da glândula de *Dufour*) está potencial ligada aos diferentes níveis de HJ que as fêmeas possuem. Em minha tese, isso foi demonstrado a partir dos experimentos que conduzi realizando manipulação hormonal e caracterização química em amostras de HCs, glândula de *Dufour* e compostos de marcação de ovos. Por fim, também reporte que vespas são capazes de aprender e memorizar odores. Essas habilidades são fundamentais para que as vespas sejam capazes de processar e responder de forma correta às diferentes interações sociais.

Embora eu tenha sido capaz de responder diversas questões associadas à comunicação química e o uso dos ovos no processo de fornecimento de informações em sociedades de vespas, minha tese também deixa algumas questões que poderão ser investigadas no futuro. Por exemplo, (1) há uma conservação de compostos de marcação de ovos em espécies que expressam distintos níveis sociais? Isso poderá ser abordado através da caracterização dos compostos que recobrem os ovos e compostos da glândula

de *Dufour* em diversas espécies de vespas. Será importante incluir vespas que pertencem a outros sistemas, como, vespas solitárias e enxameantes. O uso de abordagens filogenéticas permitirá que se investigue se há ou não a conservação de compostos ao longo do ramo das vespas. Minha hipótese é que os hidrocarbonetos liberados sobre os ovos são parecidos independente do nível social das vespas. A realização da caracterização química dos compostos de marcação de ovos em espécies diferentes permitirá que a hipótese seja testada. Essas informações nos permitirão criar hipótese acerca do nível de informação transmitida por esses compostos, por exemplo, se os compostos de marcação de ovos atuam como meras pistas ou sinais.

Uma segunda questão é (2) fêmeas de espécies primitivamente eussociais que possuem níveis mais altos de HJ também colocam ovos que possuem menos chances de serem removidos? Considerando que o HJ afeta a fertilidade das fêmeas, diferentes níveis de HJ também podem impactar a probabilidade de que os ovos sejam aceitos ou não. Essa hipótese se baseia no fato de que fêmeas que expressam altos níveis de HJ são mais férteis e consequentemente compostos que refletem essa fertilidade também seriam transferidos para seus ovos. Será interessante também avaliar se o processo de reconhecimento de ovos ocorre exclusivamente através da detecção de compostos que recobrem os ovos, ou se as vespas integram mais de um canal para isso, por exemplo, pistas visuais (por exemplo, posição do ovo em relação à parede da célula).

A terceira questão é (3) como alguns ovos de parasitas são capazes de sobreviver mesmo quando as fêmeas possuem a habilidade de reconhecer os ovos? Dentre as hipótese há (1) eles não são detectados porque são quimicamente insignificantes, (2) os ovos adquirem de forma passiva odores dos ninhos depois de um tempo em contato com os mesmos (se camuflam com o tempo), ou (3) em alguns ninhos, as fêmeas expressam baixas habilidades cognitivas, o que impede que reconheçam prole relacionada de não-relacionada. Isso poderá ser testado através de uma abordagem integrativa para (1) investigar a composição química dos compostos colocados por fêmeas que são parasitas sociais, (2) estudar a composição química dos ovos dias após serem colocados, (3) realizar experimentos que visem manipular a composição química da superfície dos ovos – o que será relevante para revelar qual composto (s) permitem o reconhecimento – (4) após a realização de experimentos comportamentais onde fêmeas seriam expostas a ovos em diferentes condições (com superfície manipulada e não-manipulada), as fêmeas poderão ser submetidas a ensaios de aprendizado e memória. O desempenho em ensaios de

aprendizado e memória podem ser correlacionados com a habilidade das fêmeas de reconhecer ovos. Esses estudos serão fundamentais para aumentar nosso conhecimento acerca das interações entre espécies sociais e seus respectivos parasitas sociais.

Por fim, uma quarta questão é (4) a taxa de remoção de ovos varia de acordo com o tipo de destino de casta do ovo em sociedades primitivamente eussociais? Após um ninho ser usurpado, fêmeas residentes podem pagar um alto custo por criarem uma prole não-relacionada. Contudo, se as fêmeas residentes são capazes de destruir os ovos de forma seletiva e levar em conta o destino da casta, os custos podem diminuir. Por exemplo, criar ovos que darão origem à fêmeas operárias pode aumentar a quantidade de indivíduos que trabalharão em favor do desenvolvimento da colônia. Por outro lado, criar ovos que darão origem à fêmeas reprodutivas (futuras rainhas) pode não ser vantajoso, uma vez que essas fêmeas não contribuirão para o desenvolvimento da colônia. Fêmeas da espécie *Polistes biglumis* possuem essa habilidade (Lorenzi & Filippone 2000). No entanto, ainda não se sabe se vespas do gênero *Mischocyttarus* expressam habilidade similar. Embora esse tópico ainda não tenha sido estudado, a capacidade de destruir os ovos de forma seletiva expressa por fêmeas de *P. biglumis* indica que existem informações que recobrem esses ovos que permitem o reconhecimento da casta da fêmea. Pelo menos três passos podem ser seguidos para que se teste se esse é o caso. A princípio (1) investigar se as pistas químicas que recobrem ovos que darão origem à operárias e futuras rainhas diferem; (2) Apresentar ovos desconhecidos para fêmeas que tenham ninhos em diferentes fases de desenvolvimento. Ovos colocados nos estágios iniciais do desenvolvimento dos ninhos dão origem às operárias, enquanto que os ovos colocados mais próximos ao fim da ontogenia colonial dão origem às futuras rainhas (Giannotti 1999); (3) para atestar se os compostos de marcação de ovos permitem que reconhecimento a nível da casta da fêmea será interessante também que experimentos troquem os compostos entre ovos de operárias e ovos de futuras rainhas, e posteriormente sejam apresentados à fêmeas adultas.

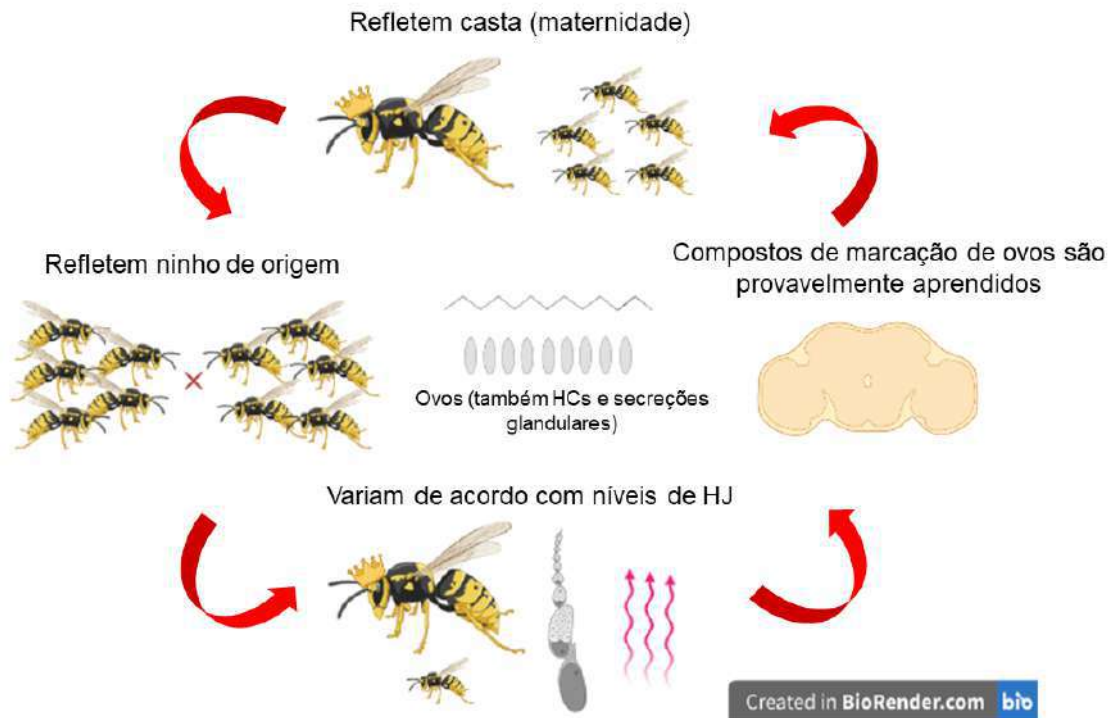


Figura 1: Figura representativa da tese. Ovos são recobertos com hidrocarbonetos, compostos químicos que mediam diversas interações entre indivíduos adultos em muitas espécies sociais, incluindo as vespas. Os hidrocarbonetos variam de acordo com a casta (= refletem maternidade) e espécie. Uma vez que os hidrocarbonetos estão associados às castas e espécies, conflitos sociais relacionados à produção de ovos podem ser resolvidos. A glândula de *Dufour* atua como reservatório de compostos que são liberados sobre os ovos. Os compostos que recobrem os ovos atuam como pistas proximais que permitem que as fêmeas lidem com eventos de usurpação de ninhos. Fêmeas são capazes de remover ovos desconhecidos e manter aqueles que pertencem aos seus ninhos. A expressão desses compostos químicos está potencialmente associada aos diferentes níveis de hormônio juvenil (HJ) das fêmeas, o qual também é responsável por afetar a capacidade reprodutiva das mesmas. As vespas demonstram a capacidade de aprender e memorizar odores, habilidades cognitivas que são essenciais para a vida em sociedade. Dessa forma, considerando que os ovos são recobertos por compostos químicos e que as fêmeas demonstram as habilidades de processos odores, a combinação desses dois fatores provavelmente contribui para que as vespas lidem com diferentes conflitos coloniais. A figura foi gerada no site BioRender (versão trial). HCs = hidrocarbonetos cuticulares.

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Appendix

Report presented to FUNDAÇÃO DE AMPARO A PESQUISA DO ESTADO DE SÃO PAULO – FAPESP as a requirement of my internship at the University of Rochester, under supervision of Prof. Dr. Flórida M.K. Uy, between March – May of 2022

FUNDAÇÃO DE AMPARO A PESQUISA DO ESTADO DE SÃO PAULO – FAPESP

Bolsa Estágio de Pesquisa no Exterior (15 março – 31 maio de 2022)

**Does parasitism drive differential neurogenomic expression in females and males
of a *Polistes* paper wasp?**

Beneficiário: Rafael Carvalho da Silva

Orientador: Prof. Dr. Fábio Santos do Nascimento

Instituição Brasileira: Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto - USP

Supervisora do estágio: Prof. Dr. Flórida Mora-Kepfer Uy

Instituição do estágio: University of Rochester, New York, United States

Número do processo: 2019/27552-0



Rafael Carvalho da Silva
Beneficiário



Prof. Dr. Fábio Santos do Nascimento
Orientador

Abstract

Host-parasite interactions represent a widespread coevolutionary example in nature, with parasitism consisting of a selective force towards exploiting a host. Parasites induce mild to dramatic changes over their hosts, which in turn results in affecting the host's fitness. The behavioral and physiological effects of parasitic manipulation are well-studied. However, much less is known about the molecular mechanisms underlying parasitism, such as host gene expression. A well-studied host-parasite system is composed by the endoparasite strepsipteran *Xenos* and the paper wasp *Polistes*. In this complex system, parasites affect their hosts in different ways depending on both host and parasite sex. Parasitized female hosts are castrated and become asocial, whereas male hosts remain sexually interested in females and can still mate, regardless of parasites presence. The fact that female and male hosts are not affected in the same way suggests that parasitic manipulation may vary in different phenotypes of the same species (i.e. host sex). Importantly, males and female parasite vary in how they manipulate the host to increase their chances of fitness. A male parasite only needs a host for a few weeks, to develop and emerge as an adult to mate in the summer. In contrast, female parasites remain as obligate parasites inside their host for many months to secure release of offspring in the next Spring. Thus, we took advantage of the parasite *Xenos peckii* and its wasp host *Polistes fuscatus* to explore whether parasites have differential effects in gene expression according to both parasite and host sex. Specifically, we compared transcriptomic profiles of female and male hosts infected by female and male parasites. These data allowed us to check which genes and their levels of expression related to reproductive, endocrine and social traits are affected by parasites. Our results allowed us to elucidate differential gene expression and candidate genes that are likely involved in the process of extending host lifespan. Lastly, we were able to uncover that female and male hosts are affected differently by the parasites. Females are drastically affected by their parasites, while males are just slightly affected by them. Considering that parasitized and unparasitized individuals were already sampled, in my internship I was able to (I) learn the procedures to dissect brains followed by RNA extractions, (II) RNA sequencing framework, (III) RNA treatment after sequencing, (IV) downstream analysis using the information extracted from the RNA samples, and (V) right now I also started writing a manuscript. Additionally, during the internship I also learnt how to dissect wasp brains to be analyzed in High Performance Liquid Chromatography (HPLC) system and how to use the software Gephi (The Open Graph Viz Platform).

Introduction

Parasitism is a widespread and successful strategy in nature, consisting of parasites exploiting resources from a host (Windsor 1998). In this arms race between hosts and parasites, hosts evolve adaptations that evade infection to overcome the parasite exploitation, and in turn the parasites evolve counter adaptations to overcome the defensive system of their hosts (Moore 2002). In this arms-race, a behavior alteration of the host is driven by the parasite presence, that ultimately leads to fitness benefits for the parasite (see Libersat et al. 2009), for example castrating the host to allocate energetic resources towards parasite offspring (Beani et al. 2011, 2017; Cappa et al. 2014; Lafferty and Kuris 2009). Parasites can induce shifts in foraging, activity, and nest desertion, highlighting the potential capacity of parasites to manipulate their hosts (see Lefèvre et al. 2009; see Libersat et al. 2009; Beani et al. 2011).

A concept named as “extended phenotype” states that a gene is capable of producing a phenotype that expands beyond the body of an organism, if the produced phenotype is able to transmit the gene to the next generation (Dawkins, 1982). In host-parasite systems, the parasitic manipulation of host behavior increases the chances of transmitting the parasite genes, acting as the parasite’s extended phenotype (Dawkins 1982; 2004). Therefore, shifts in gene expression may cause these phenotypic modifications and have been reported for a few invertebrate and vertebrate host-parasite systems (e.g. insects: Barribeau et al. 2014; Geffre et al. 2017; Stoldt et al. 2021 / fishes: Lohman et al. 2017; Piecyk et al. 2019; humans: Kano et al. 2020; see Paul et al. 2020). Even though the behavioral and physiological effects of parasitic manipulation have been widely documented, the molecular mechanisms underlying host this manipulation are less known.

Here, we took advantage of the host-parasite insect system represented by the strepsipteran endoparasite *Xenos peckii* and its paper wasp host, *Polistes fuscatus* (Kathirithamby 2009; see Cook 2014, Hrabar 2014). This genus of parasites attacks the host nests and infects host larvae (Hughes et al. 2003, Hrabar et al. 2014). Parasites develop inside their host, then they extrude their anterior part between the segments of their host’s abdomen. Male and female parasites have one of the most extreme sexual dimorphisms described in nature and also show different behavioral and physiological effects on male and female hosts (Figure 1). Adult males are winged, and emerge from inside the host to and mate with females, while females remain as permanent neotenic parasites inside their hosts. Host females are extremely affected by the parasite presence as they are castrated, desert their nests to gather in extranidal aggregations, are smaller, and induce an extended lifespan in their host (Beani et al. 2011). Surprisingly, male hosts are not castrated and can still mate with females. However, the sex also drastically affects the host. Host females infected with a female parasite have more fat bodies and live longer, while male hosts do not survive (Beani et al. 2011). Male parasites just need enough time to develop and emerge as adults, so they have detrimental effects in male

and female parasites. The modifications suffered by the host is likely to be a result of the dramatic shifts that parasites drive at gene expression levels (Geffre et al. 2017). For instance, workers infected by *Xenos vesparum* expressed an intermediate transcriptomic profile between uninfected *Polistes dominula* gynes and workers (Geffre et al. 2017). Genes responsible for controlling several molecular and biological processes were seen to be susceptible to parasite manipulation, such as feeding behavior, circadian rhythms, chemical compounds biosynthesis, and regulation of transcription (Geffre et al. 2017). Even though this first study showed that the parasites are capable of shifting the social caste female hosts by manipulating their gene expression, the specific role of host and parasite's sex in host hosts gene expression is currently unknown (Figure 1). Specifically, an undergoing study suggests that females and male hosts exhibit different behavior and physiological effects to parasitic manipulation (Uy, unpublished data, Figure 2).

Therefore, we hypothesized that differential gene expression has strong cascading molecular effects in different phenotypes within the same host species. To test whether parasites from different sex manipulate the gene expression of their hosts from different sex in a different manner, our main aim was to compare the transcriptomic profiles from the brains of four different categories: female hosts infected with a female parasite, female hosts with a male parasite, male hosts with a female parasite, stylopized male hosts with a male parasite (Figure 2). We explored candidate genes and differential gene expression among these categories and in comparison, to unparasitized females (control workers and gynes) and male hosts. Thus, we were able to track the top candidate genes that may be susceptible to manipulation, as well as their putative role. Among the candidate genes, we expected to see genes responsible for controlling reproductive, endocrine, and social processes to be differentially expressed between unparasitized and parasitized females, who are manipulated to extend their lifespan to facilitate the release of larvae by the female parasite.

The whole work was conducted at the Uy laboratory at the University Rochester, USA, where this host-parasite system has been recently established in controlled conditions. The Uy lab has recently explored gene expression of the host species (Uy et al. 2021) and the role of parasites in the brain of the host (Rozanski et al. 2021, Gandia et al. 2022). Using these previous findings, carrying out this work allowed us to shed light on how parasite manipulation drives the neurogenomic expression of their host. Besides, considering that compared infected and uninfected hosts, the results allowed us to have a better idea how the immune system of *P. fuscatus* reacts to their specific parasite *X. peckii*, and how the parasites likely suppress the immune and reproductive systems of their hosts. Lastly, with the results of this work, together with the findings reported by Geffre et al. (2017) (host: *P. dominula*; parasite: *X. vesparum*), made possible to understand whether a common strategy of host manipulation at molecular level is used by both strepsipteran species.

Material and Methods

General aspects of host parasite life cycle

Xenos peckii is an obligatory endoparasite of the paper wasp *P. fuscatus*, the active first instar larvae infest their nests, where they seek and burrow into larvae of the host. Once they burrow into their hosts, parasite larvae become apodous. When wasps

become adults, they emerge with parasites concealed within their abdomens. Male parasites extrude first than females, while females extrude two weeks after their hosts eclode from their pupae phase. Females perform a behavior named as “calling” (to attract the winged males), in which they assume a specific position and posture (Hrabar et al. 2014) - see Figure 1 for more details. These strong differences in the male and female life cycle may enhance variation in parasitic manipulation of hosts.

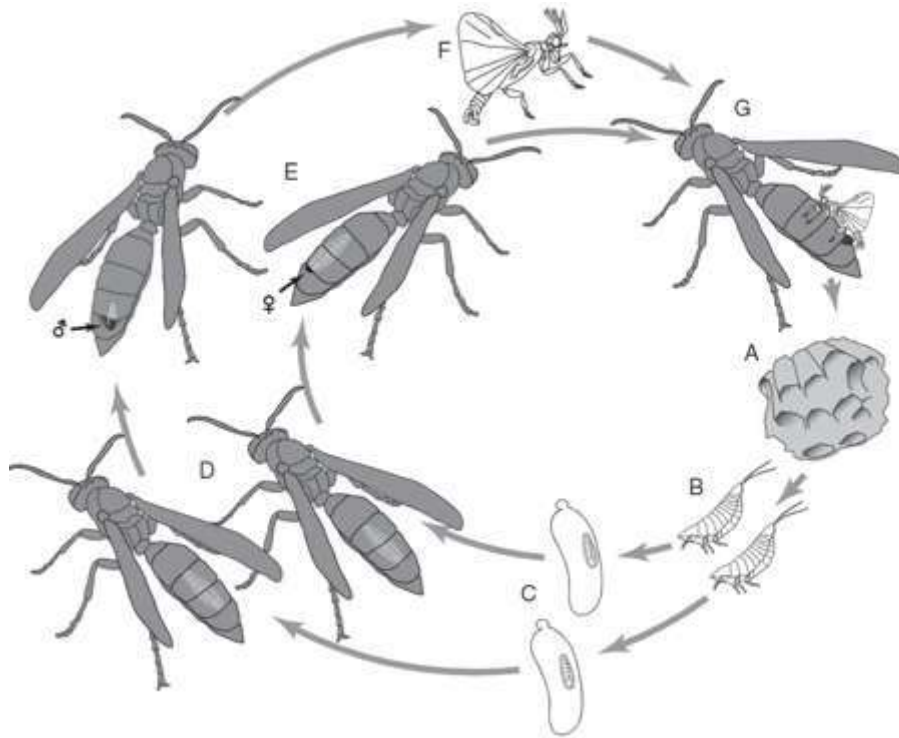


Figure 1: **Illustration of the host parasite life cycle.** (A) It starts with a nest of *Polistes fuscatus* being infested with (B) triangulins (first-instar larvae) of *Xenos peckii*. Then, the triangulins (C) search and burrow into their hosts (host larvae), after that, they turn into apodous, grub-like, second-instar and then they go on three successive instars within the host larvae. (D) Adult wasps emerge with the parasites attached to their abdomens, then (E) male and female parasites extrude from the abdomen of their hosts (E - on the right is a female; on the left a male). (F-G) After more or less two weeks of pupation period, the winged male (F) emerges as an adult, then it searches for a female partner (G) and mates. The figure was extracted from Hrabar et al. (2014).

Sample collection

Samples of parasitized individuals with either female and male parasites were already available at the laboratory of Prof. Dr. Uy, however, during the internship, I also had the chance to do some fieldwork (to collect uninfected individuals) and follow the whole process of RNA sample preparation. Wasps were collected at Rochester, United States, and upon collection their heads were placed in RNAlater (Life Technologies, AM7023) at 4° C for 24 h, then they were transferred to -20° C until brain dissections. I worked on 4 categories of experimental wasps: g 1) female host with one female parasite, 2) female host with one male parasite, (3) male host with one female parasite, and 4) male host infected with a male parasite (Figure 2). In addition, I also extracted RNA from uninfected female and male hosts as controls.

Effects of host and parasite sex on host manipulation	Female parasite 	Male parasite 
Female host 	- extended lifespan - castrated - behavioral changes	- short lifespan - castrated - behavioral changes
Male host 	- short lifespan - not castrated - mild behavioral changes	- short lifespan - not castrated - no behavioral changes

Figure 2: **Female and male parasites show differential manipulation effects in female and male hosts.** Female parasites increase female host lifespan, inhibit ovary activation and perform colony tasks. Male parasites do not extend female host lifespan, however, they castrate and induce behavioral changes similarly to female parasites. In male hosts, female and male parasites affect male hosts and do not affect host reproduction or significant behavioral changes (The scheme was provided by Uy lab).

Dissections and RNA extractions

Brains from each individual were dissected in *RNAlater* at room temperature and then the samples were kept at -80°C until RNA extraction. RNA was extracted from each brain by using RNeasy Mini Kit (Qiagen, 74104), which included a 15 min DNase I (Qiagen, 79254) step before ethanol washes. To quantify RNA, a NanoDrop 1000 (Thermo Fisher Scientific) spectrophotometer and Qubit Fluorometer (Life Technologies) were used. Following quantification, RNA was stored at -80°C until later use. We used RNA from each individual brain for sequencing.

RNA-Sequencing and data preparation

Each of the RNA samples was processed by an Illumina NovaSeq 6000 Sequencing system to obtain 150 pb paired-reads, for a goal of 20 million reads per sample. We ended up having a total of 40 pair-ended samples (control workers = 6, gynes = 4, parasitized workers = 14, control males = 6 and parasitized males = 10). To process our FASTQ samples after sequencing we first used FastQC program to check the quality of the sequencing datasets. This step was important to highlight if a given sample was low quality and also it helped us to decide how samples should be trimmed. All the libraries were high quality and we did not detect any contamination, the only exception was the adapter sequence that were present in all samples. To remove the adapter sequence and proceed with the analysis we used the tool FASTP, which is an ultra-fast preprocessor tool designed for FASTQ samples that allow cleaning and data-filtering

(Chen et al. 2018). To remove the adapter, we simply used the default parameters. After that, we checked the quality of all the samples again to make sure the adapter was removed. Once we completed this step, we used the program HISAT2 which is a fast and sensitive alignment program for mapping next-generation sequencing reads (DNA and RNA), to align our FASTQ samples to the *P. fuscatus* annotated genome (Miller et al. 2020).

Analysis of gene expression

We used featureCounts software (Liao et al. 2014) for counting the number of fragments that mapped to the *P. fuscatus* genome annotation (Miller et al. 2020) (read summarization step). These counts were used by edgeR for differential expression analyses. We followed mainly all the suggestions (default parameters) present in the edgeR user's guide. First, we filtered low expressed transcripts by the following criterion. We calculated transcript CPM (counts per million mapped reads) for each sample and preserve transcripts which satisfy $CPM \leq 5$ in at least four samples (which was our smallest group size = gynes). For that, we used the function *filterByExpr* which basically kept rows (embedded with the genes that were detected during the featureCounts step) that had a worthwhile count in a minimum number of samples. After applying the cut-off, the remaining transcripts were used for the differential expression analyses. Some of the initial analyses (checking for group formation) were performed by using the dataset including females and males. Considering that we detected that samples were primarily separated by their sex, and not by their healthy condition (parasitized and non-parasitized) after running a first heatmap and a multidimensional scaling plot (MDS), the remaining analyses were performed by splitting female and male samples in different tables. To test for differently expressed genes (DEGs), we used a quasi-likelihood (QL) F-test which is the most appropriate choice given that it reflects the uncertainty while estimating the dispersion of each gene. To proceed with that we set up different group contrasts which were the following: control workers x gynes (CW x G), parasitized workers x control workers (PW x CW), parasitized workers x gynes (PW x G) and control males x parasitized males (CM x PM). Genes were considered differently expressed if they were > two-fold and has a p value adjusted for false discovery rate (FDR) < 0.05. To perform Gene Ontology (GO) analyses, we build a Trinotate file based on the merged file including all the transcripts detected in all our samples, and then we performed BLAST against a default list of animals. We additionally, populated the Trinotate file with *Polistes dominula* orthologues (<http://blast.ncbi.nlm.nih.gov/Blast.cgi>). The actual analysis of enrichment was performed against the list of gene that were detected to be differently expressed between the group categories. We used both the function topGO and also the GO functional annotation clustering in DAVID v. 6 (Huang et al. 2009a; Huang et al. 2009b) with medium stringency; significance was assessed at $p < 0.05$ and with a Benjamini–Hochberg correction for multiple testing. To proceed with the weight gene correlation network analysis (WGCNA) we used the package WGCNA (Langfelder & Horvath 2008). We followed the instructions available in their set of tutorials ([Tutorials for WGCNA R package \(ucla.edu\)](http://www.wgcna.com/)) to conduct our analyses, which included network constructions, module detection, correlating modules to external traits (our groups of interest) and finally exporting the networks to be examined in the external software Gephi 0.9. In the software Gephi 0.9, we build different gene networks considering the genes (nodes) and their interactions (edges – how interconnected they were). We used the

rendering function ForceAtlas2 to allow a better optimal visual interpretation of the genes and their connections. Then, we run the modularity function, which allowed us to understand the presence of submodules (communities) within our modules of interest. Considering that most of the analyzed modules were represented by hundreds of genes, we decided to filter and present only the top 20 (the ones with the greatest number of connections and possibly the most important ones in the gene modules). Hub genes (the ones with more connections) were highlighted in the networks by increasing their size ID.

Results

(a) Sequenced data

Forty libraries of Sanger / Illumina 1.9 generated a total of 22797043 pair-end fragments of 150 bases in length. The majority (99.31%) of fragments (22640084) passed quality control steps. All the samples preserved up to 99.25% of their fragments after trimming steps. The mean percentage of fragments that were overall aligned to the *P. fuscatus* genome (Miller et al. 2020) were equal to 90.99%. Finally, the mean number of reads that were correctly assigned to the *P. fuscatus* genome stored as general feature format (gff) were equivalent to 14568833 (60.89%) All the libraries that including the correctly assigned fragment reads were high quality and passed the first quality control steps during the downstream analysis (Figure 3). The raw dataset included a total of 13434 features (genes).

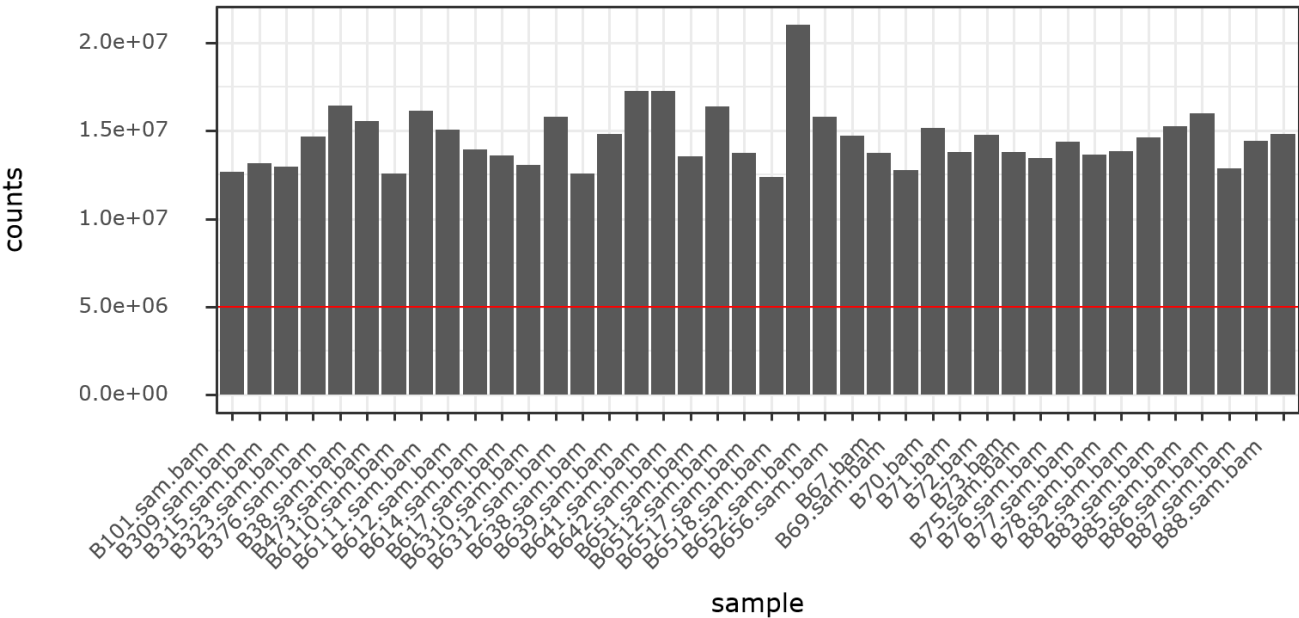


Figure 3: Raw transcript library counts obtained by the feature counts tool for all 40 samples (24 females and 16 males). All the libraries passed quality steps in the initial stage of the downstream analysis. The red line indicates the minimum number of transcripts a given library had to have to proceed in the other analysis (5000000 transcripts).

(b) Overall gene expression patterns

Taking into account that females and males grouped primarily based on transcriptional profiles associated to their sex, and not on their health status (parasitized or non-parasitized) (Figure 4), we split up raw reads according to sex and thus we present the other results separately. The MDS plot confirmed that individuals were first divided based on their sex and then to their health status (Figure 5). The first dimension explained 26% while the second dimension explained 8% of the overall variation. Analysis took into consideration 10223 features (genes) (76.09%) that passed filtered.

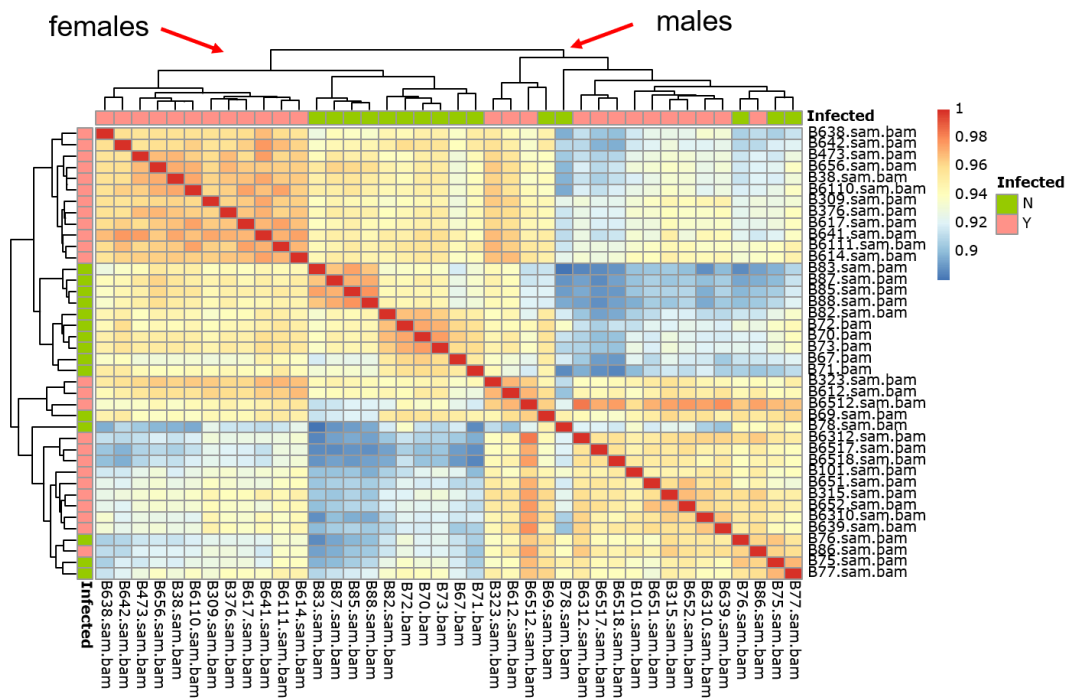


Figure 4: Heatmap showing mean centered log2 of all the transcripts from genes that passed first filtering steps (10223 genes). Individuals clustered primarily based on their sex (two main branches highlighted by the red arrows).

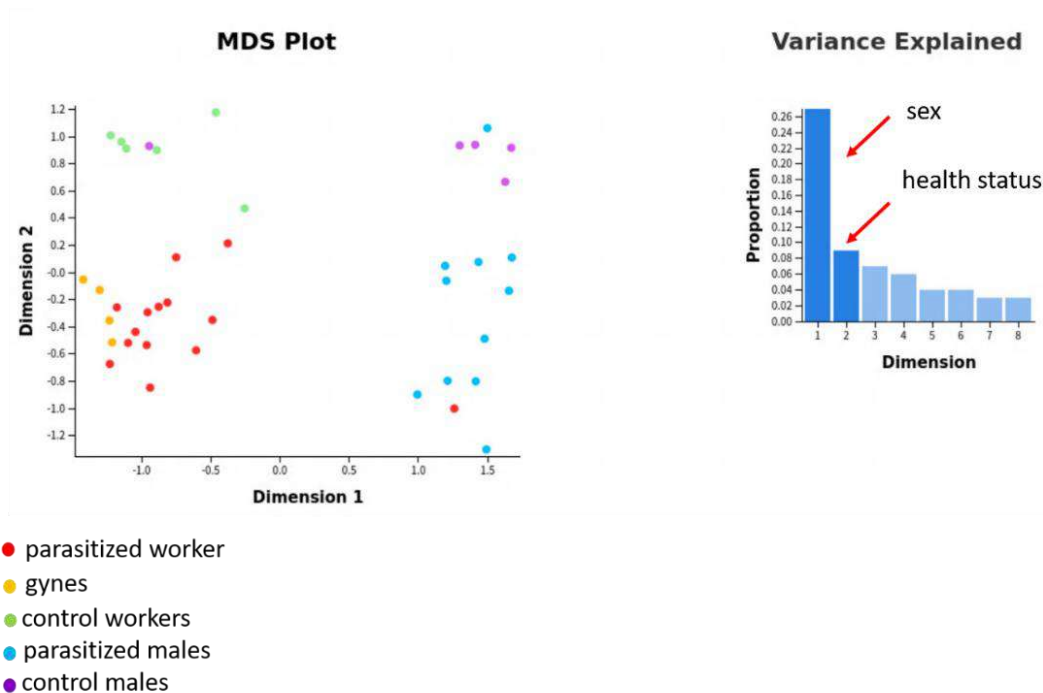


Figure 5: Multidimensional scaling plot including female and male samples used in the study (control females = 6, gynes = 4, parasitized workers = 14, control males = 5 and parasitized males = 10). Bar plot represents the proportion of variation of each dimension. In this case, the first dimension explained sex, whereas the second explained most likely health status.

(b) Overall gene expression for females

The MDS analysis revealed that gynes and parasitized workers were more similar in terms of their transcriptional profiles if compared with control workers (Figure 6). The first dimension explained 18% while the second dimension explained 15% of the overall variation in samples including only females. Analysis took into consideration 9933 features (genes) (73.93%) that passed filtering steps. The QL F-test revealed that several genes were differently expressed (DGEs) between the females from different categories (control workers x gynes = 958; parasitized workers x control workers = 882; parasitized workers x gynes = 1743). After correcting for false discovery rate ($FDR < 0.05$), the number of DGEs were equivalent to 889 DGEs - control workers x gynes = 328, parasitized workers x control workers = 274 and parasitized workers x gynes = 287 (Figure 8). The number of down and upregulated genes varied among the three group pairs. In the first pair control workers x gynes a total of 122 genes were down regulated in control workers and 206 were upregulated, for the second pair including parasitized workers x control workers a total of 116 were downregulated in parasitized workers and 158 genes were upregulated, and lastly, for the third pair that included parasitized workers x gynes a total of 127 genes were downregulated in parasitized workers and 160 were upregulated (Figure 8). The number of DGEs that were uniquely expressed between females from different pairs were equal to control workers x gynes = 139, parasitized workers x control workers = 138 and parasitized workers x gynes = 161. Additionally, there were DGEs in more that one pair of females: control workers x gynes / parasitized

workers x gynes = 95; parasitized workers x control workers / parasitized workers x gynes = 32; parasitized workers x gynes / control workers x gynes = 85. Finally, a total of 9 genes were differently expressed in common in the three pairs of females (Figure 9). The 95 DGEs detected between control workers x gynes and parasitized workers x control workers stand out as the most likely ones to be under parasite manipulation and the top 10 (lowest adjusted p-value) of the list is presented in details below. A hierarchical clustering analysis based on the top 100 DGEs of each pair revealed that the overall transcriptional profile of parasitized workers was shifted towards the profile expressed by gynes (Figure 10).

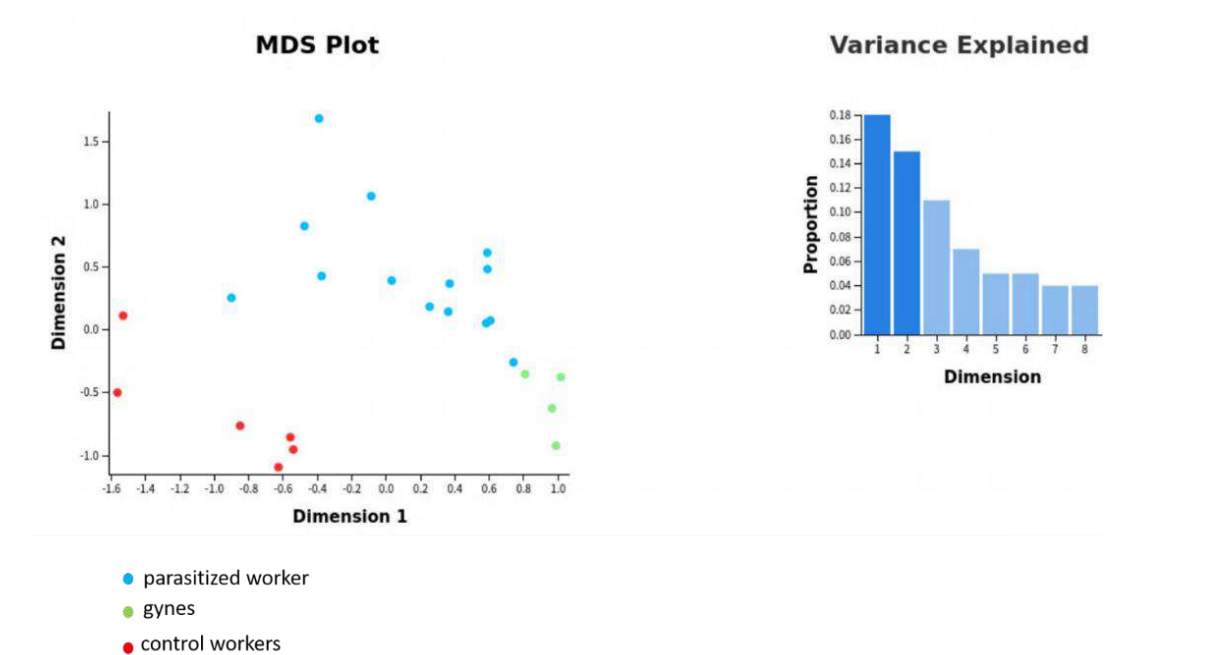


Figure 6: Multidimensional scaling plot including female samples used in the study (control females = 6, gynes = 4 and parasitized workers = 14). Bar plot represents the proportion of variation of each dimension. In this case, samples of parasitized workers and gynes clustered more closer to each other, highlighting an overall similarity in terms of transcriptional signatures between these two groups of females.

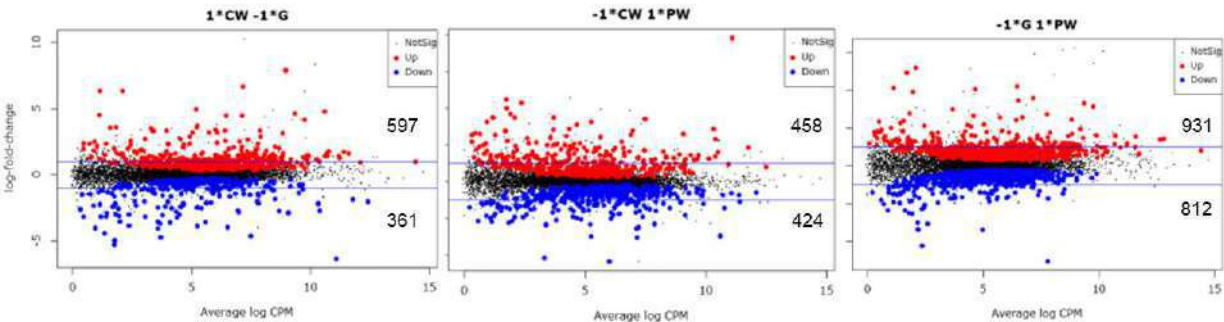


Figure 7: Plot representing the log-fold change against log-counts per million, with DEGs highlighted (before FDR correction). Red dots represent upregulated genes, blue dots represent downregulated genes and black dots represent genes that did not differ between the groups. The upregulated and downregulated genes in these graphs were plotted in accordance with the first female group that appears in the pairwise comparisons.

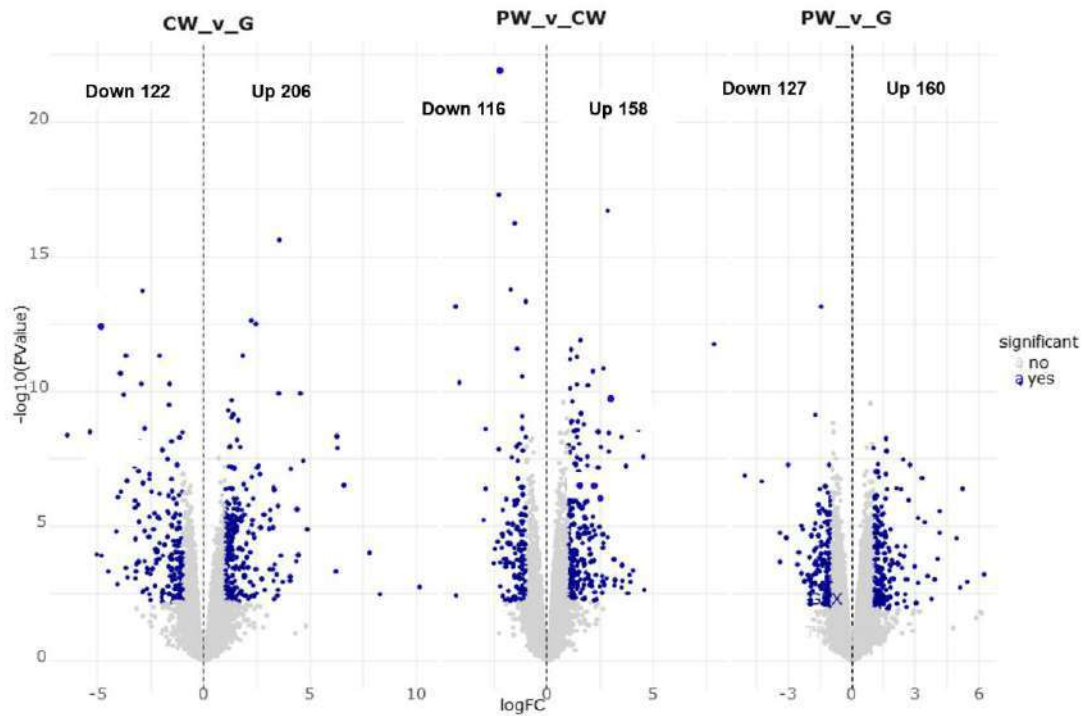


Figure 8: Volcano plot representing gene expression profiles after FDR for the three pairwise comparisons. Values below zero represent downregulated genes, while values above zero represent upregulated genes. Dark blue dots represent DGEs between the pairwise comparisons. Dots that are further from the main cluster represent the ones with the lowest FDR values (= most significant ones). The upregulated and downregulated genes in these graphs were plotted in accordance with the first female group that appears in the pairwise comparisons.

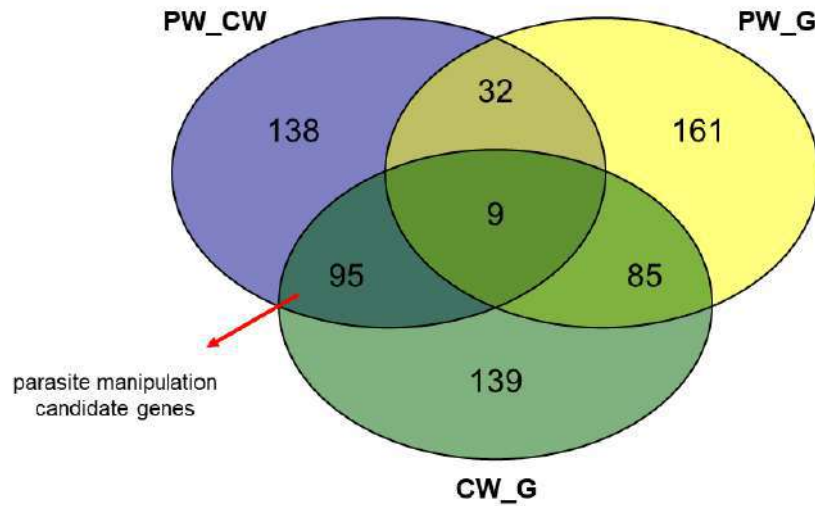


Figure 9: Venn diagrams representing the total number (upregulated + downregulated) genes between the three pairwise comparisons. Numbers in the blue, yellow and green area represent the DGEs uniquely present in the given pairwise comparisons. Numbers represented in the intersections blue / yellow, yellow / green and green / blue represent the DGEs found between the two pairs of comparisons. The number displayed in the center of the graph represents the number of DGEs that were found in common the three pairwise comparisons. The number displayed in the intersection green / blue represent the most likely the parasites would target to manipulate in their female hosts.

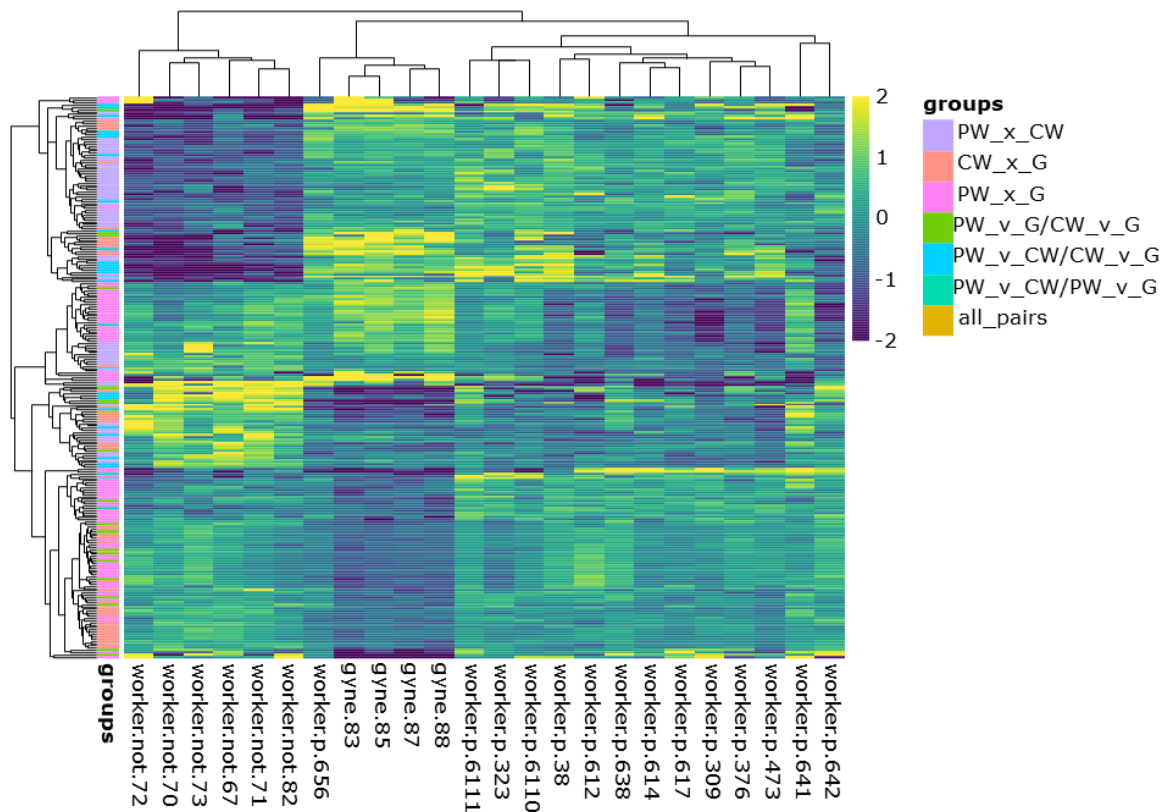


Figure 10: Heatmap including the combination of the top 100 DGEs (= 245 in total) for each of the pairwise comparisons. The heatmap represents the log2 values applied to the original transcript values of each selected gene. Considering that not all top 100 DGEs were uniquely expressed across the pairwise comparisons, we also included in the left side of the heatmap groups or clusters of gene category (if they were uniquely expressed in a given pairwise comparison, two pairwise comparison and all the three). Taking into consideration the expression levels of the top 100 DGEs, it is clear that the transcriptional signatures of parasitized workers shifted toward a gyne-like signature.

(c) Gene functions

We performed gene ontology analysis (GO) on each of the pairwise contrasts in order to highlight functional categories of genes related to caste differences (control workers x gynes) and healthy status (parasitized workers x control workers / parasitized workers x gynes) (Table 2). The DGEs list returned 13, three and four clusters, respectively (Figure 11; Table 2). For the first comparison, control workers x gynes, clusters were enriched mainly based on molecular function and cellular component, and being the majority involved in energy production (GO:0005743, GO:0015986, GO:0006122, GO:0046933, GO:0005750 and GO:0005750). For the second pairwise comparison (parasitized workers x control workers), two clusters were enriched based on molecular function and one based on cellular component (protein transport). For the last pairwise comparison (parasitized workers x gynes), two clusters were enriched by molecular function, and one for biological process and cellular component (protein transport).

Table 2: List of the GO term clusters based on the DGEs including female samples. BP = biological process, CC = cellular component and MF = molecular function.

#	pairwise	category	numDEInCat	numInCat	term	ontology
1	1	GO:0020037	34	389	heme binding	MF
2	1	GO:0070469	13	48	respirasome	CC
3	1	GO:0005743	31	454	mitochondrial inner membrane	CC
4	1	GO:0005506	28	371	iron ion binding	MF
5	1	GO:0015986	9	24	ATP synthesis coupled proton transport	BP
6	1	GO:0006122	6	10	mitochondrial electron transport, ubiquinol to cytochrome c	BP
7	1	GO:0070330	17	209	aromatase activity	MF
8	1	GO:0005747	8	44	mitochondrial respiratory chain complex I	CC
9	1	GO:0046933	5	13	proton-transporting ATP synthase activity, rotational mechanism	MF
10	1	GO:0005750	4	9	mitochondrial respiratory chain complex III	CC
11	1	GO:0008121	4	9	ubiquinol-cytochrome-c reductase activity	MF
12	1	GO:0005576	30	807	extracellular region	CC
13	1	GO:0005811	12	165	lipid droplet	CC
1	2	GO:0020037	23	389	heme binding	MF
2	2	GO:0005576	32	807	extracellular region	CC
3	2	GO:0005506	20	371	iron ion binding	MF

1	3	GO:0020037	22	389	heme binding	MF
2	3	GO:0005506	17	371	iron ion binding	MF
3	3	GO:0006122	4	10	mitochondrial electron transport, ubiquinol to cytochrome c	BP
4	3	GO:0005576	27	807	extracellular region	CC

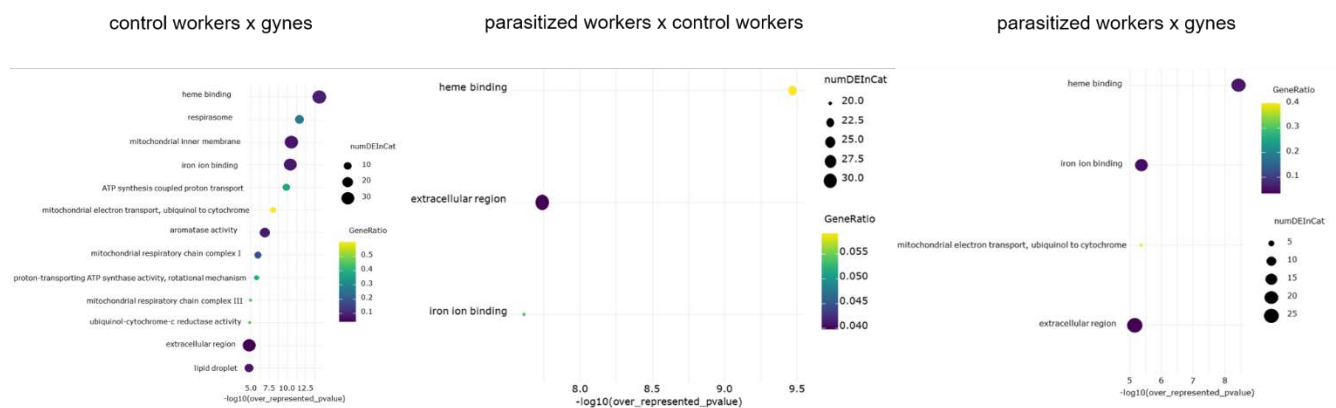


Figure 11: Plots representing the clusters enriched based on the GO analysis. Circle sizes represent the number of genes that were enriched for a given category that is displayed in the left size of each graph. On top of each graph is it included the pairwise comparison.

(d) Top ten DGEs among the different pairwise comparison including female groups

The top 10 DGEs in the pairwise comparison including control workers x gynes include genes involved in the regulation of in immune system response against infections (TNF receptor-associated factor 4 - upregulated in gynes), the transport of odour molecules in insect hemolymph (Ejaculatory bulb-specific protein 3 - upregulated in control workers), mitochondrial biogenesis (60S ribosomal protein L44 – downregulated in gynes) and sugar degradation (Trehalase – upregulated in control workers). The top 10 DGEs in the pairwise comparison including parasitized workers x control workers include genes associated to longevity (Sodium-dependent dopamine transporter – downregulated in parasitized workers), mitochondrial biogenesis (60S ribosomal protein L44 – downregulated in parasitized workers), the transport of odour molecules in insect haemolymph (Ejaculatory bulb-specific protein 3 - upregulated in control workers), and feeding status (Short neuropeptide F – upregulated in control workers). Finally, the top DGEs in the third pairwise comparison parasitized workers x gynes included genes most likely associated to neuronal processes (eg. brain development) (Carbonic anhydrase-related protein 10 – downregulated in parasitized workers), the transport of important cell nutrients and cellular metabolism (Monocarboxylate transporter 5 – upregulated in parasitized workers), cellular homeostasis (GTP:AMP phosphotransferase AK3, mitochondrial – upregulated in parasitized workers) and the transport of odor molecules in insect hemolymph (Ejaculatory bulb-specific protein 3 - upregulated in parasitized workers)

Table 3: List including the top 10 DGEs across the three different pairwise comparison. Dir = direction of the given gene, down = downregulated and up = upregulated. The

direction of the given gene corresponds to the first female group displayed in the pairwise comparison in the pair column.

pair	gene ID	description	F	PValue	FDR	dir
CW_v_G	LOC122514311	Ejaculatory bulb-specific protein 3	58.26	7.49E-08	0.000700828	up
CW_v_G	LOC122517008	60S ribosomal protein L44	52.15	1.62E-07	0.000700828	up
CW_v_G	LOC122526264	uncharacterized	51.11	2.12E-07	0.000700828	down
CW_v_G	LOC122517051	Trehalase	47.98	3.37E-07	0.000719492	up
CW_v_G	LOC122524853	Protein kinase DC2	46.3	4.23E-07	0.000719492	up
CW_v_G	LOC122516512	uncharacterized	47.06	4.73E-07	0.000719492	down
CW_v_G	LOC122525638	TNF receptor-associated factor 4	45.07	5.28E-07	0.000719492	down
CW_v_G	LOC122520242	Mitochondrial pyruvate carrier 2	44.33	6.03E-07	0.000719492	up
CW_v_G	LOC122517480	Forkhead box protein L2	43.91	6.52E-07	0.000719492	up
CW_v_G	LOC122526766	Coiled-coil-helix-coiled-coil-helix domain-containing protein 2	41.76	9.73E-07	0.000878376	up
PW_v_CW	LOC122520941	Sodium-dependent dopamine transporter	102.68	2.85E-10	2.83E-06	down
PW_v_CW	LOC122517008	60S ribosomal protein L44	95.09	6.48E-10	3.22E-06	down
PW_v_CW	LOC122514759	Synapse-associated protein of 47 kDa	73.81	7.01E-09	2.32E-05	down
PW_v_CW	LOC122514311	Ejaculatory bulb-specific protein 3	66.96	2.21E-08	5.43E-05	down
PW_v_CW	LOC122524345	uncharacterized	62.64	3.16E-08	5.43E-05	down
PW_v_CW	LOC122522366	Short neuropeptide F	61.9	3.51E-08	5.43E-05	down
PW_v_CW	LOC122526264	uncharacterized	62.38	3.83E-08	5.43E-05	up
PW_v_CW	LOC122523201	Coagulation factor V	55	9.92E-08	0.000123173	down
PW_v_CW	LOC122517865	Homeobox protein extradenticle	54.23	1.12E-07	0.000123767	down
PW_v_CW	LOC122517172	Ejaculatory bulb-specific protein 3	47.08	4.88E-07	0.000475531	down
PW_v_G	LOC122516087	Carbonic anhydrase-related protein 10	51.18	1.87E-07	0.001857564	down
PW_v_G	LOC122524235	uncharacterized	33.35	5.38E-06	0.005341065	up
PW_v_G	LOC122524023	uncharacterized	30.85	9.39E-06	0.005548933	up
PW_v_G	LOC122522444	1-phosphatidylinositol 4,5-bisphosphate phosphodiesterase classes I and II	31.18	9.66E-06	0.005548933	down
PW_v_G	LOC122517634	Monocarboxylate transporter 5	30.78	9.72E-06	0.005548933	up
PW_v_G	LOC122515448	uncharacterized	30.54	1.01E-05	0.005548933	up
PW_v_G	LOC122517480	Forkhead box protein L2	30.41	1.04E-05	0.005548933	up
PW_v_G	LOC122518324	uncharacterized	29.23	1.45E-05	0.005611863	down
PW_v_G	LOC122518534	GTP:AMP phosphotransferase AK3, mitochondrial	28.93	1.47E-05	0.005611863	up
PW_v_G	LOC122516858	Ejaculatory bulb-specific protein 3	28.73	1.54E-05	0.005611863	up

(e) DGEs to be under parasite manipulation

Out of the lists including the top 100 DGEs for each of the pairwise comparisons, we were able to identify a total of 28 DGEs between the pairs parasitized workers x gynes and control workers x gynes (Table 4). These DGEs represent the most likely candidates to be under parasite manipulation. From this list, a total of 18 genes were upregulated in both parasitized and gynes, whereas 10 were downregulated. Hence, a total of 18 genes were downregulated and 10 were upregulated in control workers. Interestingly, some of

these DGEs are likely involved in the process of resource storage and (Lipid storage droplets surface-binding protein 1, Sugar transporter ERD6-like 14 and Hexamerin). In the list there is also a DGE that may be directly associated with process involving detoxication and it is also caste-related (higher in queens) (Probable cytochrome P450 6a14) and immune system activity (TNF receptor-associated factor 4). Additionally, one of the genes is most likely involved in the process of wax biosynthesis (Fatty acyl-CoA reductase 1). All the mentioned genes were upregulated in both gynes and parasitized workers, and hence downregulated in control workers. The upregulation of these genes (higher transcripts) in parasitized workers represent direct evidence that the parasite likely manipulates their host by accessing pathways that would guarantee host survival (= increased lifespan) as gynes normally do to survive during the winter.

Table 4: List including the DGEs found in common between the two pairs control workers x gynes / parasitized workers x gynes (extracted from the top 100 DGEs list) The direction of the given gene corresponds to the first female group displayed in the pairwise comparison in the pair column. All the genes downregulated and upregulated in parasitized workers were also expressed in the same manner in gynes.

pair	gene ID	description	F	PValue	FDR	dir
PW_v_CW	LOC122517008	60S ribosomal protein L44	95.09	6.48E-10	3.22E-06	down
PW_v_CW	LOC122514759	Synapse-associated protein of 47 kDa	73.81	7.01E-09	2.32E-05	down
PW_v_CW	LOC122514311	Ejaculatory bulb-specific protein 3	66.96	2.21E-08	5.43E-05	down
PW_v_CW	LOC122526264	uncharacterized	62.38	3.83E-08	5.43E-05	up
PW_v_CW	LOC122523201	Coagulation factor V	55.00	9.92E-08	0.000123173	down
PW_v_CW	LOC122525724	uncharacterized	45.02	5.41E-07	0.000475531	up
PW_v_CW	LOC122513747	uncharacterized	42.53	8.42E-07	0.000597588	up
PW_v_CW	LOC122522301	Lipid storage droplets surface-binding protein 1	40.31	1.36E-06	0.0007266	up
PW_v_CW	LOC122525928	Hexamerin	41.12	1.37E-06	0.0007266	up
PW_v_CW	LOC122525515	Solute carrier family 23 member 2	34.83	3.95E-06	0.001088714	down
PW_v_CW	LOC122516512	uncharacterized	33.61	6.02E-06	0.001388215	up
PW_v_CW	LOC122523687	Venom allergen 5	33.24	6.32E-06	0.001388215	down
PW_v_CW	LOC122523996	Circadian clock-controlled protein	33.26	6.58E-06	0.00139005	up
PW_v_CW	LOC122525736	uncharacterized	31.60	7.92E-06	0.00154238	up
PW_v_CW	LOC122521421	Venom carboxylesterase-6	31.50	8.40E-06	0.001583626	up
PW_v_CW	LOC122519852	Glutamate receptor ionotropic, kainate 5	31.47	8.93E-06	0.001583626	up
PW_v_CW	LOC122525804	uncharacterized	30.24	1.08E-05	0.001731433	up
PW_v_CW	LOC122525638	TNF receptor-associated factor 4	28.25	1.72E-05	0.0022388	up
PW_v_CW	LOC122521050	Probable cytochrome P450 6a14	28.39	1.74E-05	0.0022388	up
PW_v_CW	LOC122515294	Esterase B1	28.52	1.86E-05	0.002307697	down
PW_v_CW	LOC122515727	Inhibin beta B chain	28.48	1.88E-05	0.002307697	up
PW_v_CW	LOC122524141	Monocarboxylate transporter 10	27.73	1.96E-05	0.002322486	down
PW_v_CW	LOC122513282	Sialin	25.47	3.50E-05	0.003191192	up
PW_v_CW	LOC122515601	Venom serine protease	23.61	5.74E-05	0.004193031	down
PW_v_CW	LOC122519438	Fatty acyl-CoA reductase 1	22.17	8.37E-05	0.005068054	up
PW_v_CW	LOC122513532	Sugar transporter ERD6-like 14	21.71	9.35E-05	0.005225156	up

PW_v_CW	LOC122521487	uncharacterized	21.61	0.00010441	0.005458421	down
PW_v_CW	LOC122516210	Venom carboxylesterase-6	21.04	0.000118156	0.005935739	up
CW_v_G	LOC122514311	Ejaculatory bulb-specific protein 3	58.26	7.49E-08	0.000700828	up
CW_v_G	LOC122517008	60S ribosomal protein L44	52.15	1.62E-07	0.000700828	up
CW_v_G	LOC122526264	uncharacterized	51.11	2.12E-07	0.000700828	down
CW_v_G	LOC122516512	uncharacterized	47.06	4.73E-07	0.000719492	down
CW_v_G	LOC122525638	TNF receptor-associated factor 4	45.07	5.28E-07	0.000719492	down
CW_v_G	LOC122522301	Lipid storage droplets surface-binding protein 1	38.57	1.92E-06	0.001119342	down
CW_v_G	LOC122523996	Circadian clock-controlled protein	37.06	3.01E-06	0.001301652	down
CW_v_G	LOC122523201	Coagulation factor V	35.43	3.44E-06	0.001355758	up
CW_v_G	LOC122525804	uncharacterized	33.75	4.92E-06	0.001685193	down
CW_v_G	LOC122521050	Probable cytochrome P450 6a14	33.20	5.82E-06	0.001918275	down
CW_v_G	LOC122521421	Venom carboxylesterase-6	32.48	6.75E-06	0.001998113	down
CW_v_G	LOC122513747	uncharacterized	32.25	6.84E-06	0.001998113	down
CW_v_G	LOC122525724	uncharacterized	30.30	1.08E-05	0.002672783	down
CW_v_G	LOC122514759	Synapse-associated protein of 47 kDa	30.04	1.13E-05	0.002740172	up
CW_v_G	LOC122525928	Hexamerin	28.60	1.84E-05	0.003760727	down
CW_v_G	LOC122523687	Venom allergen 5	27.37	2.39E-05	0.004225133	up
CW_v_G	LOC122513532	Sugar transporter ERD6-like 14	26.88	2.42E-05	0.004225133	down
CW_v_G	LOC122521487	uncharacterized	24.53	4.85E-05	0.005675671	up
CW_v_G	LOC122513282	Sialin	24.05	5.03E-05	0.00568315	down
CW_v_G	LOC122524141	Monocarboxylate transporter 10	23.90	5.15E-05	0.005689219	up
CW_v_G	LOC122515294	Esterase B1	22.12	9.21E-05	0.007448123	up
CW_v_G	LOC122515601	Venom serine protease	21.83	9.25E-05	0.007448123	up
CW_v_G	LOC122525736	uncharacterized	21.51	9.83E-05	0.007577362	down
CW_v_G	LOC122519852	Glutamate receptor ionotropic, kainate 5	21.64	0.000100258	0.007577362	down
CW_v_G	LOC122515727	Inhibin beta B chain	21.72	0.00010257	0.007600699	down
CW_v_G	LOC122525515	Solute carrier family 23 member 2	21.35	0.000103302	0.007600699	up
CW_v_G	LOC122516210	Venom carboxylesterase-6	21.25	0.000111465	0.00785237	down
CW_v_G	LOC122519438	Fatty acyl-CoA reductase 1	20.63	0.000128507	0.008342872	down

(f) Network analysis

A total of 12807 genes and 22 of our 24 female samples passed filtering checks for use in the analysis. A total of 26 modules including genes with similar co-expression values were detected (Figure 12). The largest modules included a total of 5132 genes (turquoise), while the smallest module included only 25 genes (grey). By relating the modules to our female groups (control workers, gynes and parasitized workers) we were able to identify at least two modules that were positively and significantly associated with each of the female categories (Figure 13). By plotting these gene networks, we were able to filter the most interconnected genes (~20) and hence the hub genes (genes with the greatest number of connections) (Figure 14, 15 and 16). According to the WGCNA the genes identified to be expressed in the brains of females formed 26 different modules based on their similar levels of co-expression. Parasitized workers represented the group

of females that had the greatest number of modules in which they were positively correlated to ($n = 14$), followed by control workers ($n = 10$), and finally gynes ($n = 8$).

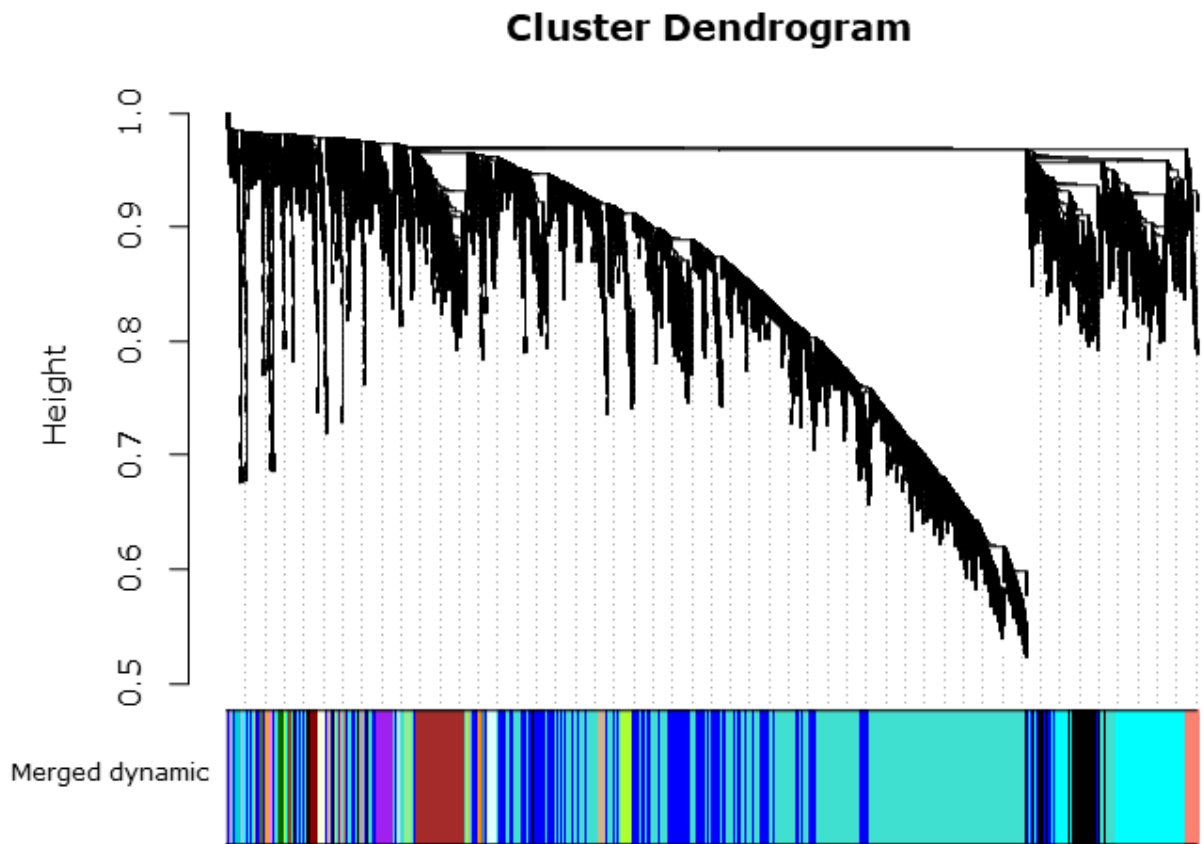


Figure 12: Cluster dendrogram combined with the colored modules. Trees represent genes with similar levels of co-expression and they are directly connected to a given module color. A total of 26 colored modules were created.

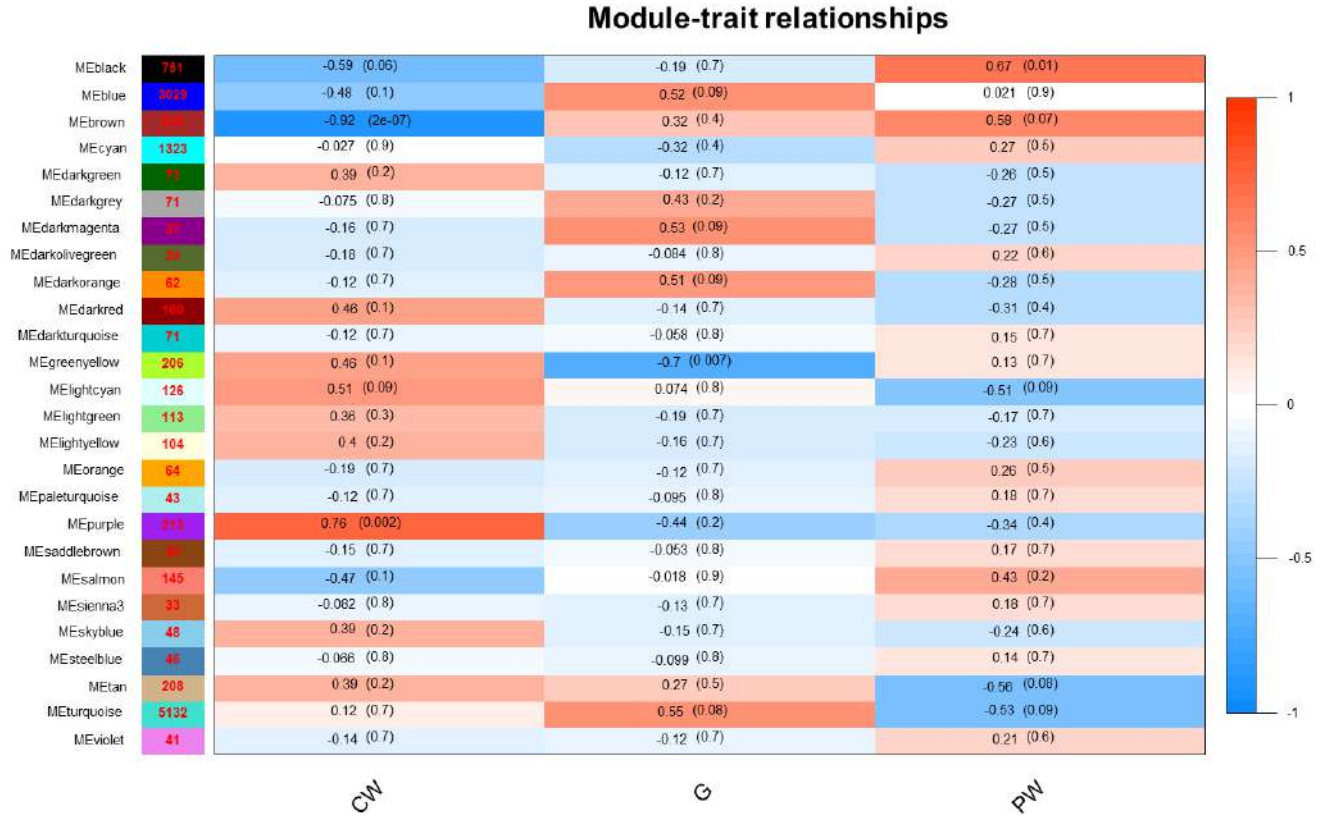


Figure 13: Module-trait relationship heatmap. In the bottom part it is displayed each of the female categories and in the left side of the panel it is displayed the 26 modules of genes. Number in red inside each module color correspond to the number of genes present in the modules. The heatmap represent the correlation (above zero = positive correlation / below zero = negative correlation) between female groups and the modules of genes. Stronger red represents stronger positive correlation, whereas stronger blue represents stronger negative correlation. The top two modules for each female group were extracted and plotted as networks below.

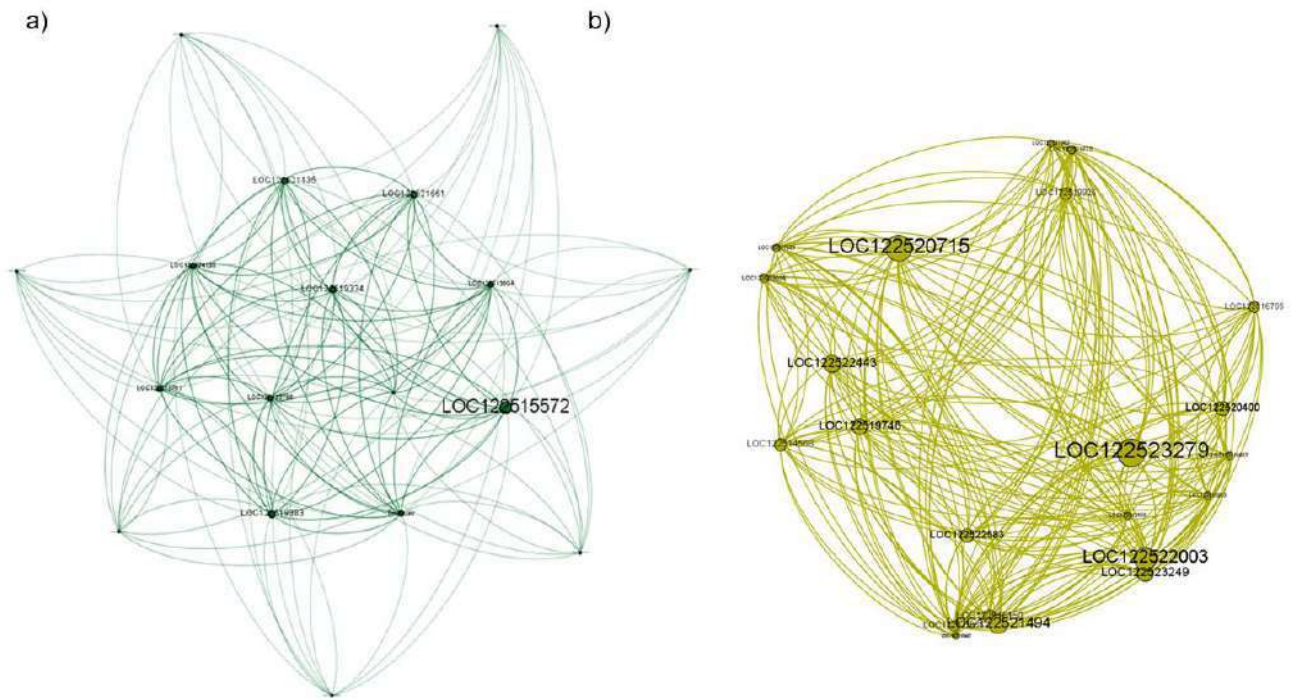


Figure 15: Visualization of the most 20 connected genes from the most positively and significantly modules associated to gyns obtained from the WGCNA. a) dark magenta module and b) turquoise module. Gene ID names in evidence (bigger names) represent hubs genes (the ones with the greatest number of connections). a) LOC122515572 – uncharacterized; LOC122519334 – uncharacterized; LOC12251661 – uncharacterized; LOC12251135 – uncharacterized; LOC122519383 – uncharacterized. b) LOC122520715 - Focal adhesion kinase 1; LOC122523279 - Telomerase-binding protein EST1A; LOC122522003 – Menin; LOC122522443 - Protein Jumonji; LOC122521494 - Intersectin-1.

and interestingly, one of them cAMP-dependent protein kinase catalytic subunit 3 is directly associated to neuronal growth and differentiation and it is downregulated in parasitized males. This was also the single gene that was detected to be differently expressed between females and males (upregulated in control and parasitized females / downregulated in gynes).

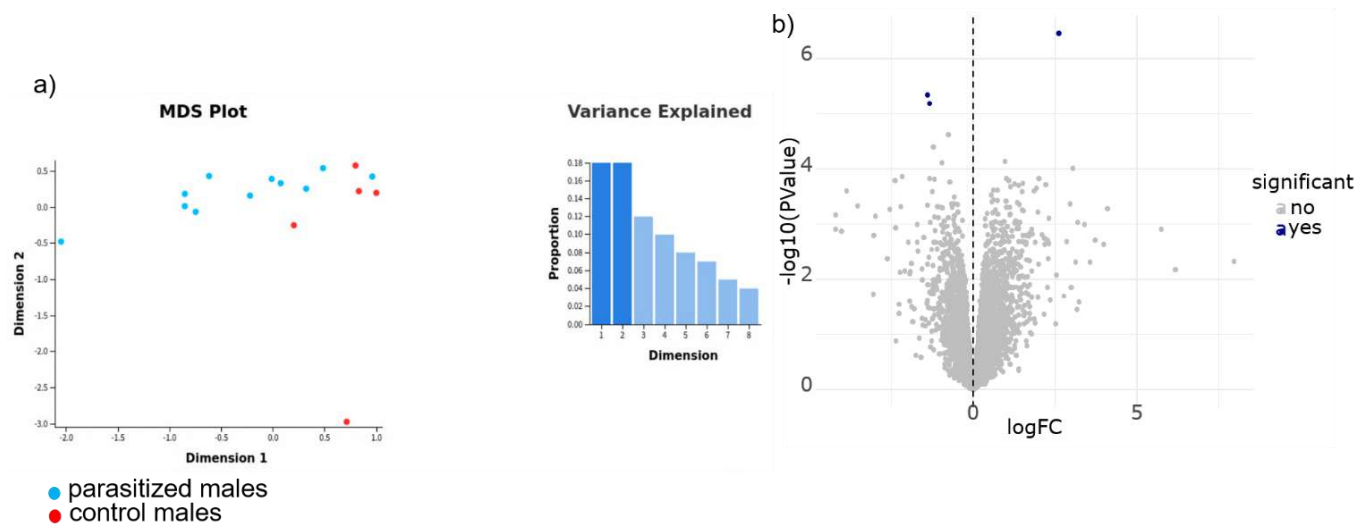


Figure 17: a) Multidimensional scaling plot including male samples used in the study (control males = 5 and parasitized males = 10). Bar plot represents the proportion of variation of each dimension. In this case, no clear separation was detected when control males and parasitized males were compared together. b) Volcano plot representing gene expression profiles of both male categories after FDR. Values below zero represent downregulated genes, while values above zero represent upregulated genes. Dark blue dots represent DGEs between the pairwise comparisons. Dots that are further from the main cluster represent the ones with the lowest FDR values (= most significant ones). The upregulated and downregulated genes in these graphs were plotted in accordance the male parasite category.

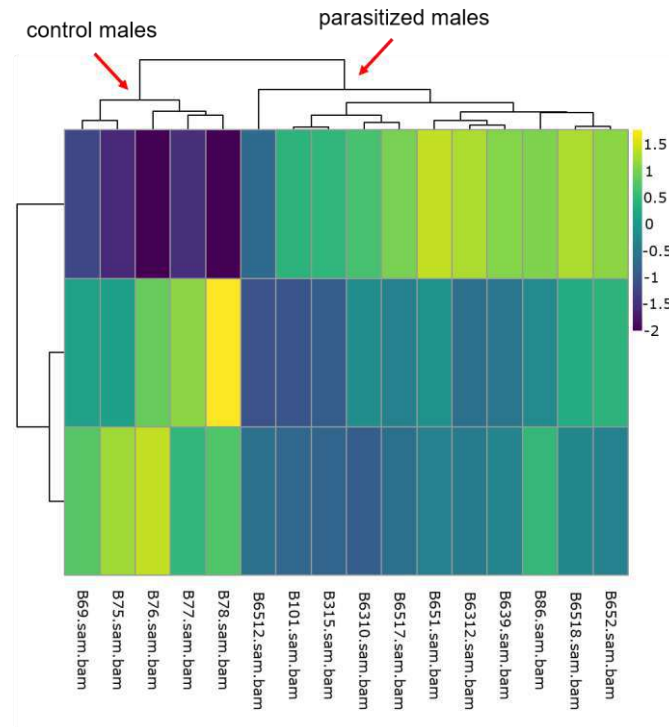


Figure 18: Heatmap including the three DGEs between male categories. The heatmap represents the log2 values applied to the original transcript values of each selected gene.

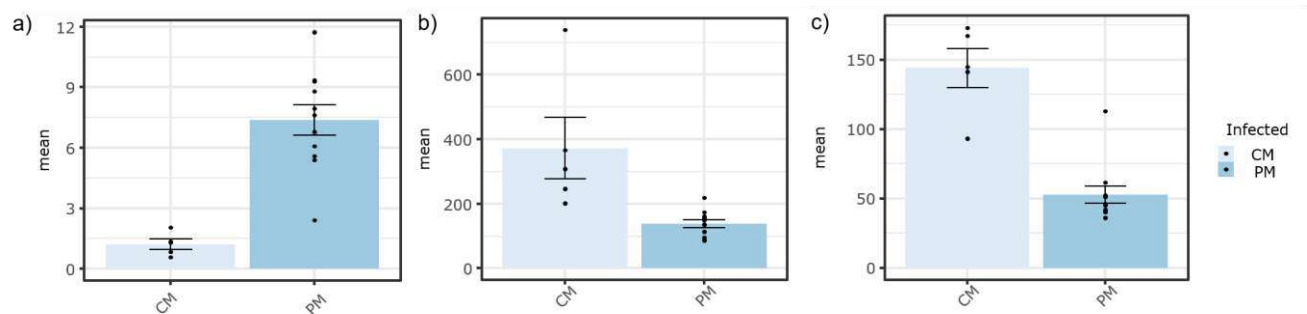


Figure 19: Barplots of the TPM mean values for the three DGEs for the male categories. Error bars represent the standard errors and the points represent the TPM values of each of the male samples. a) voltage-gated channel (LOC122514089). b) probable cytochrome P450 6a14 (LOC122519248). c) cAMP-dependent protein kinase catalytic subunit 3 (LOC122524853).

Discussion

Polistes individuals are often attacked by endoparasites *Xenos*. Hosts are affected differently, females experience extreme behavioral, morphological and physiological alterations, male hosts, on the other hand, are barely affected by them. Here, we analyzed the brain transcriptomic underlying these modifications in order to highlight

the complex molecular basis of this intricate host-parasite relationship. Our results allowed us to corroborate our initial hypothesis that the parasite *X. peckii* drives differential gene expression in host brains in a different manner. As we predicted and based on the huge body of evidence of parasite effects over their hosts in the system *Polistes-Xenos*, we found that female hosts are profoundly affected by parasites presence if compared with male hosts. A greatest number of genes were differently expressed in parasitized workers, while just a few of them demonstrated differential expression signatures in male hosts. Additionally, in line to our predictions, our results allowed us to suggest that the parasite *X. peckii* likely take advantage of the pre-existing phenotypic plasticity expressed by *Polistes* females to shift the usual expression of several genes in their advantage. By driving gene expression in their female hosts, parasites make them to express transcriptional signatures that resemble more those found in the brains of gynes rather than those found in non-infected workers (control workers). Direct evidence of that is related to the fact that a greatest number of DGEs were detected between the pairwise comparison control workers x gynes (n = 328), additionally, a subset of DGEs that are likely the candidates to be under parasite manipulation, followed similar patterns (up and downregulation) in both control workers x gynes / parasitized workers x control workers. Taking into consideration that differential gene expression occurs in several key genes that are likely associated with promoting longevity, resource storage and immunity, it is reasonable to suggest that the parasite manipulates directly genes that ensure their host female survivorship during the winter, which contributes for the parasites to reach their reproductive success after host hibernation. Excitingly, the results of our work mirror the same patterns of parasite manipulation as previously reported for the system *P. dominula* and *X. vesparum* (Geffre et al. 2017), which suggest that *Xenos* parasites may use similar strategies to deceit their female wasp (primary) hosts.

We demonstrated that gene expression signatures in host wasps vary primarily according to their sex and secondarily according to their healthy status. However, the parasites affect their host gene expression signatures in a different manner, females are deeply affected, whereas males are slightly affected. Interestingly, in the parallel system (*P. dominula* and *X. vesparum*), females and males express cuticular hydrocarbons (CHCs) that primarily divide them according to their sex, and secondarily according to their healthy status (Beani et al. 2019). Additionally, CHC modification due to infection is stronger in females (Beani et al. 2019). The combination of our results and those published by Beani et al (2019) suggest that the primary host (females) are thoroughly affected (behaviorally and castrated) in comparison to males due to how parasites extensively manipulate them at a molecular level. It is worth mentioning that in our case and in the work performed by Beani et al (2019) the samples were infected with only a single parasite; however, it is possible that parasite load (more than one parasite per host) would underly even stronger modification in their hosts. To confirm if this is the case, further investigation is needed.

An interesting aspect about our samples is that parasitized females were collected not when they were in their nests, but rather when they had already left. That said, it is likely that the parasites had already triggered the differential gene expression that causes their host aberrant behavioral (nest desert behavior) and physiological modification (ovary castration). However, parasite manipulation possibly starts right after their host emerge as adults. In the parallel system (*P. dominula* and *X. vesparum*),

parasitized workers express a gyne-like transcriptional signatures even prior leaving their nests (Geffre et al. 2017). We were able to track several genes that expressed similar levels of upregulation in parasitized workers and gynes that encode for proteins that are related to resource storage (Lipid storage droplets surface-binding protein 1, Hexamerin and Sugar transporter ERD6-like 14) which could be the key targets of the parasite to guarantee the accumulation of enough nutrients to enhance their host survival (extended lifespan). Another candidate key gene identified in our dataset that may be indirectly involved in promoting lifespan in parasitized workers is the Sodium-dependent dopamine transporter, which expressed downregulation levels in parasitized workers. In males of *Drosophila melanogaster*, the lower levels of dopamine in their nervous apparatus together with a higher capacity of antioxidation favor adult individuals to live longer (Pérez et al. 2021). By extending their female host lifespan, female parasites survive the winter and then they are able to achieve their reproductive success by releasing triungulins that will infect new wasps early in the next spring (Beani et al. 2021). Importantly, female wasp hosts infected with female parasites are the only ones that manage to survive the winter as gynes do in the parallel system (Beani et al. 2021). In a similar manner, *X. peckii* females are able to extend their female host lifespan (personal observation / data in prep Uy lab).

As in the work conducted by Geffre et al (2017) (*P. dominula* and *X. vesparum*), here the most striking variation concerning the number of DGEs was directly related to caste differences (control workers x gynes $n = 328$ DGEs). Among these DGEs, we were able to spot genes that encode for proteins associated to metabolism functioning (energy expenditure) (Trehalase / 60S ribosomal protein L44 = both upregulated in control workers / downregulated in gynes and parasitized workers). Furthermore, we also identified in our full DGEs list (not shown in the Results section) other interesting genes that have been also reported by Geffre et al (2017) to be differently expressed among their samples. Among them we highlight, Takeout which is directly involved in olfactory processing and juvenile hormone binding (in our samples we found a higher number of transcripts in brains of gynes and parasitized workers – also queen-biased gene reported by Holman et al 2019) and Fatty acyl-CoA reductase 1 which is directly involved in the process of wax and ether lipid biosynthesis (probably associated with cuticular formation) and was upregulated in both gynes and parasitized workers. Another interestingly gene that we found to be upregulated in gynes and parasitized workers in relation to control workers was the Vitellogenin. In addition to this function tightly associated to reproduction in honeybees, some evidence also suggests the likely involvement of this gene in immune system processes and lifespan extension (Wang & Li-Byarlay 2015). In bees, Vitellogenin also display antioxidant effects (Seehuus et al. 2006; Havukainen et al. 2013). The higher expression of this gene in honeybee queens and nurses may be directly connected to the fact that they tend to die to a less extent whether compared to foragers (Majoe et al. 2021). The overexpression of this gene in our parasitized worker samples strengthen the fact that the parasite is likely able to target and modulate genes that will allow their hosts to survive.

Parasitized and non-parasitized males express highly similar levels of gene expression. However, we did detect three different genes to be differently expressed between them. Even though male host are not as affected as female ones (behaviorally and physiologically), there is evidence that parasites (*X. vesparum*) affect directly and

more drastically the brain tissue of their male hosts compared to their female hosts (*P. dominula*) (Gandia et al. 2022). Taking into consideration that we found cAMP-dependent protein kinase catalytic subunit 3 to be downregulated in brain of parasitized males, and that this gene is thought to be directly associated to neuronal growth (Batty et al. 2017), it is possible that when parasites are inside their alternative host, their strategy change and then they do not drive severe neurogenomic changes, but rather they merely drain and reallocate energy from the available organs in their favor (survive as much as possible), which in turn affect directly the brain size of their hosts.

In summary, we present here data that reinforce that in the system *X. peckii* and *P. fuscatus*, the parasites are capable to explore pre-existing plasticity features in their primary hosts (females) and they manipulate the expression levels of several their host genes. The major consequence of such intricate host-parasite interaction is the shift of the overall gene expression profile of their hosts toward a more gyne-like gene expression profile. We were able to spot several genes that seem to be the key targets of the parasites and are likely connected to promoting resource storage and hence extending their lifespan. In contrary to the results that we found for female hosts, male hosts on the other hand are barely affected at molecular level by the parasites. Lastly, the results of our work strengthen that *Xenos* parasites may have evolved similar strategies to manipulate their hosts, once our results mirrored those previously presented for the parallel system (*P. dominula* and *X. vesparum*). Overall, our results reinforce that the sex-biased and well-known behavior and physiological modification driven by the *Xenos* parasites are products of the different sex-biased manipulation at gene expression level driven by them (more severe in females / less severe in males). Further research should consider to perform pharmacological assays in order to knockdown genes (in control workers) that we spotted to be directly responsible for promoting the extended lifespan in parasitized females.

Other activities performed during the internship

During my internship I had the chance to attend three seminars that were offered in the department: (1) – Biology and evolution of myrmecophilous Ophiocordyceps, the Zombie-Ant Fungi (speaker – Dr. João Araujo); (2) Behavioral and Neural correlates of facial recognition in a paper wasp (speaker - Dr. Christopher Jernigan); (3) The evolution and regulation of complex social behavior in paper wasps (speaker - Dr. Amy Toth). I also had the chance to conduct three lab meetings: (1) paper discussion with Team Wasp members “Chemical detection triggers honey bee defense against a destructive parasitic threat”; (2) I showed to all the lab members some of the results I collected during my PhD in Brazil based on the egg experiments manipulation “Do eggs act as alternative source of communication in *Mischocyttarus* wasps?”; (3) I showed to all the lab members some of the results I collected during my PhD in Brazil based on the learning and memory assays “You learn it and you learn it well: Cognitive abilities vary according to behavioural caste, age and sex in a primitively eusocial wasp”. I also had the chance to learn how the Team Wasp members collect and set up their experimental cages and provide wasp care. I learned how to dissect frozen brains, which can be used for estimating levels of biogenic amines through High Performance Liquid Chromatography (HPLC) system.

Overall conclusion of the internship and how the acquired knowledge will be applied in project

All the knowledge that I acquired under the guidance of Prof. Dr. Floria Mora-Kepfer Uy during my internship in the University of Rochester, especially regarding the computational skills, will be undoubtedly important for me to carry out with more quality the last batch of statistically analysis that I still have to conduct for my current PhD project. Besides that, the time that I spent dissecting the samples allowed me to improve my dissection skills and now I am able to deal with different types of tissues (frozen ones). Considering that I had the chance to give three different presentations while doing my internship allowed be to practice how to speak in public in another language and hence will contribute for my final PhD presentation. Additionally, the improvement of my English skills will help me in the process of writing my next manuscripts and also my thesis. All the data processed during my internship will allow us to prepare and submit a manuscript that will probably ended up being published in a high impact journal. Lastly, the computational skills that I acquired during my internship regarding how to process RNA-seq data will be extremely helpful for the upcoming steps of my career as a young scientist.

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2016 – 2018: **M.S Department of Biology**, Graduate Program in Entomology, University of São Paulo, BR

2012 – 2015: **Licenciate in Biological Sciences**, Faculdade de Filosofia, Ciências e Letras de Ituverava, FFCL, BR

Publications – Research papers

- 23) Prato, A., **da Silva, R. C.**, Oi, C. A., Turatti, I. C. C., & do Nascimento, F. S. (2022). Juvenile hormone regulates reproductive physiology and the production of fertility cues in the swarm-founding wasp *Polybia occidentalis*. *Chemoecology*, 1-10. <https://doi.org/10.1007/s00049-022-00376-6>
- 22) Prato, A., **da Silva, R. C.**, Mateus, S., & do Nascimento, F. S. (2022). A Technique for Transferring Nests of *Polybia* (Hymenoptera: Vespidae: Epiponini) Wasps in Anthropized Environment. *Sociobiology*, 69(2), e7620-e7620. <https://doi.org/10.13102/sociobiology.v69i2.7620>
- 21) **da Silva, R. C.**, Prato, A., Tannure-Nascimento, I., Oi, C. A., Wenseleers, T., & Nascimento, F. (2022). Cuticular hydrocarbons as caste-linked cues in Neotropical swarm-founding wasps. *PeerJ*, 10, e13571. <https://doi.org/10.7717/peerj.13571>
- 20) Ferreira*, H. M., **da Silva***, **R. C.**, do Nascimento, F. S., Wenseleers, T., & Oi, C. A. (2022). Reproduction and fertility signalling under joint juvenile hormone control in primitively eusocial *Mischocyttarus* wasps. *Chemoecology*, 1-12. <https://doi.org/10.1007/s00049-022-00370-y> (*) first authorship shared
- 19) Junqueira, C.N., Pereira, R.A.S., **da Silva, R.C.**, Alves Cardoso Kobal, R.O., Araújo, T.N., Prato, A., Pedrosa, J., Martínez-Martínez, C.A., Castrillon, K.P., Felício, D.T., Ferronato, P. & Augusto, S.C. (2021). Do *Apis* and non-*Apis* bees provide a similar contribution to crop production with different levels of pollination dependency? A review using meta-analysis. *Ecol Entomol.* 1 – 8. <https://doi.org/10.1111/een.13092>
- 18) Prato, A., **da Silva, R. C.**, Assis, D. S., Mateus, S., Hartfelder, K., & Nascimento, F. S. D. (2021). Juvenile hormone affects age polyethism, ovarian status, and cuticular hydrocarbon profile in workers of a *Polybia occidentalis* wasp. *J Exp Biol.* 224 (13): jeb240200. doi: <https://doi.org/10.1242/jeb.240200>
- 17) **da Silva, R.C.**, Van Meerbeeck, L., do Nascimento, F.S., Wenseleers, T. & Oi, C. A. (2021). Close-range cues used by males of *Polistes dominula* in sex discrimination. *Sci Nat.* 108 (15), 1 - 16. <https://doi.org/10.1007/s00114-021-01730-4>
- 16) dos Santos, J.P., Vieira, B.G., **da Silva, R.C.** & Nascimento, F. S. (2021) When is it necessary to avoid your enemies? A stingless bee ignores aggressive competitor cues to explore food sources. *Apidologie* 52, 801–812 (2021). <https://doi.org/10.1007/s13592-021-00866-6>
- 15) Oi, C.A., Ferreira, H.M., **da Silva, R.C.**, Bienstman, A., Nascimento, F.S., & Wenseleers, T. (2021). Effects of juvenile hormone in fertility and fertility-signaling in workers of the common wasp *Vespa vulgaris*. *PLoS One.* 16(5): e0250720. <https://doi.org/10.1371/journal.pone.0250720>

- 14) **da Silva, R.C.**, Brown, R.L., do Nascimento, F.S., Wenseleers, T. & Oi, C. A. (2021). Cuticular hydrocarbons as cues of caste and sex in the German wasp *Vespula germanica*. *Insect. Soc.* 68, 261–276. <https://doi.org/10.1007/s00040-021-00817-5>
- 13) de Souza, A. R., **Silva, R. C. D.**, Batista, N. R., Júnior, W. F. A. & Nascimento, F. S. D. (2021). Lack of caste discrimination by males during sexual context in a neotropical paper wasp. *Ethology*. 127: 613– 619. <https://doi.org/10.1111/eth.13155>
- 12) Oi, C. A., **da Silva, R. C.**, Stevens, I., Ferreira, H. M., Nascimento, F. S., & Wenseleers, T. (2021). Hormonal modulation of reproduction and fertility signaling in polistine wasps. *Curr Zool.* 67(5): 519 – 530. <https://doi.org/10.1093/cz/zoab026>
- 11) Oi, C. A., Brown, R. L., **da Silva, R. C.** & Wenseleers, T. (2020). Reproduction and signals regulating worker policing under identical hormonal control in social wasps. *Sci Rep.* 10(1): 1 - 10. <https://doi.org/10.1038/s41598-020-76084-4>
- 10) **da Silva, R. C.**, Prato, A., Oi, C. A., Turatti, I. C. C. & Nascimento, F. S. (2020). Dominance Hierarchy, Ovarian Activity and Cuticular Hydrocarbons in the Primitively Eusocial Wasp *Mischocyttarus cerberus* (Vespidae, Polistinae, Mischocyttarini). *J Chem Ecol.* 46, 835–844. <https://doi.org/10.1007/s10886-020-01206-1>
- 9) De Souza, A. R., **da Silva, R. C.**, Ferreira, R. P., Mateus, S., Prato, A., Oi, C. A., Noll, F. B. & Lino-Neto, J. (2020). Larval sex identification of in vivo and long-term ethanol-preserved social wasps. *Entomol Exp Appl.* 168: 710-714. <https://doi.org/10.1111/eea.12960>
- 8) **da Silva, R.C.**, Togni, O.C., Giannotti, E. & Nascimento, F. (2020). Cues of dominance hierarchy, fertility and nestmate recognition in the primitively eusocial wasp *Mischocyttarus parallelogrammus* (Vespidae: Polistinae: Mischocyttarini). *Chemoecology*. 30, 269–276 (2020). <https://doi.org/10.1007/s00049-020-00316-2>
- 7) de Souza, A. R., Baptista, C. F., Santos, E. F., **da Silva, R. C.**, da Silva Prato, A., Antonialli-Junior, W., Soares, E. R. P., Barbosa, B. C., Nascimento, F. S., & Lino-Neto, J. (2020). Morphological caste differences in primitively eusocial insects: the Van der Vecht organ of *Mischocyttarus* paper wasps. *Biol J Linn Soc.* 130(3): 545-554. <https://doi.org/10.1093/biolinnean/blaa067>
- 6) **da Silva, R. C.**, Assis, D. S., de Souza, A. R., Nascimento, F. S., & Giannotti, E. (2020). Notes on Brood Morphology and the Development of the Neotropical Eusocial Wasp *Mischocyttarus cerberus* (Hymenoptera, Vespidae, Polistinae). *Sociobiology*. 67(2): 301-307. <https://doi.org/10.13102/sociobiology.v67i2.4562>
- 5) **Silva, R. C. D.**, Silva, A. P. D., Assis, D. S., & Nascimento, F. S. (2019). The first record of the parasitoid wasp *Pachysomoides*, associated with *Mischocyttarus cerberus* nests and some insights about the parasitoid wasps behavior. *R. Bras. Zoo.* 20(1): 1 – 7. <https://doi.org/10.34019/2596-3325.2019.v20.24794>
- 4) **da Silva, R. C.**, da Silva, A. P., Assis, D. S., & Nascimento, F. S. (2019). Occurrence and nesting behavior of social wasps in an anthropized environment. *Sociobiology*, 66(2): 381–388. <https://doi.org/10.13102/sociobiology.v66i2.4303>
- 3) Miller, S. E., Bluher, S. E., Bell, E., Cini, A., **Silva, R. C.**, Souza, A. R., Gandia, K. M., Jandt, J., Loope, K., Prato, A., Pruitt, J. N., Rankin, D., Rankin, E., Southon, R. J., Uy, F. M. K., Weiner, S., Wright, C. M., Downing, H., Gadagkar, R., Cristina Lorenzi, M., Rusina, L., Sumner, S., Tibbetts, E. A., Toth, A., Sheehan, M. J. (2018). "WASPnest: a worldwide assessment of social Polistine nesting behavior." *Ecology* (10): 2405-2405. <https://doi.org/10.1002/ecy.2448>
- 2) de Souza, A.R., Barbosa, B.C., **da Silva, R.C.**, Prezoto, F., Lino-Neto, J. & Nascimento, F. S. (2017). No Evidence of Intersexual Kin Recognition by Males of the Neotropical Paper Wasp *Polistes versicolor* . *J Insect Behav.* 30, 180–187. <https://doi.org/10.1007/s10905-017-9609-1>
- 1) Fernandes, M. S., Filho, M. A. T. B., & **da Silva, R. C.** (2016). Análise de padrões térmicos relacionados aos ninhos de espuma de *Leptodactylus labyrinthicus* Spix, 1824. *Nucleus*, 13(1): 243 – 250. <https://doi.org/10.3738/1982.2278.1224>

Manuscripts accepted for publication 2022

- 1) **da Silva, R. C.**, Nascimento, F. S., Wenseleers, T., & Oi, C. A. Juvenile hormone modulates hydrocarbon expression and reproduction in the German wasp *Vespula germanica*. *In press* *Front. Ecol. Evol.*

Scholarships and Awards

2022) Latin American Travel Award to attend the 59th Annual Conference of the Animal Behavior Society in San José-CR (\$ 1000)

2022) IUSSI-SecBras – Virtual grant to attend the XIX International Congress of IUSSI in San Diego-EUA (\$ 200)

2022) FAPESP (2019/27552-0). Does parasitism drive differential neurogenomic expression in females and males of a *Polistes* paper wasp? Department of Biology, University of Rochester (\$ 5.672,00) – Internship conducted between 15 March – 31 May, under the supervision of Prof. Dr. Flória Mora-Kepfer Uy

2019-2022) FAPESP (2018/22461-3). Searching for the missing link: the eggs act as an alternative vehicle of communication in social systems? Departamento de Biologia, Universidade de São Paulo (\$ 35.938,64)

2019) FAPESP (2018/10996-0; 2018/22461-3). Hydrocarbon signatures of egg maternity and *Dufour's* gland in Vespine wasps. Zoological Institute, University of Leuven (\$ 1.424,80)

2018 – 2019) CAPES. Searching for the missing link: the eggs act as an alternative vehicle of communication in social systems? Departamento de Biologia, Universidade de São Paulo (\$ 1.959,10)

2016 – 2018) CAPES. Behavioural and eco-chemical dynamics of the primitively eusocial wasp *Mischocyttarus cerberus* (Vespidae, Polistinae, Mischocyttarini). Departamento de Biologia, Universidade de São Paulo (\$ 5.610,15)

2016) FAPESP (2016/08761-9). Relationship between hydrocarbons and castes in Neotropical social wasps (Hymenoptera, Vespidae, Polistinae). Departamento de Biologia, Universidade de São Paulo (\$ 809,57)

2015) CAPES. The use of didactic models in biology classes. Faculdade de Filosofia, Ciências e Letras de Ituverava, Ituverava, Brazil (\$ 854,88)

2014) CAPES. Evaluation of the use of conceptual maps in the transmission and learning of content in high school. Faculdade de Filosofia, Ciências e Letras de Ituverava, Ituverava, Brazil (\$ 854,88)

International experience

University of Rochester, New York, the United States of America (March – May 2022)

- Learn how to extract, prepare and analyze RNA data
- Project: Does parasitism drive differential neurogenomic expression in females and males of a *Polistes* paper wasp?

Supervisor: Prof. Dr. Flória Mora-Kepfer Uy

University of Leuven, Leuven, Belgium (July – October 2019)

- Field trip. Collection, and experimental manipulation of several Vespinae species.
- Project: Hydrocarbon signatures of egg maternity and *Dufour's* gland in Vespine wasps

Supervisors: Prof. Dr. Tom Wenseleers and Dr. Cintia Akemi Oi

SUPPLEMENTARY MATERIAL



Credit: The author

CHAPTER 3: Supplementary Material

Table S1: Post hoc Tukey test results based on the comparisons ran using samples of CHCs, eggs and *Dufour* gland in *Mischocyttarus metathoracicus*.

compound	contrast	estimate	SE	t.ratio	p value
C22	cuticular - <i>Dufour</i> gland	-4.752	0.302	-15.756	< 0.001
C22	cuticular - eggs	-2.839	0.346	-8.216	< 0.001
C22	<i>Dufour</i> gland - eggs	1.913	0.406	4.712	< 0.001
C23	cuticular - <i>Dufour</i> gland	-5.049	0.419	-12.060	< 0.001
C23	cuticular - eggs	-3.632	0.480	-7.572	< 0.001
C23	<i>Dufour</i> gland - eggs	1.417	0.564	2.514	1.000
C24	cuticular - <i>Dufour</i> gland	-5.186	0.312	-16.619	< 0.001
C24	cuticular - eggs	-3.253	0.358	-9.099	< 0.001
C24	<i>Dufour</i> gland - eggs	1.933	0.420	4.601	0.002
C25	cuticular - <i>Dufour</i> gland	-1.853	0.252	-7.352	< 0.001
C25	cuticular - eggs	-1.743	0.289	-6.037	< 0.001
C25	<i>Dufour</i> gland - eggs	0.110	0.339	0.324	1.000
C25:1	cuticular - <i>Dufour</i> gland	-2.277	0.219	-10.379	< 0.001
C25:1	cuticular - eggs	-0.644	0.251	-2.565	1.000
C25:1	<i>Dufour</i> gland - eggs	1.632	0.295	5.527	< 0.001
C26	cuticular - <i>Dufour</i> gland	-2.433	0.183	-13.279	< 0.001
C26	cuticular - eggs	-2.079	0.210	-9.901	< 0.001
C26	<i>Dufour</i> gland - eggs	0.355	0.247	1.438	1.000
C26:1	cuticular - <i>Dufour</i> gland	-1.187	0.176	-6.759	< 0.001
C26:1	cuticular - eggs	0.168	0.201	0.835	1.000
C26:1	<i>Dufour</i> gland - eggs	1.355	0.237	5.731	< 0.001
C27	cuticular - <i>Dufour</i> gland	-0.301	0.240	-1.255	1.000
C27	cuticular - eggs	-2.151	0.275	-7.827	< 0.001
C27	<i>Dufour</i> gland - eggs	-1.849	0.323	-5.728	< 0.001
C28	cuticular - <i>Dufour</i> gland	-2.859	0.234	-12.197	< 0.001
C28	cuticular - eggs	-2.737	0.269	-10.190	< 0.001
C28	<i>Dufour</i> gland - eggs	0.123	0.316	0.388	1.000
C29	cuticular - <i>Dufour</i> gland	-1.411	0.219	-6.436	< 0.001
C29	cuticular - eggs	-3.391	0.251	-13.506	< 0.001
C29	<i>Dufour</i> gland - eggs	-1.981	0.295	-6.712	< 0.001
C29:1	cuticular - <i>Dufour</i> gland	2.763	0.222	12.422	< 0.001
C29:1	cuticular - eggs	0.901	0.255	3.535	0.081
C29:1	<i>Dufour</i> gland - eggs	-1.862	0.299	-6.219	< 0.001
C30	cuticular - <i>Dufour</i> gland	-3.356	0.256	-13.119	< 0.001

C30	cuticular - eggs	-2.532	0.293	-8.639	< 0.001
C30	<i>Dufour</i> gland - eggs	0.824	0.344	2.393	1.000
C31	cuticular - <i>Dufour</i> gland	-2.209	0.300	-7.367	< 0.001
C31	cuticular - eggs	-3.255	0.344	-9.474	< 0.001
C31	<i>Dufour</i> gland - eggs	-1.046	0.404	-2.590	1.000
C31:1	cuticular - <i>Dufour</i> gland	-1.641	0.232	-7.058	< 0.001
C31:1	cuticular - eggs	-1.551	0.266	-5.823	< 0.001
C31:1	<i>Dufour</i> gland - eggs	0.090	0.313	0.287	1.000
Mixture + C27:1	cuticular - <i>Dufour</i> gland	3.275	0.377	8.684	< 0.001
Mixture + C27:1	cuticular - eggs	1.743	0.432	4.036	0.015
Mixture + C27:1	<i>Dufour</i> gland - eggs	-1.531	0.508	-3.016	0.406
Mixture 7-MeC29 + C30:1	cuticular - <i>Dufour</i> gland	-1.366	0.232	-5.898	< 0.001
Mixture 7-MeC29 + C30:1	cuticular - eggs	-1.183	0.265	-4.461	0.003
Mixture 7-MeC29 + C30:1	<i>Dufour</i> gland - eggs	0.182	0.312	0.584	1.000
unknown.1	cuticular - <i>Dufour</i> gland	-3.693	0.376	-9.820	< 0.001
unknown.1	cuticular - eggs	-2.105	0.431	-4.885	< 0.001
unknown.1	<i>Dufour</i> gland - eggs	1.588	0.506	3.137	0.283
unknown.2	cuticular - <i>Dufour</i> gland	-3.765	0.305	-12.345	< 0.001
unknown.2	cuticular - eggs	-2.857	0.349	-8.175	< 0.001
unknown.2	<i>Dufour</i> gland - eggs	0.908	0.411	2.213	1.000
unknown.3	cuticular - <i>Dufour</i> gland	-3.205	0.342	-9.377	< 0.001
unknown.3	cuticular - eggs	-2.047	0.392	-5.226	< 0.001
unknown.3	<i>Dufour</i> gland - eggs	1.159	0.460	2.518	1.000
unknown.4	cuticular - <i>Dufour</i> gland	-4.012	0.305	-13.159	< 0.001
unknown.4	cuticular - eggs	-2.817	0.349	-8.066	< 0.001
unknown.4	<i>Dufour</i> gland - eggs	1.195	0.410	2.911	0.552
unknown.5	cuticular - <i>Dufour</i> gland	-3.697	0.333	-11.093	< 0.001
unknown.5	cuticular - eggs	-1.969	0.382	-5.156	< 0.001
unknown.5	<i>Dufour</i> gland - eggs	1.728	0.449	3.852	0.028
unknown.6	cuticular - <i>Dufour</i> gland	-4.038	0.343	-11.764	< 0.001
unknown.6	cuticular - eggs	-2.726	0.393	-6.932	< 0.001
unknown.6	<i>Dufour</i> gland - eggs	1.312	0.462	2.839	0.676
unknown.7	cuticular - <i>Dufour</i> gland	-3.975	0.289	-13.777	< 0.001
unknown.7	cuticular - eggs	-4.898	0.331	-14.818	< 0.001
unknown.7	<i>Dufour</i> gland - eggs	-0.923	0.388	-2.376	1.000
unknown.9	cuticular - <i>Dufour</i> gland	-3.358	0.249	-13.461	< 0.001
unknown.9	cuticular - eggs	-3.973	0.286	-13.901	< 0.001
unknown.9	<i>Dufour</i> gland - eggs	-0.615	0.336	-1.831	1.000
unkown.8	cuticular - <i>Dufour</i> gland	-3.797	0.253	-15.037	< 0.001
unkown.8	cuticular - eggs	-3.628	0.289	-12.541	< 0.001

unkown.8	<i>Dufour</i> gland - eggs	0.169	0.340	0.497	1.000
x-MeC35	cuticular - <i>Dufour</i> gland	-4.347	0.233	-18.689	< 0.001
x-MeC35	cuticular - eggs	-3.445	0.266	-12.927	< 0.001
x-MeC35	<i>Dufour</i> gland - eggs	0.902	0.313	2.881	0.600
12-;10-MeC28	cuticular - <i>Dufour</i> gland	-7.402	0.414	-17.869	< 0.001
12-;10-MeC28	cuticular - eggs	-4.262	0.475	-8.980	< 0.001
12-;10-MeC28	<i>Dufour</i> gland - eggs	3.141	0.558	5.631	< 0.001
14-;12-MeC30	cuticular - <i>Dufour</i> gland	-3.343	0.363	-9.223	< 0.001
14-;12-MeC30	cuticular - eggs	-2.017	0.415	-4.858	< 0.001
14-;12-MeC30	<i>Dufour</i> gland - eggs	1.326	0.488	2.717	0.952
15-;13-;11-MeC29	cuticular - <i>Dufour</i> gland	-0.794	0.256	-3.101	0.316
15-;13-;11-MeC29	cuticular - eggs	-1.079	0.293	-3.678	0.051
15-;13-;11-MeC29	<i>Dufour</i> gland - eggs	-0.285	0.345	-0.827	1.000
15-;13-;11-MeC33	cuticular - <i>Dufour</i> gland	-2.336	0.336	-6.960	< 0.001
15-;13-;11-MeC33	cuticular - eggs	-1.533	0.385	-3.988	0.018
15-;13-;11-MeC33	<i>Dufour</i> gland - eggs	0.803	0.452	1.776	1.000
15-;13-MeC31	cuticular - <i>Dufour</i> gland	-1.073	0.366	-2.932	0.519
15-;13-MeC31	cuticular - eggs	-1.264	0.419	-3.016	0.406
15-;13-MeC31	<i>Dufour</i> gland - eggs	-0.191	0.493	-0.389	1.000
3-MeC27	cuticular - <i>Dufour</i> gland	0.824	0.286	2.878	0.605
3-MeC27	cuticular - eggs	-0.321	0.328	-0.979	1.000
3-MeC27	<i>Dufour</i> gland - eggs	-1.144	0.385	-2.971	0.463
3-MeC29	cuticular - <i>Dufour</i> gland	-0.556	0.150	-3.701	0.047
3-MeC29	cuticular - eggs	-1.690	0.172	-9.823	< 0.001
3-MeC29	<i>Dufour</i> gland - eggs	-1.134	0.202	-5.610	< 0.001
4-MeC26	cuticular - <i>Dufour</i> gland	-1.776	0.205	-8.648	< 0.001
4-MeC26	cuticular - eggs	-0.734	0.235	-3.121	0.297
4-MeC26	<i>Dufour</i> gland - eggs	1.042	0.277	3.768	0.037
4-MeC28	cuticular - <i>Dufour</i> gland	-2.880	0.212	-13.609	< 0.001
4-MeC28	cuticular - eggs	-1.683	0.242	-6.940	< 0.001
4-MeC28	<i>Dufour</i> gland - eggs	1.198	0.285	4.203	0.008
5-MeC27	cuticular - <i>Dufour</i> gland	-1.233	0.215	-5.734	< 0.001
5-MeC27	cuticular - eggs	-0.559	0.246	-2.269	1.000
5-MeC27	<i>Dufour</i> gland - eggs	0.674	0.290	2.329	1.000
7-MeC25	cuticular - <i>Dufour</i> gland	-2.097	0.264	-7.940	< 0.001
7-MeC25	cuticular - eggs	-0.869	0.302	-2.873	0.614
7-MeC25	<i>Dufour</i> gland - eggs	1.227	0.355	3.453	0.106
7-MeC27	cuticular - <i>Dufour</i> gland	-0.075	0.265	-0.283	1.000
7-MeC27	cuticular - eggs	0.050	0.304	0.164	1.000
7-MeC27	<i>Dufour</i> gland - eggs	0.125	0.357	0.350	1.000

Table S2: List of all compounds identified in the *Mischocyttarus metathoracicus* samples (CHCs, eggs and *Dufour* gland). RT = retention time, startRT = moment in which the peak started being detected, stopRT = moment in which the peak finished being detected and RI = retention index.

peaknr	RT	startRT	stopRT	RI	compound	ions
1	18.86	18.79	19.05	2200	C22	310
2	19.96	19.86	20.08	2300	C23	324
3	21.03	20.88	21.22	2400	C24	338
4	21.83	21.75	21.87	2471	C25:1	350
5	22.08	21.99	22.38	2500	C25	352
6	22.52	22.38	22.62	2535	7-MeC25	113, 280/281
7	22.90	22.81	23.05	2570	C26:1	364
8	23.17	23.06	23.28	2600	C26	366
9	23.83	23.74	23.91	2654	4-MeC26	71 / 337
10	24.08	23.91	24.19	2677	mix - C27:1	378
11	24.30	24.20	24.59	2700	C27	380
12	24.76	24.59	24.82	2736	7-MeC27	113 / 309
13	24.86	24.82	25.01	2745	5-MeC27	85 / 337
14	25.14	25.01	25.35	2770	3-MeC27	57 / 365
15	25.44	25.35	25.68	2800	C28	weak
16	25.84	25.68	26.04	2832	12-10-MeC28	155/183,253
17	26.12	26.04	26.22	2856	4-MeC28	71 / 365
18	26.35	26.22	26.51	2876	C29:1	406
19	26.60	26.51	26.89	2900	C29	weak
20	26.98	26.89	27.06	2931	15-13-11-MeC29	169,281/197,253/225
21	27.07	27.06	27.18	2939	7-MeC29 + alkene	113 / 337
22	27.47	27.27	27.67	2974	3-MeC29	57 / 393
23	27.77	27.67	28.02	3000	C30	422
24	28.13	28.02	28.24	3032	14-12-MeC30	210,x/183,y
25	28.70	28.48	28.80	3082	C31:1	435
26	28.92	28.80	29.15	3100	C31	436
27	29.28	29.15	29.37	3133	15-13-MeC31	197,281/225,253
28	31.17	31.04	31.34	3301	unkown_1	-
29	31.52	31.34	31.73	3334	15-13-11-MeC33	169,337/197,309/225,281
30	31.87	31.73	32.15	3366	unkown_2	-
31	32.28	32.16	32.60	3403	unkown_3	-
32	33.33	33.06	33.50	3501	unkown_4	-
33	33.65	33.50	33.72	3531	x-MeC35	492
34	34.38	34.29	34.48	3600	unkown_5	-
35	35.42	35.22	35.50	3700	unkown_6	-

36	36.43	36.30	36.54	3799	unkown_7	-
37	38.39	38.27	38.48	3990	unkown_8	-
38	41.79	41.68	41.98	4319	unkown_9	-
39	43.88	43.74	44.20	4520	unkown_10	-

Table S3: Post hoc Tukey test results based on the comparisons ran using samples of CHCs, eggs and *Dufour* gland in *Polistes versicolor*.

compound	contrast	estimate	SE	t.ratio	p value
C23:1-1	cuticular - <i>Dufour</i> gland	-1.950	0.364	-5.353	< 0.001
C23:1-1	cuticular - eggs	9.672	0.440	21.975	< 0.001
C23:1-1	<i>Dufour</i> gland - eggs	11.622	0.442	26.299	< 0.001
C23:1-2	cuticular - <i>Dufour</i> gland	-1.703	0.256	-6.653	< 0.001
C23:1-2	cuticular - eggs	9.364	0.309	30.275	< 0.001
C23:1-2	<i>Dufour</i> gland - eggs	11.067	0.311	35.638	< 0.001
C25:1	cuticular - <i>Dufour</i> gland	-11.292	0.201	-56.317	< 0.001
C25:1	cuticular - eggs	0.000	0.242	0.000	1.000
C25:1	<i>Dufour</i> gland - eggs	11.292	0.243	46.423	< 0.001
C27:1	cuticular - <i>Dufour</i> gland	-11.100	0.198	-56.054	< 0.001
C27:1	cuticular - eggs	0.000	0.239	0.000	1.000
C27:1	<i>Dufour</i> gland - eggs	11.100	0.240	46.207	< 0.001
C29:1	cuticular - <i>Dufour</i> gland	12.868	0.148	87.233	< 0.001
C29:1	cuticular - eggs	12.868	0.178	72.197	< 0.001
C29:1	<i>Dufour</i> gland - eggs	0.000	0.179	0.000	1.000
C31:1	cuticular - <i>Dufour</i> gland	14.673	0.105	139.442	< 0.001
C31:1	cuticular - eggs	14.673	0.127	115.407	< 0.001
C31:1	<i>Dufour</i> gland - eggs	0.000	0.128	0.000	1.000
C33:1	cuticular - <i>Dufour</i> gland	11.522	0.075	154.291	< 0.001
C33:1	cuticular - eggs	11.522	0.090	127.697	< 0.001
C33:1	<i>Dufour</i> gland - eggs	0.000	0.091	0.000	1.000
Methyl alkene C29	cuticular - <i>Dufour</i> gland	1.260	0.170	7.428	< 0.001
Methyl alkene C29	cuticular - eggs	14.546	0.205	70.989	< 0.001
Methyl alkene C29	<i>Dufour</i> gland - eggs	13.287	0.206	64.582	< 0.001
Methyl alkene C33 + 17-;15-;13-MeC33	cuticular - <i>Dufour</i> gland	17.403	0.042	416.627	< 0.001
Methyl alkene C33 + 17-;15-;13-MeC33	cuticular - eggs	17.403	0.050	344.816	< 0.001
Methyl alkene C33 + 17-;15-;13-MeC33	<i>Dufour</i> gland - eggs	0.000	0.051	0.000	1.000
Methyl alkene C31 + 15-;13-;11-;9-;7-MeC31	cuticular - <i>Dufour</i> gland	0.917	0.163	5.622	< 0.001
Methyl alkene C31 + 15-;13-;11-;9-;7-MeC31	cuticular - eggs	0.123	0.197	0.624	1.000
Methyl alkene C31 + 15-;13-;11-;9-;7-MeC31	<i>Dufour</i> gland - eggs	-0.794	0.198	-4.013	0.019
Methyl alkene C33 - 2	cuticular - <i>Dufour</i> gland	-14.602	0.224	-65.116	< 0.001

Methyl alkene C33 - 2	cuticular - eggs	0.000	0.271	0.000	1.000
Methyl alkene C33 - 2	<i>Dufour</i> gland - eggs	14.602	0.272	53.676	< 0.001
C19	cuticular - <i>Dufour</i> gland	7.829	0.110	71.165	< 0.001
C19	cuticular - eggs	7.829	0.133	58.899	< 0.001
C19	<i>Dufour</i> gland - eggs	0.000	0.133	0.000	1.000
C20	cuticular - <i>Dufour</i> gland	-2.780	0.240	-11.603	< 0.001
C20	cuticular - eggs	-3.504	0.289	-12.106	< 0.001
C20	<i>Dufour</i> gland - eggs	-0.725	0.291	-2.494	1.000
C21	cuticular - <i>Dufour</i> gland	-2.322	0.252	-9.222	< 0.001
C21	cuticular - eggs	-3.219	0.304	-10.581	< 0.001
C21	<i>Dufour</i> gland - eggs	-0.897	0.305	-2.937	0.686
C22	cuticular - <i>Dufour</i> gland	-2.221	0.244	-9.101	< 0.001
C22	cuticular - eggs	-2.959	0.295	-10.037	< 0.001
C22	<i>Dufour</i> gland - eggs	-0.738	0.296	-2.494	1.000
C23	cuticular - <i>Dufour</i> gland	-1.289	0.439	-2.936	0.688
C23	cuticular - eggs	-0.300	0.531	-0.565	1.000
C23	<i>Dufour</i> gland - eggs	0.989	0.533	1.857	1.000
C24	cuticular - <i>Dufour</i> gland	-2.989	0.236	-12.670	< 0.001
C24	cuticular - eggs	-3.110	0.285	-10.911	< 0.001
C24	<i>Dufour</i> gland - eggs	-0.121	0.286	-0.423	1.000
C25	cuticular - <i>Dufour</i> gland	-1.893	0.262	-7.230	< 0.001
C25	cuticular - eggs	-1.563	0.316	-4.941	< 0.001
C25	<i>Dufour</i> gland - eggs	0.330	0.318	1.039	1.000
C26	cuticular - <i>Dufour</i> gland	-3.079	0.212	-14.552	< 0.001
C26	cuticular - eggs	-3.125	0.256	-12.222	< 0.001
C26	<i>Dufour</i> gland - eggs	-0.046	0.257	-0.177	1.000
C27	cuticular - <i>Dufour</i> gland	-0.869	0.275	-3.164	0.343
C27	cuticular - eggs	-2.195	0.332	-6.618	< 0.001
C27	<i>Dufour</i> gland - eggs	-1.327	0.333	-3.983	0.021
C28	cuticular - <i>Dufour</i> gland	-0.893	0.132	-6.781	< 0.001
C28	cuticular - eggs	-1.338	0.159	-8.411	< 0.001
C28	<i>Dufour</i> gland - eggs	-0.445	0.160	-2.787	1.000
C29	cuticular - <i>Dufour</i> gland	0.226	0.206	1.093	1.000
C29	cuticular - eggs	-1.275	0.249	-5.110	< 0.001
C29	<i>Dufour</i> gland - eggs	-1.500	0.250	-5.991	< 0.001
C30	cuticular - <i>Dufour</i> gland	-0.322	0.144	-2.229	1.000
C30	cuticular - eggs	-1.093	0.174	-6.264	< 0.001
C30	<i>Dufour</i> gland - eggs	-0.771	0.175	-4.401	0.004
C31	cuticular - <i>Dufour</i> gland	0.695	0.185	3.753	0.048
C31	cuticular - eggs	-1.121	0.224	-5.009	< 0.001

C31	<i>Dufour</i> gland - eggs	-1.816	0.225	-8.082	< 0.001
C32	cuticular - <i>Dufour</i> gland	-1.947	0.182	-10.674	< 0.001
C32	cuticular - eggs	-0.073	0.220	-0.330	1.000
C32	<i>Dufour</i> gland - eggs	1.874	0.221	8.470	< 0.001
C33	cuticular - <i>Dufour</i> gland	0.055	0.286	0.193	1.000
C33	cuticular - eggs	-1.140	0.345	-3.302	0.221
C33	<i>Dufour</i> gland - eggs	-1.195	0.347	-3.447	0.137
C34	cuticular - <i>Dufour</i> gland	14.909	0.144	103.669	< 0.001
C34	cuticular - eggs	14.909	0.174	85.800	< 0.001
C34	<i>Dufour</i> gland - eggs	0.000	0.174	0.000	1.000
13-;11-;9-MeC27	cuticular - <i>Dufour</i> gland	-1.805	0.233	-7.735	< 0.001
13-;11-;9-MeC27	cuticular - eggs	-2.180	0.282	-7.732	< 0.001
13-;11-;9-MeC27	<i>Dufour</i> gland - eggs	-0.375	0.283	-1.325	1.000
13-;11-MeC25	cuticular - <i>Dufour</i> gland	-1.749	0.241	-7.259	< 0.001
13-;11-MeC25	cuticular - eggs	8.817	0.291	30.279	< 0.001
13-;11-MeC25	<i>Dufour</i> gland - eggs	10.566	0.292	36.142	< 0.001
13-;12-MeC26	cuticular - <i>Dufour</i> gland	-11.355	0.148	-76.914	< 0.001
13-;12-MeC26	cuticular - eggs	0.000	0.178	0.000	1.000
13-;12-MeC26	<i>Dufour</i> gland - eggs	11.355	0.179	63.402	< 0.001
13,17-;11,17-;11,15-diMeC27	cuticular - <i>Dufour</i> gland	-10.284	0.292	-35.216	< 0.001
13,17-;11,17-;11,15-diMeC27	cuticular - eggs	0.000	0.353	0.000	1.000
13,17-;11,17-;11,15-diMeC27	<i>Dufour</i> gland - eggs	10.284	0.354	29.029	< 0.001
13,17-diMeC31	cuticular - <i>Dufour</i> gland	0.124	0.171	0.722	1.000
13,17-diMeC31	cuticular - eggs	14.560	0.207	70.331	< 0.001
13,17-diMeC31	<i>Dufour</i> gland - eggs	14.436	0.208	69.454	< 0.001
13,19-;13,21-diMeC33	cuticular - <i>Dufour</i> gland	-0.380	0.154	-2.474	1.000
13,19-;13,21-diMeC33	cuticular - eggs	15.056	0.186	81.060	< 0.001
13,19-;13,21-diMeC33	<i>Dufour</i> gland - eggs	15.437	0.186	82.774	< 0.001
13,19-;13,17-diMeC35	cuticular - <i>Dufour</i> gland	-13.271	0.157	-84.532	< 0.001
13,19-;13,17-diMeC35	cuticular - eggs	0.000	0.190	0.000	1.000
13,19-;13,17-diMeC35	<i>Dufour</i> gland - eggs	13.271	0.190	69.681	< 0.001
14-;13-;12-MeC28	cuticular - <i>Dufour</i> gland	-12.572	0.163	-76.917	< 0.001
14-;13-;12-MeC28	cuticular - eggs	0.000	0.197	0.000	1.000
14-;13-;12-MeC28	<i>Dufour</i> gland - eggs	12.572	0.198	63.405	< 0.001
15-;13-;11-;9-MeC29	cuticular - <i>Dufour</i> gland	0.292	0.216	1.350	1.000
15-;13-;11-;9-MeC29	cuticular - eggs	-1.059	0.261	-4.057	0.016
15-;13-;11-;9-MeC29	<i>Dufour</i> gland - eggs	-1.351	0.262	-5.154	< 0.001
15-;14-;13-;12-MeC30	cuticular - <i>Dufour</i> gland	0.491	0.172	2.859	0.862
15-;14-;13-;12-MeC30	cuticular - eggs	13.616	0.207	65.621	< 0.001
15-;14-;13-;12-MeC30	<i>Dufour</i> gland - eggs	13.125	0.208	63.001	< 0.001

16-;14-MeC32	cuticular - <i>Dufour</i> gland	0.619	0.173	3.584	0.087
16-;14-MeC32	cuticular - eggs	1.165	0.209	5.584	< 0.001
16-;14-MeC32	<i>Dufour</i> gland - eggs	0.546	0.210	2.607	1.000
17-;15-;13-MeC33	cuticular - <i>Dufour</i> gland	-16.028	0.124	-129.467	< 0.001
17-;15-;13-MeC33	cuticular - eggs	-16.194	0.150	-108.259	< 0.001
17-;15-;13-MeC33	<i>Dufour</i> gland - eggs	-0.166	0.150	-1.103	1.000
17-;15-MeC35	cuticular - <i>Dufour</i> gland	0.443	0.146	3.029	0.521
17-;15-MeC35	cuticular - eggs	14.995	0.177	84.858	< 0.001
17-;15-MeC35	<i>Dufour</i> gland - eggs	14.552	0.177	82.022	< 0.001
17-;16-;14-MeC34	cuticular - <i>Dufour</i> gland	0.037	0.268	0.137	1.000
17-;16-;14-MeC34	cuticular - eggs	13.882	0.324	42.826	< 0.001
17-;16-;14-MeC34	<i>Dufour</i> gland - eggs	13.845	0.325	42.541	< 0.001
19-;17-;15-MeC37	cuticular - <i>Dufour</i> gland	-0.155	0.186	-0.835	1.000
19-;17-;15-MeC37	cuticular - eggs	14.114	0.224	62.898	< 0.001
19-;17-;15-MeC37	<i>Dufour</i> gland - eggs	14.270	0.225	63.335	< 0.001
3-MeC25	cuticular - <i>Dufour</i> gland	-1.546	0.244	-6.337	< 0.001
3-MeC25	cuticular - eggs	9.848	0.295	33.397	< 0.001
3-MeC25	<i>Dufour</i> gland - eggs	11.394	0.296	38.487	< 0.001
3-MeC27	cuticular - <i>Dufour</i> gland	-0.655	0.134	-4.894	< 0.001
3-MeC27	cuticular - eggs	-1.470	0.162	-9.095	< 0.001
3-MeC27	<i>Dufour</i> gland - eggs	-0.815	0.162	-5.024	< 0.001
3-MeC28	cuticular - <i>Dufour</i> gland	-13.170	0.165	-79.829	< 0.001
3-MeC28	cuticular - eggs	-12.238	0.199	-61.393	< 0.001
3-MeC28	<i>Dufour</i> gland - eggs	0.932	0.200	4.657	0.002
3-MeC29	cuticular - <i>Dufour</i> gland	16.188	0.061	266.703	< 0.001
3-MeC29	cuticular - eggs	16.188	0.073	220.733	< 0.001
3-MeC29	<i>Dufour</i> gland - eggs	0.000	0.074	0.000	1.000
3-MeC29 + 5,15-diMeC29	cuticular - <i>Dufour</i> gland	-15.975	0.120	-133.631	< 0.001
3-MeC29 + 5,15-diMeC29	cuticular - eggs	-17.029	0.144	-117.893	< 0.001
3-MeC29 + 5,15-diMeC29	<i>Dufour</i> gland - eggs	-1.054	0.145	-7.266	< 0.001
4-MeC28	cuticular - <i>Dufour</i> gland	-1.088	0.229	-4.756	0.001
4-MeC28	cuticular - eggs	-0.895	0.276	-3.240	0.270
4-MeC28	<i>Dufour</i> gland - eggs	0.192	0.277	0.693	1.000
4-MeC30	cuticular - <i>Dufour</i> gland	12.063	0.132	91.673	< 0.001
4-MeC30	cuticular - eggs	-0.583	0.159	-3.664	0.066
4-MeC30	<i>Dufour</i> gland - eggs	-12.646	0.160	-79.217	< 0.001
4,x-diMeC28	cuticular - <i>Dufour</i> gland	-10.012	0.233	-43.060	< 0.001
4,x-diMeC28	cuticular - eggs	0.000	0.281	0.000	1.000
4,x-diMeC28	<i>Dufour</i> gland - eggs	10.012	0.282	35.495	< 0.001
5-MeC27	cuticular - <i>Dufour</i> gland	-11.368	0.139	-81.620	< 0.001

5-MeC27	cuticular - eggs	-11.074	0.168	-65.802	< 0.001
5-MeC27	<i>Dufour</i> gland - eggs	0.294	0.169	1.743	1.000
5-MeC29 + 13,17-;11,17-;11,15-diMeC29	cuticular - <i>Dufour</i> gland	-13.791	0.209	-66.050	< 0.001
5-MeC29 + 13,17-;11,17-;11,15-diMeC29	cuticular - eggs	-12.910	0.252	-51.172	< 0.001
5-MeC29 + 13,17-;11,17-;11,15-diMeC29	<i>Dufour</i> gland - eggs	0.881	0.253	3.479	0.124
5,MeC29 + Alkadiene C30	cuticular - <i>Dufour</i> gland	13.951	0.106	131.464	< 0.001
5,MeC29 + Alkadiene C30	cuticular - eggs	13.951	0.128	108.804	< 0.001
5,MeC29 + Alkadiene C30	<i>Dufour</i> gland - eggs	0.000	0.129	0.000	1.000
5-MeC31	cuticular - <i>Dufour</i> gland	0.000	0.043	0.000	1.000
5-MeC31	cuticular - eggs	-14.732	0.052	-285.387	< 0.001
5-MeC31	<i>Dufour</i> gland - eggs	-14.732	0.052	-284.244	< 0.001
7-MeC29	cuticular - <i>Dufour</i> gland	13.072	0.101	129.553	< 0.001
7-MeC29	cuticular - eggs	1.134	0.122	9.298	< 0.001
7-MeC29	<i>Dufour</i> gland - eggs	-11.938	0.122	-97.533	< 0.001
9,19-diMeC31 + 3-MeC31	cuticular - <i>Dufour</i> gland	15.555	0.075	207.027	< 0.001
9,19-diMeC31 + 3-MeC31	cuticular - eggs	-0.292	0.091	-3.220	0.288
9,19-diMeC31 + 3-MeC31	<i>Dufour</i> gland - eggs	-15.848	0.091	-173.863	< 0.001

Table S4: List of all compounds identified in the *Polistes versicolor* samples (CHCs, eggs and *Dufour* gland). RT = retention time, startRT = moment in which the peak started being detected, stopRT = moment in which the peak finished being detected and RI = retention index.

peaknr	RT	startRT	stopRT	RI	compound	ions
1	15.485	15.355	15.535	1900	n-C19	268
2	16.575	16.515	16.635	2000	n-C20	282
3	17.685	17.600	17.720	2100	n-C21	296
4	18.790	18.725	18.900	2200	n-C22	310
5	19.555	19.415	19.595	2269	C23:1-1	322
6	19.625	19.600	19.705	2276	C23:1-2	322
7	19.880	19.800	19.960	2300	n-C23	324
8	20.960	20.795	21.005	2400	n-C24	338
9	21.725	21.610	21.785	2470	C25:1	350
10	22.045	21.970	22.225	2500	n-C25	352
11	22.435	22.365	22.495	2535	13-;11-MeC25	197/169/225
12	22.860	22.770	22.935	2573	3-MeC25	57/337
13	23.155	23.085	23.220	2600	n-C26	366
14	23.500	23.430	23.575	2630	13-;12-MeC26	197/210/183/225
15	23.980	23.910	24.115	2672	C27:1	378
16	24.290	24.100	24.380	2700	n-C27	380
17	24.670	24.615	24.725	2733	13-;11-;9-MeC27	197/225/169/253/141/281
18	24.855	24.810	24.950	2749	5-MeC27	85 / 337
19	25.015	24.940	25.075	2763	13,17-;11,17-;11,15-diMeC27	197/267/169/239
20	25.140	25.055	25.310	2774	3-MeC27	57/365

21	25.430	25.310	25.505	2800	n-C28	394
22	25.825	25.680	25.955	2833	14-;13-;12-MeC28	210/225/197/239/183/253
23	26.110	26.050	26.180	2857	4-MeC28	71/365
24	26.270	26.190	26.415	2871	3-MeC28	57/379
25	26.280	26.185	26.365	2872	C29:1	406
26	26.475	26.385	26.505	2888	4,x-diMeC28	71/225
27	26.610	26.500	26.720	2900	n-C29	408
28	26.885	26.725	26.925	2924	methyl-alkene C29	-
29	26.980	26.930	27.045	2932	15-;13-;11-;9-MeC29	225/197/253/169/281/141/309
30	27.080	27.050	27.145	2941	7-MeC29	113/337
31	27.255	27.150	27.355	2956	5-MeC29 + alkadiene C30	85/365 + 418
32	27.275	27.155	27.380	2958	5-MeC29 + 13,17-;11,17-;11,15-diMeC29	85/365 + 197/267/169/239/225/295
33	27.475	27.380	27.690	2975	3-MeC29 + 5,15-diMeC29	57/393 + 85/239/225/379
34	27.480	27.355	27.690	2976	3-MeC29	57/393
35	27.755	27.695	27.815	3000	n-C30	422
36	28.115	27.940	28.300	3031	15-;14-;13-;12-MeC30	225/239/210/253/197/267/183/281
37	28.435	28.300	28.490	3058	4-MeC30	71/253
38	28.615	28.490	28.700	3074	C31:1	434
39	28.910	28.830	29.005	3100	n-C31	436
40	29.300	29.055	29.470	3133	methyl-alkene C31 + 15-;13-;11-;9-7-MeC31	448 + 225/253/197/281/169/309/140/337/113/365
41	29.540	29.410	29.640	3154	5-MeC31	85/393
42	29.570	29.470	29.645	3157	13,17-diMeC31	197/267/225/295
43	29.770	29.650	30.020	3174	9,19-diMeC31 + 3-MeC31	141/197/295/351 + 57/421
44	30.110	30.020	30.190	3200	n-C32	450
45	30.390	30.195	30.560	3226	16-;14-MeC32	239/253/210/281
46	30.885	30.830	30.975	3272	C33:1	462
47	31.175	31.100	31.245	3300	n-C33	464
48	31.405	31.255	31.445	3323	methyl-alkene C33 - 2	476
49	31.475	31.395	31.585	3330	17-;15-;13-MeC33	253/225/281/197/309
50	31.525	31.245	31.720	3335	methyl-alkene C33 + 17-;15-;13-MeC33	476 + 253/225/281/197/309
51	31.810	31.725	31.945	3364	13,19-; 13,21-diMeC33	197/225/295/323
52	32.155	31.950	32.290	3400	n-C34	478
53	32.575	32.395	32.780	3437	17-;16-;14-MeC34	253/267/239/281/210/309
54	33.675	33.460	33.820	3536	17-;15-MeC35	253/281/225/309
55	33.930	33.805	34.015	3559	13,19-;13,17-diMeC35	197/295/253/351/281/267
56	35.775	35.605	35.925	3726	19-;17-;15-MeC37	281/253/309/225/337

CHAPTER 4: Supplementary material

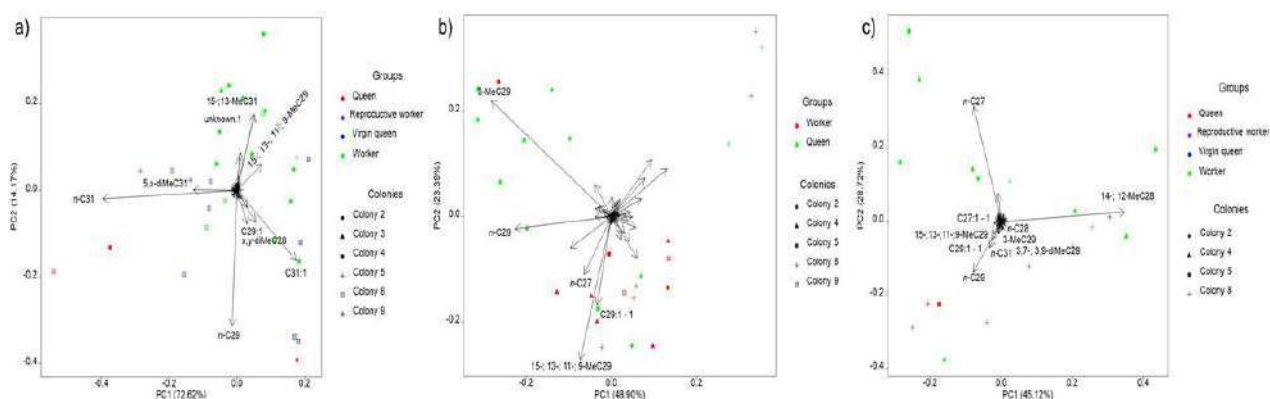


Figure S1: Principal components analysis (PCA) showing groups distribution of the three different sources for *Dolichovespula saxonica*. 1a) Cuticular hydrocarbons; 1b) Eggs; 1c) Dufour gland. Chemical compounds in evidence represent the most important for group separation according to the SIMPER results. The symbols indicate the origin of the colonies and colors correspond to castes. On the x-axis is shown principal component 1 (PC1), whereas the y-axis corresponds to principal component 2 (PC2).

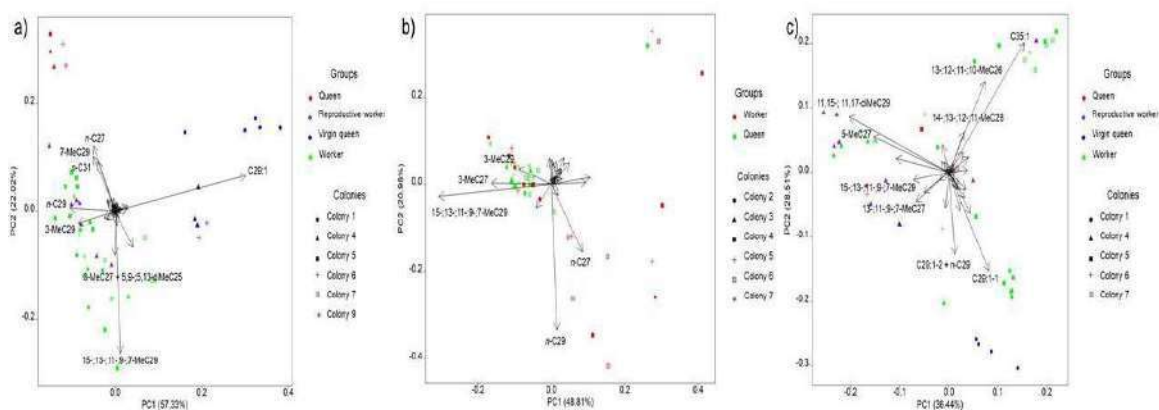


Figure S2: Principal components analysis (PCA) showing groups distribution of the three different sources for *Dolichovespula media*. 2a) Cuticular hydrocarbons; 2b) Eggs; 2c) Dufour gland. Chemical compounds in evidence represent the most important for group separation according to SIMPER result. The symbols indicate the origin of the colonies and colors correspond to castes. On the x-axis is shown principal component 1 (PC1), whereas the y-axis corresponds to principal component 2 (PC2).

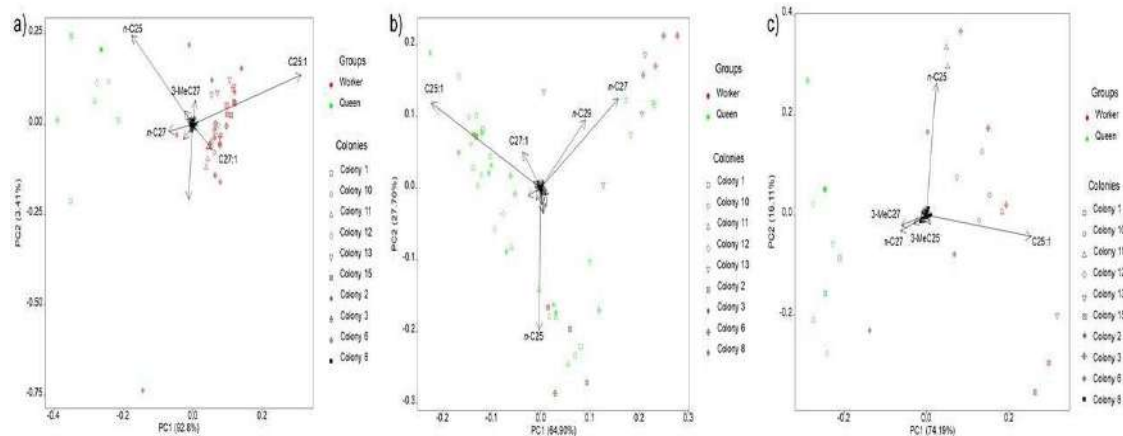


Figure S3: Principal components analysis (PCA) showing groups distribution of the three different sources for *Vespa crabro*. 3a) Cuticular hydrocarbons; 3b) Eggs; 3c) Dufour gland. Chemical compounds in evidence represent the most important for group separation according to the SIMPER result. The symbols indicate the origin of the colonies and colors correspond to castes. On the x-axis is shown principal component 1 (PC1), whereas the y-axis corresponds to principal component 2 (PC2).

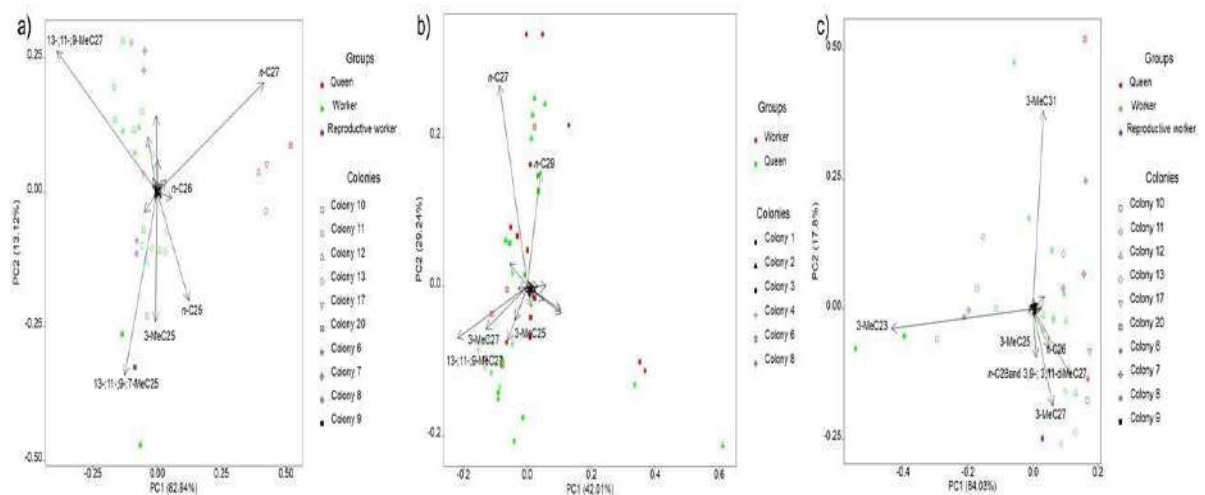


Figure S4: Principal components analysis (PCA) showing groups distribution of the three different sources for *Vespula germanica*. Chemical compounds in evidence represent the most important for group separation according to the SIMPER result. The symbols indicate the origin of the colonies and colors correspond to castes. On the x-axis is shown principal component 1 (PC1), whereas the y-axis corresponds to principal component 2 (PC2).

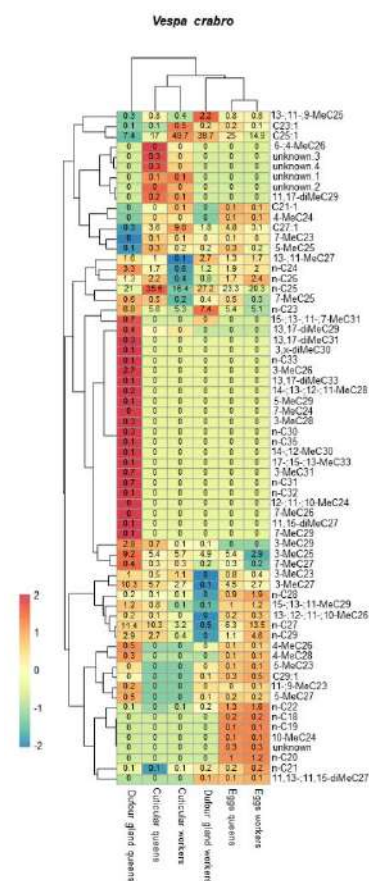


Figure S5: Heatmaps representing the differences in relative abundance of compounds (log-transformed) in the chemical profile of the cuticle (CHCs), egg surface (eggs) and in *Dufour's* gland (DG) secretion *Vespa crabro*. Colours represent the mean fold difference in relative abundance of each hydrocarbon found for each of the three groups of samples. Compounds were clustered based on a UPGMA clustering using Euclidean distance as the distance metric. We did not have CHCs and *Dufour's* gland samples for reproductive workers, so we performed the heatmap using CHCs and *Dufour's* gland samples from non-reproducing workers.

Table S1: Identified cuticular hydrocarbons of *Dolichovespula saxonica*. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons

Dolichovespula saxonica - CHCs												
#	RT	RI	Compounds	Diagnostic ions	queens		virgin queens		reproductive workers		workers	
					mean	SD	mean	SD	mean	SD	mean	SD
1	19.97	2300	n-C23	324	0.005	0.006	0.013	0.005	0.000	0.000	0.023	0.087
2	20.33	2334	7-MeC23	113/253	0.023	0.013	0.030	0.027	0.004	0.005	0.028	0.078
3	20.50	2350	unknown-1	-	0.058	0.025	0.133	0.139	0.034	0.015	0.082	0.115
4	20.74	2371	3-MeC23	57/309	0.000	0.000	0.003	0.005	0.000	0.000	0.002	0.007
5	20.98	2400	n-C24	338	0.008	0.005	0.018	0.010	0.000	0.000	0.010	0.019
6	21.09	2405	3,7-diMeC23	57/127/253/323	0.000	0.000	0.003	0.005	0.000	0.000	0.002	0.005
7	21.39	2433	8-MeC24	127/253	0.000	0.000	0.003	0.005	0.000	0.000	0.004	0.008
8	21.60	2453	C25:1	350	0.695	0.804	1.178	0.548	0.338	0.160	0.686	0.448
9	22.08	2498	n-C25	352	0.075	0.021	0.108	0.026	0.148	0.045	0.457	0.331
10	22.46	2532	13-; 11-; 9-; 7-MeC25	197/169/225/141/253/113/281	0.020	0.008	0.035	0.006	0.026	0.005	0.059	0.034
11	22.59	2544	5-MeC25	85/309	0.000	0.000	0.003	0.005	0.000	0.000	0.001	0.002

12	22.87	2570	3-MeC25	57/337	0.095	0.044	0.193	0.140	0.094	0.015	0.156	0.081
13	22.99	2581	5,9-diMeC25	85/155/253/323	0.058	0.013	0.078	0.031	0.112	0.013	0.128	0.052
14	23.10	2600	n-C26	366	0.000	0.000	0.003	0.005	0.000	0.000	0.000	0.000
15	23.22	2602	3,7-; 3,9-diMeC25	57/127/281/351/253/155	0.060	0.016	0.075	0.017	0.074	0.018	0.132	0.077
16	23.44	2622	12-; 11-; 10-MeC26	183/225/169/239/155/253	0.020	0.008	0.018	0.005	0.016	0.005	0.025	0.009
17	23.66	2642	5-MeC26	85/323	0.073	0.085	0.203	0.074	0.058	0.022	0.118	0.096
18	23.74	2649	4-MeC26	71/337	0.040	0.047	0.088	0.030	0.022	0.004	0.037	0.026
19	23.93	2666	C27:1	378	3.143	1.396	5.270	1.246	4.046	1.098	4.565	1.468
20	24.37	2700	n-C27	380	0.653	0.200	0.910	0.291	1.148	0.223	2.208	0.934
21	24.54	2720	13-; 11-; 9-MeC27	197/225/169/253/141/281	0.115	0.059	0.145	0.034	0.160	0.044	0.279	0.094
22	24.73	2737	7-MeC27	113/309	0.013	0.005	0.018	0.005	0.012	0.004	0.032	0.012
23	24.82	2745	5-MeC27	85/337	0.290	0.171	0.360	0.040	0.426	0.122	0.627	0.225
24	24.92	2754	11, 15-diMeC27	197/267/169/239	0.623	0.228	0.365	0.112	0.868	0.362	0.681	0.185
25	25.15	2774	3-MeC27	57/365	0.448	0.275	0.688	0.271	0.718	0.209	0.655	0.159
26	25.24	2782	n-C28	394	0.463	0.153	0.388	0.109	0.622	0.129	0.636	0.132
27	25.56	2810	3,7-diMeC28	57/127/309/379	0.240	0.080	0.275	0.061	0.290	0.034	0.392	0.074
28	25.75	2827	14-;13-;12-MeC28	210/225/197/239/169/267	0.020	0.014	0.020	0.000	0.012	0.004	0.023	0.010
29	25.85	2836	6-MeC28	99/337	0.113	0.055	0.103	0.005	0.104	0.023	0.141	0.037
30	26.10	2858	x,y-diMeC28	-	1.340	1.981	4.528	0.827	0.710	0.144	1.622	0.764
31	26.20	2866	C29:1	406	1.343	2.185	2.958	0.279	0.266	0.058	0.494	0.209
32	26.38	2882	n-C29	408	17.783	3.027	18.933	4.983	18.084	3.473	14.785	2.177
33	26.79	2918	15-; 13-; 11-; 9-MeC29	225/197/253/169/281/141/309	4.473	2.005	8.050	1.383	5.374	0.415	7.418	1.052
34	26.99	2936	7-MeC29	113/337	0.618	0.145	0.703	0.114	0.718	0.103	1.275	0.339
35	27.29	2962	11,15-; 11,17-; 13,17-diMeC29	225/295/169/239/197/281/267	3.868	0.485	4.363	0.346	5.818	0.515	6.245	0.784
36	27.44	2975	3-MeC29	57/393	1.135	0.267	1.238	0.210	0.656	0.084	0.795	0.141
37	27.73	3001	3,7-diMeC29	57/127/337/407	1.120	0.332	1.158	0.140	0.914	0.094	0.855	0.133
38	28.04	3028	15-;14-;12-MeC30	225/239/210/253/183/281	1.333	0.350	1.575	0.222	1.742	0.140	1.906	0.151
39	28.64	3080	C31:1	434	9.565	5.028	16.158	0.519	9.304	2.686	12.591	4.679
40	28.93	3100	n-C31	436	23.055	14.091	3.180	0.332	16.956	2.472	9.045	3.237
41	29.31	3139	15-;13;11-MeC31	252/253/197/281/169/309	8.375	1.690	11.338	1.303	11.272	0.902	12.594	1.626
42	29.56	3162	unknown	168, 196, 239, 267, 309, 295	8.375	1.690	11.338	1.303	11.272	0.902	12.594	1.626
43	29.69	3173	11,17-diMeC31	168, 323	1.185	0.359	1.423	0.144	1.306	0.302	1.614	0.376
44	29.88	3190	5,X-diMeC31	85	8.820	4.646	2.230	0.136	6.098	1.511	3.806	1.079
45	30.96	3287	C33:1	462	0.243	0.051	0.098	0.017	0.150	0.062	0.154	0.037

Table S2: Identified hydrocarbons of *Dolichovespula saxonica* eggs. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

Dolichovespula saxonica - Eggs								
#	RT	RI	Compounds	Ions	queen-laid		worker-laid	
					mean	SD	mean	SD
1	16.70	2096	n-C20	296	0.600	0.395	0.627	0.879
2	17.75	2194	n-C21	310	0.133	0.046	0.131	0.046
3	18.83	2294	n-C22	324	0.582	0.287	0.525	0.743
4	19.63	2368	C23:1	322	0.043	0.021	0.039	0.030
5	19.70	2375	C23:1	322	0.053	0.032	0.041	0.026
6	19.90	2393	n-C23	324	0.841	0.362	1.363	1.110
7	20.36	2436	11-;9-;7-MeC23	197/169/225/141/253/113	0.336	0.285	0.299	0.096
8	20.45	2444	5-MeC23	85/281	0.054	0.021	0.050	0.036
9	20.69	2466	3-MeC23	57/309	0.078	0.043	0.075	0.041
10	20.82	2478	C24:1	336	0.013	0.005	0.015	0.021
11	20.97	2492	n-C24	338	0.564	0.206	0.527	0.564
12	21.07	2501	3,7-diMeC23	57/127/253/323	0.182	0.072	0.201	0.147

13	21.32	2525	8-;6-MeC24	127/253/281/98	0.248	0.104	0.302	0.161
14	21.58	2548	4-MeC24	71/309	0.066	0.018	0.074	0.071
15	21.77	2566	C25:1	350	0.129	0.140	0.184	0.118
16	21.85	2573	C25:1	350	0.048	0.046	0.055	0.028
17	21.94	2582	4,8-diMeC24	71/141/253/323	0.113	0.040	0.111	0.059
18	22.02	2590	n-C25	352	2.847	0.736	2.847	0.426
19	22.42	2626	13-;11-;9-;7-MeC25	197/169/225/253/141/113/281	1.540	0.698	1.747	0.458
20	22.58	2640	5-MeC25	85/309	0.249	0.122	0.223	0.080
21	22.82	2663	3-MeC25	57/337	0.660	0.237	0.717	0.122
22	22.92	2671	5,9-diMeC25	85, 155, 253, 323	0.929	0.322	0.793	0.356
23	23.11	2689	n-C26	366	0.777	0.205	0.768	0.447
24	23.20	2697	3,7-; 3,9-diMeC25	57/127/281/351/155/253	0.898	0.182	0.839	0.229
25	23.50	2724	12-; 11-; 10-MeC26	183/225/253/155/169/239	0.525	0.132	0.569	0.169
26	23.76	2747	4-MeC26	71/337	0.221	0.074	0.236	0.068
27	23.97	2767	C27:1	378	0.840	0.563	1.025	0.424
28	24.05	2774	C27:1	378	0.443	0.275	0.499	0.216
29	24.22	2789	n-C27	380	8.723	1.843	8.209	1.449
30	24.59	2822	13-;11-;9-;7-MeC27	197/225/169/253/281/141/113/309	5.509	1.004	6.161	1.036
31	24.80	2840	5-MeC27	85/337	1.193	0.241	1.191	0.168
32	24.92	2851	11, 15-diMeC27	239/267/196/168	0.548	0.189	0.740	0.160
33	25.05	2863	3-MeC27	57/365	5.672	1.257	5.111	1.089
34	25.13	2870	5,9-; 5,11-diMeC27	85/155/281/351/253/183	2.393	1.192	2.164	0.839
35	25.35	2889	n-C28	394	1.398	0.442	1.457	0.511
36	25.45	2898	3,7-; 3,11-diMeC27	57/127/309/379/253/183	1.777	0.280	1.587	0.260
37	25.72	2922	14-;13-;12-;6-MeC28	210/225/197/239/183/253/98/337	2.128	0.334	2.406	0.482
38	26.03	2949	4-MeC28	71/365	0.596	0.094	0.583	0.087
39	26.25	2968	C29:1	406	5.477	1.423	5.767	1.636
40	26.34	2976	C29:1	406	2.672	1.751	2.749	1.363
41	26.50	2990	n-C29	408	9.976	2.772	9.790	2.501
42	26.86	3021	15-; 13-; 11-; 9-MeC29	224/197/253/169/281/141/309	8.225	1.942	8.767	2.426
43	26.97	3031	7-MeC29	112/337	1.968	1.235	2.071	1.444
44	27.19	3050	11,15-; 11,17-; 13,17-diMeC29	169/239/225/295/267/197	1.809	0.408	2.533	0.611
45	27.36	3066	3-MeC29	57/393	11.597	3.642	7.800	1.964
46	27.91	3114	3,7-; 3,9-; 3,13-diMeC29	57/155/309/407/281/183/253/211	0.086	0.069	0.047	0.040
47	28.02	3123	14-;12-MeC30	210/253/183/281	0.868	0.180	1.028	0.254
48	28.59	3173	C31:1	434	4.688	1.304	4.979	1.453
49	28.82	3194	n-C31	436	2.093	0.632	3.015	1.068
50	29.17	3224	15-;13-;11-MeC31	225/253/281/197/169/309	2.218	0.630	2.691	0.732
51	29.47	3251	11,15-diMeC31	169/239/253/323	1.175	0.553	1.428	0.512
52	29.69	3271	3-MeC31	57/421	2.306	0.801	1.570	0.388
53	30.89	3378	C33:1	462	0.663	0.457	0.720	0.429
54	31.10	3397	n-C33	464	0.257	0.075	0.578	0.442

Table S3: Identified hydrocarbons of *Dolichovespula saxonica* Dufour gland. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Dolichovespula saxonica</i> - Dufour gland												
#	RT	RI	Compounds	Ions	queens		virgin queen		reproductive workers		workers	
					mean	SD	mean	SD	mean	SD	mean	SD
1	19.88	2300	n-C23	324	0.075	0.007	1.550	0.297	0.340	0.095	0.646	0.248
2	20.34	2338	7-MeC23	113/253	0.010	0.000	0.060	0.014	0.040	0.030	0.036	0.026
3	21.75	2471	C25:1-1	350	0.030	0.014	0.725	0.304	0.057	0.021	0.140	0.102
4	21.83	2478	C25:1-2	350	0.020	0.014	0.285	0.035	0.067	0.038	0.079	0.047
5	21.92	2486	4,8-diMeC24	71/141/253/323	0.115	0.078	0.055	0.007	0.047	0.038	0.056	0.038
6	22.01	2500	n-C25	352	0.840	0.099	5.720	0.057	0.657	0.456	4.773	3.232
7	22.40	2531	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281	0.705	0.474	1.895	0.926	0.297	0.246	1.090	0.538
8	22.56	2545	5-MeC25	85/309	0.080	0.028	0.275	0.191	0.033	0.031	0.116	0.049
9	22.72	2560	3-MeC25	57/337	0.185	0.064	1.290	1.047	0.170	0.020	0.556	0.332
10	22.90	2577	5,9-diMeC25	85/155/253/323	1.365	0.615	0.660	0.354	0.997	0.539	0.393	0.193
11	23.09	2600	n-C26	366	0.300	0.042	0.880	0.014	0.283	0.206	1.111	0.381
12	23.18	2602	3,7-; 3,9-diMeC25	57/127/281/351/253/155	0.770	0.438	0.680	0.269	0.307	0.272	0.604	0.338

13	23.47	2628	12-; 11-; 10-MeC26	183/225/169/239/155/253	0.365	0.276	0.480	0.283	0.263	0.147	0.261	0.100
14	23.74	2652	4-MeC26	71/337	0.075	0.035	0.250	0.156	0.300	0.433	0.138	0.075
15	23.96	2672	C27:1 - 1	378	0.535	0.304	8.165	2.227	1.233	1.643	1.044	0.694
16	24.07	2682	C27:1 - 2	378	0.225	0.120	4.545	2.878	0.167	0.064	0.877	1.854
17	24.20	2700	n-C27	380	9.875	1.591	12.210	0.679	11.053	7.697	25.625	12.421
18	24.59	2728	13-; 11-; 9-MeC27	197/225/169/253/141/281	3.115	2.128	6.300	3.097	1.647	0.788	3.337	1.598
19	24.68	2736	7-MeC27	113/309	0.195	0.163	0.690	0.566	0.083	0.051	0.197	0.102
20	24.78	2745	5-MeC27	85/337	0.585	0.276	0.780	0.396	0.277	0.108	0.583	0.337
21	24.90	2756	11,15-diMeC27	197/267/169/239	0.285	0.262	1.180	0.764	0.133	0.085	0.471	0.283
22	25.05	2769	3-MeC27	57/365	3.010	0.042	3.425	2.369	2.633	1.205	3.720	2.154
23	25.14	2777	5,9-; 5,11-diMeC27	85/155/183/253/281/351	2.120	1.259	2.620	0.354	1.240	0.416	1.228	0.520
24	25.35	2800	n-C28	394	3.225	0.445	0.735	0.148	6.470	6.149	1.878	0.709
25	25.43	2802	3,7-; 3,11-diMeC27	57/127/309/379/253/183	1.155	0.601	1.845	1.110	0.577	0.293	0.818	0.311
26	25.75	2830	14-; 12-MeC28	210/225/169/267	1.605	0.884	20.480	22.500	11.977	11.549	20.911	16.675
27	26.01	2853	4-MeC28	71/365	0.420	0.156	0.390	0.057	0.397	0.350	0.315	0.131
28	26.26	2875	C29:1 - 1	406	4.055	2.072	7.605	3.090	4.890	5.099	3.482	2.376
29	26.34	2882	C29:1 - 2	406	1.175	0.247	2.455	1.577	0.953	0.959	0.853	0.582
30	26.50	2900	n-C29	408	10.430	0.198	1.600	0.495	19.833	16.111	13.009	10.129
31	26.87	2929	15-;13-;11-;9-MeC29	225/197/253/169/281/141/309	11.835	3.953	0.125	0.021	1.063	0.837	0.793	0.521
32	26.96	2937	7-MeC29	113/337	0.675	0.332	0.290	0.141	1.280	1.733	0.337	0.143
33	27.17	2955	11,15-; 11,17-diMeC29	225/295/169/239/281	1.275	1.096	2.235	0.898	0.820	0.507	0.892	0.550
34	27.39	2974	3-MeC29	57/393	9.220	1.216	1.680	0.566	5.660	3.213	2.618	1.447
35	27.65	2997	n-C30	422	2.140	0.283	0.400	0.269	0.993	0.313	0.399	0.311
36	27.76	3006	3,7-; 3,9-diMeC29	57/127/337/407/155/309	1.965	1.011	0.950	0.622	5.670	8.289	0.590	0.219
37	27.98	3025	15-;14-;13-;12-MeC30	225/239/210/253/183/281/197/267	0.095	0.064	0.045	0.021	0.130	0.095	0.078	0.036
38	28.29	3053	4-MeC30	71/253	0.460	0.127	0.190	0.042	0.667	0.922	0.128	0.055
39	28.55	3076	C31:1 - 1	434	2.710	0.820	0.685	0.431	1.087	0.739	0.375	0.227
40	28.65	3085	C31:1 - 2	434	1.000	0.014	0.185	0.120	3.090	2.511	0.386	0.213
41	28.82	3100	n-C31	436	8.935	2.991	0.570	0.438	5.790	2.352	2.043	2.549
42	29.10	3125	15-; 13-; 11-; 9-MeC31	252/253/197/281/169/309/141/337	0.980	0.438	0.660	0.481	1.100	1.129	0.370	0.176
43	29.65	3173	3-MeC31	57/421	6.015	1.223	0.720	0.141	1.390	1.096	0.864	0.426
44	29.89	3200	n-C32	450	0.325	0.064	0.330	0.042	0.837	1.077	0.213	0.102
45	30.79	3275	C33:1	462	0.640	0.085	0.210	0.071	0.770	0.704	0.319	0.460
46	31.01	3300	n-C33	464	1.830	0.962	0.205	0.205	1.163	0.808	0.323	0.235
47	31.83	3370	3-MeC33	57/449	1.215	0.389	0.555	0.488	0.470	0.216	0.572	0.321
48	32.99	3477	C35:1	490	0.265	0.177	0.045	0.007	0.130	0.056	0.155	0.093
49	33.19	3500	n-C35	492	1.495	0.884	0.130	0.141	0.473	0.225	0.225	0.164

Table S4: Percentage similarity analysis (SIMPER – Bray-Curtis 999 permutations) showing the five most important hydrocarbons for group differentiation (*Dolichovespula saxonica* samples). SD = standard deviation; Av = overall average; Sig. Level = Significance Level.

<i>Dolichovespula saxonica</i> - CHCs - queens x virgin queens							
Compounds	Average	SD	Ratio	Av. queens	Av. virgin queens	p-value	Sig. Level
n-C31	0.100	0.063	1.587	23.055	3.180	0.001	***
C31:1	0.035	0.019	1.823	9.565	16.158	0.057	n.s.
5,x-diMeC31	0.033	0.020	1.631	8.820	2.230	0.001	***
n-C29	0.022	0.015	1.494	17.783	18.933	0.269	n.s.
15-;13-;11-;9-MeC29	0.018	0.010	1.727	4.473	8.050	0.001	***
<i>Dolichovespula saxonica</i> - CHCs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level

n-C31	0.084	0.042	2.009	23.055	9.045	0.001	***
5,x-diMeC31	0.029	0.015	2.013	8.820	3.806	0.001	***
C31:1	0.028	0.021	1.293	9.565	1.259	0.239	n.s.
15-;13-MeC31	0.021	0.010	2.053	8.375	1.259	0.001	***
unknown 1	0.021	0.010	2.053	8.375	1.259	0.001	***
<i>Dolichovespula saxonica</i> - CHCs - queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. queens	Av. rep. workers	p-value	Sig. Level
n-C31	0.065	0.025	2.594	23.055	16.956	0.049	*
5,x-diMeC31	0.023	0.009	2.491	8.820	6.098	0.016	*
C31:1	0.019	0.017	1.108	9.565	9.304	0.915	n.s.
n-C29	0.017	0.012	1.401	17.783	18.084	0.685	n.s.
15-;13-MeC31	0.015	0.008	1.792	8.375	11.272	0.132	n.s.
<i>Dolichovespula saxonica</i> - CHCs - virgin queens x workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. workers	p-value	Sig. Level
n-C31	0.029	0.016	1.846	3.180	9.045	0.981	n.s.
n-C29	0.027	0.017	1.529	18.933	1.478	0.018	*
C31:1	0.026	0.012	2.187	16.158	1.259	0.373	n.s.
x,y-diMeC28	0.015	0.005	2.798	4.528	1.622	0.001	***
C29:1	0.012	0.002	7.749	2.958	4.935	0.001	***
<i>Dolichovespula saxonica</i> - CHCs - virgin queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. rep. workers	p-value	Sig. Level
n-C31	0.069	0.011	6.022	3.180	16.956	0.018	*
C31:1	0.034	0.013	2.732	16.157	9.304	0.039	*
n-C29	0.022	0.015	1.444	18.933	18.084	0.200	n.s.
5,x-diMeC31	0.019	0.007	2.779	2.230	6.098	0.107	n.s.
x,y-diMeC28	0.019	0.004	5.111	4.527	0.710	0.001	***
<i>Dolichovespula saxonica</i> - CHCs - workers x reproductive workers							
Compounds	Average	SD	Ratio	Av. workers	Av. rep. workers	p-value	Sig. Level
n-C31	0.040	0.019	2.094	9.045	16.956	0.619	n.s.
C31:1	0.023	0.020	1.154	1.259	9.304	0.806	n.s.
n-C29	0.021	0.014	1.435	1.478	18.084	0.213	n.s.
5,x-diMeC31	0.012	0.008	1.472	3.806	6.098	0.775	n.s.
15-;13-;11-;9-MeC29	0.010	0.005	1.975	7.418	5.374	0.244	n.s.
<i>Dolichovespula saxonica</i> - eggs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
3-MeC29	0.022	0.016	1.407	11.597	7.800	0.003	**
n-C29	0.015	0.010	1.414	9.976	9.790	0.765	n.s.
15-;13-;11-;9-MeC29	0.012	0.009	1.387	8.225	8.767	0.676	n.s.
n-C27	0.009	0.008	1.173	8.723	8.209	0.369	n.s.
C29:1-1	0.008	0.006	1.292	5.477	5.767	0.837	n.s.
<i>Dolichovespula saxonica</i> - DG - queens x virgin queens							
Compounds	Average	SD	Ratio	Av. queens	Av. virgin queens	p-value	Sig. Level
14-;12-MeC28	0.094	0.092	1.027	1.605	20.480	0.442	n.s.
15-;13-;11-;9-MeC29	0.059	0.016	3.630	11.835	0.125	0.001	***
n-C29	0.044	0.002	20.281	10.430	1.600	0.559	n.s.
n-C31	0.042	0.012	3.390	8.935	0.570	0.018	*
C27:1-1	0.038	0.009	4.156	0.535	8.165	0.001	***
<i>Dolichovespula saxonica</i> - DG - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
14-;12-MeC28	0.097	0.081	1.205	1.605	20.911	0.264	n.s.

<i>n</i> -C27	0.079	0.060	1.313	9.875	25.625	0.250	n.s.
15-;13-;11-;9-MeC29	0.055	0.014	3.809	11.835	0.793	0.010	**
<i>n</i> -C31	0.036	0.013	2.673	8.935	2.043	0.021	*
3-MeC29	0.033	0.008	3.964	9.220	2.618	0.005	**
<i>Dolichovespula saxonica</i> - DG - queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. queens	Av. rep. workers	<i>p</i> -value	Sig. Level
<i>n</i> -C29	0.073	0.038	1.924	10.430	19.833	0.294	n.s.
15-;13-;11-;9-MeC29	0.054	0.016	3.418	11.835	1.063	0.006	**
14-;12-MeC28	0.052	0.052	1.002	1.605	11.977	0.909	n.s.
<i>n</i> -C27	0.031	0.010	3.144	9.875	11.053	0.928	n.s.
3,7-;3,9-diMeC29	0.026	0.032	0.811	1.965	5.670	0.174	n.s.
<i>Dolichovespula saxonica</i> - DG - virgin queens x workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. workers	<i>p</i> -value	Sig. Level
14-;12-MeC28	0.090	0.070	1.290	20.480	20.911	0.446	n.s.
<i>n</i> -C27	0.070	0.057	1.221	12.210	25.625	0.380	n.s.
<i>n</i> -C29	0.057	0.050	1.151	1.600	13.009	0.332	n.s.
C27:1-1	0.036	0.009	4.078	8.165	1.044	0.003	**
C29:1-1	0.023	0.013	1.761	7.605	3.482	0.109	n.s.
<i>Dolichovespula saxonica</i> - DG - virgin queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. rep. workers	<i>p</i> -value	Sig. Level
<i>n</i> -C29	0.091	0.072	1.265	1.600	19.833	0.127	n.s.
14-;12-MeC28	0.083	0.064	1.304	20.480	11.976	0.614	n.s.
C27:1-1	0.035	0.011	3.058	8.165	1.233	0.006	**
<i>n</i> -C28	0.029	0.028	1.043	0.735	6.470	0.115	n.s.
<i>n</i> -C27	0.027	0.018	1.483	12.210	11.053	0.947	n.s.
<i>Dolichovespula saxonica</i> - DG - workers x reproductive workers							
Compounds	Average	SD	Ratio	Av. workers	Av. rep. workers	<i>p</i> -value	Sig. Level
14-;12-MeC28	0.082	0.063	1.313	20.911	11.976	0.730	n.s.
<i>n</i> -C27	0.078	0.062	1.275	25.625	11.053	0.202	n.s.
<i>n</i> -C29	0.076	0.047	1.622	13.009	19.833	0.115	n.s.
3,7-;3,9-diMeC29	0.026	0.034	0.745	0.590	5.670	0.085	n.s.
<i>n</i> -C28	0.023	0.026	0.907	1.878	6.470	0.035	*

Table S5: Identified cuticular hydrocarbons of *Dolichovespula media*. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

Dolichovespula media - CHCs												
#	RT	RI	Compounds	Ions	queens		virgin queens		reproductive workers		workers	
					mean	SD	mean	SD	mean	SD	mean	SD
1	14.65	1800	n-C18	254	0.037	0.015	0.299	0.092	0.195	0.059	0.233	0.128
2	16.66	2000	n-C20	282	0.055	0.035	0.261	0.102	0.221	0.061	0.204	0.145
3	17.72	2100	n-C21	296	0.014	0.006	0.271	0.177	0.017	0.007	0.051	0.050
4	18.59	2178	3-MeC21	57/281	0.047	0.040	0.099	0.049	0.100	0.044	0.089	0.064
5	18.76	2200	n-C22	310	0.048	0.038	0.215	0.119	0.207	0.072	0.141	0.121
6	19.43	2254	C23:1-1	322	0.005	0.004	0.013	0.006	0.017	0.017	0.014	0.008
7	19.58	2268	C23:1-2	322	0.021	0.011	0.319	0.230	0.039	0.038	0.092	0.102
8	19.83	2300	n-C23	324	0.219	0.037	1.963	1.313	0.108	0.061	0.367	0.401
9	20.89	2400	n-C24	338	0.110	0.045	0.248	0.140	0.255	0.068	0.170	0.146
10	21.92	2500	n-C25	352	1.696	0.374	0.709	0.317	0.570	0.246	0.559	0.230
11	22.30	2523	13-;11-;9-;7-MeC25	169/225/197/253/141/281/113	0.228	0.064	0.260	0.075	0.223	0.068	0.262	0.089

12	22.48	2540	5-MeC25	85/309	0.043	0.021	0.034	0.008	0.037	0.009	0.042	0.018
13	22.72	2562	3-MeC25	57/337	0.146	0.048	0.096	0.028	0.180	0.054	0.175	0.082
14	22.83	2572	5,15-diMeC25	85/169/239/323	0.029	0.006	0.089	0.036	0.038	0.013	0.053	0.014
15	23.00	2600	n-C26	366	1.222	0.145	0.352	0.121	0.572	0.091	0.390	0.172
16	23.39	2623	13-;12-MeC26	197/211/183/225	0.252	0.035	0.268	0.069	0.237	0.046	0.249	0.057
17	23.67	2648	4-MeC26	71/337	0.030	0.005	0.018	0.010	0.041	0.012	0.041	0.018
18	23.85	2664	C27:1-1	378	0.206	0.044	1.056	0.352	0.292	0.063	0.341	0.086
19	23.93	2671	C27:1-2	378	0.200	0.050	1.233	0.327	0.201	0.041	0.269	0.060
20	24.12	2700	n-C27	380	12.030	1.164	8.328	0.588	10.771	2.850	8.782	2.715
21	24.48	2721	13-;11-;9-;7-MeC27	197/225/169/253/141/281/113/309	4.992	1.124	7.850	1.499	6.160	1.138	6.966	1.413
22	24.68	2738	5-MeC27	85/337	0.936	0.181	0.888	0.170	1.129	0.192	1.100	0.160
23	24.95	2762	3-MeC27 + 5,9-;5,13-diMeC25	85/211/225/351/155/253/323	5.982	0.802	7.073	1.332	7.194	1.440	8.736	1.179
24	25.29	2800	n-C28	394	5.558	0.351	3.196	0.450	3.688	0.245	3.790	0.326
25	25.60	2820	14-;13-;12-;11-;10-MeC28	211/225/197/239/183/253/169/267/141/281	1.372	0.244	1.930	0.373	1.977	0.445	2.080	0.342
26	25.91	2847	4-MeC28	71/365	0.168	0.015	0.177	0.056	0.234	0.064	0.243	0.040
27	26.13	2866	C29:1	406	3.605	0.493	20.725	4.860	5.715	1.149	6.701	2.260
28	26.40	2900	n-C29	408	11.663	0.937	10.335	2.766	16.961	3.370	14.981	3.085
29	26.75	2920	15-;13-;11-;9-;7-MeC29	225/197/253/169/281/141/309	4.337	1.457	10.712	1.929	12.341	1.345	13.631	2.580
30	26.86	2930	7-MeC29	113/337	9.515	1.385	1.561	0.181	2.925	0.846	2.587	0.547
31	27.08	2948	11,17-;11,19-diMeC29	169/295/267/197	0.574	0.057	0.413	0.107	0.478	0.094	0.524	0.093
32	27.25	2964	3-MeC29	57/393	10.419	0.911	4.800	0.910	8.945	0.829	9.002	1.257
33	27.61	2995	x,y-diMeC29	-	2.709	0.208	1.715	0.477	2.752	0.404	2.703	0.434
34	27.91	3022	15-;14-MeC30	225/239/211/253	0.784	0.114	0.774	0.169	1.027	0.190	1.109	0.163
35	28.47	3071	C31:1	434	3.216	0.381	4.708	1.278	3.602	0.551	3.581	0.646
36	28.74	3100	n-C31	436	6.603	1.337	1.195	0.477	2.070	0.755	1.774	0.686
37	29.07	3123	15-;13-;11-;9-MeC31	225/253/197/281/169/309/141/337	4.458	0.702	2.628	0.481	4.003	0.497	3.890	0.536
38	29.57	3168	3-MeC31	57/421	2.695	0.491	0.731	0.134	1.356	0.141	1.336	0.213
39	29.89	3200	n-C32	450	0.480	0.061	0.235	0.107	0.422	0.026	0.343	0.086
40	30.78	3275	C33:1 + n-C33	462 + 464	1.052	0.226	1.038	0.462	0.832	0.236	0.741	0.253
41	31.31	3323	17-;15-;13-;11-;9-MeC33	253/225/281/197/309/169/337/141/365	0.926	0.128	0.467	0.042	0.751	0.144	0.735	0.158
42	32.13	3400	n-C34	478	0.083	0.022	0.061	0.049	0.103	0.015	0.054	0.036
43	32.51	3432	17-MeC34	253/267	0.131	0.036	0.179	0.205	0.311	0.057	0.136	0.100
44	32.79	3458	5-MeC34	85/407	0.015	0.001	0.015	0.012	0.029	0.006	0.025	0.009
45	33.50	3522	17-;15-;13-;11-MeC35	253/281/225/309/197/337/169/365	1.089	0.167	0.467	0.071	0.677	0.101	0.710	0.269

Table S6: Identified hydrocarbons of *Dolichovespula media* eggs. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Dolichovespula media</i> - Eggs								
#	RT	RI	Compounds	Ions	queens		workers	
					mean	SD	mean	SD
1	17.36	2066	C21:1-1	294	0.090	0.255	0.088	0.216
2	17.50	2079	C21:1-2	294	0.199	0.511	0.235	0.508
3	17.76	2100	n-C21	296	0.140	0.415	0.204	0.465
4	19.62	2275	C23:1	322	0.228	0.633	0.557	1.314
5	19.90	2300	n-C23	324	0.685	1.088	1.050	1.525
6	21.78	2477	C25:1	350	0.224	0.508	0.985	1.974
7	22.02	2500	n-C25	352	0.637	0.428	0.695	0.568
8	22.39	2534	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281	0.598	0.688	0.931	0.847
9	22.80	2572	3-MeC25	57/337	0.589	0.671	0.824	1.272
10	23.45	2631	12-;11-;10-MeC26	183/225/169/239/155/253	0.396	1.071	0.524	0.835
11	23.85	2667	C27:1	378	0.502	0.569	2.383	3.543

12	24.16	2700	n-C27	380	7.864	1.611	10.564	4.534
13	24.53	2728	13-;11-;9-;7-MeC27	197/225/169/253/141/281/113/309	9.586	1.952	9.409	2.912
14	24.69	2743	5-MeC27	85/337	1.626	0.169	3.725	4.054
15	24.99	2769	3-MeC27	57/365	14.498	3.289	9.492	3.316
16	25.36	2802	x,y-diMeC27	-	3.748	0.287	4.162	2.537
17	25.67	2829	14-;13-;12-MeC28	211/225/197/239/183/253	2.160	0.533	2.263	1.191
18	25.97	2855	4-MeC28	71/365	0.243	0.531	0.475	0.612
19	26.19	2875	C29:1	406	4.594	1.272	4.642	3.326
20	26.44	2900	n-C29	408	10.452	1.809	12.623	6.548
21	26.81	2929	15-;13-;11-;9-;7-MeC29	225/197/253/169/281/141/309/113/337	20.934	3.828	16.100	8.004
22	27.32	2974	3-MeC29	57/393	11.258	1.274	9.207	3.027
23	27.72	3009	x,y-diMeC29	-	2.798	0.555	2.716	1.472
24	28.59	3084	C31:1	434	2.043	1.249	2.073	1.437
25	29.19	3136	15-;13-;11-;9-MeC31	225/253/197/281/169/309/141/337	3.905	1.105	4.073	2.484

Table S7: Identified hydrocarbons of *Dolichovespula media* Dufour gland. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Dolichovespula media</i> - Dufour gland												
#	RT	RI	compound	ions	queens		virgin queens		reproductive workers		workers	
					mean	SD	mean	SD	mean	SD	mean	SD
1	17.21	2058	C21:1	294	1.587	1.154	0.134	0.243	0.861	1.524	3.014	1.793
2	17.37	2073	C21:1	294	0.506	0.714	0.189	0.256	0.180	0.286	0.536	0.359
3	17.63	2100	n-C21	296	0.607	0.916	1.047	1.456	0.052	0.094	0.755	0.787
4	18.71	2200	n-C22	310	0.312	0.230	0.325	0.327	0.499	0.634	1.163	1.219
5	19.40	2259	C23:1-1	322	1.108	1.111	0.052	0.061	0.640	1.182	2.532	1.955
6	19.79	2300	n-C23	324	1.351	1.753	6.308	7.621	0.317	0.556	2.022	1.923
7	20.19	2333	11-;9-7-MeC23	197/169/141/225/113/253	0.867	1.499	0.090	0.044	0.036	0.039	0.277	0.386
8	20.34	2347	5-MeC23	85/281	0.567	0.700	0.046	0.014	0.050	0.044	0.284	0.370
9	20.57	2369	3-MeC23	57/309	0.726	0.892	0.052	0.017	0.262	0.509	0.685	0.518
10	20.86	2400	n-C24	338	0.299	0.264	0.220	0.190	0.204	0.314	0.446	0.367
11	21.64	2469	C25:1-1	350	1.219	0.998	0.328	0.126	0.737	1.419	2.046	2.108
12	21.90	2500	n-C25	352	0.860	0.630	1.895	1.717	0.411	0.733	2.402	2.025
13	22.27	2528	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281	3.744	0.998	1.068	0.302	1.286	1.375	1.298	0.685
14	22.45	2545	5-MeC25	85/309	2.467	1.234	0.195	0.230	1.588	0.592	1.380	0.734
15	22.80	2577	5,15-diMeC25	85/239/85/323	1.536	0.667	0.361	0.142	1.456	0.753	0.840	0.568
16	22.97	2600	n-C26	366	0.446	0.399	0.336	0.060	0.283	0.191	0.331	0.251
17	23.35	2627	13-;12-;11-;10-MeC26	197/211/187/225/169/239/155/253	3.254	1.792	0.738	0.537	4.011	4.188	6.944	5.473
18	24.08	2700	n-C27	380	1.090	0.507	6.481	2.774	0.626	0.193	1.676	1.630
19	24.48	2728	13-;11-;9-;7-MeC27	197/225/169/253/141/281/113/309	12.297	8.869	9.271	4.001	8.170	8.298	3.704	3.104
20	24.65	2744	5-MeC27	85/337	7.399	3.464	3.273	4.232	12.628	5.054	5.486	5.021
21	24.94	2769	3-MeC27 + 5,9-diMeC27	57/365 + 85/155/281/351	2.412	1.129	7.564	4.467	2.205	0.772	1.837	1.612
22	25.30	2801	n-C28 + 3,9-diMeC27	394 + 57/155/281/379	6.030	3.604	4.998	1.343	7.537	5.523	3.750	2.709
23	25.58	2826	14-;13-;12-;11-MeC28	211/225/197/239/183/253/169/267	4.102	0.982	3.924	3.221	7.702	2.672	10.255	3.471
24	25.91	2855	4-MeC28	71/365	2.113	0.961	0.994	1.818	3.137	1.538	2.914	1.601
25	26.17	2878	C29:1-1	406	0.671	0.636	13.685	7.467	0.682	0.780	4.210	4.955
26	26.29	2888	C29:1-2 + n-C29	406 + 408	1.517	0.520	12.985	1.930	2.858	1.403	5.861	4.717
27	26.74	2928	15-;13-;11-;9-;7-MeC29	225/197/253/169/281/141/309/113/337	7.776	6.708	7.629	4.441	7.099	7.039	4.139	2.265
28	27.03	2953	11,15-;11,17-diMeC29	169/239/225/295/267/197	7.770	4.123	1.923	3.001	15.283	8.659	6.062	7.122
29	27.26	2974	3-MeC29	57/393	2.374	2.742	1.481	0.482	3.202	3.047	1.822	1.611
30	27.56	3000	3,13-diMeC29	57/211/253/407	5.742	1.936	2.068	0.954	8.347	4.714	5.609	4.423

31	28.40	3074	C31:1	434	0.768	1.032	4.008	2.280	0.317	0.494	1.685	1.860
32	28.62	3100	n-C31 15-;13- ;11-;9-	436	0.195	0.177	1.070	1.135	0.149	0.244	1.336	1.775
33	28.96	3124	MeC31	225/253/197/281/169/309/141/337	4.030	2.369	1.429	0.487	1.124	1.383	2.180	1.923
34	29.52	3173	C32:1	348	2.702	2.012	0.496	0.603	2.112	1.032	1.205	0.784
35	30.64	3275	C33:1	462	1.234	1.680	1.601	0.926	0.078	0.133	1.204	2.673
36	32.82	3475	C35:1 17-;15- ;13-;11-	490	3.655	3.651	0.705	0.127	3.495	7.616	7.223	9.217
37	33.33	3523	MeC35	253/281/225/309/197/337/169/365	4.663	7.070	1.034	0.538	0.378	0.439	0.888	1.644

Table S8: Percentage similarity analysis (SIMPER – Bray-curtis 999 permutations) showing the five most important hydrocarbons for group differentiation (*Dolichovespula media* samples). SD = standard deviation; Av = overall average; Sig. Level = Significance Level.

<i>Dolichovespula media</i> - CHCs - queens x virgin queens							
Compounds	Average	SD	Ratio	Av. queens	Av. virgin queens	p-value	Sig. Level
C29:1	0.086	0.023	3.659	3.605	20.725	0.001	***
7-MeC29	0.04	0.006	6.296	9.515	1.561	0.001	***
15-;13-;11-;9-;7-MeC29	0.032	0.011	2.81	4.337	10.712	0.006	**
3-MeC29	0.028	0.006	4.686	10.419	4.8	0.001	***
n-C31	0.027	0.006	4.188	6.603	1.195	0.001	***
<i>Dolichovespula media</i> - CHCs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.046	0.014	3.249	4.336	13.63	0.001	***
7-MeC29	0.035	0.007	5.113	9.515	2.587	0.001	***
n-C31	0.024	0.007	3.506	6.603	1.773	0.001	***
n-C27	0.019	0.01	1.962	12.03	8.782	0.016	*
n-C29	0.019	0.013	1.455	11.663	14.98	0.765	n.s.
<i>Dolichovespula media</i> - CHCs - queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. queens	Av. rep. workers	p-value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.04	0.009	4.376	4.336	12.34	0.001	***
7-MeC29	0.033	0.007	4.432	9.515	2.924	0.001	***
n-C29	0.026	0.016	1.616	11.663	16.96	0.071	n.s.
n-C31	0.023	0.007	3.225	6.603	2.07	0.001	***
n-C27	0.014	0.008	1.789	12.03	10.77	0.69	n.s.
<i>Dolichovespula media</i> - CHCs - virgin queens x workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. workers	p-value	Sig. Level
C29:1	0.07	0.026	2.736	20.725	6.704	0.001	***
n-C29	0.026	0.017	1.566	10.335	17.987	0.003	**
3-MeC29	0.021	0.008	2.794	4.8	9.009	0.001	***
15-;13-;11-;9-;7-MeC29	0.017	0.012	1.41	10.712	13.637	0.835	n.s.
n-C27	0.01	0.009	1.143	8.328	8.787	0.999	n.s.
<i>Dolichovespula media</i> - CHCs - virgin queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. rep. workers	p-value	Sig. Level
C29:1	0.075	0.024	3.149	20.725	5.723	0.001	***
n-C29	0.034	0.019	1.812	10.335	16.967	0.001	***
3-MeC29	0.021	0.006	3.562	4.8	8.947	0.001	***

<i>n</i> -C27	0.014	0.011	1.252	8.328	10.771	0.54	n.s.
15-;13-;11-;9-;7-MeC29	0.011	0.008	1.412	10.712	12.341	0.996	n.s.
<i>Dolichovespula media</i> - CHCs - workers x reproductive workers							
Compounds	Average	SD	Ratio	Av. workers	Av. rep. workers	<i>p</i> -value	Sig. Level
<i>n</i> -C29	0.019	0.014	1.359	14.98	16.96	0.794	n.s.
<i>n</i> -C27	0.017	0.012	1.424	8.782	10.77	0.036	*
15-;13-;11-;9-;7-MeC29	0.012	0.009	1.347	13.63	12.34	1	n.s.
3-MeC27 + 5,9-;5,13-diMeC25	0.009	0.007	1.373	8.736	7.194	0.238	n.s.
C29:1	0.009	0.009	1	6.701	5.715	1	n.s.
<i>Dolichovespula media</i> - eggs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	<i>p</i> -value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.039	0.03	1.313	20.934	16.1	0.003	**
3-MeC27	0.028	0.019	1.468	14.498	9.492	0.001	***
<i>n</i> -C29	0.028	0.021	1.289	10.452	12.623	0.001	***
<i>n</i> -C27	0.019	0.019	1.035	7.864	10.564	0.003	**
3-MeC29	0.015	0.012	1.271	11.258	9.207	0.004	**
<i>Dolichovespula media</i> - DG - queens x virgin queens							
Compounds	Average	SD	Ratio	Av. queens	Av. virgin queens	<i>p</i> -value	Sig. Level
C29:1-1	0.066	0.033	1.99	0.671	13.685	0.001	***
C29:1-2 + <i>n</i> -C29	0.057	0.009	6.284	1.517	12.985	0.001	***
13-;11-;9-;7-MeC27	0.038	0.026	1.482	12.297	9.271	0.192	n.s.
11,15-;11,17-diMeC29	0.032	0.019	1.706	7.77	1.923	0.831	n.s.
15-;13-;11-;9-;7-MeC29	0.03	0.02	1.465	7.776	7.629	0.148	n.s.
<i>Dolichovespula media</i> - DG - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	<i>p</i> -value	Sig. Level
13-;11-;9-;7-MeC27	0.047	0.037	0.241	12.297	3.704	0.022	*
C35:1	0.038	0.034	0.096	3.655	7.223	0.44	n.s.
11,15-;11,17-diMeC29	0.034	0.021	0.549	7.77	6.062	0.932	n.s.
14-;13-;12-;11-MeC28	0.032	0.016	0.957	4.101	10.255	0.011	*
15-;13-;11-;9-;7-MeC29	0.029	0.022	0.253	7.776	4.139	0.1	n.s.
<i>Dolichovespula media</i> - DG - queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. queens	Av. rep. workers	<i>p</i> -value	Sig. Level
11,15-;11,17-diMeC29	0.048	0.032	1.486	7.77	15.283	0.227	n.s.
13-;11-;9-;7-MeC27	0.048	0.035	1.355	12.297	8.17	0.024	*
15-;13-;11-;9-;7-MeC29	0.035	0.027	1.284	7.776	7.099	0.022	*
5-MeC27	0.032	0.021	1.526	7.399	12.628	0.412	n.s.
C35:1	0.027	0.029	0.922	3.655	3.495	0.834	n.s.
<i>Dolichovespula media</i> - DG - virgin queens x workers							
Compounds	Average	SD	Ratio	Av. virgin queens	Av. workers	<i>p</i> -value	Sig. Level
C29:1-1	0.055	0.03	1.844	13.685	4.21	0.002	**
C29:1-2 + <i>n</i> -C29	0.039	0.02	1.961	12.985	5.861	0.008	**
14-;13-;12-;11-MeC28	0.034	0.019	1.741	3.924	10.255	0.003	**
C35:1	0.033	0.045	0.736	0.705	7.223	0.726	n.s.
13-;11-;9-;7-MeC27	0.032	0.018	1.767	9.271	3.704	0.29	n.s.
<i>Dolichovespula media</i> - DG - virgin queens x reproductive workers							

Compounds	Average	SD	Ratio	Av. virgin queens	Av. rep. workers	p-value	Sig. Level
11,15-;11,17-diMeC29	0.068	0.041	1.654	1.923	15.283	0.004	**
C29:1-1	0.066	0.033	1.99	13.685	0.682	0.001	***
C29:1-2 + n-C29	0.051	0.011	4.62	12.985	2.858	0.001	***
5-MeC27	0.049	0.026	1.897	3.273	12.628	0.002	**
13-;11-;9-;7-MeC27	0.035	0.025	1.383	9.271	8.17	0.298	n.s.
<i>Dolichovespula media</i> - DG - workers x reproductive workers							
Compounds	Average	SD	Ratio	Av. workers	Av. rep. workers	p-value	Sig. Level
11,15-;11,17-diMeC29	0.059	0.039	1.521	6.062	15.283	0.007	**
5-MeC27	0.042	0.026	1.636	5.486	12.628	0.001	***
C35:1	0.039	0.046	0.835	7.223	3.495	0.451	n.s.
13-;11-;9-;7-MeC27	0.033	0.033	0.989	3.704	8.17	0.235	n.s.
13-;12-;11-;10-MeC26	0.028	0.023	1.215	6.944	4.011	0.392	n.s.

Table S9: Identified cuticular hydrocarbons of *Vespa crabro*. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Vespa crabro</i> - CHCs								
#	RT	RI	Compounds	Ions	queens		workers	
					mean	SD	mean	SD
1	17.46	2168	C21:1	294	0.013	0.009	0.101	0.078
2	17.73	2193	n-C21	296	0.065	0.019	0.183	0.203
3	18.83	2295	n-C22	310	0.035	0.005	0.063	0.042
4	19.61	2368	C23:1	322	0.096	0.060	0.518	0.269
5	19.88	2393	n-C23	324	5.650	0.845	5.615	2.642
6	20.36	2437	7-MeC23	112/252	0.098	0.023	0.069	0.050
7	20.68	2467	3-MeC23	57, 309	0.514	0.154	1.158	0.429
8	20.96	2493	n-C24	338	1.785	0.404	0.569	0.122
9	21.58	2550	4-MeC24	71/309	0.034	0.009	0.026	0.008
10	21.79	2569	C25:1	350	17.991	5.952	50.008	5.415
11	22.05	2593	n-C25	352	35.794	3.632	16.540	2.337
12	22.41	2626	13-;11-;9-MeC25	197/ 169/225/141/253	0.799	0.266	0.386	0.199
13	22.48	2633	7-MeC25	112/281	0.595	0.326	0.230	0.159
14	22.59	2643	5-MeC25	85/309	0.340	0.131	0.223	0.050
15	22.84	2666	3-MeC25	57/337	5.502	1.036	5.920	1.286
16	23.12	2692	n-C26	366	2.204	0.427	0.425	0.072
17	23.49	2725	13-; 12-; 11-; 10-MeC26	197/211/183/225/239/169/155/253	0.168	0.103	0.048	0.024
18	23.68	2741	6-; 4-MeC26	337/71/308/99	0.004	0.007	0.001	0.003
19	24.00	2771	C27:1	378	3.766	1.254	10.035	2.023
20	24.25	2793	n-C27	380	10.505	2.210	3.341	1.264
21	24.61	2825	13-;11-MeC27	197/225/169/253	1.184	0.814	0.073	0.050
22	24.70	2834	7-MeC27	112/309	0.370	0.244	0.364	0.309
23	24.93	2853	unknown - 1	-	0.086	0.045	0.119	0.043
24	25.09	2868	3-MeC27	57/365	5.732	0.893	2.969	1.053
25	25.75	2926	n-C28	394	0.126	0.087	0.058	0.022
26	26.06	2953	unknown - 2	-	0.059	0.035	0.019	0.010
27	26.53	2995	n-C29	408	3.081	1.642	0.513	0.499
28	26.90	3027	15-;13-;11-MeC29	225/253/197/169/281	1.085	1.189	0.145	0.173
29	27.12	3046	13,17-diMeC29	196/267	0.024	0.030	0.032	0.072
30	27.21	3054	11,17-diMeC29	295/196/267/168	0.333	0.466	0.109	0.189
31	27.40	3071	3-MeC29	57/393	0.854	0.480	0.082	0.074
32	28.85	3198	unknown - 3	-	0.640	0.782	0.014	0.011
33	29.20	3229	unknown - 4	-	0.471	0.430	0.044	0.119

Table S10: Identified hydrocarbons of *Vespa crabro* eggs. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Vespa crabro</i> - Eggs								
#	RT	RI	Compounds	Ions	queens		workers	
					mean	SD	mean	SD
1	14.56	1802	n-C18	254	0.185	0.113	0.235	0.118
2	15.59	1900	n-C19	268	0.065	0.030	0.071	0.040
3	15.89	1928	unknown - 1	-	0.344	0.217	0.461	0.346
4	16.65	1998	n-C20	282	1.281	0.930	1.741	1.368
5	17.45	2072	C21:1	294	0.146	0.119	0.092	0.062
6	17.73	2097	n-C21	296	0.202	0.072	0.261	0.097
7	18.81	2196	n-C22	310	1.631	1.442	2.348	1.988
8	19.62	2271	C23:1	322	0.356	0.299	0.169	0.102
9	19.88	2296	n-C23	324	5.613	1.391	5.156	0.949
10	20.29	2333	11-;9-MeC23	168/196/141/225	0.039	0.016	0.065	0.032
11	20.35	2339	7-MeC23	112/253	0.064	0.036	0.063	0.048
12	20.46	2349	5-MeC23	85/280	0.074	0.053	0.107	0.079
13	20.68	2370	3-MeC23	57/309	0.927	0.456	0.447	0.212
14	20.96	2396	n-C24	338	2.133	1.158	2.534	1.749
15	21.33	2430	10-MeC24	169/225	0.095	0.066	0.108	0.074
16	21.58	2454	4-MeC24	71/309	0.073	0.030	0.071	0.035
17	21.77	2472	C25:1	350	27.500	10.946	16.448	8.202
18	22.04	2497	n-C25	352	23.893	5.280	22.051	9.086
19	22.40	2531	13-;11-;9-MeC25	141/253/169/225/197	0.943	0.562	1.021	0.752
20	22.48	2539	7-MeC25	112/281	0.701	0.577	0.375	0.367
21	22.59	2548	5-MeC25	85/309	0.345	0.199	0.210	0.145
22	22.84	2571	3-MeC25	57/337	5.644	1.378	3.192	1.452
23	23.12	2597	n-C26	366	1.914	1.055	2.629	1.203
24	23.49	2630	13-;12-;11-MeC26	168/238/182/224/196/210	0.307	0.206	0.357	0.184
25	23.78	2657	4-MeC26	71/337	0.107	0.039	0.114	0.036
26	23.98	2675	C27:1	378	5.494	2.710	3.991	2.210
27	24.26	2700	n-C27	380	7.819	6.999	16.603	9.863
28	24.62	2731	13-;11-MeC27	196/224/169/253	1.713	1.264	2.496	2.447
29	24.70	2739	7-MeC27	112/309	0.398	0.317	0.246	0.164
30	24.81	2748	5-MeC27	85/337	0.229	0.104	0.204	0.125
31	24.95	2760	11,13-; 11,15-diMeC27	168/196/239/267/211/225	0.109	0.064	0.179	0.175
32	25.10	2774	3-MeC27	57/365	4.612	1.036	3.056	1.133
33	25.38	2798	n-C28	394	1.004	0.589	2.044	0.718
34	26.08	2860	4-MeC28	71/365	0.112	0.063	0.143	0.070
35	26.27	2877	C29:1	406	0.312	0.162	0.771	1.135
36	26.55	2901	n-C29	408	2.098	3.414	8.276	7.149
37	26.90	2931	15-;13-;11-;9-MeC29	169/281/197/253/225/141/309	1.519	1.490	1.673	1.638

Table S11: Identified hydrocarbons of *Vespa crabro* Dufour gland. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Vespa crabro</i> - Dufour gland								
#	RT	RI	Compounds	Ions	queens		workers	
					mean	SD	mean	SD
1	17.68	2093	n-C21	296	0.199	0.175	0.247	0.261
2	18.76	2193	n-C22	310	0.094	0.052	0.376	0.513
3	19.58	2268	C23:1	322	0.085	0.061	0.302	0.259
4	19.93	2300	n-C23	324	7.656	3.287	8.065	3.796
5	20.31	2335	11-;9-MeC23	168/196/140/224	0.195	0.143	0.054	0.034
6	20.36	2340	7-MeC23	112/252	0.000	0.000	0.054	0.050
7	20.41	2344	5-MeC23	85/281	0.031	0.016	0.026	0.019
8	20.65	2367	3-MeC23	57/309	1.116	0.522	0.013	0.017
9	20.97	2397	n-C24	338	3.704	1.713	1.242	0.397
10	21.32	2430	12-;11-;10-MeC24	155/225/169/211/183/197	0.041	0.029	0.000	0.000
11	21.39	2436	7-MeC24	112/267	0.063	0.049	0.000	0.000
12	21.79	2474	C25:1	350	7.759	2.476	40.015	11.804
13	22.13	2506	n-C25	352	22.132	8.165	28.187	9.997
14	22.54	2544	13-;11-;9-MeC25	197/169/225/141/253	0.319	0.232	2.818	2.788
15	22.60	2549	7-MeC25	112/280	0.688	0.372	0.506	0.416
16	22.67	2556	5-MeC25	85/309	0.255	0.387	0.270	0.227
17	22.89	2576	3-MeC25	57/337	9.579	2.969	5.354	2.865
18	23.13	2598	n-C26	366	1.825	1.101	0.839	0.389

19	23.49	2630	13-;12-;11-MeC26	211/197/183/225/169/239	0.260	0.243	0.000	0.000
20	23.68	2647	7-MeC26	113/295	0.040	0.018	0.000	0.000
21	23.76	2655	4-MeC26	71/337	0.580	0.234	0.013	0.010
22	23.97	2674	3-MeC26	57/351	2.721	0.676	0.000	0.000
23	24.07	2682	C27:1	378	0.325	0.148	3.141	3.312
24	24.27	2700	n-C27	380	11.455	1.843	0.516	0.271
25	24.63	2732	13-;11-;9-MeC27	196/224/169/253/141/281	1.983	1.754	3.007	1.722
26	24.72	2740	7-MeC27	112/309	0.588	0.508	0.466	0.727
27	24.81	2748	5-MeC27	85/337	0.508	0.166	0.142	0.181
28	24.92	2758	11,15-diMeC27	169/239/197/267	0.124	0.106	0.000	0.000
29	24.93	2759	11,13-diMeC27	169/183/225/267	0.000	0.000	0.201	0.236
30	25.11	2775	3-MeC27	57/365	10.563	2.752	0.121	0.166
31	25.44	2804	n-C28	394	0.213	0.226	0.000	0.000
32	25.72	2829	14-;13-;12-;11-MeC28	225/211/253/183/239/197/267/169	0.235	0.272	0.000	0.000
33	26.02	2855	4-MeC28	71/365	0.296	0.125	0.000	0.000
34	26.20	2871	3-MeC28	57/379	0.349	0.173	0.000	0.000
35	26.34	2883	C29:1	406	0.045	0.024	0.107	0.100
36	26.51	2898	n-C29	408	3.059	1.036	0.047	0.050
37	26.87	2929	15-; 13-; 11-; 9-MeC29	224/253/197/281/169/309/141	1.782	1.986	0.110	0.176
38	26.96	2937	7-MeC29	112/337	0.145	0.125	0.000	0.000
39	27.07	2946	5-MeC29	85/365	0.085	0.050	0.000	0.000
40	27.17	2955	13,17-diMeC29	197/267	0.747	1.066	0.000	0.000
41	27.36	2972	3-MeC29	57/393	2.900	0.929	0.134	0.198
42	27.63	2996	n-C30	422	0.303	0.156	0.000	0.000
43	27.99	3027	14-;12-MeC30	253/210/281/183	0.218	0.245	0.000	0.000
44	28.48	3070	3,x-diMeC30	57	0.068	0.038	0.000	0.000
45	28.78	3097	n-C31	436	0.833	0.433	0.000	0.000
46	29.12	3127	15-;13-;11-;7-MeC31	281/197/253/225/309/169/113/365	1.007	0.913	0.055	0.068
47	29.42	3153	13,17-diMeC31	196/224/295/267	0.488	0.620	0.000	0.000
48	29.63	3172	3-MeC31	57/421	0.775	0.241	0.000	0.000
49	29.91	3197	n-C32	450	0.095	0.050	0.000	0.000
50	31.03	3298	n-C33	464	0.151	0.090	0.000	0.000
51	31.35	3327	17-;15-;13-MeC33	253/281/225/197/309	0.186	0.136	0.000	0.000
52	31.64	3353	13,17-diMeC33	197/267/323/252	0.226	0.301	0.000	0.000
53	33.21	3499	n-C35	492	0.069	0.034	0.000	0.000

Table S12: Percentage similarity analysis (SIMPER – Bray-Curtis 999 permutations) showing the five most important hydrocarbons for group differentiation (*Vespa crabro* samples). SD = standard deviation; Av = overall average; Sig. Level = Significance Level.

<i>Vespa crabro</i> - CHCs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
C25:1	0.160	0.039	4.144	17.991	50.010	0.001	***
n-C25	0.096	0.021	4.682	35.794	16.540	0.001	***
n-C27	0.036	0.012	3.033	10.505	3.341	0.001	***
C27:1	0.031	0.012	2.706	3.766	10.040	0.001	***
3-MeC27	0.014	0.007	2.070	5.732	2.969	0.001	***
<i>Vespa crabro</i> - eggs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
C25:1	0.072	0.049	1.478	27.500	16.448	0.006	**
n-C27	0.058	0.045	1.305	7.819	16.603	0.001	***
n-C25	0.043	0.029	1.500	23.893	22.051	0.007	**
n-C29	0.037	0.033	1.137	2.098	8.276	0.001	***
C27:1	0.015	0.012	1.263	5.494	3.991	0.583	n.s.
<i>Vespa crabro</i> - Dufour gland - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
C25:1	0.165	0.060	2.769	7.759	40.015	0.001	***
n-C25	0.058	0.039	1.483	22.132	28.187	0.484	n.s.
n-C27	0.056	0.009	6.025	11.455	0.516	0.001	***
3-MeC27	0.053	0.013	4.002	10.563	0.121	0.001	***
3-MeC25	0.025	0.016	1.611	9.579	5.354	0.003	**

Table S13: Identified cuticular hydrocarbons of *Vespula germanica*. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Vespula germanica</i> - CHCs										
#	RT	RI	Compounds	Ions	queens		reproductive workers		workers	
					mean	SD	mean	SD	mean	SD
1	18.76	2200	n-C22	310	0.100	0.000	0.085	0.078	0.179	0.172
2	19.79	2300	n-C23	324	0.208	0.005	0.190	0.044	0.187	0.077
3	20.19	2331	11;-9-MeC23	141/169/197/225	0.000	0.000	0.050	0.055	0.051	0.052
4	20.34	2344	5-MeC23	85/281	0.000	0.000	0.000	0.000	0.011	0.034
5	20.56	2366	3-MeC23	57/309	0.128	0.055	0.102	0.066	0.113	0.034
6	20.85	2400	n-C24	338	0.365	0.064	0.188	0.125	0.343	0.206
7	21.23	2428	12;-11;-10-MeC24	155/169/183/197/211/225	0.100	0.000	0.152	0.087	0.199	0.154
8	21.47	2451	4-MeC24	71/309	0.100	0.000	0.102	0.066	0.124	0.046
9	21.63	2467	C25:1	350	0.100	0.000	0.102	0.066	0.082	0.042
10	21.90	2500	n-C25	352	13.568	2.257	7.282	1.283	8.318	2.310
11	22.29	2528	13;-11;-9;-7-MeC25	197/169/225/141/253/113/281	1.625	0.085	8.263	3.161	8.767	2.388
12	22.45	2543	5-MeC25	85/309	0.260	0.058	0.548	0.128	0.537	0.107
13	22.69	2565	3-MeC25	57/337	7.383	1.530	7.848	2.551	7.471	1.847
14	22.99	2592	n-C26	366	5.028	0.449	2.052	0.062	2.198	0.388
15	23.37	2627	12;-10-MeC26	155/183/225/253	0.775	0.103	3.400	0.465	3.380	0.280
16	23.65	2652	4-MeC26	71/337	0.645	0.155	1.112	0.165	0.978	0.134
17	23.83	2668	C27:1and 3-MeC26	378 + 57/351	0.828	0.308	1.248	0.213	0.897	0.206
18	24.10	2693	n-C27	380	31.583	3.442	10.173	2.264	10.879	2.398
19	24.50	2729	13;-11;-9-MeC27	141/169/197/225/253/281	9.445	1.047	27.685	1.701	28.829	3.628
20	24.97	2770	9,13;- 11,15-diMeC27	141/211/225/295/169/197/239/267	17.133	1.935	17.453	1.524	16.550	1.480
21	25.32	2801	n-C28 + 3,9;- 3,11-diMeC27	394 + 57/155/183/253/281/379	2.400	0.260	1.588	0.222	1.409	0.185
22	25.70	2835	12;-10-MeC28	155/183/253/281	0.390	0.054	1.383	0.359	1.156	0.249
23	26.06	2866	12,16-diMeC28	183/197/253/267	0.260	0.058	0.342	0.152	0.255	0.103
24	26.21	2879	C29:1	406	0.338	0.130	0.512	0.257	0.299	0.157
25	26.47	2902	n-C29	408	2.323	0.200	0.700	0.297	0.511	0.220
26	26.87	2937	13;-11;-9-MeC29	141/169/197/253/281/309	1.185	0.244	3.397	1.341	2.856	0.885
27	27.35	2979	9,13-diMeC29	141/211/253/323	3.070	0.112	3.073	0.664	2.633	0.534
28	28.25	3058	3-MeC29	57/393	0.075	0.050	0.100	0.000	0.102	0.004
29	29.32	3153	15;-13-MeC31	197/225/253/281	0.100	0.000	0.307	0.203	0.231	0.208
30	29.70	3187	7-MeC31	113/365	0.388	0.052	0.427	0.133	0.354	0.087
31	31.82	3380	7,x-diMeC33	113	0.100	0.000	0.137	0.057	0.109	0.057

Table S14: Identified hydrocarbons of *Vespula germanica* eggs. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Vespula germanica</i> - Eggs								
#	RT	RI	Compounds	Ions	queens		workers	
					mean	SD	mean	SD
1	17.71	2100	n-C21	296	0.343	0.874	0.439	0.967
2	19.85	2300	n-C23	324	0.754	1.040	0.752	0.882
3	20.40	2348	3-MeC23	57/309	0.081	0.283	0.218	0.505
4	20.91	2400	n-C24	338	0.421	0.634	0.737	1.202
5	21.28	2430	12;-10-MeC24	197/183/155/225	0.236	0.483	0.419	0.760
6	21.69	2469	C25:1	350	0.262	0.379	0.457	0.851
7	21.95	2500	n-C25	352	8.482	2.487	8.669	3.666
8	22.34	2530	13;-11;-9;-7-MeC25	197/169/225/141/253/113/281	5.436	2.205	5.744	2.091
9	22.49	2544	5-MeC25	85/309	0.360	0.330	0.426	0.419
10	22.74	2567	3-MeC25	57/337	8.384	4.077	5.598	1.605
11	23.04	2600	n-C26	366	2.494	0.503	2.761	0.810

12	23.43	2629	12-;10-MeC26	155/183/225/253	2.130	0.696	2.527	1.069
13	23.73	2656	4-MeC26	71/337	1.150	0.278	1.215	0.574
14	23.88	2670	C27:1and 3-MeC26	378 + 57/351	1.109	0.341	1.151	0.650
15	24.16	2695	n-C27	380	15.528	5.577	17.243	6.731
16	24.55	2730	13-;11-;9-MeC27	141/169/197/225/253/281	18.989	6.292	17.884	6.337
17	24.92	2762	9,13-; 11,15-diMeC27	141/211/225/295/169/197/239/267	3.566	1.325	3.793	1.544
18	25.01	2771	3-MeC27	57/365	13.139	3.718	9.753	3.125
19	25.34	2800	n-C28and 3,9-; 3,11-diMeC27	394 + 57/155/183/253/281/379	2.094	0.715	2.609	1.193
20	25.73	2834	12-;10-MeC28	155/183/253/281	1.453	0.979	1.644	0.969
21	26.05	2862	12,16-diMeC28	183/197/253/267	0.547	0.636	0.792	0.668
22	26.22	2877	C29:1	406	0.632	0.424	0.904	0.839
23	26.49	2900	n-C29	408	3.630	3.863	5.397	3.892
24	26.88	2935	13-;11-;9-MeC29	141/169/197/253/281/309	3.018	2.272	3.681	1.363
25	27.25	2968	3-MeC29	57/393	3.984	3.764	3.704	1.794
26	27.68	3000	n-C30	422	1.292	4.029	1.001	1.504
27	28.64	3100	n-C31	436	0.484	1.704	0.484	0.948

Table S15: Identified hydrocarbons of *Vespula germanica* Dufour gland. Retention time (RT), retention index (RI) and diagnostic ions were used to identify the hydrocarbons.

<i>Vespula germanica</i> - Dufour gland									
#	RT	RI	Compounds	Ions	queens	reproductive workers	workers		
1	19.85	2299	n-C23	324	1.367	1.989	1.495	1.612	1.868 1.703
2	20.44	2353	3-MeC23	57/309	2.122	2.510	22.453	13.760	19.897 19.646
3	20.89	2400	n-C24	338	0.241	0.300	0.309	0.365	0.259 0.480
4	21.30	2434	12-;10-MeC24	197/183/155/225	2.375	1.707	1.138	0.722	1.814 1.917
5	21.95	2495	n-C25	352	2.275	2.151	2.897	1.759	2.973 1.979
6	22.29	2527	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281	8.246	2.796	6.015	2.017	7.523 5.156
7	22.76	2571	3-MeC25	57/337	3.325	1.007	6.980	3.522	6.671 3.540
8	23.09	2600	n-C26	366	11.015	4.957	6.220	1.803	6.622 2.834
9	23.39	2628	12-;10-MeC26	155/183/225/253	4.895	2.693	2.807	1.226	3.687 2.181
10	23.77	2662	C27:1	378	1.687	1.067	0.412	0.486	0.821 1.002
11	24.07	2700	n-C27	380	1.198	0.630	1.261	0.738	1.299 0.917
12	24.24	2705	13-;11-;9-MeC27	141/169/197/225/253/281	2.659	1.164	2.251	1.272	2.191 1.321
13	24.53	2731	7-;5-MeC27	113/309/85/337	5.845	3.075	3.135	1.159	3.680 1.610
14	24.97	2770	3-MeC27	57/365	10.878	4.387	14.297	5.926	12.689 6.865
15	25.39	2808	n-C28 + 3,9-; 3,11-diMeC27	394 + 57/155/183/253/281/379	21.646	6.525	14.436	3.640	13.065 5.639
16	26.10	2870	C29:1	406	1.899	1.708	1.473	1.198	2.152 1.518
17	26.40	2900	n-C29	408	0.305	0.428	0.000	0.000	0.309 0.525
18	26.61	2915	13-;11-;9-MeC29	141/169/197/253/281/309	1.697	1.007	1.319	0.711	1.354 1.132
19	26.88	2938	7-MeC29	113/337	0.576	0.288	0.568	0.476	0.512 0.506
20	27.02	2950	3-MeC29	57/393	0.794	0.686	0.593	0.420	0.456 0.522
21	28.98	3121	15-;13-MeC31	197/225/253/281	0.611	0.839	0.577	0.873	0.696 0.867
22	29.51	3168	3-MeC31	57/421	13.837	12.914	9.179	5.118	8.815 7.394
23	31.54	3371	13,17-diMeC33	197/253/267/323	0.509	0.749	0.185	0.454	0.645 0.782

Table S16: Percentage similarity analysis (SIMPER – Bray-Curtis 999 permutations) showing the five most important hydrocarbons for group differentiation (*Vespula germanica* samples). SD = standard deviation; Av = overall average; Sig. Level = Significance Level.

<i>Vespula germanica</i> - CHCs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
n-C27	0.104	0.019	5.432	31.583	10.879	0.001	***
13-;11-;9-MeC27	0.097	0.018	5.278	9.445	28.829	0.001	***
13-;11-;9-;7-MeC25	0.036	0.012	3.047	1.625	8.767	0.001	***
n-C25	0.026	0.015	1.778	13.568	8.318	0.002	**
n-C26	0.014	0.003	5.187	5.028	2.198	0.001	***
<i>Vespula germanica</i> - CHCs - queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. queens	Av. rep. workers	p-value	Sig. Level
n-C27	0.107	0.019	5.778	31.583	10.173	0.001	***
13-;11-;9-MeC27	0.091	0.009	9.929	9.445	27.685	0.001	***
13-;11-;9-;7-MeC25	0.033	0.015	2.252	1.625	8.263	0.003	**
n-C25	0.031	0.012	2.700	13.568	7.282	0.001	***
n-C26	0.015	0.002	7.415	5.028	2.052	0.001	***
<i>Vespula germanica</i> - CHCs - workers x reproductive workers							
Compounds	Average	SD	Ratio	Av. workers	Av. rep. workers	p-value	Sig. Level
13-;11-;9-MeC27	0.016	0.012	1.407	28.829	27.685	1.000	n.s.
13-;11-;9-;7-MeC25	0.015	0.011	1.380	8.767	8.263	0.973	n.s.
n-C27	0.013	0.009	1.395	10.879	10.173	1.000	n.s.
3-MeC35	0.013	0.008	1.565	7.471	7.848	0.095	n.s.
n-C25	0.011	0.008	1.431	8.318	7.282	1.000	n.s.
<i>Vespula germanica</i> - eggs - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
13-;11-9-MeC27	0.0345	0.0272	1.2680	18.9890	17.8844	0.578	n.s.
n-C27	0.0343	0.0268	1.2763	15.5284	17.2428	0.308	n.s.
3-MeC27	0.0239	0.0167	1.4367	13.1392	9.7529	0.005	**
n-C29	0.0223	0.0173	1.2938	3.6299	5.3968	0.114	n.s.
3-MeC25	0.0182	0.0180	1.0132	8.3838	5.5983	0.29	n.s.
<i>Vespula germanica</i> - DG - queens x workers							
Compounds	Average	SD	Ratio	Av. queens	Av. workers	p-value	Sig. Level
3-MeC23	0.045	0.048	0.942	2.122	19.897	0.538	n.s.
3-MeC31	0.026	0.027	0.948	13.837	8.815	0.097	n.s.
n-C28 + 3,9-;3,11-diMeC27	0.025	0.016	1.567	21.646	13.065	0.003	**
3-MeC27	0.016	0.012	1.303	10.878	12.689	0.767	n.s.
n-C26	0.015	0.009	1.540	11.015	6.622	0.002	**
<i>Vespula germanica</i> - DG - queens x reproductive workers							
Compounds	Average	SD	Ratio	Av. queens	Av. rep. workers	p-value	Sig. Level
3-MeC23	0.051	0.032	1.600	2.122	22.453	0.310	n.s.
3-MeC31	0.024	0.025	0.972	13.837	9.179	0.340	n.s.
n-C28 + 3,9-;3,11-diMeC27	0.021	0.013	1.597	21.646	14.436	0.176	n.s.
n-C26	0.015	0.009	1.591	11.015	6.220	0.017	*
3-MeC27	0.015	0.012	1.182	10.878	14.297	0.813	n.s.
<i>Vespula germanica</i> - CHCs - workers x reproductive workers							
Compounds	Average	SD	Ratio	Av. workers	Av. rep. workers	p-value	Sig. Level
3-MeC23	0.046	0.035	1.296	19.897	22.453	0.414	n.s.
3-MeC27	0.018	0.013	1.353	12.689	14.297	0.390	n.s.

3-MeC31	0.015	0.015	1.041	8.815	9.179	0.897	n.s.
n-C28 + 3,9-;3,11-diMeC27	0.013	0.009	1.449	13.065	14.436	0.999	n.s.
3-MeC25	0.009	0.007	1.324	6.671	6.980	0.427	n.s.

Table S17: Percentage of compounds grouped by compound class based on samples of cuticular hydrocarbons for the four study species. Freq % = frequency %.

Group	Species	Class	Freq %	Number
overall	Dolichovespula_saxonica	linear_alkanes	30.297	1
queens	Dolichovespula_saxonica	linear_alkanes	42.040	1
virgin_queens	Dolichovespula_saxonica	linear_alkanes	23.550	1
workers	Dolichovespula_saxonica	linear_alkanes	27.163	1
reproductive_workers	Dolichovespula_saxonica	linear_alkanes	36.958	1
overall	Dolichovespula_saxonica	methyl_alkanes	24.000	1
queens	Dolichovespula_saxonica	methyl_alkanes	17.200	1
virgin_queens	Dolichovespula_saxonica	methyl_alkanes	24.810	1
workers	Dolichovespula_saxonica	methyl_alkanes	26.170	1
reproductive_workers	Dolichovespula_saxonica	methyl_alkanes	21.410	1
overall	Dolichovespula_saxonica	dimethyl_alkanes	15.710	1
queens	Dolichovespula_saxonica	dimethyl_alkanes	17.310	1
virgin_queens	Dolichovespula_saxonica	dimethyl_alkanes	14.500	1
workers	Dolichovespula_saxonica	dimethyl_alkanes	15.480	1
reproductive_workers	Dolichovespula_saxonica	dimethyl_alkanes	16.190	1
overall	Dolichovespula_saxonica	alkenes	18.250	1
queens	Dolichovespula_saxonica	alkenes	14.990	1
virgin_queens	Dolichovespula_saxonica	alkenes	25.660	1
workers	Dolichovespula_saxonica	alkenes	18.490	1
reproductive_workers	Dolichovespula_saxonica	alkenes	14.100	1
overall	Dolichovespula_saxonica	unknown	11.720	1
queens	Dolichovespula_saxonica	unknown	8.430	1
virgin_queens	Dolichovespula_saxonica	unknown	11.470	1
workers	Dolichovespula_saxonica	unknown	12.680	1
reproductive_workers	Dolichovespula_saxonica	unknown	11.310	1
overall	Dolichovespula_media	linear_alkanes	32.400	2
queens	Dolichovespula_media	linear_alkanes	39.820	2
virgin_queens	Dolichovespula_media	linear_alkanes	27.670	2
workers	Dolichovespula_media	linear_alkanes	31.840	2
reproductive_workers	Dolichovespula_media	linear_alkanes	36.160	2
overall	Dolichovespula_media	methyl_alkanes	49.870	2
queens	Dolichovespula_media	methyl_alkanes	48.560	2
virgin_queens	Dolichovespula_media	methyl_alkanes	41.020	2
workers	Dolichovespula_media	methyl_alkanes	53.140	2
reproductive_workers	Dolichovespula_media	methyl_alkanes	49.870	2
overall	Dolichovespula_media	dimethyl_alkanes	3.070	2
queens	Dolichovespula_media	dimethyl_alkanes	3.310	2
virgin_queens	Dolichovespula_media	dimethyl_alkanes	2.220	2
workers	Dolichovespula_media	dimethyl_alkanes	3.280	2

reproductive_workers	Dolichovespula_media	dimethyl_alkanes	3.270	2
overall	Dolichovespula_media	alkenes	14.660	2
queens	Dolichovespula_media	alkenes	8.310	2
virgin_queens	Dolichovespula_media	alkenes	29.090	2
workers	Dolichovespula_media	alkenes	11.740	2
reproductive_workers	Dolichovespula_media	alkenes	10.700	2
overall	Vespa_crabro	linear_alkanes	33.250	3
queens	Vespa_crabro	linear_alkanes	59.240	3
workers	Vespa_crabro	linear_alkanes	27.310	3
overall	Vespa_crabro	methyl_alkanes	12.730	3
queens	Vespa_crabro	methyl_alkanes	17.280	3
workers	Vespa_crabro	methyl_alkanes	11.690	3
overall	Vespa_crabro	dimethyl_alkanes	0.180	3
queens	Vespa_crabro	dimethyl_alkanes	0.360	3
workers	Vespa_crabro	dimethyl_alkanes	0.140	3
overall	Vespa_crabro	alkenes	53.440	3
queens	Vespa_crabro	alkenes	21.870	3
workers	Vespa_crabro	alkenes	60.660	3
overall	Vespa_crabro	unknown	0.390	3
queens	Vespa_crabro	unknown	1.260	3
workers	Vespa_crabro	unknown	0.200	3
overall	Vespula_germanica	linear_alkanes	27.870	4
queens	Vespula_germanica	linear_alkanes	55.570	4
workers	Vespula_germanica	linear_alkanes	24.020	4
reproductive_workers	Vespula_germanica	linear_alkanes	22.260	4
overall	Vespula_germanica	methyl_alkanes	50.760	4
queens	Vespula_germanica	methyl_alkanes	22.600	4
workers	Vespula_germanica	methyl_alkanes	55.160	4
reproductive_workers	Vespula_germanica	methyl_alkanes	54.880	4
overall	Vespula_germanica	dimethyl_alkanes	19.970	4
queens	Vespula_germanica	dimethyl_alkanes	20.560	4
workers	Vespula_germanica	dimethyl_alkanes	19.550	4
reproductive_workers	Vespula_germanica	dimethyl_alkanes	21.000	4
overall	Vespula_germanica	alkenes	1.390	4
queens	Vespula_germanica	alkenes	1.270	4
workers	Vespula_germanica	alkenes	1.280	4
reproductive_workers	Vespula_germanica	alkenes	1.860	4

Table S18: Percentage of compounds grouped by compound class based on samples of eggs for the four study species. Freq % = frequency %.

Group	Species	Class	Freq %	Number
overall	Dolichovespula_saxonica	linear_alkanes	29.370	1
queens	Dolichovespula_saxonica	linear_alkanes	28.790	1
workers	Dolichovespula_saxonica	linear_alkanes	29.840	1
overall	Dolichovespula_saxonica	methyl_alkanes	43.630	1
queens	Dolichovespula_saxonica	methyl_alkanes	45.060	1
workers	Dolichovespula_saxonica	methyl_alkanes	42.480	1
overall	Dolichovespula_saxonica	dimethyl_alkanes	11.400	1
queens	Dolichovespula_saxonica	dimethyl_alkanes	11.100	1

workers	Dolichovespula_saxonica	dimethyl_alkanes	11.630	1
overall	Dolichovespula_saxonica	alkenes	15.630	1
queens	Dolichovespula_saxonica	alkenes	15.070	1
workers	Dolichovespula_saxonica	alkenes	16.070	1
overall	Dolichovespula_media	linear_alkanes	22.280	2
queens	Dolichovespula_media	linear_alkanes	19.780	2
workers	Dolichovespula_media	linear_alkanes	25.140	2
overall	Dolichovespula_media	methyl_alkanes	61.700	2
queens	Dolichovespula_media	methyl_alkanes	65.790	2
workers	Dolichovespula_media	methyl_alkanes	57.020	2
overall	Dolichovespula_media	dimethyl_alkanes	6.700	2
queens	Dolichovespula_media	dimethyl_alkanes	6.550	2
workers	Dolichovespula_media	dimethyl_alkanes	6.880	2
overall	Dolichovespula_media	alkenes	9.320	2
queens	Dolichovespula_media	alkenes	7.880	2
workers	Dolichovespula_media	alkenes	10.960	2
overall	Vespa_crabro	linear_alkanes	52.180	3
queens	Vespa_crabro	linear_alkanes	47.840	3
workers	Vespa_crabro	linear_alkanes	63.950	3
overall	Vespa_crabro	methyl_alkanes	16.840	3
queens	Vespa_crabro	methyl_alkanes	17.900	3
workers	Vespa_crabro	methyl_alkanes	13.950	3
overall	Vespa_crabro	dimethyl_alkanes	0.130	3
queens	Vespa_crabro	dimethyl_alkanes	0.110	3
workers	Vespa_crabro	dimethyl_alkanes	0.180	3
overall	Vespa_crabro	alkenes	30.490	3
queens	Vespa_crabro	alkenes	33.810	3
workers	Vespa_crabro	alkenes	21.470	3
overall	Vespa_crabro	unknown	0.380	3
queens	Vespa_crabro	unknown	0.340	3
workers	Vespa_crabro	unknown	0.460	3
overall	Vespula_germanica	linear_alkanes	37.350	4
queens	Vespula_germanica	linear_alkanes	35.520	4
workers	Vespula_germanica	linear_alkanes	40.090	4
overall	Vespula_germanica	methyl_alkanes	56.140	4
queens	Vespula_germanica	methyl_alkanes	58.360	4
workers	Vespula_germanica	methyl_alkanes	52.810	4
overall	Vespula_germanica	dimethyl_alkanes	4.300	4
queens	Vespula_germanica	dimethyl_alkanes	4.110	4
workers	Vespula_germanica	dimethyl_alkanes	4.580	4
overall	Vespula_germanica	alkenes	2.210	4
queens	Vespula_germanica	alkenes	2.000	4
workers	Vespula_germanica	alkenes	2.510	4

Table S19: Percentage of compounds grouped by compound class based on samples of *Dufour* gland for the four study species. Freq % = frequency %.

Group	Species	Class	Freq %	Number
overall	Dolichovespula_saxonica	linear_alkanes	46.010	1
queens	Dolichovespula_saxonica	linear_alkanes	39.470	1
virgin_queens	Dolichovespula_saxonica	linear_alkanes	24.330	1
workers	Dolichovespula_saxonica	linear_alkanes	50.240	1
reproductive_workers	Dolichovespula_saxonica	linear_alkanes	47.890	1
overall	Dolichovespula_saxonica	methyl_alkanes	36.670	1
queens	Dolichovespula_saxonica	methyl_alkanes	40.850	1
virgin_queens	Dolichovespula_saxonica	methyl_alkanes	40.580	1
workers	Dolichovespula_saxonica	methyl_alkanes	37.020	1
reproductive_workers	Dolichovespula_saxonica	methyl_alkanes	29.880	1
overall	Dolichovespula_saxonica	dimethyl_alkanes	6.760	1
queens	Dolichovespula_saxonica	dimethyl_alkanes	9.050	1
virgin_queens	Dolichovespula_saxonica	dimethyl_alkanes	10.230	1
workers	Dolichovespula_saxonica	dimethyl_alkanes	5.050	1
reproductive_workers	Dolichovespula_saxonica	dimethyl_alkanes	9.790	1
overall	Dolichovespula_saxonica	alkenes	10.580	1
queens	Dolichovespula_saxonica	alkenes	10.660	1
virgin_queens	Dolichovespula_saxonica	alkenes	24.910	1
workers	Dolichovespula_saxonica	alkenes	7.710	1
reproductive_workers	Dolichovespula_saxonica	alkenes	12.440	1
overall	Dolichovespula_media	linear_alkanes	13.970	2
queens	Dolichovespula_media	linear_alkanes	11.190	2
virgin_queens	Dolichovespula_media	linear_alkanes	22.680	2
workers	Dolichovespula_media	linear_alkanes	13.880	2
reproductive_workers	Dolichovespula_media	linear_alkanes	10.080	2
overall	Dolichovespula_media	methyl_alkanes	46.560	2
queens	Dolichovespula_media	methyl_alkanes	58.790	2
virgin_queens	Dolichovespula_media	methyl_alkanes	38.790	2
workers	Dolichovespula_media	methyl_alkanes	44.090	2
reproductive_workers	Dolichovespula_media	methyl_alkanes	52.880	2
overall	Dolichovespula_media	dimethyl_alkanes	13.870	2
queens	Dolichovespula_media	dimethyl_alkanes	15.050	2
virgin_queens	Dolichovespula_media	dimethyl_alkanes	4.350	2
workers	Dolichovespula_media	dimethyl_alkanes	12.510	2
reproductive_workers	Dolichovespula_media	dimethyl_alkanes	25.090	2
overall	Dolichovespula_media	alkenes	25.600	2
queens	Dolichovespula_media	alkenes	14.970	2
virgin_queens	Dolichovespula_media	alkenes	34.180	2
workers	Dolichovespula_media	alkenes	29.520	2
reproductive_workers	Dolichovespula_media	alkenes	11.960	2
overall	Vespa_crabro	linear_alkanes	44.500	3
queens	Vespa_crabro	linear_alkanes	52.210	3
workers	Vespa_crabro	linear_alkanes	40.650	3

overall	Vespa_crabro	methyl_alkanes	21.720	3
queens	Vespa_crabro	methyl_alkanes	37.830	3
workers	Vespa_crabro	methyl_alkanes	13.670	3
overall	Vespa_crabro	dimethyl_alkanes	0.700	3
queens	Vespa_crabro	dimethyl_alkanes	1.670	3
workers	Vespa_crabro	dimethyl_alkanes	0.220	3
overall	Vespa_crabro	alkenes	33.080	3
queens	Vespa_crabro	alkenes	8.290	3
workers	Vespa_crabro	alkenes	45.470	3
overall	Vespula_germanica	linear_alkanes	29.440	4
queens	Vespula_germanica	linear_alkanes	38.050	4
workers	Vespula_germanica	linear_alkanes	26.390	4
reproductive_workers	Vespula_germanica	linear_alkanes	26.620	4
overall	Vespula_germanica	methyl_alkanes	67.110	4
queens	Vespula_germanica	methyl_alkanes	57.860	4
workers	Vespula_germanica	methyl_alkanes	69.990	4
reproductive_workers	Vespula_germanica	methyl_alkanes	71.310	4
overall	Vespula_germanica	dimethyl_alkanes	0.520	4
queens	Vespula_germanica	dimethyl_alkanes	0.510	4
workers	Vespula_germanica	dimethyl_alkanes	0.640	4
reproductive_workers	Vespula_germanica	dimethyl_alkanes	0.190	4
overall	Vespula_germanica	alkenes	2.920	4
queens	Vespula_germanica	alkenes	3.590	4
workers	Vespula_germanica	alkenes	2.970	4
reproductive_workers	Vespula_germanica	alkenes	1.890	4

Table S20: Pairwise comparisons considering the chemical compounds of each group of sample (CHC, eggs or *Dufour's* gland) and each group of female (queen and reproductive worker) in *Dolichovespula saxonica*. chc = cuticular hydrocarbons, rep = reproductive worker, dg = *Dufour's* gland, padj = p value adjusted. All the values highlighted in red correspond to significant values $p < 0.05^*$.

compound	contrast	estimate	SE	df	t.ratio	padj
C23.1...1	queen_chc - queen_dg	0.00	0.62	35	0.00	1.000
C23.1...1	queen_chc - queen_eggs	-5.24	0.41	35	-12.69	0.000
C23.1...1	queen_chc - rep_worker_dg	0.00	0.55	35	0.00	1.000
C23.1...1	queen_chc - repr_worker_chc	0.00	0.48	35	0.00	1.000
C23.1...1	queen_chc - worker_eggs	-5.00	0.40	35	-12.42	0.000
C23.1...1	queen_dg - queen_eggs	-5.24	0.55	35	-9.59	0.000
C23.1...1	queen_dg - rep_worker_dg	0.00	0.65	35	0.00	1.000
C23.1...1	queen_dg - repr_worker_chc	0.00	0.60	35	0.00	1.000
C23.1...1	queen_dg - worker_eggs	-5.00	0.54	35	-9.29	0.000
C23.1...1	queen_eggs - rep_worker_dg	5.24	0.46	35	11.35	0.000
C23.1...1	queen_eggs - repr_worker_chc	5.24	0.38	35	13.76	0.000
C23.1...1	queen_eggs - worker_eggs	0.24	0.28	35	0.87	1.000
C23.1...1	rep_worker_dg - repr_worker_chc	0.00	0.52	35	0.00	1.000
C23.1...1	rep_worker_dg - worker_eggs	-5.00	0.45	35	-11.05	0.000
C23.1...1	repr_worker_chc - worker_eggs	-5.00	0.37	35	-13.54	0.000
C23.1...2	queen_chc - queen_dg	0.00	0.63	35	0.00	1.000

C23.1...2	queen_chc - queen_eggs	-5.48	0.42	35	-13.14	0.000
C23.1...2	queen_chc - rep_worker_dg	0.00	0.55	35	0.00	1.000
C23.1...2	queen_chc - repr_worker_chc	0.00	0.48	35	0.00	1.000
C23.1...2	queen_chc - worker_eggs	-5.13	0.41	35	-12.62	0.000
C23.1...2	queen_dg - queen_eggs	-5.48	0.55	35	-9.94	0.000
C23.1...2	queen_dg - rep_worker_dg	0.00	0.66	35	0.00	1.000
C23.1...2	queen_dg - repr_worker_chc	0.00	0.60	35	0.00	1.000
C23.1...2	queen_dg - worker_eggs	-5.13	0.54	35	-9.44	0.000
C23.1...2	queen_eggs - rep_worker_dg	5.48	0.47	35	11.76	0.000
C23.1...2	queen_eggs - repr_worker_chc	5.48	0.38	35	14.26	0.000
C23.1...2	queen_eggs - worker_eggs	0.35	0.28	35	1.26	1.000
C23.1...2	rep_worker_dg - repr_worker_chc	0.00	0.53	35	0.00	1.000
C23.1...2	rep_worker_dg - worker_eggs	-5.13	0.46	35	-11.23	0.000
C23.1...2	repr_worker_chc - worker_eggs	-5.13	0.37	35	-13.76	0.000
C24.1	queen_chc - queen_dg	0.00	0.50	35	0.00	1.000
C24.1	queen_chc - queen_eggs	-3.57	0.33	35	-10.73	0.000
C24.1	queen_chc - rep_worker_dg	0.00	0.44	35	0.00	1.000
C24.1	queen_chc - repr_worker_chc	0.00	0.39	35	0.00	1.000
C24.1	queen_chc - worker_eggs	-3.53	0.32	35	-10.89	0.000
C24.1	queen_dg - queen_eggs	-3.57	0.44	35	-8.11	0.000
C24.1	queen_dg - rep_worker_dg	0.00	0.53	35	0.00	1.000
C24.1	queen_dg - repr_worker_chc	0.00	0.48	35	0.00	1.000
C24.1	queen_dg - worker_eggs	-3.53	0.43	35	-8.14	0.000
C24.1	queen_eggs - rep_worker_dg	3.57	0.37	35	9.60	0.000
C24.1	queen_eggs - repr_worker_chc	3.57	0.31	35	11.64	0.000
C24.1	queen_eggs - worker_eggs	0.04	0.22	35	0.17	1.000
C24.1	rep_worker_dg - repr_worker_chc	0.00	0.42	35	0.00	1.000
C24.1	rep_worker_dg - worker_eggs	-3.53	0.36	35	-9.69	0.000
C24.1	repr_worker_chc - worker_eggs	-3.53	0.30	35	-11.87	0.000
C25.1...1	queen_chc - queen_dg	4.04	0.87	35	4.63	0.050
C25.1...1	queen_chc - queen_eggs	2.45	0.58	35	4.21	0.190
C25.1...1	queen_chc - rep_worker_dg	3.10	0.77	35	4.03	0.320
C25.1...1	queen_chc - repr_worker_chc	0.57	0.68	35	0.85	1.000
C25.1...1	queen_chc - worker_eggs	1.58	0.57	35	2.79	1.000
C25.1...1	queen_dg - queen_eggs	-1.59	0.77	35	-2.07	1.000
C25.1...1	queen_dg - rep_worker_dg	-0.94	0.92	35	-1.02	1.000
C25.1...1	queen_dg - repr_worker_chc	-3.47	0.84	35	-4.11	0.250
C25.1...1	queen_dg - worker_eggs	-2.46	0.76	35	-3.24	1.000
C25.1...1	queen_eggs - rep_worker_dg	0.65	0.65	35	1.00	1.000
C25.1...1	queen_eggs - repr_worker_chc	-1.88	0.54	35	-3.50	1.000
C25.1...1	queen_eggs - worker_eggs	-0.87	0.39	35	-2.23	1.000
C25.1...1	rep_worker_dg - repr_worker_chc	-2.53	0.74	35	-3.43	1.000
C25.1...1	rep_worker_dg - worker_eggs	-1.52	0.64	35	-2.39	1.000
C25.1...1	repr_worker_chc - worker_eggs	1.01	0.52	35	1.93	1.000
C25.1...2	queen_chc - queen_dg	-4.11	0.84	35	-4.92	0.020
C25.1...2	queen_chc - queen_eggs	-4.95	0.56	35	-8.89	0.000
C25.1...2	queen_chc - rep_worker_dg	-5.92	0.74	35	-8.03	0.000
C25.1...2	queen_chc - repr_worker_chc	0.00	0.65	35	0.00	1.000

C25.1...2	queen_chc - worker_eggs	-5.58	0.54	35	-10.28	0.000
C25.1...2	queen_dg - queen_eggs	-0.84	0.74	35	-1.14	1.000
C25.1...2	queen_dg - rep_worker_dg	-1.80	0.88	35	-2.05	1.000
C25.1...2	queen_dg - repr_worker_chc	4.11	0.81	35	5.10	0.010
C25.1...2	queen_dg - worker_eggs	-1.47	0.73	35	-2.02	1.000
C25.1...2	queen_eggs - rep_worker_dg	-0.96	0.62	35	-1.55	1.000
C25.1...2	queen_eggs - repr_worker_chc	4.95	0.51	35	9.64	0.000
C25.1...2	queen_eggs - worker_eggs	-0.63	0.37	35	-1.69	1.000
C25.1...2	rep_worker_dg - repr_worker_chc	5.92	0.70	35	8.39	0.000
C25.1...2	rep_worker_dg - worker_eggs	0.33	0.61	35	0.54	1.000
C25.1...2	repr_worker_chc - worker_eggs	-5.58	0.50	35	-11.20	0.000
C27.1...1	queen_chc - queen_dg	2.59	0.74	35	3.51	1.000
C27.1...1	queen_chc - queen_eggs	2.06	0.49	35	4.18	0.210
C27.1...1	queen_chc - rep_worker_dg	2.22	0.65	35	3.41	1.000
C27.1...1	queen_chc - repr_worker_chc	-0.41	0.57	35	-0.71	1.000
C27.1...1	queen_chc - worker_eggs	1.67	0.48	35	3.48	1.000
C27.1...1	queen_dg - queen_eggs	-0.53	0.65	35	-0.82	1.000
C27.1...1	queen_dg - rep_worker_dg	-0.37	0.78	35	-0.47	1.000
C27.1...1	queen_dg - repr_worker_chc	-3.00	0.71	35	-4.20	0.190
C27.1...1	queen_dg - worker_eggs	-0.92	0.64	35	-1.43	1.000
C27.1...1	queen_eggs - rep_worker_dg	0.17	0.55	35	0.30	1.000
C27.1...1	queen_eggs - repr_worker_chc	-2.47	0.45	35	-5.43	0.000
C27.1...1	queen_eggs - worker_eggs	-0.39	0.33	35	-1.17	1.000
C27.1...1	rep_worker_dg - repr_worker_chc	-2.63	0.62	35	-4.23	0.180
C27.1...1	rep_worker_dg - worker_eggs	-0.55	0.54	35	-1.02	1.000
C27.1...1	repr_worker_chc - worker_eggs	2.08	0.44	35	4.72	0.040
C27.1...2	queen_chc - queen_dg	-7.70	0.58	35	-13.36	0.000
C27.1...2	queen_chc - queen_eggs	-8.58	0.38	35	-22.33	0.000
C27.1...2	queen_chc - rep_worker_dg	-7.32	0.51	35	-14.39	0.000
C27.1...2	queen_chc - repr_worker_chc	0.00	0.45	35	0.00	1.000
C27.1...2	queen_chc - worker_eggs	-8.80	0.37	35	-23.50	0.000
C27.1...2	queen_dg - queen_eggs	-0.88	0.51	35	-1.73	1.000
C27.1...2	queen_dg - rep_worker_dg	0.39	0.61	35	0.63	1.000
C27.1...2	queen_dg - repr_worker_chc	7.70	0.56	35	13.83	0.000
C27.1...2	queen_dg - worker_eggs	-1.10	0.50	35	-2.19	1.000
C27.1...2	queen_eggs - rep_worker_dg	1.27	0.43	35	2.95	1.000
C27.1...2	queen_eggs - repr_worker_chc	8.58	0.35	35	24.22	0.000
C27.1...2	queen_eggs - worker_eggs	-0.22	0.26	35	-0.85	1.000
C27.1...2	rep_worker_dg - repr_worker_chc	7.32	0.49	35	15.05	0.000
C27.1...2	rep_worker_dg - worker_eggs	-1.48	0.42	35	-3.53	1.000
C27.1...2	repr_worker_chc - worker_eggs	-8.80	0.34	35	-25.61	0.000
C29.1...1	queen_chc - queen_dg	-2.87	0.72	35	-3.96	0.400
C29.1...1	queen_chc - queen_eggs	-3.35	0.48	35	-6.93	0.000
C29.1...1	queen_chc - rep_worker_dg	-2.69	0.64	35	-4.21	0.190
C29.1...1	queen_chc - repr_worker_chc	0.99	0.56	35	1.76	1.000
C29.1...1	queen_chc - worker_eggs	-3.41	0.47	35	-7.24	0.000
C29.1...1	queen_dg - queen_eggs	-0.48	0.64	35	-0.75	1.000
C29.1...1	queen_dg - rep_worker_dg	0.18	0.76	35	0.24	1.000

C29.1...1	queen_dg - repr_worker_chc	3.86	0.70	35	5.51	0.000
C29.1...1	queen_dg - worker_eggs	-0.54	0.63	35	-0.86	1.000
C29.1...1	queen_eggs - rep_worker_dg	0.66	0.54	35	1.22	1.000
C29.1...1	queen_eggs - repr_worker_chc	4.33	0.45	35	9.73	0.000
C29.1...1	queen_eggs - worker_eggs	-0.06	0.32	35	-0.20	1.000
C29.1...1	rep_worker_dg - repr_worker_chc	3.68	0.61	35	6.01	0.000
C29.1...1	rep_worker_dg - worker_eggs	-0.72	0.53	35	-1.37	1.000
C29.1...1	repr_worker_chc - worker_eggs	-4.40	0.43	35	-10.18	0.000
C29.1...2	queen_chc - queen_dg	-10.18	0.59	35	-17.15	0.000
C29.1...2	queen_chc - queen_eggs	-11.17	0.40	35	-28.21	0.000
C29.1...2	queen_chc - rep_worker_dg	-9.43	0.52	35	-18.00	0.000
C29.1...2	queen_chc - repr_worker_chc	0.00	0.46	35	0.00	1.000
C29.1...2	queen_chc - worker_eggs	-11.28	0.39	35	-29.24	0.000
C29.1...2	queen_dg - queen_eggs	-0.99	0.52	35	-1.88	1.000
C29.1...2	queen_dg - rep_worker_dg	0.75	0.63	35	1.21	1.000
C29.1...2	queen_dg - repr_worker_chc	10.18	0.57	35	17.75	0.000
C29.1...2	queen_dg - worker_eggs	-1.10	0.52	35	-2.13	1.000
C29.1...2	queen_eggs - rep_worker_dg	1.74	0.44	35	3.94	0.420
C29.1...2	queen_eggs - repr_worker_chc	11.17	0.36	35	30.60	0.000
C29.1...2	queen_eggs - worker_eggs	-0.11	0.27	35	-0.43	1.000
C29.1...2	rep_worker_dg - repr_worker_chc	9.43	0.50	35	18.83	0.000
C29.1...2	rep_worker_dg - worker_eggs	-1.86	0.43	35	-4.28	0.160
C29.1...2	repr_worker_chc - worker_eggs	-11.28	0.35	35	-31.86	0.000
C31.1	queen_chc - queen_dg	1.73	0.43	35	4.04	0.310
C31.1	queen_chc - queen_eggs	0.95	0.28	35	3.35	1.000
C31.1	queen_chc - rep_worker_dg	3.23	0.38	35	8.58	0.000
C31.1	queen_chc - repr_worker_chc	-0.04	0.33	35	-0.13	1.000
C31.1	queen_chc - worker_eggs	0.88	0.28	35	3.15	1.000
C31.1	queen_dg - queen_eggs	-0.77	0.38	35	-2.05	1.000
C31.1	queen_dg - rep_worker_dg	1.50	0.45	35	3.34	1.000
C31.1	queen_dg - repr_worker_chc	-1.77	0.41	35	-4.29	0.150
C31.1	queen_dg - worker_eggs	-0.85	0.37	35	-2.29	1.000
C31.1	queen_eggs - rep_worker_dg	2.28	0.32	35	7.16	0.000
C31.1	queen_eggs - repr_worker_chc	-1.00	0.26	35	-3.80	0.630
C31.1	queen_eggs - worker_eggs	-0.08	0.19	35	-0.41	1.000
C31.1	rep_worker_dg - repr_worker_chc	-3.27	0.36	35	-9.09	0.000
C31.1	rep_worker_dg - worker_eggs	-2.36	0.31	35	-7.55	0.000
C31.1	repr_worker_chc - worker_eggs	0.92	0.25	35	3.61	1.000
C31.1...2	queen_chc - queen_dg	-9.97	0.28	35	-35.22	0.000
C31.1...2	queen_chc - queen_eggs	0.00	0.19	35	0.00	1.000
C31.1...2	queen_chc - rep_worker_dg	-11.20	0.25	35	-44.90	0.000
C31.1...2	queen_chc - repr_worker_chc	0.00	0.22	35	0.00	1.000
C31.1...2	queen_chc - worker_eggs	0.00	0.18	35	0.00	1.000
C31.1...2	queen_dg - queen_eggs	9.97	0.25	35	39.93	0.000
C31.1...2	queen_dg - rep_worker_dg	-1.24	0.30	35	-4.16	0.220
C31.1...2	queen_dg - repr_worker_chc	9.97	0.27	35	36.45	0.000
C31.1...2	queen_dg - worker_eggs	9.97	0.25	35	40.52	0.000
C31.1...2	queen_eggs - rep_worker_dg	-11.21	0.21	35	-53.13	0.000

C31.1...2	queen_eggs - repr_worker_chc	0.00	0.17	35	0.00	1.000
C31.1...2	queen_eggs - worker_eggs	0.00	0.13	35	0.00	1.000
C31.1...2	rep_worker_dg - repr_worker_chc	11.20	0.24	35	46.96	0.000
C31.1...2	rep_worker_dg - worker_eggs	11.21	0.21	35	54.22	0.000
C31.1...2	repr_worker_chc - worker_eggs	0.00	0.17	35	0.00	1.000
C33.1	queen_chc - queen_dg	-1.42	1.14	35	-1.24	1.000
C33.1	queen_chc - queen_eggs	-1.13	0.76	35	-1.49	1.000
C33.1	queen_chc - rep_worker_dg	-1.30	1.00	35	-1.30	1.000
C33.1	queen_chc - repr_worker_chc	0.77	0.88	35	0.87	1.000
C33.1	queen_chc - worker_eggs	-1.00	0.74	35	-1.35	1.000
C33.1	queen_dg - queen_eggs	0.29	1.00	35	0.28	1.000
C33.1	queen_dg - rep_worker_dg	0.11	1.20	35	0.10	1.000
C33.1	queen_dg - repr_worker_chc	2.18	1.10	35	1.98	1.000
C33.1	queen_dg - worker_eggs	0.42	0.99	35	0.42	1.000
C33.1	queen_eggs - rep_worker_dg	-0.17	0.85	35	-0.20	1.000
C33.1	queen_eggs - repr_worker_chc	1.90	0.70	35	2.71	1.000
C33.1	queen_eggs - worker_eggs	0.13	0.51	35	0.26	1.000
C33.1	rep_worker_dg - repr_worker_chc	2.07	0.96	35	2.15	1.000
C33.1	rep_worker_dg - worker_eggs	0.31	0.83	35	0.37	1.000
C33.1	repr_worker_chc - worker_eggs	-1.76	0.68	35	-2.60	1.000
C35.1	queen_chc - queen_dg	-7.87	0.21	35	-37.21	0.000
C35.1	queen_chc - queen_eggs	0.00	0.14	35	0.00	1.000
C35.1	queen_chc - rep_worker_dg	-6.92	0.19	35	-37.09	0.000
C35.1	queen_chc - repr_worker_chc	0.00	0.16	35	0.00	1.000
C35.1	queen_chc - worker_eggs	0.00	0.14	35	0.00	1.000
C35.1	queen_dg - queen_eggs	7.87	0.19	35	42.19	0.000
C35.1	queen_dg - rep_worker_dg	0.95	0.22	35	4.27	0.160
C35.1	queen_dg - repr_worker_chc	7.87	0.20	35	38.51	0.000
C35.1	queen_dg - worker_eggs	7.87	0.18	35	42.81	0.000
C35.1	queen_eggs - rep_worker_dg	-6.92	0.16	35	-43.89	0.000
C35.1	queen_eggs - repr_worker_chc	0.00	0.13	35	0.00	1.000
C35.1	queen_eggs - worker_eggs	0.00	0.09	35	0.00	1.000
C35.1	rep_worker_dg - repr_worker_chc	6.92	0.18	35	38.79	0.000
C35.1	rep_worker_dg - worker_eggs	6.92	0.15	35	44.79	0.000
C35.1	repr_worker_chc - worker_eggs	0.00	0.13	35	0.00	1.000
n.C20	queen_chc - queen_dg	0.00	0.82	35	0.00	1.000
n.C20	queen_chc - queen_eggs	-8.95	0.55	35	-16.42	0.000
n.C20	queen_chc - rep_worker_dg	0.00	0.72	35	0.00	1.000
n.C20	queen_chc - repr_worker_chc	0.00	0.63	35	0.00	1.000
n.C20	queen_chc - worker_eggs	-8.65	0.53	35	-16.27	0.000
n.C20	queen_dg - queen_eggs	-8.95	0.72	35	-12.42	0.000
n.C20	queen_dg - rep_worker_dg	0.00	0.86	35	0.00	1.000
n.C20	queen_dg - repr_worker_chc	0.00	0.79	35	0.00	1.000
n.C20	queen_dg - worker_eggs	-8.65	0.71	35	-12.17	0.000
n.C20	queen_eggs - rep_worker_dg	8.95	0.61	35	14.69	0.000
n.C20	queen_eggs - repr_worker_chc	8.95	0.50	35	17.81	0.000
n.C20	queen_eggs - worker_eggs	0.31	0.37	35	0.84	1.000
n.C20	rep_worker_dg - repr_worker_chc	0.00	0.69	35	0.00	1.000

n.C20	rep_worker_dg - worker_eggs	-8.65	0.60	35	-14.48	0.000
n.C20	repr_worker_chc - worker_eggs	-8.65	0.49	35	-17.73	0.000
n.C21	queen_chc - queen_dg	0.00	0.41	35	0.00	1.000
n.C21	queen_chc - queen_eggs	-6.96	0.27	35	-25.57	0.000
n.C21	queen_chc - rep_worker_dg	0.00	0.36	35	0.00	1.000
n.C21	queen_chc - repr_worker_chc	0.00	0.32	35	0.00	1.000
n.C21	queen_chc - worker_eggs	-6.94	0.27	35	-26.19	0.000
n.C21	queen_dg - queen_eggs	-6.96	0.36	35	-19.33	0.000
n.C21	queen_dg - rep_worker_dg	0.00	0.43	35	0.00	1.000
n.C21	queen_dg - repr_worker_chc	0.00	0.39	35	0.00	1.000
n.C21	queen_dg - worker_eggs	-6.95	0.35	35	-19.58	0.000
n.C21	queen_eggs - rep_worker_dg	6.96	0.30	35	22.87	0.000
n.C21	queen_eggs - repr_worker_chc	6.96	0.25	35	27.74	0.000
n.C21	queen_eggs - worker_eggs	0.01	0.18	35	0.07	1.000
n.C21	rep_worker_dg - repr_worker_chc	0.00	0.34	35	0.00	1.000
n.C21	rep_worker_dg - worker_eggs	-6.94	0.30	35	-23.30	0.000
n.C21	repr_worker_chc - worker_eggs	-6.94	0.24	35	-28.54	0.000
n.C22	queen_chc - queen_dg	0.00	0.71	35	0.00	1.000
n.C22	queen_chc - queen_eggs	-9.03	0.47	35	-19.08	0.000
n.C22	queen_chc - rep_worker_dg	0.00	0.63	35	0.00	1.000
n.C22	queen_chc - repr_worker_chc	0.00	0.55	35	0.00	1.000
n.C22	queen_chc - worker_eggs	-8.45	0.46	35	-18.31	0.000
n.C22	queen_dg - queen_eggs	-9.03	0.63	35	-14.42	0.000
n.C22	queen_dg - rep_worker_dg	0.00	0.75	35	0.00	1.000
n.C22	queen_dg - repr_worker_chc	0.00	0.69	35	0.00	1.000
n.C22	queen_dg - worker_eggs	-8.45	0.62	35	-13.69	0.000
n.C22	queen_eggs - rep_worker_dg	9.03	0.53	35	17.07	0.000
n.C22	queen_eggs - repr_worker_chc	9.03	0.44	35	20.70	0.000
n.C22	queen_eggs - worker_eggs	0.59	0.32	35	1.84	1.000
n.C22	rep_worker_dg - repr_worker_chc	0.00	0.60	35	0.00	1.000
n.C22	rep_worker_dg - worker_eggs	-8.45	0.52	35	-16.29	0.000
n.C22	repr_worker_chc - worker_eggs	-8.45	0.42	35	-19.95	0.000
n.C23	queen_chc - queen_dg	-4.56	0.83	35	-5.50	0.000
n.C23	queen_chc - queen_eggs	-7.92	0.55	35	-14.33	0.000
n.C23	queen_chc - rep_worker_dg	-6.70	0.73	35	-9.16	0.000
n.C23	queen_chc - repr_worker_chc	1.66	0.64	35	2.59	1.000
n.C23	queen_chc - worker_eggs	-8.35	0.54	35	-15.50	0.000
n.C23	queen_dg - queen_eggs	-3.36	0.73	35	-4.59	0.060
n.C23	queen_dg - rep_worker_dg	-2.14	0.87	35	-2.45	1.000
n.C23	queen_dg - repr_worker_chc	6.23	0.80	35	7.77	0.000
n.C23	queen_dg - worker_eggs	-3.79	0.72	35	-5.26	0.010
n.C23	queen_eggs - rep_worker_dg	1.22	0.62	35	1.97	1.000
n.C23	queen_eggs - repr_worker_chc	9.58	0.51	35	18.80	0.000
n.C23	queen_eggs - worker_eggs	-0.43	0.37	35	-1.16	1.000
n.C23	rep_worker_dg - repr_worker_chc	8.37	0.70	35	11.96	0.000
n.C23	rep_worker_dg - worker_eggs	-1.65	0.61	35	-2.72	1.000
n.C23	repr_worker_chc - worker_eggs	-10.02	0.49	35	-20.25	0.000
n.C24	queen_chc - queen_dg	2.49	0.67	35	3.72	0.790

n.C24	queen_chc - queen_eggs	-6.57	0.45	35	-14.68	0.000
n.C24	queen_chc - rep_worker_dg	2.49	0.59	35	4.21	0.190
n.C24	queen_chc - repr_worker_chc	2.49	0.52	35	4.80	0.030
n.C24	queen_chc - worker_eggs	-6.21	0.44	35	-14.25	0.000
n.C24	queen_dg - queen_eggs	-9.06	0.59	35	-15.31	0.000
n.C24	queen_dg - rep_worker_dg	0.00	0.71	35	0.00	1.000
n.C24	queen_dg - repr_worker_chc	0.00	0.65	35	0.00	1.000
n.C24	queen_dg - worker_eggs	-8.70	0.58	35	-14.93	0.000
n.C24	queen_eggs - rep_worker_dg	9.06	0.50	35	18.12	0.000
n.C24	queen_eggs - repr_worker_chc	9.06	0.41	35	21.97	0.000
n.C24	queen_eggs - worker_eggs	0.35	0.30	35	1.18	1.000
n.C24	rep_worker_dg - repr_worker_chc	0.00	0.57	35	0.00	1.000
n.C24	rep_worker_dg - worker_eggs	-8.70	0.49	35	-17.77	0.000
n.C24	repr_worker_chc - worker_eggs	-8.70	0.40	35	-21.76	0.000
n.C25	queen_chc - queen_dg	-3.52	0.44	35	-8.00	0.000
n.C25	queen_chc - queen_eggs	-5.24	0.29	35	-17.85	0.000
n.C25	queen_chc - rep_worker_dg	-2.72	0.39	35	-7.00	0.000
n.C25	queen_chc - repr_worker_chc	-0.97	0.34	35	-2.84	1.000
n.C25	queen_chc - worker_eggs	-5.27	0.29	35	-18.42	0.000
n.C25	queen_dg - queen_eggs	-1.72	0.39	35	-4.42	0.100
n.C25	queen_dg - rep_worker_dg	0.80	0.46	35	1.73	1.000
n.C25	queen_dg - repr_worker_chc	2.55	0.43	35	6.00	0.000
n.C25	queen_dg - worker_eggs	-1.75	0.38	35	-4.57	0.070
n.C25	queen_eggs - rep_worker_dg	2.52	0.33	35	7.68	0.000
n.C25	queen_eggs - repr_worker_chc	4.27	0.27	35	15.77	0.000
n.C25	queen_eggs - worker_eggs	-0.03	0.20	35	-0.16	1.000
n.C25	rep_worker_dg - repr_worker_chc	1.75	0.37	35	4.70	0.040
n.C25	rep_worker_dg - worker_eggs	-2.55	0.32	35	-7.94	0.000
n.C25	repr_worker_chc - worker_eggs	-4.30	0.26	35	-16.37	0.000
n.C26	queen_chc - queen_dg	-8.22	0.50	35	-16.49	0.000
n.C26	queen_chc - queen_eggs	-9.56	0.33	35	-28.76	0.000
n.C26	queen_chc - rep_worker_dg	-7.64	0.44	35	-17.37	0.000
n.C26	queen_chc - repr_worker_chc	0.00	0.39	35	0.00	1.000
n.C26	queen_chc - worker_eggs	-9.46	0.32	35	-29.20	0.000
n.C26	queen_dg - queen_eggs	-1.34	0.44	35	-3.04	1.000
n.C26	queen_dg - rep_worker_dg	0.58	0.53	35	1.11	1.000
n.C26	queen_dg - repr_worker_chc	8.22	0.48	35	17.07	0.000
n.C26	queen_dg - worker_eggs	-1.24	0.43	35	-2.86	1.000
n.C26	queen_eggs - rep_worker_dg	1.92	0.37	35	5.16	0.010
n.C26	queen_eggs - repr_worker_chc	9.56	0.31	35	31.19	0.000
n.C26	queen_eggs - worker_eggs	0.10	0.22	35	0.45	1.000
n.C26	rep_worker_dg - repr_worker_chc	7.64	0.42	35	18.17	0.000
n.C26	rep_worker_dg - worker_eggs	-1.82	0.36	35	-5.00	0.020
n.C26	repr_worker_chc - worker_eggs	-9.46	0.30	35	-31.82	0.000
n.C27	queen_chc - queen_dg	-3.97	0.41	35	-9.65	0.000
n.C27	queen_chc - queen_eggs	-3.77	0.27	35	-13.76	0.000
n.C27	queen_chc - rep_worker_dg	-3.70	0.36	35	-10.21	0.000
n.C27	queen_chc - repr_worker_chc	-0.85	0.32	35	-2.68	1.000

n.C27	queen_chc - worker_eggs	-3.69	0.27	35	-13.82	0.000
n.C27	queen_dg - queen_eggs	0.20	0.36	35	0.54	1.000
n.C27	queen_dg - rep_worker_dg	0.27	0.43	35	0.62	1.000
n.C27	queen_dg - repr_worker_chc	3.12	0.40	35	7.84	0.000
n.C27	queen_dg - worker_eggs	0.28	0.36	35	0.77	1.000
n.C27	queen_eggs - rep_worker_dg	0.07	0.31	35	0.23	1.000
n.C27	queen_eggs - repr_worker_chc	2.92	0.25	35	11.55	0.000
n.C27	queen_eggs - worker_eggs	0.08	0.18	35	0.43	1.000
n.C27	rep_worker_dg - repr_worker_chc	2.85	0.35	35	8.21	0.000
n.C27	rep_worker_dg - worker_eggs	0.01	0.30	35	0.03	1.000
n.C27	repr_worker_chc - worker_eggs	-2.84	0.25	35	-11.58	0.000
n.C28	queen_chc - queen_dg	-2.86	0.47	35	-6.14	0.000
n.C28	queen_chc - queen_eggs	-1.57	0.31	35	-5.08	0.010
n.C28	queen_chc - rep_worker_dg	-3.46	0.41	35	-8.43	0.000
n.C28	queen_chc - repr_worker_chc	-0.47	0.36	35	-1.29	1.000
n.C28	queen_chc - worker_eggs	-1.65	0.30	35	-5.47	0.000
n.C28	queen_dg - queen_eggs	1.28	0.41	35	3.13	1.000
n.C28	queen_dg - rep_worker_dg	-0.60	0.49	35	-1.23	1.000
n.C28	queen_dg - repr_worker_chc	2.39	0.45	35	5.32	0.010
n.C28	queen_dg - worker_eggs	1.20	0.40	35	2.98	1.000
n.C28	queen_eggs - rep_worker_dg	-1.88	0.35	35	-5.44	0.000
n.C28	queen_eggs - repr_worker_chc	1.11	0.29	35	3.88	0.500
n.C28	queen_eggs - worker_eggs	-0.08	0.21	35	-0.38	1.000
n.C28	rep_worker_dg - repr_worker_chc	2.99	0.39	35	7.63	0.000
n.C28	rep_worker_dg - worker_eggs	1.80	0.34	35	5.31	0.010
n.C28	repr_worker_chc - worker_eggs	-1.19	0.28	35	-4.29	0.150
n.C29	queen_chc - queen_dg	0.76	0.52	35	1.44	1.000
n.C29	queen_chc - queen_eggs	0.88	0.35	35	2.52	1.000
n.C29	queen_chc - rep_worker_dg	0.48	0.46	35	1.03	1.000
n.C29	queen_chc - repr_worker_chc	-0.02	0.40	35	-0.04	1.000
n.C29	queen_chc - worker_eggs	0.89	0.34	35	2.63	1.000
n.C29	queen_dg - queen_eggs	0.12	0.46	35	0.27	1.000
n.C29	queen_dg - rep_worker_dg	-0.28	0.55	35	-0.50	1.000
n.C29	queen_dg - repr_worker_chc	-0.77	0.50	35	-1.53	1.000
n.C29	queen_dg - worker_eggs	0.14	0.45	35	0.30	1.000
n.C29	queen_eggs - rep_worker_dg	-0.40	0.39	35	-1.03	1.000
n.C29	queen_eggs - repr_worker_chc	-0.89	0.32	35	-2.79	1.000
n.C29	queen_eggs - worker_eggs	0.02	0.23	35	0.07	1.000
n.C29	rep_worker_dg - repr_worker_chc	-0.49	0.44	35	-1.12	1.000
n.C29	rep_worker_dg - worker_eggs	0.42	0.38	35	1.09	1.000
n.C29	repr_worker_chc - worker_eggs	0.91	0.31	35	2.92	1.000
n.C30	queen_chc - queen_dg	-11.06	0.11	35	-105.30	0.000
n.C30	queen_chc - queen_eggs	0.00	0.07	35	0.01	1.000
n.C30	queen_chc - rep_worker_dg	-9.90	0.09	35	-106.94	0.000
n.C30	queen_chc - repr_worker_chc	0.00	0.08	35	0.00	1.000
n.C30	queen_chc - worker_eggs	0.00	0.07	35	0.01	1.000
n.C30	queen_dg - queen_eggs	11.06	0.09	35	119.40	0.000
n.C30	queen_dg - rep_worker_dg	1.15	0.11	35	10.42	0.000

n.C30	queen_dg - repr_worker_chc	11.06	0.10	35	108.99	0.000
n.C30	queen_dg - worker_eggs	11.06	0.09	35	121.15	0.000
n.C30	queen_eggs - rep_worker_dg	-9.90	0.08	35	-126.54	0.000
n.C30	queen_eggs - repr_worker_chc	0.00	0.06	35	-0.01	1.000
n.C30	queen_eggs - worker_eggs	0.00	0.05	35	0.00	1.000
n.C30	rep_worker_dg - repr_worker_chc	9.90	0.09	35	111.84	0.000
n.C30	rep_worker_dg - worker_eggs	9.90	0.08	35	129.15	0.000
n.C30	repr_worker_chc - worker_eggs	0.00	0.06	35	0.01	1.000
n.C31	queen_chc - queen_dg	0.96	0.56	35	1.71	1.000
n.C31	queen_chc - queen_eggs	3.08	0.38	35	8.20	0.000
n.C31	queen_chc - rep_worker_dg	1.62	0.50	35	3.27	1.000
n.C31	queen_chc - repr_worker_chc	0.01	0.44	35	0.02	1.000
n.C31	queen_chc - worker_eggs	2.58	0.37	35	7.04	0.000
n.C31	queen_dg - queen_eggs	2.11	0.50	35	4.26	0.170
n.C31	queen_dg - rep_worker_dg	0.66	0.59	35	1.11	1.000
n.C31	queen_dg - repr_worker_chc	-0.95	0.54	35	-1.75	1.000
n.C31	queen_dg - worker_eggs	1.61	0.49	35	3.29	1.000
n.C31	queen_eggs - rep_worker_dg	-1.45	0.42	35	-3.46	1.000
n.C31	queen_eggs - repr_worker_chc	-3.07	0.35	35	-8.86	0.000
n.C31	queen_eggs - worker_eggs	-0.50	0.25	35	-1.99	1.000
n.C31	rep_worker_dg - repr_worker_chc	-1.61	0.48	35	-3.40	1.000
n.C31	rep_worker_dg - worker_eggs	0.95	0.41	35	2.32	1.000
n.C31	repr_worker_chc - worker_eggs	2.57	0.34	35	7.64	0.000
n.C32	queen_chc - queen_dg	-8.33	0.39	35	-21.12	0.000
n.C32	queen_chc - queen_eggs	0.00	0.26	35	0.00	1.000
n.C32	queen_chc - rep_worker_dg	-8.84	0.35	35	-25.40	0.000
n.C32	queen_chc - repr_worker_chc	0.00	0.31	35	0.00	1.000
n.C32	queen_chc - worker_eggs	0.00	0.26	35	0.00	1.000
n.C32	queen_dg - queen_eggs	8.33	0.35	35	23.94	0.000
n.C32	queen_dg - rep_worker_dg	-0.51	0.42	35	-1.22	1.000
n.C32	queen_dg - repr_worker_chc	8.33	0.38	35	21.86	0.000
n.C32	queen_dg - worker_eggs	8.33	0.34	35	24.29	0.000
n.C32	queen_eggs - rep_worker_dg	-8.84	0.29	35	-30.06	0.000
n.C32	queen_eggs - repr_worker_chc	0.00	0.24	35	0.00	1.000
n.C32	queen_eggs - worker_eggs	0.00	0.18	35	0.00	1.000
n.C32	rep_worker_dg - repr_worker_chc	8.84	0.33	35	26.56	0.000
n.C32	rep_worker_dg - worker_eggs	8.84	0.29	35	30.68	0.000
n.C32	repr_worker_chc - worker_eggs	0.00	0.24	35	0.00	1.000
n.C33	queen_chc - queen_dg	-10.73	0.72	35	-14.92	0.000
n.C33	queen_chc - queen_eggs	-7.94	0.48	35	-16.57	0.000
n.C33	queen_chc - rep_worker_dg	-9.94	0.63	35	-15.67	0.000
n.C33	queen_chc - repr_worker_chc	0.00	0.56	35	0.00	1.000
n.C33	queen_chc - worker_eggs	-8.75	0.47	35	-18.73	0.000
n.C33	queen_dg - queen_eggs	2.79	0.63	35	4.39	0.110
n.C33	queen_dg - rep_worker_dg	0.79	0.76	35	1.04	1.000
n.C33	queen_dg - repr_worker_chc	10.73	0.69	35	15.45	0.000
n.C33	queen_dg - worker_eggs	1.98	0.63	35	3.16	1.000
n.C33	queen_eggs - rep_worker_dg	-2.00	0.54	35	-3.72	0.770

n.C33	queen_eggs - repr_worker_chc	7.94	0.44	35	17.97	0.000
n.C33	queen_eggs - worker_eggs	-0.81	0.32	35	-2.52	1.000
n.C33	rep_worker_dg - repr_worker_chc	9.94	0.61	35	16.39	0.000
n.C33	rep_worker_dg - worker_eggs	1.19	0.53	35	2.26	1.000
n.C33	repr_worker_chc - worker_eggs	-8.75	0.43	35	-20.42	0.000
n.C35	queen_chc - queen_dg	-10.41	0.20	35	-50.94	0.000
n.C35	queen_chc - queen_eggs	0.00	0.14	35	0.00	1.000
n.C35	queen_chc - rep_worker_dg	-8.76	0.18	35	-48.65	0.000
n.C35	queen_chc - repr_worker_chc	0.00	0.16	35	0.00	1.000
n.C35	queen_chc - worker_eggs	0.00	0.13	35	0.00	1.000
n.C35	queen_dg - queen_eggs	10.41	0.18	35	57.77	0.000
n.C35	queen_dg - rep_worker_dg	1.64	0.22	35	7.63	0.000
n.C35	queen_dg - repr_worker_chc	10.41	0.20	35	52.73	0.000
n.C35	queen_dg - worker_eggs	10.41	0.18	35	58.61	0.000
n.C35	queen_eggs - rep_worker_dg	-8.76	0.15	35	-57.56	0.000
n.C35	queen_eggs - repr_worker_chc	0.00	0.13	35	0.00	1.000
n.C35	queen_eggs - worker_eggs	0.00	0.09	35	0.00	1.000
n.C35	rep_worker_dg - repr_worker_chc	8.76	0.17	35	50.88	0.000
n.C35	rep_worker_dg - worker_eggs	8.76	0.15	35	58.75	0.000
n.C35	repr_worker_chc - worker_eggs	0.00	0.12	35	0.00	1.000
unknown	queen_chc - queen_dg	5.74	0.24	35	24.29	0.000
unknown	queen_chc - queen_eggs	5.74	0.16	35	36.43	0.000
unknown	queen_chc - rep_worker_dg	5.74	0.21	35	27.54	0.000
unknown	queen_chc - repr_worker_chc	0.75	0.18	35	4.08	0.270
unknown	queen_chc - worker_eggs	5.74	0.15	35	37.38	0.000
unknown	queen_dg - queen_eggs	0.00	0.21	35	0.00	1.000
unknown	queen_dg - rep_worker_dg	0.00	0.25	35	0.00	1.000
unknown	queen_dg - repr_worker_chc	-4.99	0.23	35	-21.87	0.000
unknown	queen_dg - worker_eggs	0.00	0.21	35	0.00	1.000
unknown	queen_eggs - rep_worker_dg	0.00	0.18	35	0.00	1.000
unknown	queen_eggs - repr_worker_chc	-4.99	0.15	35	-34.37	0.000
unknown	queen_eggs - worker_eggs	0.00	0.11	35	0.00	1.000
unknown	rep_worker_dg - repr_worker_chc	-4.99	0.20	35	-25.05	0.000
unknown	rep_worker_dg - worker_eggs	0.00	0.17	35	0.00	1.000
unknown	repr_worker_chc - worker_eggs	4.99	0.14	35	35.43	0.000
unknown.1	queen_chc - queen_dg	13.01	0.08	35	159.88	0.000
unknown.1	queen_chc - queen_eggs	13.01	0.05	35	239.82	0.000
unknown.1	queen_chc - rep_worker_dg	13.01	0.07	35	181.29	0.000
unknown.1	queen_chc - repr_worker_chc	-0.45	0.06	35	-7.09	0.000
unknown.1	queen_chc - worker_eggs	13.01	0.05	35	246.05	0.000
unknown.1	queen_dg - queen_eggs	0.00	0.07	35	0.00	1.000
unknown.1	queen_dg - rep_worker_dg	0.00	0.09	35	0.00	1.000
unknown.1	queen_dg - repr_worker_chc	-13.46	0.08	35	-171.18	0.000
unknown.1	queen_dg - worker_eggs	0.00	0.07	35	0.00	1.000
unknown.1	queen_eggs - rep_worker_dg	0.00	0.06	35	0.00	1.000
unknown.1	queen_eggs - repr_worker_chc	-13.46	0.05	35	-269.06	0.000
unknown.1	queen_eggs - worker_eggs	0.00	0.04	35	0.00	1.000
unknown.1	rep_worker_dg - repr_worker_chc	-13.46	0.07	35	-196.10	0.000

unknown.1	rep_worker_dg - worker_eggs	0.00	0.06	35	0.00	1.000
unknown.1	repr_worker_chc - worker_eggs	13.46	0.05	35	277.34	0.000
.y.diMeC28	queen_chc - queen_dg	9.35	0.47	35	19.77	0.000
.y.diMeC28	queen_chc - queen_eggs	9.35	0.32	35	29.66	0.000
.y.diMeC28	queen_chc - rep_worker_dg	9.35	0.42	35	22.42	0.000
.y.diMeC28	queen_chc - repr_worker_chc	-0.10	0.37	35	-0.27	1.000
.y.diMeC28	queen_chc - worker_eggs	9.35	0.31	35	30.43	0.000
.y.diMeC28	queen_dg - queen_eggs	0.00	0.42	35	0.00	1.000
.y.diMeC28	queen_dg - rep_worker_dg	0.00	0.50	35	0.00	1.000
.y.diMeC28	queen_dg - repr_worker_chc	-9.45	0.46	35	-20.69	0.000
.y.diMeC28	queen_dg - worker_eggs	0.00	0.41	35	0.00	1.000
.y.diMeC28	queen_eggs - rep_worker_dg	0.00	0.35	35	0.00	1.000
.y.diMeC28	queen_eggs - repr_worker_chc	-9.45	0.29	35	-32.51	0.000
.y.diMeC28	queen_eggs - worker_eggs	0.00	0.21	35	0.00	1.000
.y.diMeC28	rep_worker_dg - repr_worker_chc	-9.45	0.40	35	-23.70	0.000
.y.diMeC28	rep_worker_dg - worker_eggs	0.00	0.35	35	0.00	1.000
.y.diMeC28	repr_worker_chc - worker_eggs	9.45	0.28	35	33.52	0.000
11..15.diMeC27	queen_chc - queen_dg	1.44	0.51	35	2.85	1.000
11..15.diMeC27	queen_chc - queen_eggs	0.18	0.34	35	0.53	1.000
11..15.diMeC27	queen_chc - rep_worker_dg	2.38	0.45	35	5.35	0.010
11..15.diMeC27	queen_chc - repr_worker_chc	-0.46	0.39	35	-1.19	1.000
11..15.diMeC27	queen_chc - worker_eggs	-0.29	0.33	35	-0.90	1.000
11..15.diMeC27	queen_dg - queen_eggs	-1.26	0.45	35	-2.83	1.000
11..15.diMeC27	queen_dg - rep_worker_dg	0.94	0.53	35	1.77	1.000
11..15.diMeC27	queen_dg - repr_worker_chc	-1.90	0.49	35	-3.90	0.470
11..15.diMeC27	queen_dg - worker_eggs	-1.73	0.44	35	-3.95	0.410
11..15.diMeC27	queen_eggs - rep_worker_dg	2.20	0.38	35	5.86	0.000
11..15.diMeC27	queen_eggs - repr_worker_chc	-0.64	0.31	35	-2.07	1.000
11..15.diMeC27	queen_eggs - worker_eggs	-0.47	0.23	35	-2.09	1.000
11..15.diMeC27	rep_worker_dg - repr_worker_chc	-2.85	0.43	35	-6.68	0.000
11..15.diMeC27	rep_worker_dg - worker_eggs	-2.68	0.37	35	-7.26	0.000
11..15.diMeC27	repr_worker_chc - worker_eggs	0.17	0.30	35	0.57	1.000
11..9..7.MeC23	queen_chc - queen_dg	0.00	0.58	35	0.00	1.000
11..9..7.MeC23	queen_chc - queen_eggs	-7.99	0.39	35	-20.70	0.000
11..9..7.MeC23	queen_chc - rep_worker_dg	0.00	0.51	35	0.00	1.000
11..9..7.MeC23	queen_chc - repr_worker_chc	0.00	0.45	35	0.00	1.000
11..9..7.MeC23	queen_chc - worker_eggs	-8.15	0.38	35	-21.67	0.000
11..9..7.MeC23	queen_dg - queen_eggs	-7.99	0.51	35	-15.65	0.000
11..9..7.MeC23	queen_dg - rep_worker_dg	0.00	0.61	35	0.00	1.000
11..9..7.MeC23	queen_dg - repr_worker_chc	0.00	0.56	35	0.00	1.000
11..9..7.MeC23	queen_dg - worker_eggs	-8.16	0.50	35	-16.20	0.000
11..9..7.MeC23	queen_eggs - rep_worker_dg	7.99	0.43	35	18.52	0.000
11..9..7.MeC23	queen_eggs - repr_worker_chc	7.99	0.36	35	22.46	0.000
11..9..7.MeC23	queen_eggs - worker_eggs	-0.16	0.26	35	-0.62	1.000
11..9..7.MeC23	rep_worker_dg - repr_worker_chc	0.00	0.49	35	0.00	1.000
11..9..7.MeC23	rep_worker_dg - worker_eggs	-8.16	0.42	35	-19.28	0.000
11..9..7.MeC23	repr_worker_chc - worker_eggs	-8.15	0.35	35	-23.61	0.000
11.15...11.17...13.17.diMeC29	queen_chc - queen_dg	1.93	0.43	35	4.47	0.090

11.15...11.17...13.17.diMeC29	queen_chc - queen_eggs	1.12	0.29	35	3.90	0.460
11.15...11.17...13.17.diMeC29	queen_chc - rep_worker_dg	2.40	0.38	35	6.32	0.000
11.15...11.17...13.17.diMeC29	queen_chc - repr_worker_chc	-0.59	0.33	35	-1.78	1.000
11.15...11.17...13.17.diMeC29	queen_chc - worker_eggs	0.67	0.28	35	2.39	1.000
11.15...11.17...13.17.diMeC29	queen_dg - queen_eggs	-0.80	0.38	35	-2.12	1.000
11.15...11.17...13.17.diMeC29	queen_dg - rep_worker_dg	0.47	0.45	35	1.05	1.000
11.15...11.17...13.17.diMeC29	queen_dg - repr_worker_chc	-2.52	0.42	35	-6.05	0.000
11.15...11.17...13.17.diMeC29	queen_dg - worker_eggs	-1.26	0.37	35	-3.36	1.000
11.15...11.17...13.17.diMeC29	queen_eggs - rep_worker_dg	1.28	0.32	35	3.98	0.370
11.15...11.17...13.17.diMeC29	queen_eggs - repr_worker_chc	-1.71	0.26	35	-6.48	0.000
11.15...11.17...13.17.diMeC29	queen_eggs - worker_eggs	-0.45	0.19	35	-2.35	1.000
11.15...11.17...13.17.diMeC29	rep_worker_dg - repr_worker_chc	-2.99	0.36	35	-8.24	0.000
11.15...11.17...13.17.diMeC29	rep_worker_dg - worker_eggs	-1.73	0.31	35	-5.50	0.000
11.15...11.17...13.17.diMeC29	repr_worker_chc - worker_eggs	1.26	0.26	35	4.91	0.020
11.15.diMeC31	queen_chc - queen_dg	0.00	0.50	35	0.00	1.000
11.15.diMeC31	queen_chc - queen_eggs	-10.07	0.34	35	-29.93	0.000
11.15.diMeC31	queen_chc - rep_worker_dg	0.00	0.44	35	0.00	1.000
11.15.diMeC31	queen_chc - repr_worker_chc	0.00	0.39	35	0.00	1.000
11.15.diMeC31	queen_chc - worker_eggs	-10.34	0.33	35	-31.56	0.000
11.15.diMeC31	queen_dg - queen_eggs	-10.07	0.44	35	-22.63	0.000
11.15.diMeC31	queen_dg - rep_worker_dg	0.00	0.53	35	0.00	1.000
11.15.diMeC31	queen_dg - repr_worker_chc	0.00	0.49	35	0.00	1.000
11.15.diMeC31	queen_dg - worker_eggs	-10.35	0.44	35	-23.60	0.000
11.15.diMeC31	queen_eggs - rep_worker_dg	10.07	0.38	35	26.77	0.000
11.15.diMeC31	queen_eggs - repr_worker_chc	10.07	0.31	35	32.47	0.000
11.15.diMeC31	queen_eggs - worker_eggs	-0.28	0.23	35	-1.24	1.000
11.15.diMeC31	rep_worker_dg - repr_worker_chc	0.00	0.43	35	0.00	1.000
11.15.diMeC31	rep_worker_dg - worker_eggs	-10.34	0.37	35	-28.08	0.000
11.15.diMeC31	repr_worker_chc - worker_eggs	-10.34	0.30	35	-34.39	0.000
11.17.diMeC31	queen_chc - queen_dg	10.16	0.16	35	61.65	0.000
11.17.diMeC31	queen_chc - queen_eggs	10.16	0.11	35	92.47	0.000
11.17.diMeC31	queen_chc - rep_worker_dg	10.16	0.15	35	69.90	0.000
11.17.diMeC31	queen_chc - repr_worker_chc	-0.16	0.13	35	-1.24	1.000
11.17.diMeC31	queen_chc - worker_eggs	10.16	0.11	35	94.88	0.000
11.17.diMeC31	queen_dg - queen_eggs	0.00	0.15	35	0.00	1.000
11.17.diMeC31	queen_dg - rep_worker_dg	0.00	0.17	35	0.00	1.000
11.17.diMeC31	queen_dg - repr_worker_chc	-10.31	0.16	35	-64.81	0.000
11.17.diMeC31	queen_dg - worker_eggs	0.00	0.14	35	0.00	1.000
11.17.diMeC31	queen_eggs - rep_worker_dg	0.00	0.12	35	0.00	1.000
11.17.diMeC31	queen_eggs - repr_worker_chc	-10.31	0.10	35	-101.87	0.000
11.17.diMeC31	queen_eggs - worker_eggs	0.00	0.07	35	0.00	1.000
11.17.diMeC31	rep_worker_dg - repr_worker_chc	-10.31	0.14	35	-74.25	0.000
11.17.diMeC31	rep_worker_dg - worker_eggs	0.00	0.12	35	0.00	1.000
11.17.diMeC31	repr_worker_chc - worker_eggs	10.31	0.10	35	105.00	0.000
12..11..10.MeC26	queen_chc - queen_dg	-4.05	0.44	35	-9.12	0.000
12..11..10.MeC26	queen_chc - queen_eggs	-4.78	0.30	35	-16.14	0.000
12..11..10.MeC26	queen_chc - rep_worker_dg	-3.68	0.39	35	-9.39	0.000
12..11..10.MeC26	queen_chc - repr_worker_chc	0.30	0.34	35	0.86	1.000

12..11..10.MeC26	queen_chc - worker_eggs	-4.87	0.29	35	-16.88	0.000
12..11..10.MeC26	queen_dg - queen_eggs	-0.73	0.39	35	-1.86	1.000
12..11..10.MeC26	queen_dg - rep_worker_dg	0.37	0.47	35	0.79	1.000
12..11..10.MeC26	queen_dg - repr_worker_chc	4.35	0.43	35	10.13	0.000
12..11..10.MeC26	queen_dg - worker_eggs	-0.82	0.39	35	-2.13	1.000
12..11..10.MeC26	queen_eggs - rep_worker_dg	1.10	0.33	35	3.32	1.000
12..11..10.MeC26	queen_eggs - repr_worker_chc	5.08	0.27	35	18.59	0.000
12..11..10.MeC26	queen_eggs - worker_eggs	-0.09	0.20	35	-0.47	1.000
12..11..10.MeC26	rep_worker_dg - repr_worker_chc	3.97	0.37	35	10.61	0.000
12..11..10.MeC26	rep_worker_dg - worker_eggs	-1.19	0.32	35	-3.68	0.880
12..11..10.MeC26	repr_worker_chc - worker_eggs	-5.17	0.26	35	-19.51	0.000
13...11...9.MeC27	queen_chc - queen_dg	-4.69	0.31	35	-15.16	0.000
13...11...9.MeC27	queen_chc - queen_eggs	6.72	0.21	35	32.56	0.000
13...11...9.MeC27	queen_chc - rep_worker_dg	-3.82	0.27	35	-14.01	0.000
13...11...9.MeC27	queen_chc - repr_worker_chc	-0.56	0.24	35	-2.34	1.000
13...11...9.MeC27	queen_chc - worker_eggs	6.72	0.20	35	33.41	0.000
13...11...9.MeC27	queen_dg - queen_eggs	11.41	0.27	35	41.81	0.000
13...11...9.MeC27	queen_dg - rep_worker_dg	0.87	0.33	35	2.66	1.000
13...11...9.MeC27	queen_dg - repr_worker_chc	4.13	0.30	35	13.82	0.000
13...11...9.MeC27	queen_dg - worker_eggs	11.41	0.27	35	42.42	0.000
13...11...9.MeC27	queen_eggs - rep_worker_dg	-10.54	0.23	35	-45.70	0.000
13...11...9.MeC27	queen_eggs - repr_worker_chc	-7.28	0.19	35	-38.27	0.000
13...11...9.MeC27	queen_eggs - worker_eggs	0.00	0.14	35	0.00	1.000
13...11...9.MeC27	rep_worker_dg - repr_worker_chc	3.26	0.26	35	12.50	0.000
13...11...9.MeC27	rep_worker_dg - worker_eggs	10.54	0.23	35	46.64	0.000
13...11...9.MeC27	repr_worker_chc - worker_eggs	7.28	0.18	35	39.45	0.000
13..11..9..7.MeC25	queen_chc - queen_dg	-5.06	0.60	35	-8.40	0.000
13..11..9..7.MeC25	queen_chc - queen_eggs	-6.25	0.40	35	-15.56	0.000
13..11..9..7.MeC25	queen_chc - rep_worker_dg	-3.35	0.53	35	-6.30	0.000
13..11..9..7.MeC25	queen_chc - repr_worker_chc	-0.45	0.47	35	-0.97	1.000
13..11..9..7.MeC25	queen_chc - worker_eggs	-6.50	0.39	35	-16.60	0.000
13..11..9..7.MeC25	queen_dg - queen_eggs	-1.19	0.53	35	-2.25	1.000
13..11..9..7.MeC25	queen_dg - rep_worker_dg	1.71	0.64	35	2.70	1.000
13..11..9..7.MeC25	queen_dg - repr_worker_chc	4.60	0.58	35	7.91	0.000
13..11..9..7.MeC25	queen_dg - worker_eggs	-1.44	0.52	35	-2.75	1.000
13..11..9..7.MeC25	queen_eggs - rep_worker_dg	2.91	0.45	35	6.47	0.000
13..11..9..7.MeC25	queen_eggs - repr_worker_chc	5.80	0.37	35	15.65	0.000
13..11..9..7.MeC25	queen_eggs - worker_eggs	-0.25	0.27	35	-0.92	1.000
13..11..9..7.MeC25	rep_worker_dg - repr_worker_chc	2.89	0.51	35	5.69	0.000
13..11..9..7.MeC25	rep_worker_dg - worker_eggs	-3.15	0.44	35	-7.17	0.000
13..11..9..7.MeC25	repr_worker_chc - worker_eggs	-6.04	0.36	35	-16.82	0.000
13..11..9..7.MeC27	queen_chc - queen_dg	0.00	0.20	35	0.00	1.000
13..11..9..7.MeC27	queen_chc - queen_eggs	-12.40	0.13	35	-94.48	0.000
13..11..9..7.MeC27	queen_chc - rep_worker_dg	0.00	0.17	35	0.00	1.000
13..11..9..7.MeC27	queen_chc - repr_worker_chc	0.00	0.15	35	0.00	1.000
13..11..9..7.MeC27	queen_chc - worker_eggs	-12.57	0.13	35	-98.20	0.000
13..11..9..7.MeC27	queen_dg - queen_eggs	-12.41	0.17	35	-71.42	0.000
13..11..9..7.MeC27	queen_dg - rep_worker_dg	0.00	0.21	35	0.00	1.000

13..11..9..7.MeC27	queen_dg - repr_worker_chc	0.00	0.19	35	0.00	1.000
13..11..9..7.MeC27	queen_dg - worker_eggs	-12.57	0.17	35	-73.41	0.000
13..11..9..7.MeC27	queen_eggs - rep_worker_dg	12.41	0.15	35	84.51	0.000
13..11..9..7.MeC27	queen_eggs - repr_worker_chc	12.40	0.12	35	102.48	0.000
13..11..9..7.MeC27	queen_eggs - worker_eggs	-0.16	0.09	35	-1.83	1.000
13..11..9..7.MeC27	rep_worker_dg - repr_worker_chc	0.00	0.17	35	0.00	1.000
13..11..9..7.MeC27	rep_worker_dg - worker_eggs	-12.57	0.14	35	-87.37	0.000
13..11..9..7.MeC27	repr_worker_chc - worker_eggs	-12.57	0.12	35	-107.01	0.000
14..12.MeC30	queen_chc - queen_dg	0.00	0.27	35	0.00	1.000
14..12.MeC30	queen_chc - queen_eggs	-9.73	0.18	35	-54.23	0.000
14..12.MeC30	queen_chc - rep_worker_dg	0.00	0.24	35	0.00	1.000
14..12.MeC30	queen_chc - repr_worker_chc	0.00	0.21	35	0.00	1.000
14..12.MeC30	queen_chc - worker_eggs	-9.96	0.17	35	-56.94	0.000
14..12.MeC30	queen_dg - queen_eggs	-9.73	0.24	35	-41.00	0.000
14..12.MeC30	queen_dg - rep_worker_dg	0.00	0.28	35	0.00	1.000
14..12.MeC30	queen_dg - repr_worker_chc	0.00	0.26	35	0.00	1.000
14..12.MeC30	queen_dg - worker_eggs	-9.96	0.23	35	-42.56	0.000
14..12.MeC30	queen_eggs - rep_worker_dg	9.73	0.20	35	48.50	0.000
14..12.MeC30	queen_eggs - repr_worker_chc	9.73	0.17	35	58.82	0.000
14..12.MeC30	queen_eggs - worker_eggs	-0.23	0.12	35	-1.89	1.000
14..12.MeC30	rep_worker_dg - repr_worker_chc	0.00	0.23	35	0.00	1.000
14..12.MeC30	rep_worker_dg - worker_eggs	-9.96	0.20	35	-50.66	0.000
14..12.MeC30	repr_worker_chc - worker_eggs	-9.96	0.16	35	-62.05	0.000
14..13..12.MeC28	queen_chc - queen_dg	-6.46	0.51	35	-12.75	0.000
14..13..12.MeC28	queen_chc - queen_eggs	-6.97	0.34	35	-20.64	0.000
14..13..12.MeC28	queen_chc - rep_worker_dg	-8.88	0.45	35	-19.89	0.000
14..13..12.MeC28	queen_chc - repr_worker_chc	0.55	0.39	35	1.40	1.000
14..13..12.MeC28	queen_chc - worker_eggs	-7.13	0.33	35	-21.68	0.000
14..13..12.MeC28	queen_dg - queen_eggs	-0.51	0.45	35	-1.14	1.000
14..13..12.MeC28	queen_dg - rep_worker_dg	-2.43	0.53	35	-4.54	0.070
14..13..12.MeC28	queen_dg - repr_worker_chc	7.01	0.49	35	14.32	0.000
14..13..12.MeC28	queen_dg - worker_eggs	-0.68	0.44	35	-1.54	1.000
14..13..12.MeC28	queen_eggs - rep_worker_dg	-1.92	0.38	35	-5.08	0.010
14..13..12.MeC28	queen_eggs - repr_worker_chc	7.52	0.31	35	24.15	0.000
14..13..12.MeC28	queen_eggs - worker_eggs	-0.17	0.23	35	-0.74	1.000
14..13..12.MeC28	rep_worker_dg - repr_worker_chc	9.43	0.43	35	22.09	0.000
14..13..12.MeC28	rep_worker_dg - worker_eggs	1.75	0.37	35	4.73	0.040
14..13..12.MeC28	repr_worker_chc - worker_eggs	-7.68	0.30	35	-25.45	0.000
15..13..11..9..7.MeC29	queen_chc - queen_dg	-1.48	0.43	35	-3.41	1.000
15..13..11..9..7.MeC29	queen_chc - queen_eggs	-0.96	0.29	35	-3.30	1.000
15..13..11..9..7.MeC29	queen_chc - rep_worker_dg	2.23	0.38	35	5.81	0.000
15..13..11..9..7.MeC29	queen_chc - repr_worker_chc	-0.38	0.34	35	-1.13	1.000
15..13..11..9..7.MeC29	queen_chc - worker_eggs	-1.02	0.28	35	-3.62	1.000
15..13..11..9..7.MeC29	queen_dg - queen_eggs	0.52	0.38	35	1.37	1.000
15..13..11..9..7.MeC29	queen_dg - rep_worker_dg	3.71	0.46	35	8.10	0.000
15..13..11..9..7.MeC29	queen_dg - repr_worker_chc	1.10	0.42	35	2.62	1.000
15..13..11..9..7.MeC29	queen_dg - worker_eggs	0.46	0.38	35	1.22	1.000
15..13..11..9..7.MeC29	queen_eggs - rep_worker_dg	3.18	0.32	35	9.83	0.000

15..13..11..9..7.MeC29	queen_eggs - repr_worker_chc	0.58	0.27	35	2.16	1.000
15..13..11..9..7.MeC29	queen_eggs - worker_eggs	-0.06	0.19	35	-0.33	1.000
15..13..11..9..7.MeC29	rep_worker_dg - repr_worker_chc	-2.61	0.37	35	-7.12	0.000
15..13..11..9..7.MeC29	rep_worker_dg - worker_eggs	-3.25	0.32	35	-10.24	0.000
15..13..11..9..7.MeC29	repr_worker_chc - worker_eggs	-0.64	0.26	35	-2.48	1.000
15..13..11..9.MeC31	queen_chc - queen_dg	-9.86	0.45	35	-21.86	0.000
15..13..11..9.MeC31	queen_chc - queen_eggs	-11.06	0.30	35	-36.78	0.000
15..13..11..9.MeC31	queen_chc - rep_worker_dg	-9.60	0.40	35	-24.14	0.000
15..13..11..9.MeC31	queen_chc - repr_worker_chc	0.00	0.35	35	0.00	1.000
15..13..11..9.MeC31	queen_chc - worker_eggs	-11.33	0.29	35	-38.65	0.000
15..13..11..9.MeC31	queen_dg - queen_eggs	-1.20	0.40	35	-3.02	1.000
15..13..11..9.MeC31	queen_dg - rep_worker_dg	0.26	0.48	35	0.54	1.000
15..13..11..9.MeC31	queen_dg - repr_worker_chc	9.86	0.44	35	22.62	0.000
15..13..11..9.MeC31	queen_dg - worker_eggs	-1.47	0.39	35	-3.75	0.720
15..13..11..9.MeC31	queen_eggs - rep_worker_dg	1.46	0.34	35	4.34	0.130
15..13..11..9.MeC31	queen_eggs - repr_worker_chc	11.06	0.28	35	39.90	0.000
15..13..11..9.MeC31	queen_eggs - worker_eggs	-0.27	0.20	35	-1.32	1.000
15..13..11..9.MeC31	rep_worker_dg - repr_worker_chc	9.60	0.38	35	25.24	0.000
15..13..11..9.MeC31	rep_worker_dg - worker_eggs	-1.73	0.33	35	-5.24	0.010
15..13..11..9.MeC31	repr_worker_chc - worker_eggs	-11.33	0.27	35	-42.12	0.000
15..13.MeC31	queen_chc - queen_dg	13.01	0.08	35	159.88	0.000
15..13.MeC31	queen_chc - queen_eggs	13.01	0.05	35	239.82	0.000
15..13.MeC31	queen_chc - rep_worker_dg	13.01	0.07	35	181.29	0.000
15..13.MeC31	queen_chc - repr_worker_chc	-0.45	0.06	35	-7.09	0.000
15..13.MeC31	queen_chc - worker_eggs	13.01	0.05	35	246.05	0.000
15..13.MeC31	queen_dg - queen_eggs	0.00	0.07	35	0.00	1.000
15..13.MeC31	queen_dg - rep_worker_dg	0.00	0.09	35	0.00	1.000
15..13.MeC31	queen_dg - repr_worker_chc	-13.46	0.08	35	-171.18	0.000
15..13.MeC31	queen_dg - worker_eggs	0.00	0.07	35	0.00	1.000
15..13.MeC31	queen_eggs - rep_worker_dg	0.00	0.06	35	0.00	1.000
15..13.MeC31	queen_eggs - repr_worker_chc	-13.46	0.05	35	-269.06	0.000
15..13.MeC31	queen_eggs - worker_eggs	0.00	0.04	35	0.00	1.000
15..13.MeC31	rep_worker_dg - repr_worker_chc	-13.46	0.07	35	-196.10	0.000
15..13.MeC31	rep_worker_dg - worker_eggs	0.00	0.06	35	0.00	1.000
15..13.MeC31	repr_worker_chc - worker_eggs	13.46	0.05	35	277.34	0.000
15..14..13..12.MeC30	queen_chc - queen_dg	-6.39	0.31	35	-20.90	0.000
15..14..13..12.MeC30	queen_chc - queen_eggs	0.00	0.20	35	0.00	1.000
15..14..13..12.MeC30	queen_chc - rep_worker_dg	-6.69	0.27	35	-24.83	0.000
15..14..13..12.MeC30	queen_chc - repr_worker_chc	0.00	0.24	35	0.00	1.000
15..14..13..12.MeC30	queen_chc - worker_eggs	0.00	0.20	35	0.00	1.000
15..14..13..12.MeC30	queen_dg - queen_eggs	6.39	0.27	35	23.70	0.000
15..14..13..12.MeC30	queen_dg - rep_worker_dg	-0.31	0.32	35	-0.95	1.000
15..14..13..12.MeC30	queen_dg - repr_worker_chc	6.39	0.30	35	21.63	0.000
15..14..13..12.MeC30	queen_dg - worker_eggs	6.39	0.27	35	24.05	0.000
15..14..13..12.MeC30	queen_eggs - rep_worker_dg	-6.69	0.23	35	-29.38	0.000
15..14..13..12.MeC30	queen_eggs - repr_worker_chc	0.00	0.19	35	0.00	1.000
15..14..13..12.MeC30	queen_eggs - worker_eggs	0.00	0.14	35	0.00	1.000
15..14..13..12.MeC30	rep_worker_dg - repr_worker_chc	6.69	0.26	35	25.97	0.000

15..14..13..12.MeC30	rep_worker_dg - worker_eggs	6.69	0.22	35	29.99	0.000
15..14..13..12.MeC30	repr_worker_chc - worker_eggs	0.00	0.18	35	0.00	1.000
16..14..12.MeC30	queen_chc - queen_dg	10.33	0.12	35	87.99	0.000
16..14..12.MeC30	queen_chc - queen_eggs	10.33	0.08	35	131.98	0.000
16..14..12.MeC30	queen_chc - rep_worker_dg	10.33	0.10	35	99.77	0.000
16..14..12.MeC30	queen_chc - repr_worker_chc	-0.43	0.09	35	-4.71	0.040
16..14..12.MeC30	queen_chc - worker_eggs	10.33	0.08	35	135.41	0.000
16..14..12.MeC30	queen_dg - queen_eggs	0.00	0.10	35	0.00	1.000
16..14..12.MeC30	queen_dg - rep_worker_dg	0.00	0.12	35	0.00	1.000
16..14..12.MeC30	queen_dg - repr_worker_chc	-10.76	0.11	35	-94.85	0.000
16..14..12.MeC30	queen_dg - worker_eggs	0.00	0.10	35	0.00	1.000
16..14..12.MeC30	queen_eggs - rep_worker_dg	0.00	0.09	35	0.00	1.000
16..14..12.MeC30	queen_eggs - repr_worker_chc	-10.76	0.07	35	-149.09	0.000
16..14..12.MeC30	queen_eggs - worker_eggs	0.00	0.05	35	0.00	1.000
16..14..12.MeC30	rep_worker_dg - repr_worker_chc	-10.76	0.10	35	-108.66	0.000
16..14..12.MeC30	rep_worker_dg - worker_eggs	0.00	0.09	35	0.00	1.000
16..14..12.MeC30	repr_worker_chc - worker_eggs	10.76	0.07	35	153.68	0.000
3.7...3.11.diMeC27	queen_chc - queen_dg	-2.24	0.32	35	-6.91	0.000
3.7...3.11.diMeC27	queen_chc - queen_eggs	-2.95	0.22	35	-13.64	0.000
3.7...3.11.diMeC27	queen_chc - rep_worker_dg	-1.17	0.29	35	-4.09	0.270
3.7...3.11.diMeC27	queen_chc - repr_worker_chc	-0.35	0.25	35	-1.38	1.000
3.7...3.11.diMeC27	queen_chc - worker_eggs	-2.79	0.21	35	-13.23	0.000
3.7...3.11.diMeC27	queen_dg - queen_eggs	-0.71	0.29	35	-2.48	1.000
3.7...3.11.diMeC27	queen_dg - rep_worker_dg	1.07	0.34	35	3.13	1.000
3.7...3.11.diMeC27	queen_dg - repr_worker_chc	1.90	0.31	35	6.04	0.000
3.7...3.11.diMeC27	queen_dg - worker_eggs	-0.55	0.28	35	-1.94	1.000
3.7...3.11.diMeC27	queen_eggs - rep_worker_dg	1.78	0.24	35	7.36	0.000
3.7...3.11.diMeC27	queen_eggs - repr_worker_chc	2.61	0.20	35	13.05	0.000
3.7...3.11.diMeC27	queen_eggs - worker_eggs	0.16	0.15	35	1.12	1.000
3.7...3.11.diMeC27	rep_worker_dg - repr_worker_chc	0.82	0.27	35	3.01	1.000
3.7...3.11.diMeC27	rep_worker_dg - worker_eggs	-1.62	0.24	35	-6.83	0.000
3.7...3.11.diMeC27	repr_worker_chc - worker_eggs	-2.44	0.19	35	-12.62	0.000
3.7...3.9...3.13.diMeC29	queen_chc - queen_dg	-0.76	1.44	35	-0.53	1.000
3.7...3.9...3.13.diMeC29	queen_chc - queen_eggs	4.34	0.96	35	4.52	0.080
3.7...3.9...3.13.diMeC29	queen_chc - rep_worker_dg	10.08	1.27	35	7.93	0.000
3.7...3.9...3.13.diMeC29	queen_chc - repr_worker_chc	10.08	1.12	35	9.03	0.000
3.7...3.9...3.13.diMeC29	queen_chc - worker_eggs	5.37	0.94	35	5.74	0.000
3.7...3.9...3.13.diMeC29	queen_dg - queen_eggs	5.10	1.27	35	4.02	0.330
3.7...3.9...3.13.diMeC29	queen_dg - rep_worker_dg	10.84	1.52	35	7.14	0.000
3.7...3.9...3.13.diMeC29	queen_dg - repr_worker_chc	10.84	1.39	35	7.79	0.000
3.7...3.9...3.13.diMeC29	queen_dg - worker_eggs	6.13	1.25	35	4.90	0.020
3.7...3.9...3.13.diMeC29	queen_eggs - rep_worker_dg	5.74	1.07	35	5.34	0.010
3.7...3.9...3.13.diMeC29	queen_eggs - repr_worker_chc	5.74	0.89	35	6.48	0.000
3.7...3.9...3.13.diMeC29	queen_eggs - worker_eggs	1.03	0.64	35	1.60	1.000
3.7...3.9...3.13.diMeC29	rep_worker_dg - repr_worker_chc	0.00	1.21	35	0.00	1.000
3.7...3.9...3.13.diMeC29	rep_worker_dg - worker_eggs	-4.70	1.05	35	-4.47	0.090
3.7...3.9...3.13.diMeC29	repr_worker_chc - worker_eggs	-4.70	0.86	35	-5.48	0.000
3.7...3.9.diMeC25	queen_chc - queen_dg	-3.60	0.62	35	-5.76	0.000

3.7...3.9.diMeC25	queen_chc - queen_eggs	-3.92	0.42	35	-9.42	0.000
3.7...3.9.diMeC25	queen_chc - repr_worker_dg	-1.42	0.55	35	-2.58	1.000
3.7...3.9.diMeC25	queen_chc - repr_worker_chc	-0.31	0.48	35	-0.64	1.000
3.7...3.9.diMeC25	queen_chc - worker_eggs	-3.80	0.41	35	-9.37	0.000
3.7...3.9.diMeC25	queen_dg - queen_eggs	-0.32	0.55	35	-0.59	1.000
3.7...3.9.diMeC25	queen_dg - repr_worker_dg	2.17	0.66	35	3.30	1.000
3.7...3.9.diMeC25	queen_dg - repr_worker_chc	3.29	0.60	35	5.45	0.000
3.7...3.9.diMeC25	queen_dg - worker_eggs	-0.20	0.54	35	-0.37	1.000
3.7...3.9.diMeC25	queen_eggs - repr_worker_dg	2.50	0.47	35	5.37	0.010
3.7...3.9.diMeC25	queen_eggs - repr_worker_chc	3.61	0.38	35	9.41	0.000
3.7...3.9.diMeC25	queen_eggs - worker_eggs	0.12	0.28	35	0.43	1.000
3.7...3.9.diMeC25	repr_worker_dg - repr_worker_chc	1.11	0.53	35	2.11	1.000
3.7...3.9.diMeC25	repr_worker_dg - worker_eggs	-2.38	0.46	35	-5.21	0.010
3.7...3.9.diMeC25	repr_worker_chc - worker_eggs	-3.49	0.37	35	-9.38	0.000
3.7.diMeC23	queen_chc - queen_dg	0.00	0.52	35	0.00	1.000
3.7.diMeC23	queen_chc - queen_eggs	-7.40	0.35	35	-21.31	0.000
3.7.diMeC23	queen_chc - repr_worker_dg	0.00	0.46	35	0.00	1.000
3.7.diMeC23	queen_chc - repr_worker_chc	0.00	0.40	35	0.00	1.000
3.7.diMeC23	queen_chc - worker_eggs	-7.41	0.34	35	-21.88	0.000
3.7.diMeC23	queen_dg - queen_eggs	-7.40	0.46	35	-16.11	0.000
3.7.diMeC23	queen_dg - repr_worker_dg	0.00	0.55	35	0.00	1.000
3.7.diMeC23	queen_dg - repr_worker_chc	0.00	0.50	35	0.00	1.000
3.7.diMeC23	queen_dg - worker_eggs	-7.41	0.45	35	-16.36	0.000
3.7.diMeC23	queen_eggs - repr_worker_dg	7.40	0.39	35	19.06	0.000
3.7.diMeC23	queen_eggs - repr_worker_chc	7.40	0.32	35	23.11	0.000
3.7.diMeC23	queen_eggs - worker_eggs	-0.01	0.23	35	-0.02	1.000
3.7.diMeC23	repr_worker_dg - repr_worker_chc	0.00	0.44	35	0.00	1.000
3.7.diMeC23	repr_worker_dg - worker_eggs	-7.41	0.38	35	-19.47	0.000
3.7.diMeC23	repr_worker_chc - worker_eggs	-7.41	0.31	35	-23.84	0.000
3.7.diMeC29	queen_chc - queen_dg	0.00	0.50	35	0.00	1.000
3.7.diMeC29	queen_chc - queen_eggs	0.00	0.33	35	0.00	1.000
3.7.diMeC29	queen_chc - repr_worker_dg	-11.15	0.44	35	-25.53	0.000
3.7.diMeC29	queen_chc - repr_worker_chc	-9.83	0.38	35	-25.63	0.000
3.7.diMeC29	queen_chc - worker_eggs	0.00	0.32	35	0.00	1.000
3.7.diMeC29	queen_dg - queen_eggs	0.00	0.44	35	0.00	1.000
3.7.diMeC29	queen_dg - repr_worker_dg	-11.15	0.52	35	-21.36	0.000
3.7.diMeC29	queen_dg - repr_worker_chc	-9.83	0.48	35	-20.55	0.000
3.7.diMeC29	queen_dg - worker_eggs	0.00	0.43	35	0.00	1.000
3.7.diMeC29	queen_eggs - repr_worker_dg	-11.15	0.37	35	-30.21	0.000
3.7.diMeC29	queen_eggs - repr_worker_chc	-9.83	0.30	35	-32.30	0.000
3.7.diMeC29	queen_eggs - worker_eggs	0.00	0.22	35	0.00	1.000
3.7.diMeC29	repr_worker_dg - repr_worker_chc	1.32	0.42	35	3.16	1.000
3.7.diMeC29	repr_worker_dg - worker_eggs	11.15	0.36	35	30.84	0.000
3.7.diMeC29	repr_worker_chc - worker_eggs	9.83	0.30	35	33.29	0.000
3.MeC23	queen_chc - queen_dg	0.00	0.48	35	0.00	1.000
3.MeC23	queen_chc - queen_eggs	-6.11	0.32	35	-19.16	0.000
3.MeC23	queen_chc - repr_worker_dg	0.00	0.42	35	0.00	1.000
3.MeC23	queen_chc - repr_worker_chc	0.00	0.37	35	0.00	1.000

3.MeC23	queen_chc - worker_eggs	-6.08	0.31	35	-19.57	0.000
3.MeC23	queen_dg - queen_eggs	-6.11	0.42	35	-14.48	0.000
3.MeC23	queen_dg - rep_worker_dg	0.00	0.50	35	0.00	1.000
3.MeC23	queen_dg - repr_worker_chc	0.00	0.46	35	0.00	1.000
3.MeC23	queen_dg - worker_eggs	-6.08	0.42	35	-14.63	0.000
3.MeC23	queen_eggs - rep_worker_dg	6.11	0.36	35	17.14	0.000
3.MeC23	queen_eggs - repr_worker_chc	6.11	0.29	35	20.78	0.000
3.MeC23	queen_eggs - worker_eggs	0.03	0.21	35	0.12	1.000
3.MeC23	rep_worker_dg - repr_worker_chc	0.00	0.40	35	0.00	1.000
3.MeC23	rep_worker_dg - worker_eggs	-6.08	0.35	35	-17.42	0.000
3.MeC23	repr_worker_chc - worker_eggs	-6.08	0.29	35	-21.33	0.000
3.MeC25	queen_chc - queen_dg	-1.02	0.32	35	-3.14	1.000
3.MeC25	queen_chc - queen_eggs	-2.82	0.22	35	-13.05	0.000
3.MeC25	queen_chc - rep_worker_dg	-0.93	0.29	35	-3.27	1.000
3.MeC25	queen_chc - repr_worker_chc	-0.07	0.25	35	-0.28	1.000
3.MeC25	queen_chc - worker_eggs	-3.00	0.21	35	-14.23	0.000
3.MeC25	queen_dg - queen_eggs	-1.80	0.29	35	-6.30	0.000
3.MeC25	queen_dg - rep_worker_dg	0.08	0.34	35	0.25	1.000
3.MeC25	queen_dg - repr_worker_chc	0.95	0.31	35	3.03	1.000
3.MeC25	queen_dg - worker_eggs	-1.98	0.28	35	-7.03	0.000
3.MeC25	queen_eggs - rep_worker_dg	1.89	0.24	35	7.81	0.000
3.MeC25	queen_eggs - repr_worker_chc	2.75	0.20	35	13.81	0.000
3.MeC25	queen_eggs - worker_eggs	-0.18	0.15	35	-1.23	1.000
3.MeC25	rep_worker_dg - repr_worker_chc	0.86	0.27	35	3.16	1.000
3.MeC25	rep_worker_dg - worker_eggs	-2.07	0.24	35	-8.72	0.000
3.MeC25	repr_worker_chc - worker_eggs	-2.93	0.19	35	-15.15	0.000
3.MeC27	queen_chc - queen_dg	-2.91	0.39	35	-7.41	0.000
3.MeC27	queen_chc - queen_eggs	-3.78	0.26	35	-14.43	0.000
3.MeC27	queen_chc - rep_worker_dg	-2.58	0.35	35	-7.45	0.000
3.MeC27	queen_chc - repr_worker_chc	-0.79	0.30	35	-2.59	1.000
3.MeC27	queen_chc - worker_eggs	-3.64	0.26	35	-14.25	0.000
3.MeC27	queen_dg - queen_eggs	-0.87	0.35	35	-2.51	1.000
3.MeC27	queen_dg - rep_worker_dg	0.33	0.41	35	0.79	1.000
3.MeC27	queen_dg - repr_worker_chc	2.12	0.38	35	5.59	0.000
3.MeC27	queen_dg - worker_eggs	-0.73	0.34	35	-2.13	1.000
3.MeC27	queen_eggs - rep_worker_dg	1.20	0.29	35	4.09	0.270
3.MeC27	queen_eggs - repr_worker_chc	2.99	0.24	35	12.39	0.000
3.MeC27	queen_eggs - worker_eggs	0.14	0.18	35	0.80	1.000
3.MeC27	rep_worker_dg - repr_worker_chc	1.80	0.33	35	5.42	0.010
3.MeC27	rep_worker_dg - worker_eggs	-1.06	0.29	35	-3.68	0.880
3.MeC27	repr_worker_chc - worker_eggs	-2.85	0.23	35	-12.16	0.000
3.MeC29	queen_chc - queen_dg	-3.05	0.38	35	-8.09	0.000
3.MeC29	queen_chc - queen_eggs	-3.31	0.25	35	-13.20	0.000
3.MeC29	queen_chc - rep_worker_dg	-2.14	0.33	35	-6.46	0.000
3.MeC29	queen_chc - repr_worker_chc	0.77	0.29	35	2.64	1.000
3.MeC29	queen_chc - worker_eggs	-2.77	0.24	35	-11.34	0.000
3.MeC29	queen_dg - queen_eggs	-0.27	0.33	35	-0.80	1.000
3.MeC29	queen_dg - rep_worker_dg	0.90	0.40	35	2.27	1.000

3.MeC29	queen_dg - repr_worker_chc	3.82	0.36	35	10.49	0.000
3.MeC29	queen_dg - worker_eggs	0.27	0.33	35	0.83	1.000
3.MeC29	queen_eggs - rep_worker_dg	1.17	0.28	35	4.17	0.220
3.MeC29	queen_eggs - repr_worker_chc	4.08	0.23	35	17.64	0.000
3.MeC29	queen_eggs - worker_eggs	0.54	0.17	35	3.21	1.000
3.MeC29	rep_worker_dg - repr_worker_chc	2.91	0.32	35	9.18	0.000
3.MeC29	rep_worker_dg - worker_eggs	-0.63	0.27	35	-2.29	1.000
3.MeC29	repr_worker_chc - worker_eggs	-3.54	0.22	35	-15.78	0.000
3.MeC31	queen_chc - queen_dg	-12.54	0.47	35	-26.45	0.000
3.MeC31	queen_chc - queen_eggs	-11.09	0.32	35	-35.09	0.000
3.MeC31	queen_chc - rep_worker_dg	-9.94	0.42	35	-23.79	0.000
3.MeC31	queen_chc - repr_worker_chc	0.00	0.37	35	0.00	1.000
3.MeC31	queen_chc - worker_eggs	-10.57	0.31	35	-34.33	0.000
3.MeC31	queen_dg - queen_eggs	1.45	0.42	35	3.47	1.000
3.MeC31	queen_dg - rep_worker_dg	2.59	0.50	35	5.19	0.010
3.MeC31	queen_dg - repr_worker_chc	12.54	0.46	35	27.38	0.000
3.MeC31	queen_dg - worker_eggs	1.97	0.41	35	4.77	0.040
3.MeC31	queen_eggs - rep_worker_dg	1.15	0.35	35	3.24	1.000
3.MeC31	queen_eggs - repr_worker_chc	11.09	0.29	35	38.07	0.000
3.MeC31	queen_eggs - worker_eggs	0.52	0.21	35	2.44	1.000
3.MeC31	rep_worker_dg - repr_worker_chc	9.94	0.40	35	24.88	0.000
3.MeC31	rep_worker_dg - worker_eggs	-0.63	0.35	35	-1.81	1.000
3.MeC31	repr_worker_chc - worker_eggs	-10.57	0.28	35	-37.41	0.000
3.MeC33	queen_chc - queen_dg	-10.21	0.18	35	-57.28	0.000
3.MeC33	queen_chc - queen_eggs	0.00	0.12	35	0.00	1.000
3.MeC33	queen_chc - rep_worker_dg	-8.75	0.16	35	-55.65	0.000
3.MeC33	queen_chc - repr_worker_chc	0.00	0.14	35	0.00	1.000
3.MeC33	queen_chc - worker_eggs	0.00	0.12	35	0.00	1.000
3.MeC33	queen_dg - queen_eggs	10.21	0.16	35	64.95	0.000
3.MeC33	queen_dg - rep_worker_dg	1.46	0.19	35	7.78	0.000
3.MeC33	queen_dg - repr_worker_chc	10.21	0.17	35	59.29	0.000
3.MeC33	queen_dg - worker_eggs	10.21	0.15	35	65.90	0.000
3.MeC33	queen_eggs - rep_worker_dg	-8.75	0.13	35	-65.85	0.000
3.MeC33	queen_eggs - repr_worker_chc	0.00	0.11	35	0.00	1.000
3.MeC33	queen_eggs - worker_eggs	0.00	0.08	35	0.00	1.000
3.MeC33	rep_worker_dg - repr_worker_chc	8.75	0.15	35	58.20	0.000
3.MeC33	rep_worker_dg - worker_eggs	8.75	0.13	35	67.20	0.000
3.MeC33	repr_worker_chc - worker_eggs	0.00	0.11	35	0.00	1.000
4.8.diMeC24	queen_chc - queen_dg	-6.66	0.57	35	-11.62	0.000
4.8.diMeC24	queen_chc - queen_eggs	-6.74	0.38	35	-17.64	0.000
4.8.diMeC24	queen_chc - rep_worker_dg	-5.24	0.51	35	-10.37	0.000
4.8.diMeC24	queen_chc - repr_worker_chc	0.00	0.44	35	0.00	1.000
4.8.diMeC24	queen_chc - worker_eggs	-6.61	0.37	35	-17.75	0.000
4.8.diMeC24	queen_dg - queen_eggs	-0.08	0.51	35	-0.16	1.000
4.8.diMeC24	queen_dg - rep_worker_dg	1.42	0.60	35	2.35	1.000
4.8.diMeC24	queen_dg - repr_worker_chc	6.66	0.55	35	12.03	0.000
4.8.diMeC24	queen_dg - worker_eggs	0.05	0.50	35	0.10	1.000
4.8.diMeC24	queen_eggs - rep_worker_dg	1.50	0.43	35	3.50	1.000

4.8.diMeC24	queen_eggs - repr_worker_chc	6.74	0.35	35	19.13	0.000
4.8.diMeC24	queen_eggs - worker_eggs	0.13	0.26	35	0.50	1.000
4.8.diMeC24	rep_worker_dg - repr_worker_chc	5.24	0.48	35	10.85	0.000
4.8.diMeC24	rep_worker_dg - worker_eggs	-1.37	0.42	35	-3.27	1.000
4.8.diMeC24	repr_worker_chc - worker_eggs	-6.61	0.34	35	-19.35	0.000
4.MeC24	queen_chc - queen_dg	0.00	0.54	35	0.00	1.000
4.MeC24	queen_chc - queen_eggs	-5.99	0.36	35	-16.77	0.000
4.MeC24	queen_chc - rep_worker_dg	0.00	0.47	35	0.00	1.000
4.MeC24	queen_chc - repr_worker_chc	0.00	0.41	35	0.00	1.000
4.MeC24	queen_chc - worker_eggs	-5.88	0.35	35	-16.88	0.000
4.MeC24	queen_dg - queen_eggs	-5.99	0.47	35	-12.68	0.000
4.MeC24	queen_dg - rep_worker_dg	0.00	0.56	35	0.00	1.000
4.MeC24	queen_dg - repr_worker_chc	0.00	0.52	35	0.00	1.000
4.MeC24	queen_dg - worker_eggs	-5.88	0.47	35	-12.62	0.000
4.MeC24	queen_eggs - rep_worker_dg	5.99	0.40	35	15.00	0.000
4.MeC24	queen_eggs - repr_worker_chc	5.99	0.33	35	18.19	0.000
4.MeC24	queen_eggs - worker_eggs	0.11	0.24	35	0.47	1.000
4.MeC24	rep_worker_dg - repr_worker_chc	0.00	0.45	35	0.00	1.000
4.MeC24	rep_worker_dg - worker_eggs	-5.88	0.39	35	-15.02	0.000
4.MeC24	repr_worker_chc - worker_eggs	-5.88	0.32	35	-18.40	0.000
4.MeC26	queen_chc - queen_dg	-1.46	0.69	35	-2.10	1.000
4.MeC27	queen_chc - queen_eggs	-3.04	0.46	35	-6.56	0.000
4.MeC28	queen_chc - rep_worker_dg	-2.27	0.61	35	-3.71	0.810
4.MeC29	queen_chc - repr_worker_chc	0.25	0.54	35	0.46	1.000
4.MeC30	queen_chc - worker_eggs	-3.14	0.45	35	-6.97	0.000
4.MeC31	queen_dg - queen_eggs	-1.58	0.61	35	-2.58	1.000
4.MeC32	queen_dg - rep_worker_dg	-0.81	0.73	35	-1.11	1.000
4.MeC33	queen_dg - repr_worker_chc	1.70	0.67	35	2.54	1.000
4.MeC34	queen_dg - worker_eggs	-1.69	0.60	35	-2.80	1.000
4.MeC35	queen_eggs - rep_worker_dg	0.77	0.52	35	1.48	1.000
4.MeC36	queen_eggs - repr_worker_chc	3.28	0.43	35	7.69	0.000
4.MeC37	queen_eggs - worker_eggs	-0.11	0.31	35	-0.35	1.000
4.MeC38	rep_worker_dg - repr_worker_chc	2.52	0.59	35	4.30	0.150
4.MeC39	rep_worker_dg - worker_eggs	-0.87	0.51	35	-1.72	1.000
4.MeC40	repr_worker_chc - worker_eggs	-3.39	0.41	35	-8.19	0.000
4.MeC28	queen_chc - queen_dg	-8.66	0.30	35	-28.56	0.000
4.MeC28	queen_chc - queen_eggs	-9.20	0.20	35	-45.51	0.000
4.MeC28	queen_chc - rep_worker_dg	-8.28	0.27	35	-30.97	0.000
4.MeC28	queen_chc - repr_worker_chc	0.00	0.23	35	0.00	1.000
4.MeC28	queen_chc - worker_eggs	-9.17	0.20	35	-46.54	0.000
4.MeC28	queen_dg - queen_eggs	-0.54	0.27	35	-2.02	1.000
4.MeC28	queen_dg - rep_worker_dg	0.38	0.32	35	1.19	1.000
4.MeC28	queen_dg - repr_worker_chc	8.66	0.29	35	29.56	0.000
4.MeC28	queen_dg - worker_eggs	-0.51	0.26	35	-1.94	1.000
4.MeC28	queen_eggs - rep_worker_dg	0.92	0.23	35	4.07	0.290
4.MeC28	queen_eggs - repr_worker_chc	9.20	0.19	35	49.37	0.000
4.MeC28	queen_eggs - worker_eggs	0.03	0.14	35	0.22	1.000
4.MeC28	rep_worker_dg - repr_worker_chc	8.28	0.26	35	32.39	0.000

4.MeC28	rep_worker_dg - worker_eggs	-0.89	0.22	35	-4.02	0.330
4.MeC28	repr_worker_chc - worker_eggs	-9.17	0.18	35	-50.72	0.000
4.MeC30	queen_chc - queen_dg	-8.82	0.47	35	-18.94	0.000
4.MeC30	queen_chc - queen_eggs	0.00	0.31	35	0.00	1.000
4.MeC30	queen_chc - rep_worker_dg	-8.25	0.41	35	-20.09	0.000
4.MeC30	queen_chc - repr_worker_chc	0.00	0.36	35	0.00	1.000
4.MeC30	queen_chc - worker_eggs	0.00	0.30	35	0.00	1.000
4.MeC30	queen_dg - queen_eggs	8.82	0.41	35	21.48	0.000
4.MeC30	queen_dg - rep_worker_dg	0.57	0.49	35	1.16	1.000
4.MeC30	queen_dg - repr_worker_chc	8.82	0.45	35	19.61	0.000
4.MeC30	queen_dg - worker_eggs	8.82	0.40	35	21.79	0.000
4.MeC30	queen_eggs - rep_worker_dg	-8.25	0.35	35	-23.77	0.000
4.MeC30	queen_eggs - repr_worker_chc	0.00	0.29	35	0.00	1.000
4.MeC30	queen_eggs - worker_eggs	0.00	0.21	35	0.00	1.000
4.MeC30	rep_worker_dg - repr_worker_chc	8.25	0.39	35	21.01	0.000
4.MeC30	rep_worker_dg - worker_eggs	8.25	0.34	35	24.26	0.000
4.MeC30	repr_worker_chc - worker_eggs	0.00	0.28	35	0.00	1.000
5.9...5.11.diMeC27	queen_chc - queen_dg	-10.91	0.41	35	-26.58	0.000
5.9...5.11.diMeC27	queen_chc - queen_eggs	-11.11	0.27	35	-40.60	0.000
5.9...5.11.diMeC27	queen_chc - rep_worker_dg	-10.21	0.36	35	-28.21	0.000
5.9...5.11.diMeC27	queen_chc - repr_worker_chc	0.00	0.32	35	0.00	1.000
5.9...5.11.diMeC27	queen_chc - worker_eggs	-11.00	0.27	35	-41.25	0.000
5.9...5.11.diMeC27	queen_dg - queen_eggs	-0.20	0.36	35	-0.55	1.000
5.9...5.11.diMeC27	queen_dg - rep_worker_dg	0.70	0.43	35	1.61	1.000
5.9...5.11.diMeC27	queen_dg - repr_worker_chc	10.91	0.40	35	27.52	0.000
5.9...5.11.diMeC27	queen_dg - worker_eggs	-0.09	0.36	35	-0.25	1.000
5.9...5.11.diMeC27	queen_eggs - rep_worker_dg	0.90	0.31	35	2.93	1.000
5.9...5.11.diMeC27	queen_eggs - repr_worker_chc	11.11	0.25	35	44.03	0.000
5.9...5.11.diMeC27	queen_eggs - worker_eggs	0.11	0.18	35	0.58	1.000
5.9...5.11.diMeC27	rep_worker_dg - repr_worker_chc	10.21	0.35	35	29.51	0.000
5.9...5.11.diMeC27	rep_worker_dg - worker_eggs	-0.79	0.30	35	-2.63	1.000
5.9...5.11.diMeC27	repr_worker_chc - worker_eggs	-11.00	0.24	35	-44.95	0.000
5.9.diMeC25	queen_chc - queen_dg	-4.52	0.44	35	-10.30	0.000
5.9.diMeC25	queen_chc - queen_eggs	-3.98	0.29	35	-13.59	0.000
5.9.diMeC25	queen_chc - rep_worker_dg	-3.99	0.39	35	-10.31	0.000
5.9.diMeC25	queen_chc - repr_worker_chc	-0.98	0.34	35	-2.89	1.000
5.9.diMeC25	queen_chc - worker_eggs	-3.70	0.29	35	-12.97	0.000
5.9.diMeC25	queen_dg - queen_eggs	0.54	0.39	35	1.41	1.000
5.9.diMeC25	queen_dg - rep_worker_dg	0.53	0.46	35	1.14	1.000
5.9.diMeC25	queen_dg - repr_worker_chc	3.54	0.42	35	8.34	0.000
5.9.diMeC25	queen_dg - worker_eggs	0.82	0.38	35	2.15	1.000
5.9.diMeC25	queen_eggs - rep_worker_dg	-0.02	0.33	35	-0.05	1.000
5.9.diMeC25	queen_eggs - repr_worker_chc	2.99	0.27	35	11.09	0.000
5.9.diMeC25	queen_eggs - worker_eggs	0.28	0.20	35	1.41	1.000
5.9.diMeC25	rep_worker_dg - repr_worker_chc	3.01	0.37	35	8.13	0.000
5.9.diMeC25	rep_worker_dg - worker_eggs	0.29	0.32	35	0.91	1.000
5.9.diMeC25	repr_worker_chc - worker_eggs	-2.72	0.26	35	-10.38	0.000
5.MeC23	queen_chc - queen_dg	0.00	0.47	35	0.00	1.000

5.MeC23	queen_chc - queen_eggs	-5.66	0.31	35	-18.14	0.000
5.MeC23	queen_chc - rep_worker_dg	0.00	0.41	35	0.00	1.000
5.MeC23	queen_chc - repr_worker_chc	0.00	0.36	35	0.00	1.000
5.MeC23	queen_chc - worker_eggs	-5.45	0.30	35	-17.91	0.000
5.MeC23	queen_dg - queen_eggs	-5.66	0.41	35	-13.71	0.000
5.MeC23	queen_dg - rep_worker_dg	0.00	0.49	35	0.00	1.000
5.MeC23	queen_dg - repr_worker_chc	0.00	0.45	35	0.00	1.000
5.MeC23	queen_dg - worker_eggs	-5.45	0.41	35	-13.39	0.000
5.MeC23	queen_eggs - rep_worker_dg	5.66	0.35	35	16.22	0.000
5.MeC23	queen_eggs - repr_worker_chc	5.66	0.29	35	19.67	0.000
5.MeC23	queen_eggs - worker_eggs	0.21	0.21	35	1.02	1.000
5.MeC23	rep_worker_dg - repr_worker_chc	0.00	0.39	35	0.00	1.000
5.MeC23	rep_worker_dg - worker_eggs	-5.45	0.34	35	-15.94	0.000
5.MeC23	repr_worker_chc - worker_eggs	-5.45	0.28	35	-19.52	0.000
5.MeC25	queen_chc - queen_dg	-6.27	0.78	35	-8.07	0.000
5.MeC25	queen_chc - queen_eggs	-7.83	0.52	35	-15.11	0.000
5.MeC25	queen_chc - rep_worker_dg	-3.74	0.69	35	-5.46	0.000
5.MeC25	queen_chc - repr_worker_chc	0.00	0.60	35	0.00	1.000
5.MeC25	queen_chc - worker_eggs	-7.73	0.51	35	-15.29	0.000
5.MeC25	queen_dg - queen_eggs	-1.56	0.69	35	-2.27	1.000
5.MeC25	queen_dg - rep_worker_dg	2.53	0.82	35	3.09	1.000
5.MeC25	queen_dg - repr_worker_chc	6.27	0.75	35	8.35	0.000
5.MeC25	queen_dg - worker_eggs	-1.46	0.68	35	-2.15	1.000
5.MeC25	queen_eggs - rep_worker_dg	4.09	0.58	35	7.06	0.000
5.MeC25	queen_eggs - repr_worker_chc	7.83	0.48	35	16.39	0.000
5.MeC25	queen_eggs - worker_eggs	0.10	0.35	35	0.30	1.000
5.MeC25	rep_worker_dg - repr_worker_chc	3.74	0.66	35	5.71	0.000
5.MeC25	rep_worker_dg - worker_eggs	-3.99	0.57	35	-7.02	0.000
5.MeC25	repr_worker_chc - worker_eggs	-7.73	0.46	35	-16.67	0.000
5.MeC26	queen_chc - queen_dg	5.55	0.40	35	13.91	0.000
5.MeC26	queen_chc - queen_eggs	5.55	0.27	35	20.87	0.000
5.MeC26	queen_chc - rep_worker_dg	5.55	0.35	35	15.77	0.000
5.MeC26	queen_chc - repr_worker_chc	-0.23	0.31	35	-0.75	1.000
5.MeC26	queen_chc - worker_eggs	5.55	0.26	35	21.41	0.000
5.MeC26	queen_dg - queen_eggs	0.00	0.35	35	0.00	1.000
5.MeC26	queen_dg - rep_worker_dg	0.00	0.42	35	0.00	1.000
5.MeC26	queen_dg - repr_worker_chc	-5.78	0.39	35	-15.00	0.000
5.MeC26	queen_dg - worker_eggs	0.00	0.35	35	0.00	1.000
5.MeC26	queen_eggs - rep_worker_dg	0.00	0.30	35	0.00	1.000
5.MeC26	queen_eggs - repr_worker_chc	-5.78	0.25	35	-23.58	0.000
5.MeC26	queen_eggs - worker_eggs	0.00	0.18	35	0.00	1.000
5.MeC26	rep_worker_dg - repr_worker_chc	-5.78	0.34	35	-17.19	0.000
5.MeC26	rep_worker_dg - worker_eggs	0.00	0.29	35	0.00	1.000
5.MeC26	repr_worker_chc - worker_eggs	5.78	0.24	35	24.31	0.000
5.MeC27	queen_chc - queen_dg	-1.09	0.32	35	-3.42	1.000
5.MeC27	queen_chc - queen_eggs	-2.18	0.21	35	-10.23	0.000
5.MeC27	queen_chc - rep_worker_dg	-0.03	0.28	35	-0.10	1.000
5.MeC27	queen_chc - repr_worker_chc	-0.68	0.25	35	-2.74	1.000

5.MeC27	queen_chc - worker_eggs	-2.19	0.21	35	-10.54	0.000
5.MeC27	queen_dg - queen_eggs	-1.09	0.28	35	-3.86	0.520
5.MeC27	queen_dg - rep_worker_dg	1.06	0.34	35	3.15	1.000
5.MeC27	queen_dg - repr_worker_chc	0.41	0.31	35	1.34	1.000
5.MeC27	queen_dg - worker_eggs	-1.10	0.28	35	-3.95	0.400
5.MeC27	queen_eggs - rep_worker_dg	2.15	0.24	35	9.03	0.000
5.MeC27	queen_eggs - repr_worker_chc	1.50	0.20	35	7.65	0.000
5.MeC27	queen_eggs - worker_eggs	-0.01	0.14	35	-0.06	1.000
5.MeC27	rep_worker_dg - repr_worker_chc	-0.65	0.27	35	-2.41	1.000
5.MeC27	rep_worker_dg - worker_eggs	-2.16	0.23	35	-9.26	0.000
5.MeC27	repr_worker_chc - worker_eggs	-1.51	0.19	35	-7.93	0.000
5..diMeC31	queen_chc - queen_dg	12.83	0.32	35	40.41	0.000
5..diMeC31	queen_chc - queen_eggs	12.83	0.21	35	60.62	0.000
5..diMeC31	queen_chc - rep_worker_dg	12.83	0.28	35	45.82	0.000
5..diMeC31	queen_chc - repr_worker_chc	0.29	0.25	35	1.19	1.000
5..diMeC31	queen_chc - worker_eggs	12.83	0.21	35	62.19	0.000
5..diMeC31	queen_dg - queen_eggs	0.00	0.28	35	0.00	1.000
5..diMeC31	queen_dg - rep_worker_dg	0.00	0.33	35	0.00	1.000
5..diMeC31	queen_dg - repr_worker_chc	-12.54	0.31	35	-40.88	0.000
5..diMeC31	queen_dg - worker_eggs	0.00	0.28	35	0.00	1.000
5..diMeC31	queen_eggs - rep_worker_dg	0.00	0.24	35	0.00	1.000
5..diMeC31	queen_eggs - repr_worker_chc	-12.54	0.20	35	-64.25	0.000
5..diMeC31	queen_eggs - worker_eggs	0.00	0.14	35	0.00	1.000
5..diMeC31	rep_worker_dg - repr_worker_chc	-12.54	0.27	35	-46.83	0.000
5..diMeC31	rep_worker_dg - worker_eggs	0.00	0.23	35	0.00	1.000
5..diMeC31	repr_worker_chc - worker_eggs	12.54	0.19	35	66.23	0.000
6.MeC28	queen_chc - queen_dg	6.69	0.19	35	34.37	0.000
6.MeC28	queen_chc - queen_eggs	6.69	0.13	35	51.55	0.000
6.MeC28	queen_chc - rep_worker_dg	6.69	0.17	35	38.97	0.000
6.MeC28	queen_chc - repr_worker_chc	0.02	0.15	35	0.12	1.000
6.MeC28	queen_chc - worker_eggs	6.69	0.13	35	52.89	0.000
6.MeC28	queen_dg - queen_eggs	0.00	0.17	35	0.00	1.000
6.MeC28	queen_dg - rep_worker_dg	0.00	0.21	35	0.00	1.000
6.MeC28	queen_dg - repr_worker_chc	-6.67	0.19	35	-35.48	0.000
6.MeC28	queen_dg - worker_eggs	0.00	0.17	35	0.00	1.000
6.MeC28	queen_eggs - rep_worker_dg	0.00	0.15	35	0.00	1.000
6.MeC28	queen_eggs - repr_worker_chc	-6.67	0.12	35	-55.77	0.000
6.MeC28	queen_eggs - worker_eggs	0.00	0.09	35	0.00	1.000
6.MeC28	rep_worker_dg - repr_worker_chc	-6.67	0.16	35	-40.65	0.000
6.MeC28	rep_worker_dg - worker_eggs	0.00	0.14	35	0.00	1.000
6.MeC28	repr_worker_chc - worker_eggs	6.67	0.12	35	57.49	0.000
7.MeC23	queen_chc - queen_dg	1.00	0.65	35	1.55	1.000
7.MeC23	queen_chc - queen_eggs	4.32	0.43	35	10.05	0.000
7.MeC23	queen_chc - rep_worker_dg	-0.60	0.57	35	-1.06	1.000
7.MeC23	queen_chc - repr_worker_chc	2.99	0.50	35	5.99	0.000
7.MeC23	queen_chc - worker_eggs	4.32	0.42	35	10.31	0.000
7.MeC23	queen_dg - queen_eggs	3.32	0.57	35	5.84	0.000
7.MeC23	queen_dg - rep_worker_dg	-1.60	0.68	35	-2.36	1.000

7.MeC23	queen_dg - repr_worker_chc	1.99	0.62	35	3.20	1.000
7.MeC23	queen_dg - worker_eggs	3.32	0.56	35	5.92	0.000
7.MeC23	queen_eggs - rep_worker_dg	-4.92	0.48	35	-10.24	0.000
7.MeC23	queen_eggs - repr_worker_chc	-1.33	0.40	35	-3.35	1.000
7.MeC23	queen_eggs - worker_eggs	0.00	0.29	35	0.00	1.000
7.MeC23	rep_worker_dg - repr_worker_chc	3.60	0.54	35	6.61	0.000
7.MeC23	rep_worker_dg - worker_eggs	4.92	0.47	35	10.45	0.000
7.MeC23	repr_worker_chc - worker_eggs	1.33	0.38	35	3.46	1.000
7.MeC27	queen_chc - queen_dg	-3.73	0.33	35	-11.27	0.000
7.MeC27	queen_chc - queen_eggs	3.57	0.22	35	16.21	0.000
7.MeC27	queen_chc - rep_worker_dg	-2.62	0.29	35	-8.99	0.000
7.MeC27	queen_chc - repr_worker_chc	0.05	0.26	35	0.20	1.000
7.MeC27	queen_chc - worker_eggs	3.57	0.21	35	16.63	0.000
7.MeC27	queen_dg - queen_eggs	7.30	0.29	35	25.03	0.000
7.MeC27	queen_dg - rep_worker_dg	1.11	0.35	35	3.17	1.000
7.MeC27	queen_dg - repr_worker_chc	3.78	0.32	35	11.82	0.000
7.MeC27	queen_dg - worker_eggs	7.30	0.29	35	25.40	0.000
7.MeC27	queen_eggs - rep_worker_dg	-6.19	0.25	35	-25.13	0.000
7.MeC27	queen_eggs - repr_worker_chc	-3.52	0.20	35	-17.33	0.000
7.MeC27	queen_eggs - worker_eggs	0.00	0.15	35	0.00	1.000
7.MeC27	rep_worker_dg - repr_worker_chc	2.67	0.28	35	9.58	0.000
7.MeC27	rep_worker_dg - worker_eggs	6.19	0.24	35	25.65	0.000
7.MeC27	repr_worker_chc - worker_eggs	3.52	0.20	35	17.87	0.000
7.MeC29	queen_chc - queen_dg	-0.07	0.67	35	-0.10	1.000
7.MeC29	queen_chc - queen_eggs	-1.54	0.45	35	-3.44	1.000
7.MeC29	queen_chc - rep_worker_dg	-0.06	0.59	35	-0.10	1.000
7.MeC29	queen_chc - repr_worker_chc	-0.24	0.52	35	-0.45	1.000
7.MeC29	queen_chc - worker_eggs	-1.57	0.44	35	-3.59	1.000
7.MeC29	queen_dg - queen_eggs	-1.48	0.59	35	-2.49	1.000
7.MeC29	queen_dg - rep_worker_dg	0.01	0.71	35	0.01	1.000
7.MeC29	queen_dg - repr_worker_chc	-0.17	0.65	35	-0.26	1.000
7.MeC29	queen_dg - worker_eggs	-1.50	0.58	35	-2.57	1.000
7.MeC29	queen_eggs - rep_worker_dg	1.49	0.50	35	2.96	1.000
7.MeC29	queen_eggs - repr_worker_chc	1.31	0.41	35	3.16	1.000
7.MeC29	queen_eggs - worker_eggs	-0.03	0.30	35	-0.09	1.000
7.MeC29	rep_worker_dg - repr_worker_chc	-0.18	0.57	35	-0.31	1.000
7.MeC29	rep_worker_dg - worker_eggs	-1.51	0.49	35	-3.08	1.000
7.MeC29	repr_worker_chc - worker_eggs	-1.33	0.40	35	-3.33	1.000
8..6.MeC24	queen_chc - queen_dg	0.00	0.56	35	0.00	1.000
8..6.MeC24	queen_chc - queen_eggs	-7.85	0.37	35	-21.12	0.000
8..6.MeC24	queen_chc - rep_worker_dg	0.00	0.49	35	0.00	1.000
8..6.MeC24	queen_chc - repr_worker_chc	0.00	0.43	35	0.00	1.000
8..6.MeC24	queen_chc - worker_eggs	-8.01	0.36	35	-22.11	0.000
8..6.MeC24	queen_dg - queen_eggs	-7.85	0.49	35	-15.97	0.000
8..6.MeC24	queen_dg - rep_worker_dg	0.00	0.59	35	0.00	1.000
8..6.MeC24	queen_dg - repr_worker_chc	0.00	0.54	35	0.00	1.000
8..6.MeC24	queen_dg - worker_eggs	-8.01	0.48	35	-16.53	0.000
8..6.MeC24	queen_eggs - rep_worker_dg	7.85	0.42	35	18.89	0.000

8..6.MeC24	queen_eggs - repr_worker_chc	7.85	0.34	35	22.91	0.000
8..6.MeC24	queen_eggs - worker_eggs	-0.16	0.25	35	-0.63	1.000
8..6.MeC24	rep_worker_dg - repr_worker_chc	0.00	0.47	35	0.00	1.000
8..6.MeC24	rep_worker_dg - worker_eggs	-8.01	0.41	35	-19.67	0.000
8..6.MeC24	repr_worker_chc - worker_eggs	-8.01	0.33	35	-24.09	0.000

Table S21: Pairwise comparisons considering the chemical compounds of each group of sample (CHC, eggs or *Dufour's* gland) and each group of female (queen and reproductive worker) in *Dolichovespula media*. chc = cuticular hydrocarbons, rep = reproductive worker, dg = *Dufour's* gland, padj = p value adjusted. All the values highlighted in red correspond to significant values $p < 0.05^*$.

compound	contrast	estimate	SE	df	t.ratio	padj
C21.1.1	queen_chc - queen_dg	-10.27	1.33	63	-7.71	0.00
C21.1.1	queen_chc - queen_eggs	-4.64	1.04	63	-4.48	0.03
C21.1.1	queen_chc - rep_worker_chc	0.00	1.23	63	0.00	1.00
C21.1.1	queen_chc - rep_worker_dg	-8.60	1.23	63	-6.98	0.00
C21.1.1	queen_chc - worker_eggs	-3.92	1.05	63	-3.75	0.38
C21.1.1	queen_dg - queen_eggs	5.62	1.04	63	5.43	0.00
C21.1.1	queen_dg - rep_worker_chc	10.27	1.23	63	8.33	0.00
C21.1.1	queen_dg - rep_worker_dg	1.66	1.23	63	1.35	1.00
C21.1.1	queen_dg - worker_eggs	6.34	1.05	63	6.05	0.00
C21.1.1	queen_eggs - rep_worker_chc	4.64	0.90	63	5.13	0.00
C21.1.1	queen_eggs - rep_worker_dg	-3.96	0.90	63	-4.38	0.04
C21.1.1	queen_eggs - worker_eggs	0.72	0.63	63	1.14	1.00
C21.1.1	rep_worker_chc - rep_worker_dg	-8.60	1.13	63	-7.64	0.00
C21.1.1	rep_worker_chc - worker_eggs	-3.92	0.92	63	-4.27	0.07
C21.1.1	rep_worker_dg - worker_eggs	4.68	0.92	63	5.09	0.00
C21.1.2	queen_chc - queen_dg	-7.89	1.44	63	-5.47	0.00
C21.1.2	queen_chc - queen_eggs	-5.59	1.12	63	-4.98	0.01
C21.1.2	queen_chc - rep_worker_chc	0.00	1.33	63	0.00	1.00
C21.1.2	queen_chc - rep_worker_dg	-6.57	1.33	63	-4.92	0.01
C21.1.2	queen_chc - worker_eggs	-5.23	1.13	63	-4.61	0.02
C21.1.2	queen_dg - queen_eggs	2.31	1.12	63	2.06	1.00
C21.1.2	queen_dg - rep_worker_chc	7.89	1.33	63	5.91	0.00
C21.1.2	queen_dg - rep_worker_dg	1.32	1.33	63	0.99	1.00
C21.1.2	queen_dg - worker_eggs	2.66	1.13	63	2.35	1.00
C21.1.2	queen_eggs - rep_worker_chc	5.59	0.98	63	5.70	0.00
C21.1.2	queen_eggs - rep_worker_dg	-0.98	0.98	63	-1.00	1.00
C21.1.2	queen_eggs - worker_eggs	0.36	0.68	63	0.53	1.00
C21.1.2	rep_worker_chc - rep_worker_dg	-6.57	1.22	63	-5.39	0.00
C21.1.2	rep_worker_chc - worker_eggs	-5.23	0.99	63	-5.26	0.00
C21.1.2	rep_worker_dg - worker_eggs	1.34	0.99	63	1.35	1.00
C23.1	queen_chc - queen_dg	0.00	1.12	63	0.00	1.00
C23.1	queen_chc - queen_eggs	-6.11	0.87	63	-7.00	0.00
C23.1	queen_chc - rep_worker_chc	0.00	1.04	63	0.00	1.00
C23.1	queen_chc - rep_worker_dg	0.00	1.04	63	0.00	1.00
C23.1	queen_chc - worker_eggs	-6.84	0.88	63	-7.75	0.00

C23.1	queen_dg - queen_eggs	-6.11	0.87	63	-7.00	0.00
C23.1	queen_dg - rep_worker_chc	0.00	1.04	63	0.00	1.00
C23.1	queen_dg - rep_worker_dg	0.00	1.04	63	0.00	1.00
C23.1	queen_dg - worker_eggs	-6.84	0.88	63	-7.75	0.00
C23.1	queen_eggs - rep_worker_chc	6.11	0.76	63	8.01	0.00
C23.1	queen_eggs - rep_worker_dg	6.11	0.76	63	8.01	0.00
C23.1	queen_eggs - worker_eggs	-0.73	0.53	63	-1.38	1.00
C23.1	rep_worker_chc - rep_worker_dg	0.00	0.95	63	0.00	1.00
C23.1	rep_worker_chc - worker_eggs	-6.84	0.77	63	-8.83	0.00
C23.1	rep_worker_dg - worker_eggs	-6.84	0.77	63	-8.83	0.00
C23.1...1	queen_chc - queen_dg	1.73	0.29	63	5.89	0.00
C23.1...1	queen_chc - queen_eggs	1.73	0.23	63	7.58	0.00
C23.1...1	queen_chc - rep_worker_chc	-1.97	0.27	63	-7.27	0.00
C23.1...1	queen_chc - rep_worker_dg	1.73	0.27	63	6.36	0.00
C23.1...1	queen_chc - worker_eggs	1.73	0.23	63	7.49	0.00
C23.1...1	queen_dg - queen_eggs	0.00	0.23	63	0.00	1.00
C23.1...1	queen_dg - rep_worker_chc	-3.70	0.27	63	-13.64	0.00
C23.1...1	queen_dg - rep_worker_dg	0.00	0.27	63	0.00	1.00
C23.1...1	queen_dg - worker_eggs	0.00	0.23	63	0.00	1.00
C23.1...1	queen_eggs - rep_worker_chc	-3.70	0.20	63	-18.59	0.00
C23.1...1	queen_eggs - rep_worker_dg	0.00	0.20	63	0.00	1.00
C23.1...1	queen_eggs - worker_eggs	0.00	0.14	63	0.00	1.00
C23.1...1	rep_worker_chc - rep_worker_dg	3.70	0.25	63	14.94	0.00
C23.1...1	rep_worker_chc - worker_eggs	3.70	0.20	63	18.30	0.00
C23.1...1	rep_worker_dg - worker_eggs	0.00	0.20	63	0.00	1.00
C23.1...2	queen_chc - queen_dg	4.28	0.26	63	16.63	0.00
C23.1...2	queen_chc - queen_eggs	4.28	0.20	63	21.40	0.00
C23.1...2	queen_chc - rep_worker_chc	-0.51	0.24	63	-2.16	1.00
C23.1...2	queen_chc - rep_worker_dg	4.28	0.24	63	17.96	0.00
C23.1...2	queen_chc - worker_eggs	4.28	0.20	63	21.14	0.00
C23.1...2	queen_dg - queen_eggs	0.00	0.20	63	0.00	1.00
C23.1...2	queen_dg - rep_worker_chc	-4.80	0.24	63	-20.12	0.00
C23.1...2	queen_dg - rep_worker_dg	0.00	0.24	63	0.00	1.00
C23.1...2	queen_dg - worker_eggs	0.00	0.20	63	0.00	1.00
C23.1...2	queen_eggs - rep_worker_chc	-4.80	0.17	63	-27.43	0.00
C23.1...2	queen_eggs - rep_worker_dg	0.00	0.17	63	0.00	1.00
C23.1...2	queen_eggs - worker_eggs	0.00	0.12	63	0.00	1.00
C23.1...2	rep_worker_chc - rep_worker_dg	4.80	0.22	63	22.04	0.00
C23.1...2	rep_worker_chc - worker_eggs	4.80	0.18	63	27.00	0.00
C23.1...2	rep_worker_dg - worker_eggs	0.00	0.18	63	0.00	1.00
C23.1.4	queen_chc - queen_dg	-9.40	0.44	63	-21.39	0.00
C23.1.4	queen_chc - queen_eggs	0.00	0.34	63	0.00	1.00
C23.1.4	queen_chc - rep_worker_chc	0.00	0.41	63	0.00	1.00
C23.1.4	queen_chc - rep_worker_dg	-8.03	0.41	63	-19.73	0.00
C23.1.4	queen_chc - worker_eggs	0.00	0.35	63	0.00	1.00
C23.1.4	queen_dg - queen_eggs	9.40	0.34	63	27.53	0.00
C23.1.4	queen_dg - rep_worker_chc	9.40	0.41	63	23.11	0.00
C23.1.4	queen_dg - rep_worker_dg	1.38	0.41	63	3.38	1.00

C23.1.4	queen_dg - worker_eggs	9.40	0.35	63	27.19	0.00
C23.1.4	queen_eggs - rep_worker_chc	0.00	0.30	63	0.00	1.00
C23.1.4	queen_eggs - rep_worker_dg	-8.03	0.30	63	-26.89	0.00
C23.1.4	queen_eggs - worker_eggs	0.00	0.21	63	0.00	1.00
C23.1.4	rep_worker_chc - rep_worker_dg	-8.03	0.37	63	-21.61	0.00
C23.1.4	rep_worker_chc - worker_eggs	0.00	0.30	63	0.00	1.00
C23.1.4	rep_worker_dg - worker_eggs	8.03	0.30	63	26.47	0.00
C25.1	queen_chc - queen_dg	-9.64	0.97	63	-9.91	0.00
C25.1	queen_chc - queen_eggs	-7.01	0.76	63	-9.27	0.00
C25.1	queen_chc - rep_worker_chc	0.00	0.90	63	0.00	1.00
C25.1	queen_chc - rep_worker_dg	-8.17	0.90	63	-9.07	0.00
C25.1	queen_chc - worker_eggs	-8.04	0.77	63	-10.51	0.00
C25.1	queen_dg - queen_eggs	2.63	0.76	63	3.47	0.91
C25.1	queen_dg - rep_worker_chc	9.64	0.90	63	10.70	0.00
C25.1	queen_dg - rep_worker_dg	1.47	0.90	63	1.63	1.00
C25.1	queen_dg - worker_eggs	1.60	0.77	63	2.09	1.00
C25.1	queen_eggs - rep_worker_chc	7.01	0.66	63	10.61	0.00
C25.1	queen_eggs - rep_worker_dg	-1.16	0.66	63	-1.75	1.00
C25.1	queen_eggs - worker_eggs	-1.03	0.46	63	-2.24	1.00
C25.1	rep_worker_chc - rep_worker_dg	-8.17	0.82	63	-9.94	0.00
C25.1	rep_worker_chc - worker_eggs	-8.04	0.67	63	-11.98	0.00
C25.1	rep_worker_dg - worker_eggs	0.13	0.67	63	0.19	1.00
C27.1	queen_chc - queen_dg	0.00	0.76	63	0.00	1.00
C27.1	queen_chc - queen_eggs	-8.66	0.59	63	-14.70	0.00
C27.1	queen_chc - rep_worker_chc	0.00	0.70	63	0.00	1.00
C27.1	queen_chc - rep_worker_dg	0.00	0.70	63	0.00	1.00
C27.1	queen_chc - worker_eggs	-9.82	0.60	63	-16.45	0.00
C27.1	queen_dg - queen_eggs	-8.66	0.59	63	-14.70	0.00
C27.1	queen_dg - rep_worker_chc	0.00	0.70	63	0.00	1.00
C27.1	queen_dg - rep_worker_dg	0.00	0.70	63	0.00	1.00
C27.1	queen_dg - worker_eggs	-9.82	0.60	63	-16.45	0.00
C27.1	queen_eggs - rep_worker_chc	8.66	0.52	63	16.82	0.00
C27.1	queen_eggs - rep_worker_dg	8.66	0.52	63	16.82	0.00
C27.1	queen_eggs - worker_eggs	-1.15	0.36	63	-3.21	1.00
C27.1	rep_worker_chc - rep_worker_dg	0.00	0.64	63	0.00	1.00
C27.1	rep_worker_chc - worker_eggs	-9.82	0.52	63	-18.76	0.00
C27.1	rep_worker_dg - worker_eggs	-9.82	0.52	63	-18.76	0.00
C27.1...1	queen_chc - queen_dg	7.66	0.08	63	93.95	0.00
C27.1...1	queen_chc - queen_eggs	7.66	0.06	63	120.88	0.00
C27.1...1	queen_chc - rep_worker_chc	-0.50	0.08	63	-6.57	0.00
C27.1...1	queen_chc - rep_worker_dg	7.66	0.08	63	101.48	0.00
C27.1...1	queen_chc - worker_eggs	7.66	0.06	63	119.41	0.00
C27.1...1	queen_dg - queen_eggs	0.00	0.06	63	0.00	1.00
C27.1...1	queen_dg - rep_worker_chc	-8.16	0.08	63	-108.05	0.00
C27.1...1	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
C27.1...1	queen_dg - worker_eggs	0.00	0.06	63	0.00	1.00
C27.1...1	queen_eggs - rep_worker_chc	-8.16	0.06	63	-147.28	0.00
C27.1...1	queen_eggs - rep_worker_dg	0.00	0.06	63	0.00	1.00

C27.1...1	queen_eggs - worker_eggs	0.00	0.04	63	0.00	1.00
C27.1...1	rep_worker_chc - rep_worker_dg	8.16	0.07	63	118.36	0.00
C27.1...1	rep_worker_chc - worker_eggs	8.16	0.06	63	144.96	0.00
C27.1...1	rep_worker_dg - worker_eggs	0.00	0.06	63	0.00	1.00
C27.1...2	queen_chc - queen_dg	7.60	0.08	63	91.89	0.00
C27.1...2	queen_chc - queen_eggs	7.60	0.06	63	118.22	0.00
C27.1...2	queen_chc - rep_worker_chc	-0.02	0.08	63	-0.27	1.00
C27.1...2	queen_chc - rep_worker_dg	7.60	0.08	63	99.25	0.00
C27.1...2	queen_chc - worker_eggs	7.60	0.07	63	116.79	0.00
C27.1...2	queen_dg - queen_eggs	0.00	0.06	63	0.00	1.00
C27.1...2	queen_dg - rep_worker_chc	-7.63	0.08	63	-99.52	0.00
C27.1...2	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
C27.1...2	queen_dg - worker_eggs	0.00	0.07	63	0.00	1.00
C27.1...2	queen_eggs - rep_worker_chc	-7.63	0.06	63	-135.66	0.00
C27.1...2	queen_eggs - rep_worker_dg	0.00	0.06	63	0.00	1.00
C27.1...2	queen_eggs - worker_eggs	0.00	0.04	63	0.00	1.00
C27.1...2	rep_worker_chc - rep_worker_dg	7.63	0.07	63	109.02	0.00
C27.1...2	rep_worker_chc - worker_eggs	7.63	0.06	63	133.53	0.00
C27.1...2	rep_worker_dg - worker_eggs	0.00	0.06	63	0.00	1.00
C29.1	queen_chc - queen_dg	2.98	0.50	63	5.90	0.00
C29.1	queen_chc - queen_eggs	-0.31	0.39	63	-0.78	1.00
C29.1	queen_chc - rep_worker_chc	-0.65	0.47	63	-1.40	1.00
C29.1	queen_chc - rep_worker_dg	2.97	0.47	63	6.37	0.00
C29.1	queen_chc - worker_eggs	-0.10	0.40	63	-0.24	1.00
C29.1	queen_dg - queen_eggs	-3.28	0.39	63	-8.37	0.00
C29.1	queen_dg - rep_worker_chc	-3.63	0.47	63	-7.77	0.00
C29.1	queen_dg - rep_worker_dg	0.00	0.47	63	-0.01	1.00
C29.1	queen_dg - worker_eggs	-3.07	0.40	63	-7.74	0.00
C29.1	queen_eggs - rep_worker_chc	-0.35	0.34	63	-1.01	1.00
C29.1	queen_eggs - rep_worker_dg	3.28	0.34	63	9.57	0.00
C29.1	queen_eggs - worker_eggs	0.21	0.24	63	0.88	1.00
C29.1	rep_worker_chc - rep_worker_dg	3.63	0.43	63	8.51	0.00
C29.1	rep_worker_chc - worker_eggs	0.56	0.35	63	1.60	1.00
C29.1	rep_worker_dg - worker_eggs	-3.07	0.35	63	-8.82	0.00
C29.1.2...n.C29	queen_chc - queen_dg	-10.46	0.26	63	-40.82	0.00
C29.1.2...n.C29	queen_chc - queen_eggs	0.00	0.20	63	0.00	1.00
C29.1.2...n.C29	queen_chc - rep_worker_chc	0.00	0.24	63	0.00	1.00
C29.1.2...n.C29	queen_chc - rep_worker_dg	-11.19	0.24	63	-47.19	0.00
C29.1.2...n.C29	queen_chc - worker_eggs	0.00	0.20	63	0.00	1.00
C29.1.2...n.C29	queen_dg - queen_eggs	10.46	0.20	63	52.52	0.00
C29.1.2...n.C29	queen_dg - rep_worker_chc	10.46	0.24	63	44.10	0.00
C29.1.2...n.C29	queen_dg - rep_worker_dg	-0.73	0.24	63	-3.09	1.00
C29.1.2...n.C29	queen_dg - worker_eggs	10.46	0.20	63	51.89	0.00
C29.1.2...n.C29	queen_eggs - rep_worker_chc	0.00	0.17	63	0.00	1.00
C29.1.2...n.C29	queen_eggs - rep_worker_dg	-11.19	0.17	63	-64.32	0.00
C29.1.2...n.C29	queen_eggs - worker_eggs	0.00	0.12	63	0.00	1.00
C29.1.2...n.C29	rep_worker_chc - rep_worker_dg	-11.19	0.22	63	-51.69	0.00
C29.1.2...n.C29	rep_worker_chc - worker_eggs	0.00	0.18	63	0.00	1.00

C29.1.2...n.C29	rep_worker_dg - worker_eggs	11.19	0.18	63	63.31	0.00
C31.1...2	queen_chc - queen_dg	3.25	0.82	63	3.97	0.18
C31.1...2	queen_chc - queen_eggs	0.96	0.64	63	1.52	1.00
C31.1...2	queen_chc - rep_worker_chc	-0.16	0.76	63	-0.21	1.00
C31.1...2	queen_chc - rep_worker_dg	4.94	0.76	63	6.53	0.00
C31.1...2	queen_chc - worker_eggs	0.91	0.64	63	1.41	1.00
C31.1...2	queen_dg - queen_eggs	-2.28	0.64	63	-3.59	0.63
C31.1...2	queen_dg - rep_worker_chc	-3.40	0.76	63	-4.49	0.03
C31.1...2	queen_dg - rep_worker_dg	1.70	0.76	63	2.24	1.00
C31.1...2	queen_dg - worker_eggs	-2.34	0.64	63	-3.63	0.55
C31.1...2	queen_eggs - rep_worker_chc	-1.12	0.56	63	-2.02	1.00
C31.1...2	queen_eggs - rep_worker_dg	3.98	0.56	63	7.17	0.00
C31.1...2	queen_eggs - worker_eggs	-0.05	0.39	63	-0.14	1.00
C31.1...2	rep_worker_chc - rep_worker_dg	5.10	0.69	63	7.38	0.00
C31.1...2	rep_worker_chc - worker_eggs	1.07	0.56	63	1.89	1.00
C31.1...2	rep_worker_dg - worker_eggs	-4.03	0.56	63	-7.15	0.00
C32.1	queen_chc - queen_dg	-11.05	0.23	63	-47.39	0.00
C32.1	queen_chc - queen_eggs	0.00	0.18	63	0.00	1.00
C32.1	queen_chc - rep_worker_chc	0.00	0.22	63	0.00	1.00
C32.1	queen_chc - rep_worker_dg	-10.89	0.22	63	-50.44	0.00
C32.1	queen_chc - worker_eggs	0.00	0.18	63	0.00	1.00
C32.1	queen_dg - queen_eggs	11.05	0.18	63	60.97	0.00
C32.1	queen_dg - rep_worker_chc	11.05	0.22	63	51.19	0.00
C32.1	queen_dg - rep_worker_dg	0.16	0.22	63	0.75	1.00
C32.1	queen_dg - worker_eggs	11.05	0.18	63	60.23	0.00
C32.1	queen_eggs - rep_worker_chc	0.00	0.16	63	0.00	1.00
C32.1	queen_eggs - rep_worker_dg	-10.89	0.16	63	-68.75	0.00
C32.1	queen_eggs - worker_eggs	0.00	0.11	63	0.00	1.00
C32.1	rep_worker_chc - rep_worker_dg	-10.89	0.20	63	-55.25	0.00
C32.1	rep_worker_chc - worker_eggs	0.00	0.16	63	0.00	1.00
C32.1	rep_worker_dg - worker_eggs	10.89	0.16	63	67.67	0.00
C33.1	queen_chc - queen_dg	-7.57	0.86	63	-8.80	0.00
C33.1	queen_chc - queen_eggs	0.00	0.67	63	0.00	1.00
C33.1	queen_chc - rep_worker_chc	0.00	0.80	63	0.00	1.00
C33.1	queen_chc - rep_worker_dg	-3.64	0.80	63	-4.57	0.02
C33.1	queen_chc - worker_eggs	0.00	0.68	63	0.00	1.00
C33.1	queen_dg - queen_eggs	7.57	0.67	63	11.32	0.00
C33.1	queen_dg - rep_worker_chc	7.57	0.80	63	9.50	0.00
C33.1	queen_dg - rep_worker_dg	3.93	0.80	63	4.94	0.01
C33.1	queen_dg - worker_eggs	7.57	0.68	63	11.18	0.00
C33.1	queen_eggs - rep_worker_chc	0.00	0.58	63	0.00	1.00
C33.1	queen_eggs - rep_worker_dg	-3.64	0.58	63	-6.23	0.00
C33.1	queen_eggs - worker_eggs	0.00	0.41	63	0.00	1.00
C33.1	rep_worker_chc - rep_worker_dg	-3.64	0.73	63	-5.00	0.00
C33.1	rep_worker_chc - worker_eggs	0.00	0.59	63	0.00	1.00
C33.1	rep_worker_dg - worker_eggs	3.64	0.59	63	6.13	0.00
C33.1...n.C33	queen_chc - queen_dg	10.01	0.09	63	109.20	0.00
C33.1...n.C33	queen_chc - queen_eggs	10.01	0.07	63	140.49	0.00

C33.1...n.C33	queen_chc - rep_worker_chc	0.36	0.08	63	4.25	0.07
C33.1...n.C33	queen_chc - rep_worker_dg	10.01	0.08	63	117.94	0.00
C33.1...n.C33	queen_chc - worker_eggs	10.01	0.07	63	138.79	0.00
C33.1...n.C33	queen_dg - queen_eggs	0.00	0.07	63	0.00	1.00
C33.1...n.C33	queen_dg - rep_worker_chc	-9.65	0.08	63	-113.69	0.00
C33.1...n.C33	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
C33.1...n.C33	queen_dg - worker_eggs	0.00	0.07	63	0.00	1.00
C33.1...n.C33	queen_eggs - rep_worker_chc	-9.65	0.06	63	-154.97	0.00
C33.1...n.C33	queen_eggs - rep_worker_dg	0.00	0.06	63	0.00	1.00
C33.1...n.C33	queen_eggs - worker_eggs	0.00	0.04	63	0.00	1.00
C33.1...n.C33	rep_worker_chc - rep_worker_dg	9.65	0.08	63	124.54	0.00
C33.1...n.C33	rep_worker_chc - worker_eggs	9.65	0.06	63	152.53	0.00
C33.1...n.C33	rep_worker_dg - worker_eggs	0.00	0.06	63	0.00	1.00
C35.1	queen_chc - queen_dg	-10.61	0.58	63	-18.34	0.00
C35.1	queen_chc - queen_eggs	0.00	0.45	63	0.00	1.00
C35.1	queen_chc - rep_worker_chc	0.00	0.54	63	0.00	1.00
C35.1	queen_chc - rep_worker_dg	-9.85	0.54	63	-18.41	0.00
C35.1	queen_chc - worker_eggs	0.00	0.45	63	0.00	1.00
C35.1	queen_dg - queen_eggs	10.61	0.45	63	23.60	0.00
C35.1	queen_dg - rep_worker_chc	10.61	0.54	63	19.81	0.00
C35.1	queen_dg - rep_worker_dg	0.75	0.54	63	1.40	1.00
C35.1	queen_dg - worker_eggs	10.61	0.45	63	23.31	0.00
C35.1	queen_eggs - rep_worker_chc	0.00	0.39	63	0.00	1.00
C35.1	queen_eggs - rep_worker_dg	-9.85	0.39	63	-25.09	0.00
C35.1	queen_eggs - worker_eggs	0.00	0.27	63	0.00	1.00
C35.1	rep_worker_chc - rep_worker_dg	-9.85	0.49	63	-20.17	0.00
C35.1	rep_worker_chc - worker_eggs	0.00	0.40	63	0.00	1.00
C35.1	rep_worker_dg - worker_eggs	9.85	0.40	63	24.70	0.00
n.C18	queen_chc - queen_dg	5.14	0.11	63	45.19	0.00
n.C18	queen_chc - queen_eggs	5.14	0.09	63	58.14	0.00
n.C18	queen_chc - rep_worker_chc	-2.41	0.11	63	-22.94	0.00
n.C18	queen_chc - rep_worker_dg	5.14	0.11	63	48.81	0.00
n.C18	queen_chc - worker_eggs	5.14	0.09	63	57.44	0.00
n.C18	queen_dg - queen_eggs	0.00	0.09	63	0.00	1.00
n.C18	queen_dg - rep_worker_chc	-7.55	0.11	63	-71.75	0.00
n.C18	queen_dg - rep_worker_dg	0.00	0.11	63	0.00	1.00
n.C18	queen_dg - worker_eggs	0.00	0.09	63	0.00	1.00
n.C18	queen_eggs - rep_worker_chc	-7.55	0.08	63	-97.81	0.00
n.C18	queen_eggs - rep_worker_dg	0.00	0.08	63	0.00	1.00
n.C18	queen_eggs - worker_eggs	0.00	0.05	63	0.00	1.00
n.C18	rep_worker_chc - rep_worker_dg	7.55	0.10	63	78.60	0.00
n.C18	rep_worker_chc - worker_eggs	7.55	0.08	63	96.27	0.00
n.C18	rep_worker_dg - worker_eggs	0.00	0.08	63	0.00	1.00
n.C20	queen_chc - queen_dg	5.53	0.18	63	31.41	0.00
n.C20	queen_chc - queen_eggs	5.53	0.14	63	40.42	0.00
n.C20	queen_chc - rep_worker_chc	-2.21	0.16	63	-13.59	0.00
n.C20	queen_chc - rep_worker_dg	5.53	0.16	63	33.93	0.00
n.C20	queen_chc - worker_eggs	5.53	0.14	63	39.93	0.00

n.C20	queen_dg - queen_eggs	0.00	0.14	63	0.00	1.00
n.C20	queen_dg - rep_worker_chc	-7.74	0.16	63	-47.52	0.00
n.C20	queen_dg - rep_worker_dg	0.00	0.16	63	0.00	1.00
n.C20	queen_dg - worker_eggs	0.00	0.14	63	0.00	1.00
n.C20	queen_eggs - rep_worker_chc	-7.74	0.12	63	-64.78	0.00
n.C20	queen_eggs - rep_worker_dg	0.00	0.12	63	0.00	1.00
n.C20	queen_eggs - worker_eggs	0.00	0.08	63	0.00	1.00
n.C20	rep_worker_chc - rep_worker_dg	7.74	0.15	63	52.06	0.00
n.C20	rep_worker_chc - worker_eggs	7.74	0.12	63	63.76	0.00
n.C20	rep_worker_dg - worker_eggs	0.00	0.12	63	0.00	1.00
n.C21	queen_chc - queen_dg	-4.55	1.26	63	-3.61	0.60
n.C21	queen_chc - queen_eggs	-1.50	0.98	63	-1.53	1.00
n.C21	queen_chc - rep_worker_chc	-0.28	1.17	63	-0.24	1.00
n.C21	queen_chc - rep_worker_dg	-0.61	1.17	63	-0.52	1.00
n.C21	queen_chc - worker_eggs	-1.79	0.99	63	-1.80	1.00
n.C21	queen_dg - queen_eggs	3.05	0.98	63	3.11	1.00
n.C21	queen_dg - rep_worker_chc	4.27	1.17	63	3.66	0.50
n.C21	queen_dg - rep_worker_dg	3.94	1.17	63	3.38	1.00
n.C21	queen_dg - worker_eggs	2.76	0.99	63	2.79	1.00
n.C21	queen_eggs - rep_worker_chc	1.22	0.86	63	1.43	1.00
n.C21	queen_eggs - rep_worker_dg	0.89	0.86	63	1.04	1.00
n.C21	queen_eggs - worker_eggs	-0.29	0.60	63	-0.48	1.00
n.C21	rep_worker_chc - rep_worker_dg	-0.33	1.07	63	-0.31	1.00
n.C21	rep_worker_chc - worker_eggs	-1.51	0.87	63	-1.73	1.00
n.C21	rep_worker_dg - worker_eggs	-1.18	0.87	63	-1.35	1.00
n.C22	queen_chc - queen_dg	-2.84	0.45	63	-6.30	0.00
n.C22	queen_chc - queen_eggs	5.17	0.35	63	14.74	0.00
n.C22	queen_chc - rep_worker_chc	-2.47	0.42	63	-5.91	0.00
n.C22	queen_chc - rep_worker_dg	-2.74	0.42	63	-6.55	0.00
n.C22	queen_chc - worker_eggs	5.17	0.35	63	14.56	0.00
n.C22	queen_dg - queen_eggs	8.00	0.35	63	22.84	0.00
n.C22	queen_dg - rep_worker_chc	0.37	0.42	63	0.89	1.00
n.C22	queen_dg - rep_worker_dg	0.10	0.42	63	0.25	1.00
n.C22	queen_dg - worker_eggs	8.00	0.35	63	22.56	0.00
n.C22	queen_eggs - rep_worker_chc	-7.63	0.31	63	-24.92	0.00
n.C22	queen_eggs - rep_worker_dg	-7.90	0.31	63	-25.80	0.00
n.C22	queen_eggs - worker_eggs	0.00	0.21	63	0.00	1.00
n.C22	rep_worker_chc - rep_worker_dg	-0.27	0.38	63	-0.71	1.00
n.C22	rep_worker_chc - worker_eggs	7.63	0.31	63	24.53	0.00
n.C22	rep_worker_dg - worker_eggs	7.90	0.31	63	25.40	0.00
n.C23	queen_chc - queen_dg	-1.68	0.90	63	-1.87	1.00
n.C23	queen_chc - queen_eggs	-1.13	0.70	63	-1.61	1.00
n.C23	queen_chc - rep_worker_chc	1.22	0.83	63	1.46	1.00
n.C23	queen_chc - rep_worker_dg	0.55	0.83	63	0.66	1.00
n.C23	queen_chc - worker_eggs	-1.02	0.71	63	-1.44	1.00
n.C23	queen_dg - queen_eggs	0.56	0.70	63	0.80	1.00
n.C23	queen_dg - rep_worker_chc	2.90	0.83	63	3.49	0.88
n.C23	queen_dg - rep_worker_dg	2.23	0.83	63	2.68	1.00

n.C23	queen_dg - worker_eggs	0.66	0.71	63	0.94	1.00
n.C23	queen_eggs - rep_worker_chc	2.34	0.61	63	3.84	0.28
n.C23	queen_eggs - rep_worker_dg	1.67	0.61	63	2.74	1.00
n.C23	queen_eggs - worker_eggs	0.11	0.42	63	0.25	1.00
n.C23	rep_worker_chc - rep_worker_dg	-0.67	0.76	63	-0.88	1.00
n.C23	rep_worker_chc - worker_eggs	-2.24	0.62	63	-3.61	0.59
n.C23	rep_worker_dg - worker_eggs	-1.57	0.62	63	-2.53	1.00
n.C24	queen_chc - queen_dg	-0.80	0.55	63	-1.47	1.00
n.C24	queen_chc - queen_eggs	6.70	0.42	63	15.81	0.00
n.C24	queen_chc - rep_worker_chc	-1.25	0.50	63	-2.48	1.00
n.C24	queen_chc - rep_worker_dg	0.72	0.50	63	1.43	1.00
n.C24	queen_chc - worker_eggs	6.70	0.43	63	15.62	0.00
n.C24	queen_dg - queen_eggs	7.50	0.42	63	17.70	0.00
n.C24	queen_dg - rep_worker_chc	-0.45	0.50	63	-0.90	1.00
n.C24	queen_dg - rep_worker_dg	1.52	0.50	63	3.01	1.00
n.C24	queen_dg - worker_eggs	7.50	0.43	63	17.49	0.00
n.C24	queen_eggs - rep_worker_chc	-7.95	0.37	63	-21.48	0.00
n.C24	queen_eggs - rep_worker_dg	-5.98	0.37	63	-16.15	0.00
n.C24	queen_eggs - worker_eggs	0.00	0.26	63	0.00	1.00
n.C24	rep_worker_chc - rep_worker_dg	1.97	0.46	63	4.28	0.06
n.C24	rep_worker_chc - worker_eggs	7.95	0.38	63	21.14	0.00
n.C24	rep_worker_dg - worker_eggs	5.98	0.38	63	15.89	0.00
n.C25	queen_chc - queen_dg	1.31	0.60	63	2.18	1.00
n.C25	queen_chc - queen_eggs	1.59	0.47	63	3.42	1.00
n.C25	queen_chc - rep_worker_chc	1.66	0.56	63	2.98	1.00
n.C25	queen_chc - rep_worker_dg	3.12	0.56	63	5.62	0.00
n.C25	queen_chc - worker_eggs	1.62	0.47	63	3.42	1.00
n.C25	queen_dg - queen_eggs	0.28	0.47	63	0.61	1.00
n.C25	queen_dg - rep_worker_chc	0.35	0.56	63	0.63	1.00
n.C25	queen_dg - rep_worker_dg	1.81	0.56	63	3.27	1.00
n.C25	queen_dg - worker_eggs	0.31	0.47	63	0.65	1.00
n.C25	queen_eggs - rep_worker_chc	0.06	0.41	63	0.16	1.00
n.C25	queen_eggs - rep_worker_dg	1.53	0.41	63	3.76	0.37
n.C25	queen_eggs - worker_eggs	0.02	0.28	63	0.08	1.00
n.C25	rep_worker_chc - rep_worker_dg	1.47	0.51	63	2.89	1.00
n.C25	rep_worker_chc - worker_eggs	-0.04	0.41	63	-0.10	1.00
n.C25	rep_worker_dg - worker_eggs	-1.51	0.41	63	-3.64	0.53
n.C26	queen_chc - queen_dg	1.91	0.34	63	5.59	0.00
n.C26	queen_chc - queen_eggs	10.25	0.27	63	38.63	0.00
n.C26	queen_chc - rep_worker_chc	1.10	0.32	63	3.49	0.87
n.C26	queen_chc - rep_worker_dg	2.54	0.32	63	8.05	0.00
n.C26	queen_chc - worker_eggs	10.25	0.27	63	38.16	0.00
n.C26	queen_dg - queen_eggs	8.34	0.27	63	31.44	0.00
n.C26	queen_dg - rep_worker_chc	-0.81	0.32	63	-2.55	1.00
n.C26	queen_dg - rep_worker_dg	0.63	0.32	63	2.01	1.00
n.C26	queen_dg - worker_eggs	8.34	0.27	63	31.06	0.00
n.C26	queen_eggs - rep_worker_chc	-9.14	0.23	63	-39.45	0.00
n.C26	queen_eggs - rep_worker_dg	-7.70	0.23	63	-33.24	0.00

n.C26	queen_eggs - worker_eggs	0.00	0.16	63	0.00	1.00
n.C26	rep_worker_chc - rep_worker_dg	1.44	0.29	63	4.99	0.00
n.C26	rep_worker_chc - worker_eggs	9.14	0.24	63	38.83	0.00
n.C26	rep_worker_dg - worker_eggs	7.70	0.24	63	32.72	0.00
n.C27	queen_chc - queen_dg	3.58	0.30	63	12.05	0.00
n.C27	queen_chc - queen_eggs	0.64	0.23	63	2.78	1.00
n.C27	queen_chc - rep_worker_chc	0.20	0.28	63	0.72	1.00
n.C27	queen_chc - rep_worker_dg	4.33	0.28	63	15.71	0.00
n.C27	queen_chc - worker_eggs	0.30	0.23	63	1.28	1.00
n.C27	queen_dg - queen_eggs	-2.94	0.23	63	-12.72	0.00
n.C27	queen_dg - rep_worker_chc	-3.39	0.28	63	-12.30	0.00
n.C27	queen_dg - rep_worker_dg	0.74	0.28	63	2.70	1.00
n.C27	queen_dg - worker_eggs	-3.29	0.23	63	-14.04	0.00
n.C27	queen_eggs - rep_worker_chc	-0.45	0.20	63	-2.21	1.00
n.C27	queen_eggs - rep_worker_dg	3.68	0.20	63	18.23	0.00
n.C27	queen_eggs - worker_eggs	-0.34	0.14	63	-2.45	1.00
n.C27	rep_worker_chc - rep_worker_dg	4.13	0.25	63	16.43	0.00
n.C27	rep_worker_chc - worker_eggs	0.10	0.21	63	0.50	1.00
n.C27	rep_worker_dg - worker_eggs	-4.03	0.21	63	-19.63	0.00
n.C28	queen_chc - queen_dg	12.44	0.02	63	525.33	0.00
n.C28	queen_chc - queen_eggs	12.44	0.02	63	675.87	0.00
n.C28	queen_chc - rep_worker_chc	0.59	0.02	63	27.01	0.00
n.C28	queen_chc - rep_worker_dg	12.44	0.02	63	567.43	0.00
n.C28	queen_chc - worker_eggs	12.44	0.02	63	667.70	0.00
n.C28	queen_dg - queen_eggs	0.00	0.02	63	0.01	1.00
n.C28	queen_dg - rep_worker_chc	-11.85	0.02	63	-540.42	0.00
n.C28	queen_dg - rep_worker_dg	0.00	0.02	63	0.00	1.00
n.C28	queen_dg - worker_eggs	0.00	0.02	63	0.01	1.00
n.C28	queen_eggs - rep_worker_chc	-11.85	0.02	63	-736.66	0.00
n.C28	queen_eggs - rep_worker_dg	0.00	0.02	63	-0.01	1.00
n.C28	queen_eggs - worker_eggs	0.00	0.01	63	0.00	1.00
n.C28	rep_worker_chc - rep_worker_dg	11.85	0.02	63	592.00	0.00
n.C28	rep_worker_chc - worker_eggs	11.85	0.02	63	725.05	0.00
n.C28	rep_worker_dg - worker_eggs	0.00	0.02	63	0.01	1.00
n.C28...3.9.diMeC27	queen_chc - queen_dg	-12.33	0.28	63	-43.63	0.00
n.C28...3.9.diMeC27	queen_chc - queen_eggs	0.00	0.22	63	0.00	1.00
n.C28...3.9.diMeC27	queen_chc - rep_worker_chc	0.00	0.26	63	0.00	1.00
n.C28...3.9.diMeC27	queen_chc - rep_worker_dg	-12.49	0.26	63	-47.75	0.00
n.C28...3.9.diMeC27	queen_chc - worker_eggs	0.00	0.22	63	0.00	1.00
n.C28...3.9.diMeC27	queen_dg - queen_eggs	12.33	0.22	63	56.14	0.00
n.C28...3.9.diMeC27	queen_dg - rep_worker_chc	12.33	0.26	63	47.13	0.00
n.C28...3.9.diMeC27	queen_dg - rep_worker_dg	-0.16	0.26	63	-0.62	1.00
n.C28...3.9.diMeC27	queen_dg - worker_eggs	12.33	0.22	63	55.46	0.00
n.C28...3.9.diMeC27	queen_eggs - rep_worker_chc	0.00	0.19	63	0.00	1.00
n.C28...3.9.diMeC27	queen_eggs - rep_worker_dg	-12.49	0.19	63	-65.09	0.00
n.C28...3.9.diMeC27	queen_eggs - worker_eggs	0.00	0.13	63	0.00	1.00
n.C28...3.9.diMeC27	rep_worker_chc - rep_worker_dg	-12.49	0.24	63	-52.30	0.00
n.C28...3.9.diMeC27	rep_worker_chc - worker_eggs	0.00	0.19	63	0.00	1.00

n.C28...3.9.diMeC27	rep_worker_dg - worker_eggs	12.49	0.19	63	64.06	0.00
n.C29	queen_chc - queen_dg	13.51	0.78	63	17.37	0.00
n.C29	queen_chc - queen_eggs	0.18	0.60	63	0.29	1.00
n.C29	queen_chc - rep_worker_chc	-0.52	0.72	63	-0.72	1.00
n.C29	queen_chc - rep_worker_dg	13.51	0.72	63	18.76	0.00
n.C29	queen_chc - worker_eggs	0.44	0.61	63	0.71	1.00
n.C29	queen_dg - queen_eggs	-13.33	0.60	63	-22.05	0.00
n.C29	queen_dg - rep_worker_chc	-14.03	0.72	63	-19.48	0.00
n.C29	queen_dg - rep_worker_dg	0.00	0.72	63	0.00	1.00
n.C29	queen_dg - worker_eggs	-13.07	0.61	63	-21.36	0.00
n.C29	queen_eggs - rep_worker_chc	-0.70	0.53	63	-1.32	1.00
n.C29	queen_eggs - rep_worker_dg	13.33	0.53	63	25.24	0.00
n.C29	queen_eggs - worker_eggs	0.26	0.37	63	0.71	1.00
n.C29	rep_worker_chc - rep_worker_dg	14.03	0.66	63	21.34	0.00
n.C29	rep_worker_chc - worker_eggs	0.96	0.54	63	1.78	1.00
n.C29	rep_worker_dg - worker_eggs	-13.07	0.54	63	-24.35	0.00
n.C31	queen_chc - queen_dg	5.73	0.56	63	10.31	0.00
n.C31	queen_chc - queen_eggs	12.66	0.43	63	29.30	0.00
n.C31	queen_chc - rep_worker_chc	1.73	0.51	63	3.36	1.00
n.C31	queen_chc - rep_worker_dg	7.00	0.51	63	13.60	0.00
n.C31	queen_chc - worker_eggs	12.66	0.44	63	28.94	0.00
n.C31	queen_dg - queen_eggs	6.93	0.43	63	16.03	0.00
n.C31	queen_dg - rep_worker_chc	-4.00	0.51	63	-7.77	0.00
n.C31	queen_dg - rep_worker_dg	1.27	0.51	63	2.47	1.00
n.C31	queen_dg - worker_eggs	6.93	0.44	63	15.84	0.00
n.C31	queen_eggs - rep_worker_chc	-10.93	0.38	63	-28.95	0.00
n.C31	queen_eggs - rep_worker_dg	-5.66	0.38	63	-14.99	0.00
n.C31	queen_eggs - worker_eggs	0.00	0.26	63	0.00	1.00
n.C31	rep_worker_chc - rep_worker_dg	5.27	0.47	63	11.22	0.00
n.C31	rep_worker_chc - worker_eggs	10.93	0.38	63	28.49	0.00
n.C31	rep_worker_dg - worker_eggs	5.66	0.38	63	14.75	0.00
n.C32	queen_chc - queen_dg	8.90	0.03	63	260.73	0.00
n.C32	queen_chc - queen_eggs	8.90	0.03	63	335.44	0.00
n.C32	queen_chc - rep_worker_chc	0.18	0.03	63	5.63	0.00
n.C32	queen_chc - rep_worker_dg	8.90	0.03	63	281.62	0.00
n.C32	queen_chc - worker_eggs	8.90	0.03	63	331.38	0.00
n.C32	queen_dg - queen_eggs	0.00	0.03	63	0.01	1.00
n.C32	queen_dg - rep_worker_chc	-8.72	0.03	63	-275.99	0.00
n.C32	queen_dg - rep_worker_dg	0.00	0.03	63	0.00	1.00
n.C32	queen_dg - worker_eggs	0.00	0.03	63	0.01	1.00
n.C32	queen_eggs - rep_worker_chc	-8.72	0.02	63	-376.21	0.00
n.C32	queen_eggs - rep_worker_dg	0.00	0.02	63	-0.01	1.00
n.C32	queen_eggs - worker_eggs	0.00	0.02	63	0.00	1.00
n.C32	rep_worker_chc - rep_worker_dg	8.72	0.03	63	302.33	0.00
n.C32	rep_worker_chc - worker_eggs	8.72	0.02	63	370.29	0.00
n.C32	rep_worker_dg - worker_eggs	0.00	0.02	63	0.01	1.00
n.C34	queen_chc - queen_dg	6.34	0.07	63	89.39	0.00
n.C34	queen_chc - queen_eggs	6.34	0.06	63	115.00	0.00

n.C34	queen_chc - rep_worker_chc	-0.34	0.07	63	-5.19	0.00
n.C34	queen_chc - rep_worker_dg	6.34	0.07	63	96.55	0.00
n.C34	queen_chc - worker_eggs	6.34	0.06	63	113.61	0.00
n.C34	queen_dg - queen_eggs	0.00	0.06	63	0.00	1.00
n.C34	queen_dg - rep_worker_chc	-6.68	0.07	63	-101.74	0.00
n.C34	queen_dg - rep_worker_dg	0.00	0.07	63	0.00	1.00
n.C34	queen_dg - worker_eggs	0.00	0.06	63	0.00	1.00
n.C34	queen_eggs - rep_worker_chc	-6.68	0.05	63	-138.68	0.00
n.C34	queen_eggs - rep_worker_dg	0.00	0.05	63	0.00	1.00
n.C34	queen_eggs - worker_eggs	0.00	0.03	63	0.00	1.00
n.C34	rep_worker_chc - rep_worker_dg	6.68	0.06	63	111.45	0.00
n.C34	rep_worker_chc - worker_eggs	6.68	0.05	63	136.50	0.00
n.C34	rep_worker_dg - worker_eggs	0.00	0.05	63	0.00	1.00
x.y.diMeC27	queen_chc - queen_dg	0.00	0.23	63	0.00	1.00
x.y.diMeC27	queen_chc - queen_eggs	-11.87	0.18	63	-67.41	0.00
x.y.diMeC27	queen_chc - rep_worker_chc	0.00	0.21	63	0.00	1.00
x.y.diMeC27	queen_chc - rep_worker_dg	0.00	0.21	63	0.00	1.00
x.y.diMeC27	queen_chc - worker_eggs	-11.87	0.18	63	-66.59	0.00
x.y.diMeC27	queen_dg - queen_eggs	-11.87	0.18	63	-67.41	0.00
x.y.diMeC27	queen_dg - rep_worker_chc	0.00	0.21	63	0.00	1.00
x.y.diMeC27	queen_dg - rep_worker_dg	0.00	0.21	63	0.00	1.00
x.y.diMeC27	queen_dg - worker_eggs	-11.87	0.18	63	-66.59	0.00
x.y.diMeC27	queen_eggs - rep_worker_chc	11.87	0.15	63	77.15	0.00
x.y.diMeC27	queen_eggs - rep_worker_dg	11.87	0.15	63	77.15	0.00
x.y.diMeC27	queen_eggs - worker_eggs	0.00	0.11	63	0.01	1.00
x.y.diMeC27	rep_worker_chc - rep_worker_dg	0.00	0.19	63	0.00	1.00
x.y.diMeC27	rep_worker_chc - worker_eggs	-11.87	0.16	63	-75.92	0.00
x.y.diMeC27	rep_worker_dg - worker_eggs	-11.87	0.16	63	-75.92	0.00
x.y.diMeC29	queen_chc - queen_dg	11.40	0.28	63	41.42	0.00
x.y.diMeC29	queen_chc - queen_eggs	-0.03	0.21	63	-0.13	1.00
x.y.diMeC29	queen_chc - rep_worker_chc	-0.01	0.25	63	-0.05	1.00
x.y.diMeC29	queen_chc - rep_worker_dg	11.40	0.25	63	44.74	0.00
x.y.diMeC29	queen_chc - worker_eggs	0.17	0.22	63	0.77	1.00
x.y.diMeC29	queen_dg - queen_eggs	-11.43	0.21	63	-53.41	0.00
x.y.diMeC29	queen_dg - rep_worker_chc	-11.41	0.25	63	-44.79	0.00
x.y.diMeC29	queen_dg - rep_worker_dg	0.00	0.25	63	0.00	1.00
x.y.diMeC29	queen_dg - worker_eggs	-11.23	0.22	63	-51.87	0.00
x.y.diMeC29	queen_eggs - rep_worker_chc	0.02	0.19	63	0.08	1.00
x.y.diMeC29	queen_eggs - rep_worker_dg	11.43	0.19	63	61.13	0.00
x.y.diMeC29	queen_eggs - worker_eggs	0.20	0.13	63	1.50	1.00
x.y.diMeC29	rep_worker_chc - rep_worker_dg	11.41	0.23	63	49.06	0.00
x.y.diMeC29	rep_worker_chc - worker_eggs	0.18	0.19	63	0.95	1.00
x.y.diMeC29	rep_worker_dg - worker_eggs	-11.23	0.19	63	-59.14	0.00
11..9.7.MeC23	queen_chc - queen_dg	-6.23	0.76	63	-8.17	0.00
11..9.7.MeC23	queen_chc - queen_eggs	0.00	0.59	63	0.00	1.00
11..9.7.MeC23	queen_chc - rep_worker_chc	0.00	0.71	63	0.00	1.00
11..9.7.MeC23	queen_chc - rep_worker_dg	-4.54	0.71	63	-6.43	0.00
11..9.7.MeC23	queen_chc - worker_eggs	0.00	0.60	63	0.00	1.00

11..9.7.MeC23	queen_dg - queen_eggs	6.23	0.59	63	10.52	0.00
11..9.7.MeC23	queen_dg - rep_worker_chc	6.23	0.71	63	8.83	0.00
11..9.7.MeC23	queen_dg - rep_worker_dg	1.69	0.71	63	2.40	1.00
11..9.7.MeC23	queen_dg - worker_eggs	6.23	0.60	63	10.39	0.00
11..9.7.MeC23	queen_eggs - rep_worker_chc	0.00	0.52	63	0.00	1.00
11..9.7.MeC23	queen_eggs - rep_worker_dg	-4.54	0.52	63	-8.77	0.00
11..9.7.MeC23	queen_eggs - worker_eggs	0.00	0.36	63	0.00	1.00
11..9.7.MeC23	rep_worker_chc - rep_worker_dg	-4.54	0.64	63	-7.04	0.00
11..9.7.MeC23	rep_worker_chc - worker_eggs	0.00	0.53	63	0.00	1.00
11..9.7.MeC23	rep_worker_dg - worker_eggs	4.54	0.53	63	8.63	0.00
11.15...11.17.diMeC29	queen_chc - queen_dg	-12.73	0.25	63	-50.26	0.00
11.15...11.17.diMeC29	queen_chc - queen_eggs	0.00	0.20	63	0.00	1.00
11.15...11.17.diMeC29	queen_chc - rep_worker_chc	0.00	0.23	63	0.00	1.00
11.15...11.17.diMeC29	queen_chc - rep_worker_dg	-13.61	0.23	63	-58.04	0.00
11.15...11.17.diMeC29	queen_chc - worker_eggs	0.00	0.20	63	0.00	1.00
11.15...11.17.diMeC29	queen_dg - queen_eggs	12.73	0.20	63	64.67	0.00
11.15...11.17.diMeC29	queen_dg - rep_worker_chc	12.73	0.23	63	54.29	0.00
11.15...11.17.diMeC29	queen_dg - rep_worker_dg	-0.88	0.23	63	-3.75	0.37
11.15...11.17.diMeC29	queen_dg - worker_eggs	12.73	0.20	63	63.88	0.00
11.15...11.17.diMeC29	queen_eggs - rep_worker_chc	0.00	0.17	63	0.00	1.00
11.15...11.17.diMeC29	queen_eggs - rep_worker_dg	-13.61	0.17	63	-79.12	0.00
11.15...11.17.diMeC29	queen_eggs - worker_eggs	0.00	0.12	63	0.00	1.00
11.15...11.17.diMeC29	rep_worker_chc - rep_worker_dg	-13.61	0.21	63	-63.58	0.00
11.15...11.17.diMeC29	rep_worker_chc - worker_eggs	0.00	0.17	63	0.00	1.00
11.15...11.17.diMeC29	rep_worker_dg - worker_eggs	13.61	0.17	63	77.87	0.00
11.17...11.19.diMeC29	queen_chc - queen_dg	9.16	0.06	63	152.58	0.00
11.17...11.19.diMeC29	queen_chc - queen_eggs	9.16	0.05	63	196.30	0.00
11.17...11.19.diMeC29	queen_chc - rep_worker_chc	0.28	0.06	63	5.10	0.00
11.17...11.19.diMeC29	queen_chc - rep_worker_dg	9.16	0.06	63	164.80	0.00
11.17...11.19.diMeC29	queen_chc - worker_eggs	9.16	0.05	63	193.93	0.00
11.17...11.19.diMeC29	queen_dg - queen_eggs	0.00	0.05	63	0.00	1.00
11.17...11.19.diMeC29	queen_dg - rep_worker_chc	-8.88	0.06	63	-159.70	0.00
11.17...11.19.diMeC29	queen_dg - rep_worker_dg	0.00	0.06	63	0.00	1.00
11.17...11.19.diMeC29	queen_dg - worker_eggs	0.00	0.05	63	0.00	1.00
11.17...11.19.diMeC29	queen_eggs - rep_worker_chc	-8.88	0.04	63	-217.70	0.00
11.17...11.19.diMeC29	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00
11.17...11.19.diMeC29	queen_eggs - worker_eggs	0.00	0.03	63	0.00	1.00
11.17...11.19.diMeC29	rep_worker_chc - rep_worker_dg	8.88	0.05	63	174.95	0.00
11.17...11.19.diMeC29	rep_worker_chc - worker_eggs	8.88	0.04	63	214.27	0.00
11.17...11.19.diMeC29	rep_worker_dg - worker_eggs	0.00	0.04	63	0.00	1.00
12..11..10.MeC26	queen_chc - queen_dg	0.00	0.62	63	0.00	1.00
12..11..10.MeC26	queen_chc - queen_eggs	-7.63	0.48	63	-15.79	0.00
12..11..10.MeC26	queen_chc - rep_worker_chc	0.00	0.58	63	0.00	1.00
12..11..10.MeC26	queen_chc - rep_worker_dg	0.00	0.58	63	0.00	1.00
12..11..10.MeC26	queen_chc - worker_eggs	-8.22	0.49	63	-16.81	0.00
12..11..10.MeC26	queen_dg - queen_eggs	-7.63	0.48	63	-15.79	0.00
12..11..10.MeC26	queen_dg - rep_worker_chc	0.00	0.58	63	0.00	1.00
12..11..10.MeC26	queen_dg - rep_worker_dg	0.00	0.58	63	0.00	1.00

12..11..10.MeC26	queen_dg - worker_eggs	-8.22	0.49	63	-16.81	0.00
12..11..10.MeC26	queen_eggs - rep_worker_chc	7.63	0.42	63	18.07	0.00
12..11..10.MeC26	queen_eggs - rep_worker_dg	7.63	0.42	63	18.07	0.00
12..11..10.MeC26	queen_eggs - worker_eggs	-0.59	0.29	63	-2.02	1.00
12..11..10.MeC26	rep_worker_chc - rep_worker_dg	0.00	0.53	63	0.00	1.00
12..11..10.MeC26	rep_worker_chc - worker_eggs	-8.22	0.43	63	-19.16	0.00
12..11..10.MeC26	rep_worker_dg - worker_eggs	-8.22	0.43	63	-19.16	0.00
13..11..9..7.MeC25	queen_chc - queen_dg	-4.04	0.58	63	-6.94	0.00
13..11..9..7.MeC25	queen_chc - queen_eggs	-1.12	0.45	63	-2.48	1.00
13..11..9..7.MeC25	queen_chc - rep_worker_chc	0.04	0.54	63	0.07	1.00
13..11..9..7.MeC25	queen_chc - rep_worker_dg	-1.88	0.54	63	-3.49	0.88
13..11..9..7.MeC25	queen_chc - worker_eggs	-1.67	0.46	63	-3.64	0.53
13..11..9..7.MeC25	queen_dg - queen_eggs	2.92	0.45	63	6.45	0.00
13..11..9..7.MeC25	queen_dg - rep_worker_chc	4.08	0.54	63	7.57	0.00
13..11..9..7.MeC25	queen_dg - rep_worker_dg	2.16	0.54	63	4.01	0.16
13..11..9..7.MeC25	queen_dg - worker_eggs	2.37	0.46	63	5.18	0.00
13..11..9..7.MeC25	queen_eggs - rep_worker_chc	1.16	0.40	63	2.93	1.00
13..11..9..7.MeC25	queen_eggs - rep_worker_dg	-0.76	0.40	63	-1.91	1.00
13..11..9..7.MeC25	queen_eggs - worker_eggs	-0.55	0.27	63	-1.99	1.00
13..11..9..7.MeC25	rep_worker_chc - rep_worker_dg	-1.91	0.49	63	-3.89	0.24
13..11..9..7.MeC25	rep_worker_chc - worker_eggs	-1.71	0.40	63	-4.25	0.07
13..11..9..7.MeC25	rep_worker_dg - worker_eggs	0.21	0.40	63	0.52	1.00
13..11..9..7.MeC27	queen_chc - queen_dg	-0.93	0.45	63	-2.06	1.00
13..11..9..7.MeC27	queen_chc - queen_eggs	-0.93	0.35	63	-2.64	1.00
13..11..9..7.MeC27	queen_chc - rep_worker_chc	-0.31	0.42	63	-0.74	1.00
13..11..9..7.MeC27	queen_chc - rep_worker_dg	-0.01	0.42	63	-0.02	1.00
13..11..9..7.MeC27	queen_chc - worker_eggs	-0.87	0.36	63	-2.43	1.00
13..11..9..7.MeC27	queen_dg - queen_eggs	0.00	0.35	63	0.01	1.00
13..11..9..7.MeC27	queen_dg - rep_worker_chc	0.63	0.42	63	1.49	1.00
13..11..9..7.MeC27	queen_dg - rep_worker_dg	0.92	0.42	63	2.20	1.00
13..11..9..7.MeC27	queen_dg - worker_eggs	0.07	0.36	63	0.19	1.00
13..11..9..7.MeC27	queen_eggs - rep_worker_chc	0.62	0.31	63	2.02	1.00
13..11..9..7.MeC27	queen_eggs - rep_worker_dg	0.92	0.31	63	2.99	1.00
13..11..9..7.MeC27	queen_eggs - worker_eggs	0.07	0.21	63	0.30	1.00
13..11..9..7.MeC27	rep_worker_chc - rep_worker_dg	0.30	0.38	63	0.78	1.00
13..11..9..7.MeC27	rep_worker_chc - worker_eggs	-0.56	0.31	63	-1.78	1.00
13..11..9..7.MeC27	rep_worker_dg - worker_eggs	-0.86	0.31	63	-2.74	1.00
13..12..11..10.MeC26	queen_chc - queen_dg	-11.49	0.24	63	-48.16	0.00
13..12..11..10.MeC26	queen_chc - queen_eggs	0.00	0.19	63	0.00	1.00
13..12..11..10.MeC26	queen_chc - rep_worker_chc	0.00	0.22	63	0.00	1.00
13..12..11..10.MeC26	queen_chc - rep_worker_dg	-11.56	0.22	63	-52.36	0.00
13..12..11..10.MeC26	queen_chc - worker_eggs	0.00	0.19	63	0.00	1.00
13..12..11..10.MeC26	queen_dg - queen_eggs	11.49	0.19	63	61.96	0.00
13..12..11..10.MeC26	queen_dg - rep_worker_chc	11.49	0.22	63	52.01	0.00
13..12..11..10.MeC26	queen_dg - rep_worker_dg	-0.08	0.22	63	-0.34	1.00
13..12..11..10.MeC26	queen_dg - worker_eggs	11.49	0.19	63	61.21	0.00
13..12..11..10.MeC26	queen_eggs - rep_worker_chc	0.00	0.16	63	0.00	1.00
13..12..11..10.MeC26	queen_eggs - rep_worker_dg	-11.56	0.16	63	-71.37	0.00

13..12..11..10.MeC26	queen_eggs - worker_eggs	0.00	0.11	63	0.00	1.00
13..12..11..10.MeC26	rep_worker_chc - rep_worker_dg	-11.56	0.20	63	-57.36	0.00
13..12..11..10.MeC26	rep_worker_chc - worker_eggs	0.00	0.16	63	0.00	1.00
13..12..11..10.MeC26	rep_worker_dg - worker_eggs	11.56	0.16	63	70.25	0.00
13..12.MeC26	queen_chc - queen_dg	7.97	0.07	63	122.34	0.00
13..12.MeC26	queen_chc - queen_eggs	7.97	0.05	63	157.40	0.00
13..12.MeC26	queen_chc - rep_worker_chc	0.10	0.06	63	1.72	1.00
13..12.MeC26	queen_chc - rep_worker_dg	7.97	0.06	63	132.15	0.00
13..12.MeC26	queen_chc - worker_eggs	7.97	0.05	63	155.50	0.00
13..12.MeC26	queen_dg - queen_eggs	0.00	0.05	63	0.00	1.00
13..12.MeC26	queen_dg - rep_worker_chc	-7.86	0.06	63	-130.42	0.00
13..12.MeC26	queen_dg - rep_worker_dg	0.00	0.06	63	0.00	1.00
13..12.MeC26	queen_dg - worker_eggs	0.00	0.05	63	0.00	1.00
13..12.MeC26	queen_eggs - rep_worker_chc	-7.86	0.04	63	-177.78	0.00
13..12.MeC26	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00
13..12.MeC26	queen_eggs - worker_eggs	0.00	0.03	63	0.00	1.00
13..12.MeC26	rep_worker_chc - rep_worker_dg	7.86	0.06	63	142.87	0.00
13..12.MeC26	rep_worker_chc - worker_eggs	7.86	0.04	63	174.98	0.00
13..12.MeC26	rep_worker_dg - worker_eggs	0.00	0.04	63	0.00	1.00
14..13..12..11..10.MeC28	queen_chc - queen_dg	0.00	0.13	63	0.00	1.00
14..13..12..11..10.MeC28	queen_chc - queen_eggs	0.00	0.10	63	0.00	1.00
14..13..12..11..10.MeC28	queen_chc - rep_worker_chc	-10.91	0.12	63	-89.13	0.00
14..13..12..11..10.MeC28	queen_chc - rep_worker_dg	-12.82	0.12	63	-104.73	0.00
14..13..12..11..10.MeC28	queen_chc - worker_eggs	0.00	0.10	63	0.00	1.00
14..13..12..11..10.MeC28	queen_dg - queen_eggs	0.00	0.10	63	0.00	1.00
14..13..12..11..10.MeC28	queen_dg - rep_worker_chc	-10.91	0.12	63	-89.13	0.00
14..13..12..11..10.MeC28	queen_dg - rep_worker_dg	-12.82	0.12	63	-104.73	0.00
14..13..12..11..10.MeC28	queen_dg - worker_eggs	0.00	0.10	63	0.00	1.00
14..13..12..11..10.MeC28	queen_eggs - rep_worker_chc	-10.91	0.09	63	-121.49	0.00
14..13..12..11..10.MeC28	queen_eggs - rep_worker_dg	-12.82	0.09	63	-142.76	0.00
14..13..12..11..10.MeC28	queen_eggs - worker_eggs	0.00	0.06	63	0.00	1.00
14..13..12..11..10.MeC28	rep_worker_chc - rep_worker_dg	-1.91	0.11	63	-17.09	0.00
14..13..12..11..10.MeC28	rep_worker_chc - worker_eggs	10.91	0.09	63	119.58	0.00
14..13..12..11..10.MeC28	rep_worker_dg - worker_eggs	12.82	0.09	63	140.51	0.00
14..13..12.MeC28	queen_chc - queen_dg	-1.57	0.40	63	-3.91	0.22
14..13..12.MeC28	queen_chc - queen_eggs	-0.64	0.31	63	-2.05	1.00
14..13..12.MeC28	queen_chc - rep_worker_chc	10.40	0.37	63	28.10	0.00
14..13..12.MeC28	queen_chc - rep_worker_dg	10.40	0.37	63	28.10	0.00
14..13..12.MeC28	queen_chc - worker_eggs	-0.47	0.31	63	-1.49	1.00
14..13..12.MeC28	queen_dg - queen_eggs	0.93	0.31	63	2.98	1.00
14..13..12.MeC28	queen_dg - rep_worker_chc	11.97	0.37	63	32.33	0.00
14..13..12.MeC28	queen_dg - rep_worker_dg	11.97	0.37	63	32.33	0.00
14..13..12.MeC28	queen_dg - worker_eggs	1.10	0.31	63	3.48	0.89
14..13..12.MeC28	queen_eggs - rep_worker_chc	11.04	0.27	63	40.65	0.00
14..13..12.MeC28	queen_eggs - rep_worker_dg	11.04	0.27	63	40.65	0.00
14..13..12.MeC28	queen_eggs - worker_eggs	0.17	0.19	63	0.89	1.00
14..13..12.MeC28	rep_worker_chc - rep_worker_dg	0.00	0.34	63	0.00	1.00
14..13..12.MeC28	rep_worker_chc - worker_eggs	-10.87	0.28	63	-39.40	0.00

14..13..12.MeC28	rep_worker_dg - worker_eggs	-10.87	0.28	63	-39.40	0.00
15..13..11..9.MeC29	queen_chc - queen_dg	-0.23	0.59	63	-0.40	1.00
15..13..11..9.MeC29	queen_chc - queen_eggs	-2.29	0.46	63	-4.97	0.01
15..13..11..9.MeC29	queen_chc - rep_worker_chc	-1.57	0.55	63	-2.85	1.00
15..13..11..9.MeC29	queen_chc - rep_worker_dg	-0.06	0.55	63	-0.11	1.00
15..13..11..9.MeC29	queen_chc - worker_eggs	-1.69	0.47	63	-3.62	0.57
15..13..11..9.MeC29	queen_dg - queen_eggs	-2.06	0.46	63	-4.46	0.03
15..13..11..9.MeC29	queen_dg - rep_worker_chc	-1.33	0.55	63	-2.42	1.00
15..13..11..9.MeC29	queen_dg - rep_worker_dg	0.17	0.55	63	0.31	1.00
15..13..11..9.MeC29	queen_dg - worker_eggs	-1.46	0.47	63	-3.12	1.00
15..13..11..9.MeC29	queen_eggs - rep_worker_chc	0.73	0.40	63	1.80	1.00
15..13..11..9.MeC29	queen_eggs - rep_worker_dg	2.23	0.40	63	5.53	0.00
15..13..11..9.MeC29	queen_eggs - worker_eggs	0.60	0.28	63	2.15	1.00
15..13..11..9.MeC29	rep_worker_chc - rep_worker_dg	1.50	0.50	63	3.00	1.00
15..13..11..9.MeC29	rep_worker_chc - worker_eggs	-0.12	0.41	63	-0.30	1.00
15..13..11..9.MeC29	rep_worker_dg - worker_eggs	-1.63	0.41	63	-3.98	0.18
15..13..11..9.MeC31	queen_chc - queen_dg	0.37	0.77	63	0.48	1.00
15..13..11..9.MeC31	queen_chc - queen_eggs	0.22	0.60	63	0.37	1.00
15..13..11..9.MeC31	queen_chc - rep_worker_chc	0.15	0.71	63	0.21	1.00
15..13..11..9.MeC31	queen_chc - rep_worker_dg	3.57	0.71	63	5.00	0.00
15..13..11..9.MeC31	queen_chc - worker_eggs	0.39	0.61	63	0.64	1.00
15..13..11..9.MeC31	queen_dg - queen_eggs	-0.14	0.60	63	-0.24	1.00
15..13..11..9.MeC31	queen_dg - rep_worker_chc	-0.22	0.71	63	-0.30	1.00
15..13..11..9.MeC31	queen_dg - rep_worker_dg	3.20	0.71	63	4.48	0.03
15..13..11..9.MeC31	queen_dg - worker_eggs	0.02	0.61	63	0.04	1.00
15..13..11..9.MeC31	queen_eggs - rep_worker_chc	-0.08	0.52	63	-0.14	1.00
15..13..11..9.MeC31	queen_eggs - rep_worker_dg	3.34	0.52	63	6.38	0.00
15..13..11..9.MeC31	queen_eggs - worker_eggs	0.17	0.36	63	0.46	1.00
15..13..11..9.MeC31	rep_worker_chc - rep_worker_dg	3.42	0.65	63	5.24	0.00
15..13..11..9.MeC31	rep_worker_chc - worker_eggs	0.24	0.53	63	0.45	1.00
15..13..11..9.MeC31	rep_worker_dg - worker_eggs	-3.18	0.53	63	-5.97	0.00
15..14.MeC30	queen_chc - queen_dg	9.60	0.06	63	148.07	0.00
15..14.MeC30	queen_chc - queen_eggs	9.60	0.05	63	190.50	0.00
15..14.MeC30	queen_chc - rep_worker_chc	-0.38	0.06	63	-6.31	0.00
15..14.MeC30	queen_chc - rep_worker_dg	9.60	0.06	63	159.94	0.00
15..14.MeC30	queen_chc - worker_eggs	9.60	0.05	63	188.20	0.00
15..14.MeC30	queen_dg - queen_eggs	0.00	0.05	63	0.00	1.00
15..14.MeC30	queen_dg - rep_worker_chc	-9.98	0.06	63	-166.24	0.00
15..14.MeC30	queen_dg - rep_worker_dg	0.00	0.06	63	0.00	1.00
15..14.MeC30	queen_dg - worker_eggs	0.00	0.05	63	0.00	1.00
15..14.MeC30	queen_eggs - rep_worker_chc	-9.98	0.04	63	-226.61	0.00
15..14.MeC30	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00
15..14.MeC30	queen_eggs - worker_eggs	0.00	0.03	63	0.00	1.00
15..14.MeC30	rep_worker_chc - rep_worker_dg	9.98	0.05	63	182.11	0.00
15..14.MeC30	rep_worker_chc - worker_eggs	9.98	0.04	63	223.04	0.00
15..14.MeC30	rep_worker_dg - worker_eggs	0.00	0.04	63	0.00	1.00
17..15..13..11..9.MeC33	queen_chc - queen_dg	9.84	0.06	63	159.33	0.00
17..15..13..11..9.MeC33	queen_chc - queen_eggs	9.84	0.05	63	204.99	0.00

17..15..13..11..9.MeC33	queen_chc - rep_worker_chc	0.31	0.06	63	5.46	0.00
17..15..13..11..9.MeC33	queen_chc - rep_worker_dg	9.84	0.06	63	172.10	0.00
17..15..13..11..9.MeC33	queen_chc - worker_eggs	9.84	0.05	63	202.51	0.00
17..15..13..11..9.MeC33	queen_dg - queen_eggs	0.00	0.05	63	0.00	1.00
17..15..13..11..9.MeC33	queen_dg - rep_worker_chc	-9.53	0.06	63	-166.64	0.00
17..15..13..11..9.MeC33	queen_dg - rep_worker_dg	0.00	0.06	63	0.00	1.00
17..15..13..11..9.MeC33	queen_dg - worker_eggs	0.00	0.05	63	0.00	1.00
17..15..13..11..9.MeC33	queen_eggs - rep_worker_chc	-9.53	0.04	63	-227.15	0.00
17..15..13..11..9.MeC33	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00
17..15..13..11..9.MeC33	queen_eggs - worker_eggs	0.00	0.03	63	0.00	1.00
17..15..13..11..9.MeC33	rep_worker_chc - rep_worker_dg	9.53	0.05	63	182.54	0.00
17..15..13..11..9.MeC33	rep_worker_chc - worker_eggs	9.53	0.04	63	223.57	0.00
17..15..13..11..9.MeC33	rep_worker_dg - worker_eggs	0.00	0.04	63	0.00	1.00
17..15..13..11.MeC35	queen_chc - queen_dg	-0.53	0.51	63	-1.05	1.00
17..15..13..11.MeC35	queen_chc - queen_eggs	10.07	0.39	63	25.64	0.00
17..15..13..11.MeC35	queen_chc - rep_worker_chc	0.68	0.47	63	1.46	1.00
17..15..13..11.MeC35	queen_chc - rep_worker_dg	2.26	0.47	63	4.84	0.01
17..15..13..11.MeC35	queen_chc - worker_eggs	10.07	0.40	63	25.33	0.00
17..15..13..11.MeC35	queen_dg - queen_eggs	10.61	0.39	63	27.00	0.00
17..15..13..11.MeC35	queen_dg - rep_worker_chc	1.22	0.47	63	2.60	1.00
17..15..13..11.MeC35	queen_dg - rep_worker_dg	2.79	0.47	63	5.97	0.00
17..15..13..11.MeC35	queen_dg - worker_eggs	10.61	0.40	63	26.67	0.00
17..15..13..11.MeC35	queen_eggs - rep_worker_chc	-9.39	0.34	63	-27.35	0.00
17..15..13..11.MeC35	queen_eggs - rep_worker_dg	-7.81	0.34	63	-22.76	0.00
17..15..13..11.MeC35	queen_eggs - worker_eggs	0.00	0.24	63	0.00	1.00
17..15..13..11.MeC35	rep_worker_chc - rep_worker_dg	1.58	0.43	63	3.69	0.45
17..15..13..11.MeC35	rep_worker_chc - worker_eggs	9.39	0.35	63	26.92	0.00
17..15..13..11.MeC35	rep_worker_dg - worker_eggs	7.81	0.35	63	22.40	0.00
17.MeC34	queen_chc - queen_dg	6.99	0.08	63	90.09	0.00
17.MeC34	queen_chc - queen_eggs	6.99	0.06	63	115.91	0.00
17.MeC34	queen_chc - rep_worker_chc	-1.26	0.07	63	-17.58	0.00
17.MeC34	queen_chc - rep_worker_dg	6.99	0.07	63	97.31	0.00
17.MeC34	queen_chc - worker_eggs	6.99	0.06	63	114.50	0.00
17.MeC34	queen_dg - queen_eggs	0.00	0.06	63	0.00	1.00
17.MeC34	queen_dg - rep_worker_chc	-8.26	0.07	63	-114.89	0.00
17.MeC34	queen_dg - rep_worker_dg	0.00	0.07	63	0.00	1.00
17.MeC34	queen_dg - worker_eggs	0.00	0.06	63	0.00	1.00
17.MeC34	queen_eggs - rep_worker_chc	-8.26	0.05	63	-156.61	0.00
17.MeC34	queen_eggs - rep_worker_dg	0.00	0.05	63	0.00	1.00
17.MeC34	queen_eggs - worker_eggs	0.00	0.04	63	0.00	1.00
17.MeC34	rep_worker_chc - rep_worker_dg	8.26	0.07	63	125.85	0.00
17.MeC34	rep_worker_chc - worker_eggs	8.26	0.05	63	154.14	0.00
17.MeC34	rep_worker_dg - worker_eggs	0.00	0.05	63	0.00	1.00
3.13.diMeC29	queen_chc - queen_dg	-12.41	0.25	63	-49.38	0.00
3.13.diMeC29	queen_chc - queen_eggs	0.00	0.20	63	0.00	1.00
3.13.diMeC29	queen_chc - rep_worker_chc	0.00	0.23	63	0.00	1.00
3.13.diMeC29	queen_chc - rep_worker_dg	-12.70	0.23	63	-54.55	0.00
3.13.diMeC29	queen_chc - worker_eggs	0.00	0.20	63	0.00	1.00

3.13.diMeC29	queen_dg - queen_eggs	12.41	0.20	63	63.53	0.00
3.13.diMeC29	queen_dg - rep_worker_chc	12.41	0.23	63	53.34	0.00
3.13.diMeC29	queen_dg - rep_worker_dg	-0.28	0.23	63	-1.22	1.00
3.13.diMeC29	queen_dg - worker_eggs	12.41	0.20	63	62.76	0.00
3.13.diMeC29	queen_eggs - rep_worker_chc	0.00	0.17	63	0.00	1.00
3.13.diMeC29	queen_eggs - rep_worker_dg	-12.70	0.17	63	-74.37	0.00
3.13.diMeC29	queen_eggs - worker_eggs	0.00	0.12	63	0.00	1.00
3.13.diMeC29	rep_worker_chc - rep_worker_dg	-12.70	0.21	63	-59.76	0.00
3.13.diMeC29	rep_worker_chc - worker_eggs	0.00	0.17	63	0.00	1.00
3.13.diMeC29	rep_worker_dg - worker_eggs	12.70	0.17	63	73.19	0.00
3.MeC21	queen_chc - queen_dg	5.06	0.24	63	21.08	0.00
3.MeC21	queen_chc - queen_eggs	5.06	0.19	63	27.12	0.00
3.MeC21	queen_chc - rep_worker_chc	-1.48	0.22	63	-6.67	0.00
3.MeC21	queen_chc - rep_worker_dg	5.06	0.22	63	22.77	0.00
3.MeC21	queen_chc - worker_eggs	5.06	0.19	63	26.79	0.00
3.MeC21	queen_dg - queen_eggs	0.00	0.19	63	0.00	1.00
3.MeC21	queen_dg - rep_worker_chc	-6.54	0.22	63	-29.44	0.00
3.MeC21	queen_dg - rep_worker_dg	0.00	0.22	63	0.00	1.00
3.MeC21	queen_dg - worker_eggs	0.00	0.19	63	0.00	1.00
3.MeC21	queen_eggs - rep_worker_chc	-6.54	0.16	63	-40.13	0.00
3.MeC21	queen_eggs - rep_worker_dg	0.00	0.16	63	0.00	1.00
3.MeC21	queen_eggs - worker_eggs	0.00	0.11	63	0.00	1.00
3.MeC21	rep_worker_chc - rep_worker_dg	6.54	0.20	63	32.25	0.00
3.MeC21	rep_worker_chc - worker_eggs	6.54	0.17	63	39.50	0.00
3.MeC21	rep_worker_dg - worker_eggs	0.00	0.17	63	0.00	1.00
3.MeC23	queen_chc - queen_dg	-8.69	0.46	63	-19.10	0.00
3.MeC23	queen_chc - queen_eggs	0.00	0.35	63	0.00	1.00
3.MeC23	queen_chc - rep_worker_chc	0.00	0.42	63	0.00	1.00
3.MeC23	queen_chc - rep_worker_dg	-6.55	0.42	63	-15.55	0.00
3.MeC23	queen_chc - worker_eggs	0.00	0.36	63	0.00	1.00
3.MeC23	queen_dg - queen_eggs	8.69	0.35	63	24.57	0.00
3.MeC23	queen_dg - rep_worker_chc	8.69	0.42	63	20.63	0.00
3.MeC23	queen_dg - rep_worker_dg	2.14	0.42	63	5.07	0.00
3.MeC23	queen_dg - worker_eggs	8.69	0.36	63	24.27	0.00
3.MeC23	queen_eggs - rep_worker_chc	0.00	0.31	63	0.00	1.00
3.MeC23	queen_eggs - rep_worker_dg	-6.55	0.31	63	-21.20	0.00
3.MeC23	queen_eggs - worker_eggs	0.00	0.22	63	0.00	1.00
3.MeC23	rep_worker_chc - rep_worker_dg	-6.55	0.38	63	-17.04	0.00
3.MeC23	rep_worker_chc - worker_eggs	0.00	0.31	63	0.00	1.00
3.MeC23	rep_worker_dg - worker_eggs	6.55	0.31	63	20.86	0.00
3.MeC25	queen_chc - queen_dg	7.12	0.50	63	14.25	0.00
3.MeC25	queen_chc - queen_eggs	-1.75	0.39	63	-4.50	0.03
3.MeC25	queen_chc - rep_worker_chc	-0.30	0.46	63	-0.66	1.00
3.MeC25	queen_chc - rep_worker_dg	7.12	0.46	63	15.39	0.00
3.MeC25	queen_chc - worker_eggs	-2.00	0.39	63	-5.08	0.00
3.MeC25	queen_dg - queen_eggs	-8.87	0.39	63	-22.83	0.00
3.MeC25	queen_dg - rep_worker_chc	-7.43	0.46	63	-16.05	0.00
3.MeC25	queen_dg - rep_worker_dg	0.00	0.46	63	0.00	1.00

3.MeC25	queen_dg - worker_eggs	-9.12	0.39	63	-23.18	0.00
3.MeC25	queen_eggs - rep_worker_chc	1.44	0.34	63	4.25	0.07
3.MeC25	queen_eggs - rep_worker_dg	8.87	0.34	63	26.12	0.00
3.MeC25	queen_eggs - worker_eggs	-0.25	0.24	63	-1.05	1.00
3.MeC25	rep_worker_chc - rep_worker_dg	7.43	0.42	63	17.58	0.00
3.MeC25	rep_worker_chc - worker_eggs	-1.69	0.34	63	-4.91	0.01
3.MeC25	rep_worker_dg - worker_eggs	-9.12	0.34	63	-26.43	0.00
3.MeC27	queen_chc - queen_dg	1.40	0.32	63	4.43	0.04
3.MeC27	queen_chc - queen_eggs	-1.24	0.25	63	-5.04	0.00
3.MeC27	queen_chc - rep_worker_chc	-0.25	0.29	63	-0.86	1.00
3.MeC27	queen_chc - rep_worker_dg	1.53	0.29	63	5.22	0.00
3.MeC27	queen_chc - worker_eggs	-0.57	0.25	63	-2.29	1.00
3.MeC27	queen_dg - queen_eggs	-2.64	0.25	63	-10.73	0.00
3.MeC27	queen_dg - rep_worker_chc	-1.65	0.29	63	-5.64	0.00
3.MeC27	queen_dg - rep_worker_dg	0.13	0.29	63	0.44	1.00
3.MeC27	queen_dg - worker_eggs	-1.97	0.25	63	-7.92	0.00
3.MeC27	queen_eggs - rep_worker_chc	0.99	0.22	63	4.60	0.02
3.MeC27	queen_eggs - rep_worker_dg	2.77	0.22	63	12.88	0.00
3.MeC27	queen_eggs - worker_eggs	0.67	0.15	63	4.47	0.03
3.MeC27	rep_worker_chc - rep_worker_dg	1.78	0.27	63	6.65	0.00
3.MeC27	rep_worker_chc - worker_eggs	-0.32	0.22	63	-1.46	1.00
3.MeC27	rep_worker_dg - worker_eggs	-2.10	0.22	63	-9.61	0.00
3.MeC29	queen_chc - queen_dg	2.67	0.39	63	6.83	0.00
3.MeC29	queen_chc - queen_eggs	-0.11	0.30	63	-0.35	1.00
3.MeC29	queen_chc - rep_worker_chc	0.22	0.36	63	0.61	1.00
3.MeC29	queen_chc - rep_worker_dg	2.22	0.36	63	6.12	0.00
3.MeC29	queen_chc - worker_eggs	0.26	0.31	63	0.85	1.00
3.MeC29	queen_dg - queen_eggs	-2.78	0.30	63	-9.13	0.00
3.MeC29	queen_dg - rep_worker_chc	-2.45	0.36	63	-6.76	0.00
3.MeC29	queen_dg - rep_worker_dg	-0.45	0.36	63	-1.25	1.00
3.MeC29	queen_dg - worker_eggs	-2.41	0.31	63	-7.82	0.00
3.MeC29	queen_eggs - rep_worker_chc	0.33	0.27	63	1.23	1.00
3.MeC29	queen_eggs - rep_worker_dg	2.33	0.27	63	8.75	0.00
3.MeC29	queen_eggs - worker_eggs	0.37	0.18	63	2.00	1.00
3.MeC29	rep_worker_chc - rep_worker_dg	2.00	0.33	63	6.04	0.00
3.MeC29	rep_worker_chc - worker_eggs	0.04	0.27	63	0.16	1.00
3.MeC29	rep_worker_dg - worker_eggs	-1.96	0.27	63	-7.24	0.00
3.MeC31	queen_chc - queen_dg	11.38	0.05	63	215.84	0.00
3.MeC31	queen_chc - queen_eggs	11.38	0.04	63	277.69	0.00
3.MeC31	queen_chc - rep_worker_chc	0.98	0.05	63	20.03	0.00
3.MeC31	queen_chc - rep_worker_dg	11.38	0.05	63	233.13	0.00
3.MeC31	queen_chc - worker_eggs	11.38	0.04	63	274.33	0.00
3.MeC31	queen_dg - queen_eggs	0.00	0.04	63	0.00	1.00
3.MeC31	queen_dg - rep_worker_chc	-10.40	0.05	63	-213.10	0.00
3.MeC31	queen_dg - rep_worker_dg	0.00	0.05	63	0.00	1.00
3.MeC31	queen_dg - worker_eggs	0.00	0.04	63	0.00	1.00
3.MeC31	queen_eggs - rep_worker_chc	-10.40	0.04	63	-290.48	0.00
3.MeC31	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00

3.MeC31	queen_eggs - worker_eggs	0.00	0.02	63	0.00	1.00
3.MeC31	rep_worker_chc - rep_worker_dg	10.40	0.04	63	233.44	0.00
3.MeC31	rep_worker_chc - worker_eggs	10.40	0.04	63	285.91	0.00
3.MeC31	rep_worker_dg - worker_eggs	0.00	0.04	63	0.00	1.00
4.MeC26	queen_chc - queen_dg	4.88	0.09	63	56.39	0.00
4.MeC26	queen_chc - queen_eggs	4.88	0.07	63	72.56	0.00
4.MeC26	queen_chc - rep_worker_chc	-0.41	0.08	63	-5.11	0.00
4.MeC26	queen_chc - rep_worker_dg	4.88	0.08	63	60.91	0.00
4.MeC26	queen_chc - worker_eggs	4.88	0.07	63	71.68	0.00
4.MeC26	queen_dg - queen_eggs	0.00	0.07	63	0.00	1.00
4.MeC26	queen_dg - rep_worker_chc	-5.29	0.08	63	-66.02	0.00
4.MeC26	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
4.MeC26	queen_dg - worker_eggs	0.00	0.07	63	0.00	1.00
4.MeC26	queen_eggs - rep_worker_chc	-5.29	0.06	63	-90.00	0.00
4.MeC26	queen_eggs - rep_worker_dg	0.00	0.06	63	0.00	1.00
4.MeC26	queen_eggs - worker_eggs	0.00	0.04	63	0.00	1.00
4.MeC26	rep_worker_chc - rep_worker_dg	5.29	0.07	63	72.32	0.00
4.MeC26	rep_worker_chc - worker_eggs	5.29	0.06	63	88.58	0.00
4.MeC26	rep_worker_dg - worker_eggs	0.00	0.06	63	0.00	1.00
4.MeC28	queen_chc - queen_dg	-3.56	0.80	63	-4.43	0.04
4.MeC28	queen_chc - queen_eggs	0.38	0.62	63	0.61	1.00
4.MeC28	queen_chc - rep_worker_chc	-0.43	0.74	63	-0.58	1.00
4.MeC28	queen_chc - rep_worker_dg	-4.03	0.74	63	-5.43	0.00
4.MeC28	queen_chc - worker_eggs	-0.50	0.63	63	-0.79	1.00
4.MeC28	queen_dg - queen_eggs	3.93	0.62	63	6.31	0.00
4.MeC28	queen_dg - rep_worker_chc	3.12	0.74	63	4.21	0.08
4.MeC28	queen_dg - rep_worker_dg	-0.48	0.74	63	-0.64	1.00
4.MeC28	queen_dg - worker_eggs	3.06	0.63	63	4.84	0.01
4.MeC28	queen_eggs - rep_worker_chc	-0.81	0.54	63	-1.49	1.00
4.MeC28	queen_eggs - rep_worker_dg	-4.41	0.54	63	-8.09	0.00
4.MeC28	queen_eggs - worker_eggs	-0.88	0.38	63	-2.32	1.00
4.MeC28	rep_worker_chc - rep_worker_dg	-3.60	0.68	63	-5.31	0.00
4.MeC28	rep_worker_chc - worker_eggs	-0.07	0.55	63	-0.12	1.00
4.MeC28	rep_worker_dg - worker_eggs	3.53	0.55	63	6.38	0.00
5.15.diMeC25	queen_chc - queen_dg	-5.67	0.23	63	-24.71	0.00
5.15.diMeC25	queen_chc - queen_eggs	4.82	0.18	63	27.01	0.00
5.15.diMeC25	queen_chc - rep_worker_chc	-0.35	0.21	63	-1.65	1.00
5.15.diMeC25	queen_chc - rep_worker_dg	-5.49	0.21	63	-25.84	0.00
5.15.diMeC25	queen_chc - worker_eggs	4.82	0.18	63	26.68	0.00
5.15.diMeC25	queen_dg - queen_eggs	10.48	0.18	63	58.80	0.00
5.15.diMeC25	queen_dg - rep_worker_chc	5.32	0.21	63	25.04	0.00
5.15.diMeC25	queen_dg - rep_worker_dg	0.18	0.21	63	0.85	1.00
5.15.diMeC25	queen_dg - worker_eggs	10.48	0.18	63	58.09	0.00
5.15.diMeC25	queen_eggs - rep_worker_chc	-5.16	0.16	63	-33.16	0.00
5.15.diMeC25	queen_eggs - rep_worker_dg	-10.30	0.16	63	-66.13	0.00
5.15.diMeC25	queen_eggs - worker_eggs	0.00	0.11	63	0.00	1.00
5.15.diMeC25	rep_worker_chc - rep_worker_dg	-5.14	0.19	63	-26.50	0.00
5.15.diMeC25	rep_worker_chc - worker_eggs	5.16	0.16	63	32.63	0.00

5.15.diMeC25	rep_worker_dg - worker_eggs	10.30	0.16	63	65.09	0.00
5.MeC23	queen_chc - queen_dg	-8.16	0.35	63	-23.13	0.00
5.MeC23	queen_chc - queen_eggs	0.00	0.27	63	0.00	1.00
5.MeC23	queen_chc - rep_worker_chc	0.00	0.33	63	0.00	1.00
5.MeC23	queen_chc - rep_worker_dg	-5.31	0.33	63	-16.26	0.00
5.MeC23	queen_chc - worker_eggs	0.00	0.28	63	0.00	1.00
5.MeC23	queen_dg - queen_eggs	8.16	0.27	63	29.76	0.00
5.MeC23	queen_dg - rep_worker_chc	8.16	0.33	63	24.98	0.00
5.MeC23	queen_dg - rep_worker_dg	2.85	0.33	63	8.72	0.00
5.MeC23	queen_dg - worker_eggs	8.16	0.28	63	29.40	0.00
5.MeC23	queen_eggs - rep_worker_chc	0.00	0.24	63	0.00	1.00
5.MeC23	queen_eggs - rep_worker_dg	-5.31	0.24	63	-22.17	0.00
5.MeC23	queen_eggs - worker_eggs	0.00	0.17	63	0.00	1.00
5.MeC23	rep_worker_chc - rep_worker_dg	-5.31	0.30	63	-17.82	0.00
5.MeC23	rep_worker_chc - worker_eggs	0.00	0.24	63	0.00	1.00
5.MeC23	rep_worker_dg - worker_eggs	5.31	0.24	63	21.82	0.00
5.MeC25	queen_chc - queen_dg	-5.87	0.22	63	-26.11	0.00
5.MeC25	queen_chc - queen_eggs	5.29	0.17	63	30.31	0.00
5.MeC25	queen_chc - rep_worker_chc	0.13	0.21	63	0.62	1.00
5.MeC25	queen_chc - rep_worker_dg	-5.20	0.21	63	-24.99	0.00
5.MeC25	queen_chc - worker_eggs	5.29	0.18	63	29.94	0.00
5.MeC25	queen_dg - queen_eggs	11.16	0.17	63	63.90	0.00
5.MeC25	queen_dg - rep_worker_chc	6.00	0.21	63	28.83	0.00
5.MeC25	queen_dg - rep_worker_dg	0.67	0.21	63	3.21	1.00
5.MeC25	queen_dg - worker_eggs	11.16	0.18	63	63.13	0.00
5.MeC25	queen_eggs - rep_worker_chc	-5.16	0.15	63	-33.84	0.00
5.MeC25	queen_eggs - rep_worker_dg	-10.49	0.15	63	-68.75	0.00
5.MeC25	queen_eggs - worker_eggs	0.00	0.11	63	0.00	1.00
5.MeC25	rep_worker_chc - rep_worker_dg	-5.33	0.19	63	-28.06	0.00
5.MeC25	rep_worker_chc - worker_eggs	5.16	0.16	63	33.30	0.00
5.MeC25	rep_worker_dg - worker_eggs	10.49	0.16	63	67.67	0.00
5.MeC27	queen_chc - queen_dg	-2.84	0.46	63	-6.24	0.00
5.MeC27	queen_chc - queen_eggs	-0.81	0.35	63	-2.29	1.00
5.MeC27	queen_chc - rep_worker_chc	-0.27	0.42	63	-0.65	1.00
5.MeC27	queen_chc - rep_worker_dg	-3.63	0.42	63	-8.61	0.00
5.MeC27	queen_chc - worker_eggs	-1.49	0.36	63	-4.15	0.10
5.MeC27	queen_dg - queen_eggs	2.03	0.35	63	5.73	0.00
5.MeC27	queen_dg - rep_worker_chc	2.57	0.42	63	6.09	0.00
5.MeC27	queen_dg - rep_worker_dg	-0.79	0.42	63	-1.87	1.00
5.MeC27	queen_dg - worker_eggs	1.35	0.36	63	3.77	0.35
5.MeC27	queen_eggs - rep_worker_chc	0.54	0.31	63	1.74	1.00
5.MeC27	queen_eggs - rep_worker_dg	-2.82	0.31	63	-9.11	0.00
5.MeC27	queen_eggs - worker_eggs	-0.68	0.22	63	-3.15	1.00
5.MeC27	rep_worker_chc - rep_worker_dg	-3.36	0.38	63	-8.72	0.00
5.MeC27	rep_worker_chc - worker_eggs	-1.21	0.31	63	-3.87	0.26
5.MeC27	rep_worker_dg - worker_eggs	2.14	0.31	63	6.82	0.00
5.MeC34	queen_chc - queen_dg	3.86	0.06	63	63.06	0.00
5.MeC34	queen_chc - queen_eggs	3.86	0.05	63	81.13	0.00

5.MeC34	queen_chc - rep_worker_chc	-0.97	0.06	63	-17.17	0.00
5.MeC34	queen_chc - rep_worker_dg	3.86	0.06	63	68.11	0.00
5.MeC34	queen_chc - worker_eggs	3.86	0.05	63	80.15	0.00
5.MeC34	queen_dg - queen_eggs	0.00	0.05	63	0.00	1.00
5.MeC34	queen_dg - rep_worker_chc	-4.84	0.06	63	-85.28	0.00
5.MeC34	queen_dg - rep_worker_dg	0.00	0.06	63	0.00	1.00
5.MeC34	queen_dg - worker_eggs	0.00	0.05	63	0.00	1.00
5.MeC34	queen_eggs - rep_worker_chc	-4.84	0.04	63	-116.25	0.00
5.MeC34	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00
5.MeC34	queen_eggs - worker_eggs	0.00	0.03	63	0.00	1.00
5.MeC34	rep_worker_chc - rep_worker_dg	4.84	0.05	63	93.42	0.00
5.MeC34	rep_worker_chc - worker_eggs	4.84	0.04	63	114.42	0.00
5.MeC34	rep_worker_dg - worker_eggs	0.00	0.04	63	0.00	1.00
7.MeC29	queen_chc - queen_dg	13.20	0.08	63	157.09	0.00
7.MeC29	queen_chc - queen_eggs	13.20	0.07	63	202.11	0.00
7.MeC29	queen_chc - rep_worker_chc	1.74	0.08	63	22.33	0.00
7.MeC29	queen_chc - rep_worker_dg	13.20	0.08	63	169.68	0.00
7.MeC29	queen_chc - worker_eggs	13.20	0.07	63	199.66	0.00
7.MeC29	queen_dg - queen_eggs	0.00	0.07	63	0.00	1.00
7.MeC29	queen_dg - rep_worker_chc	-11.47	0.08	63	-147.35	0.00
7.MeC29	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
7.MeC29	queen_dg - worker_eggs	0.00	0.07	63	0.00	1.00
7.MeC29	queen_eggs - rep_worker_chc	-11.47	0.06	63	-200.86	0.00
7.MeC29	queen_eggs - rep_worker_dg	0.00	0.06	63	0.00	1.00
7.MeC29	queen_eggs - worker_eggs	0.00	0.04	63	0.00	1.00
7.MeC29	rep_worker_chc - rep_worker_dg	11.47	0.07	63	161.42	0.00
7.MeC29	rep_worker_chc - worker_eggs	11.47	0.06	63	197.70	0.00
7.MeC29	rep_worker_dg - worker_eggs	0.00	0.06	63	0.00	1.00

Table S22: Pairwise comparisons considering the chemical compounds of each group of sample (CHC, eggs or *Dufour's* gland) and each group of female (queen and reproductive worker) in *Vespula germanica*. chc = cuticular hydrocarbons, rep = reproductive worker, dg = *Dufour's* gland, padj = p value adjusted. All the values highlighted in red correspond to significant values $p < 0.05^*$.

compound	contrast	estimate	SE	df	t.ratio	padj
C25.1	queen_chc - queen_dg	6.64	1.47	63	4.53	0.02
C25.1	queen_chc - queen_eggs	-0.56	1.28	63	-0.43	1.00
C25.1	queen_chc - rep_worker_chc	0.93	1.55	63	0.60	1.00
C25.1	queen_chc - rep_worker_dg	6.64	1.55	63	4.30	0.04
C25.1	queen_chc - rep_worker_eggs	0.47	1.32	63	0.36	1.00
C25.1	queen_dg - queen_eggs	-7.20	0.96	63	-7.47	0.00
C25.1	queen_dg - rep_worker_chc	-5.72	1.29	63	-4.42	0.03
C25.1	queen_dg - rep_worker_dg	0.00	1.29	63	0.00	1.00
C25.1	queen_dg - rep_worker_eggs	-6.17	1.02	63	-6.06	0.00
C25.1	queen_eggs - rep_worker_chc	1.48	1.08	63	1.37	1.00
C25.1	queen_eggs - rep_worker_dg	7.20	1.08	63	6.66	0.00
C25.1	queen_eggs - rep_worker_eggs	1.03	0.73	63	1.41	1.00

C25.1	rep_worker_chc - rep_worker_dg	5.72	1.38	63	4.13	0.07
C25.1	rep_worker_chc - rep_worker_eggs	-0.45	1.13	63	-0.40	1.00
C25.1	rep_worker_dg - rep_worker_eggs	-6.17	1.13	63	-5.46	0.00
C27.1	queen_chc - queen_dg	-10.48	0.93	63	-11.28	0.00
C27.1	queen_chc - queen_eggs	0.00	0.81	63	0.00	1.00
C27.1	queen_chc - rep_worker_chc	0.00	0.98	63	0.00	1.00
C27.1	queen_chc - rep_worker_dg	-4.81	0.98	63	-4.92	0.00
C27.1	queen_chc - rep_worker_eggs	0.00	0.84	63	0.00	1.00
C27.1	queen_dg - queen_eggs	10.48	0.61	63	17.17	0.00
C27.1	queen_dg - rep_worker_chc	10.48	0.82	63	12.80	0.00
C27.1	queen_dg - rep_worker_dg	5.67	0.82	63	6.92	0.00
C27.1	queen_dg - rep_worker_eggs	10.48	0.64	63	16.26	0.00
C27.1	queen_eggs - rep_worker_chc	0.00	0.68	63	0.00	1.00
C27.1	queen_eggs - rep_worker_dg	-4.81	0.68	63	-7.03	0.00
C27.1	queen_eggs - rep_worker_eggs	0.00	0.46	63	0.00	1.00
C27.1	rep_worker_chc - rep_worker_dg	-4.81	0.88	63	-5.50	0.00
C27.1	rep_worker_chc - rep_worker_eggs	0.00	0.72	63	0.00	1.00
C27.1	rep_worker_dg - rep_worker_eggs	4.81	0.72	63	6.73	0.00
C27.1and.3.MeC26	queen_chc - queen_dg	9.62	0.32	63	30.19	0.00
C27.1and.3.MeC26	queen_chc - queen_eggs	-0.43	0.28	63	-1.56	1.00
C27.1and.3.MeC26	queen_chc - rep_worker_chc	-0.65	0.34	63	-1.93	1.00
C27.1and.3.MeC26	queen_chc - rep_worker_dg	9.62	0.34	63	28.64	0.00
C27.1and.3.MeC26	queen_chc - rep_worker_eggs	-0.34	0.29	63	-1.19	1.00
C27.1and.3.MeC26	queen_dg - queen_eggs	-10.05	0.21	63	-47.99	0.00
C27.1and.3.MeC26	queen_dg - rep_worker_chc	-10.27	0.28	63	-36.53	0.00
C27.1and.3.MeC26	queen_dg - rep_worker_dg	0.00	0.28	63	0.00	1.00
C27.1and.3.MeC26	queen_dg - rep_worker_eggs	-9.96	0.22	63	-45.05	0.00
C27.1and.3.MeC26	queen_eggs - rep_worker_chc	-0.21	0.23	63	-0.91	1.00
C27.1and.3.MeC26	queen_eggs - rep_worker_dg	10.05	0.23	63	42.80	0.00
C27.1and.3.MeC26	queen_eggs - rep_worker_eggs	0.09	0.16	63	0.58	1.00
C27.1and.3.MeC26	rep_worker_chc - rep_worker_dg	10.27	0.30	63	34.17	0.00
C27.1and.3.MeC26	rep_worker_chc - rep_worker_eggs	0.31	0.25	63	1.25	1.00
C27.1and.3.MeC26	rep_worker_dg - rep_worker_eggs	-9.96	0.25	63	-40.60	0.00
C29.1	queen_chc - queen_dg	-2.07	0.92	63	-2.25	1.00
C29.1	queen_chc - queen_eggs	-0.80	0.81	63	-1.00	1.00
C29.1	queen_chc - rep_worker_chc	-0.56	0.97	63	-0.58	1.00
C29.1	queen_chc - rep_worker_dg	-0.44	0.97	63	-0.45	1.00
C29.1	queen_chc - rep_worker_eggs	-1.07	0.83	63	-1.28	1.00
C29.1	queen_dg - queen_eggs	1.27	0.61	63	2.09	1.00
C29.1	queen_dg - rep_worker_chc	1.51	0.81	63	1.86	1.00
C29.1	queen_dg - rep_worker_dg	1.64	0.81	63	2.01	1.00
C29.1	queen_dg - rep_worker_eggs	1.00	0.64	63	1.57	1.00
C29.1	queen_eggs - rep_worker_chc	0.24	0.68	63	0.36	1.00
C29.1	queen_eggs - rep_worker_dg	0.37	0.68	63	0.54	1.00
C29.1	queen_eggs - rep_worker_eggs	-0.26	0.46	63	-0.58	1.00
C29.1	rep_worker_chc - rep_worker_dg	0.13	0.87	63	0.14	1.00
C29.1	rep_worker_chc - rep_worker_eggs	-0.51	0.71	63	-0.71	1.00
C29.1	rep_worker_dg - rep_worker_eggs	-0.63	0.71	63	-0.89	1.00

n.C21	queen_chc - queen_dg	0.00	1.97	63	0.00	1.00
n.C21	queen_chc - queen_eggs	-5.95	1.72	63	-3.45	0.66
n.C21	queen_chc - rep_worker_chc	0.00	2.08	63	0.00	1.00
n.C21	queen_chc - rep_worker_dg	0.00	2.08	63	0.00	1.00
n.C21	queen_chc - rep_worker_eggs	-4.61	1.78	63	-2.59	1.00
n.C21	queen_dg - queen_eggs	-5.95	1.29	63	-4.59	0.01
n.C21	queen_dg - rep_worker_chc	0.00	1.74	63	0.00	1.00
n.C21	queen_dg - rep_worker_dg	0.00	1.74	63	0.00	1.00
n.C21	queen_dg - rep_worker_eggs	-4.61	1.37	63	-3.37	0.84
n.C21	queen_eggs - rep_worker_chc	5.95	1.45	63	4.10	0.08
n.C21	queen_eggs - rep_worker_dg	5.95	1.45	63	4.10	0.08
n.C21	queen_eggs - rep_worker_eggs	1.34	0.98	63	1.36	1.00
n.C21	rep_worker_chc - rep_worker_dg	0.00	1.86	63	0.00	1.00
n.C21	rep_worker_chc - rep_worker_eggs	-4.61	1.52	63	-3.04	1.00
n.C21	rep_worker_dg - rep_worker_eggs	-4.61	1.52	63	-3.04	1.00
n.C22	queen_chc - queen_dg	6.64	0.62	63	10.72	0.00
n.C22	queen_chc - queen_eggs	6.64	0.54	63	12.25	0.00
n.C22	queen_chc - rep_worker_chc	2.04	0.65	63	3.12	1.00
n.C22	queen_chc - rep_worker_dg	6.64	0.65	63	10.17	0.00
n.C22	queen_chc - rep_worker_eggs	6.64	0.56	63	11.87	0.00
n.C22	queen_dg - queen_eggs	0.00	0.41	63	0.00	1.00
n.C22	queen_dg - rep_worker_chc	-4.61	0.55	63	-8.43	0.00
n.C22	queen_dg - rep_worker_dg	0.00	0.55	63	0.00	1.00
n.C22	queen_dg - rep_worker_eggs	0.00	0.43	63	0.00	1.00
n.C22	queen_eggs - rep_worker_chc	-4.61	0.46	63	-10.09	0.00
n.C22	queen_eggs - rep_worker_dg	0.00	0.46	63	0.00	1.00
n.C22	queen_eggs - rep_worker_eggs	0.00	0.31	63	0.00	1.00
n.C22	rep_worker_chc - rep_worker_dg	4.61	0.58	63	7.88	0.00
n.C22	rep_worker_chc - rep_worker_eggs	4.61	0.48	63	9.66	0.00
n.C22	rep_worker_dg - rep_worker_eggs	0.00	0.48	63	0.00	1.00
n.C23	queen_chc - queen_dg	-1.00	1.27	63	-0.79	1.00
n.C23	queen_chc - queen_eggs	-1.08	1.11	63	-0.98	1.00
n.C23	queen_chc - rep_worker_chc	0.17	1.34	63	0.13	1.00
n.C23	queen_chc - rep_worker_dg	-0.94	1.34	63	-0.70	1.00
n.C23	queen_chc - rep_worker_eggs	-1.28	1.15	63	-1.12	1.00
n.C23	queen_dg - queen_eggs	-0.08	0.83	63	-0.10	1.00
n.C23	queen_dg - rep_worker_chc	1.17	1.12	63	1.05	1.00
n.C23	queen_dg - rep_worker_dg	0.06	1.12	63	0.06	1.00
n.C23	queen_dg - rep_worker_eggs	-0.28	0.88	63	-0.32	1.00
n.C23	queen_eggs - rep_worker_chc	1.26	0.94	63	1.34	1.00
n.C23	queen_eggs - rep_worker_dg	0.15	0.94	63	0.16	1.00
n.C23	queen_eggs - rep_worker_eggs	-0.20	0.63	63	-0.32	1.00
n.C23	rep_worker_chc - rep_worker_dg	-1.11	1.20	63	-0.93	1.00
n.C23	rep_worker_chc - rep_worker_eggs	-1.46	0.98	63	-1.49	1.00
n.C23	rep_worker_dg - rep_worker_eggs	-0.35	0.98	63	-0.35	1.00
n.C24	queen_chc - queen_dg	4.10	1.49	63	2.74	1.00
n.C24	queen_chc - queen_eggs	0.48	1.31	63	0.37	1.00
n.C24	queen_chc - rep_worker_chc	1.16	1.58	63	0.74	1.00

n.C24	queen_chc - rep_worker_dg	3.89	1.58	63	2.47	1.00
n.C24	queen_chc - rep_worker_eggs	0.13	1.35	63	0.10	1.00
n.C24	queen_dg - queen_eggs	-3.62	0.98	63	-3.68	0.32
n.C24	queen_dg - rep_worker_chc	-2.94	1.32	63	-2.23	1.00
n.C24	queen_dg - rep_worker_dg	-0.21	1.32	63	-0.16	1.00
n.C24	queen_dg - rep_worker_eggs	-3.97	1.04	63	-3.83	0.20
n.C24	queen_eggs - rep_worker_chc	0.68	1.10	63	0.62	1.00
n.C24	queen_eggs - rep_worker_dg	3.41	1.10	63	3.10	1.00
n.C24	queen_eggs - rep_worker_eggs	-0.35	0.74	63	-0.47	1.00
n.C24	rep_worker_chc - rep_worker_dg	2.73	1.41	63	1.94	1.00
n.C24	rep_worker_chc - rep_worker_eggs	-1.03	1.15	63	-0.90	1.00
n.C24	rep_worker_dg - rep_worker_eggs	-3.76	1.15	63	-3.27	1.00
n.C25	queen_chc - queen_dg	3.15	0.45	63	7.03	0.00
n.C25	queen_chc - queen_eggs	0.75	0.39	63	1.91	1.00
n.C25	queen_chc - rep_worker_chc	0.90	0.47	63	1.91	1.00
n.C25	queen_chc - rep_worker_dg	2.50	0.47	63	5.29	0.00
n.C25	queen_chc - rep_worker_eggs	0.73	0.40	63	1.81	1.00
n.C25	queen_dg - queen_eggs	-2.40	0.29	63	-8.15	0.00
n.C25	queen_dg - rep_worker_chc	-2.25	0.39	63	-5.69	0.00
n.C25	queen_dg - rep_worker_dg	-0.65	0.39	63	-1.65	1.00
n.C25	queen_dg - rep_worker_eggs	-2.41	0.31	63	-7.77	0.00
n.C25	queen_eggs - rep_worker_chc	0.15	0.33	63	0.46	1.00
n.C25	queen_eggs - rep_worker_dg	1.75	0.33	63	5.29	0.00
n.C25	queen_eggs - rep_worker_eggs	-0.02	0.22	63	-0.08	1.00
n.C25	rep_worker_chc - rep_worker_dg	1.59	0.42	63	3.78	0.23
n.C25	rep_worker_chc - rep_worker_eggs	-0.17	0.34	63	-0.49	1.00
n.C25	rep_worker_dg - rep_worker_eggs	-1.76	0.34	63	-5.12	0.00
n.C26	queen_chc - queen_dg	-0.96	0.24	63	-3.97	0.12
n.C26	queen_chc - queen_eggs	1.03	0.21	63	4.86	0.01
n.C26	queen_chc - rep_worker_chc	1.29	0.26	63	5.05	0.00
n.C26	queen_chc - rep_worker_dg	-0.26	0.26	63	-1.02	1.00
n.C26	queen_chc - rep_worker_eggs	0.91	0.22	63	4.17	0.06
n.C26	queen_dg - queen_eggs	1.99	0.16	63	12.52	0.00
n.C26	queen_dg - rep_worker_chc	2.25	0.21	63	10.54	0.00
n.C26	queen_dg - rep_worker_dg	0.70	0.21	63	3.29	1.00
n.C26	queen_dg - rep_worker_eggs	1.87	0.17	63	11.15	0.00
n.C26	queen_eggs - rep_worker_chc	0.26	0.18	63	1.45	1.00
n.C26	queen_eggs - rep_worker_dg	-1.29	0.18	63	-7.22	0.00
n.C26	queen_eggs - rep_worker_eggs	-0.12	0.12	63	-0.98	1.00
n.C26	rep_worker_chc - rep_worker_dg	-1.55	0.23	63	-6.78	0.00
n.C26	rep_worker_chc - rep_worker_eggs	-0.38	0.19	63	-2.02	1.00
n.C26	rep_worker_dg - rep_worker_eggs	1.17	0.19	63	6.28	0.00
n.C27	queen_chc - queen_dg	4.87	0.41	63	11.90	0.00
n.C27	queen_chc - queen_eggs	1.14	0.36	63	3.19	1.00
n.C27	queen_chc - rep_worker_chc	1.66	0.43	63	3.84	0.19
n.C27	queen_chc - rep_worker_dg	4.86	0.43	63	11.26	0.00
n.C27	queen_chc - rep_worker_eggs	1.00	0.37	63	2.70	1.00
n.C27	queen_dg - queen_eggs	-3.73	0.27	63	-13.86	0.00

n.C27	queen_dg - rep_worker_chc	-3.21	0.36	63	-8.90	0.00
n.C27	queen_dg - rep_worker_dg	-0.01	0.36	63	-0.03	1.00
n.C27	queen_dg - rep_worker_eggs	-3.87	0.28	63	-13.63	0.00
n.C27	queen_eggs - rep_worker_chc	0.52	0.30	63	1.71	1.00
n.C27	queen_eggs - rep_worker_dg	3.72	0.30	63	12.32	0.00
n.C27	queen_eggs - rep_worker_eggs	-0.14	0.20	63	-0.70	1.00
n.C27	rep_worker_chc - rep_worker_dg	3.20	0.39	63	8.29	0.00
n.C27	rep_worker_chc - rep_worker_eggs	-0.66	0.32	63	-2.10	1.00
n.C27	rep_worker_dg - rep_worker_eggs	-3.86	0.32	63	-12.25	0.00
n.C28and.3.9...3.11.diMeC27	queen_chc - queen_dg	-3.11	0.26	63	-11.79	0.00
n.C28and.3.9...3.11.diMeC27	queen_chc - queen_eggs	0.25	0.23	63	1.07	1.00
n.C28and.3.9...3.11.diMeC27	queen_chc - rep_worker_chc	0.60	0.28	63	2.16	1.00
n.C28and.3.9...3.11.diMeC27	queen_chc - rep_worker_dg	-2.56	0.28	63	-9.20	0.00
n.C28and.3.9...3.11.diMeC27	queen_chc - rep_worker_eggs	-0.01	0.24	63	-0.06	1.00
n.C28and.3.9...3.11.diMeC27	queen_dg - queen_eggs	3.36	0.17	63	19.36	0.00
n.C28and.3.9...3.11.diMeC27	queen_dg - rep_worker_chc	3.71	0.23	63	15.95	0.00
n.C28and.3.9...3.11.diMeC27	queen_dg - rep_worker_dg	0.55	0.23	63	2.36	1.00
n.C28and.3.9...3.11.diMeC27	queen_dg - rep_worker_eggs	3.09	0.18	63	16.91	0.00
n.C28and.3.9...3.11.diMeC27	queen_eggs - rep_worker_chc	0.35	0.19	63	1.82	1.00
n.C28and.3.9...3.11.diMeC27	queen_eggs - rep_worker_dg	-2.81	0.19	63	-14.44	0.00
n.C28and.3.9...3.11.diMeC27	queen_eggs - rep_worker_eggs	-0.26	0.13	63	-2.00	1.00
n.C28and.3.9...3.11.diMeC27	rep_worker_chc - rep_worker_dg	-3.16	0.25	63	-12.71	0.00
n.C28and.3.9...3.11.diMeC27	rep_worker_chc - rep_worker_eggs	-0.62	0.20	63	-3.03	1.00
n.C28and.3.9...3.11.diMeC27	rep_worker_dg - rep_worker_eggs	2.54	0.20	63	12.53	0.00
n.C29	queen_chc - queen_dg	6.66	1.28	63	5.22	0.00
n.C29	queen_chc - queen_eggs	0.24	1.12	63	0.21	1.00
n.C29	queen_chc - rep_worker_chc	1.89	1.34	63	1.41	1.00
n.C29	queen_chc - rep_worker_dg	11.18	1.34	63	8.31	0.00
n.C29	queen_chc - rep_worker_eggs	-0.74	1.15	63	-0.64	1.00
n.C29	queen_dg - queen_eggs	-6.42	0.84	63	-7.66	0.00
n.C29	queen_dg - rep_worker_chc	-4.77	1.12	63	-4.24	0.05
n.C29	queen_dg - rep_worker_dg	4.52	1.12	63	4.02	0.11
n.C29	queen_dg - rep_worker_eggs	-7.40	0.88	63	-8.36	0.00
n.C29	queen_eggs - rep_worker_chc	1.65	0.94	63	1.76	1.00
n.C29	queen_eggs - rep_worker_dg	10.94	0.94	63	11.64	0.00
n.C29	queen_eggs - rep_worker_eggs	-0.98	0.63	63	-1.54	1.00
n.C29	rep_worker_chc - rep_worker_dg	9.29	1.20	63	7.72	0.00
n.C29	rep_worker_chc - rep_worker_eggs	-2.63	0.98	63	-2.68	1.00
n.C29	rep_worker_dg - rep_worker_eggs	-11.92	0.98	63	-12.14	0.00
n.C30	queen_chc - queen_dg	0.00	0.70	63	0.00	1.00
n.C30	queen_chc - queen_eggs	-8.94	0.61	63	-14.67	0.00
n.C30	queen_chc - rep_worker_chc	0.00	0.73	63	0.00	1.00
n.C30	queen_chc - rep_worker_dg	0.00	0.73	63	0.00	1.00
n.C30	queen_chc - rep_worker_eggs	-9.01	0.63	63	-14.33	0.00
n.C30	queen_dg - queen_eggs	-8.94	0.46	63	-19.52	0.00
n.C30	queen_dg - rep_worker_chc	0.00	0.61	63	0.00	1.00
n.C30	queen_dg - rep_worker_dg	0.00	0.61	63	0.00	1.00
n.C30	queen_dg - rep_worker_eggs	-9.01	0.48	63	-18.64	0.00

n.C30	queen_eggs - rep_worker_chc	8.94	0.51	63	17.41	0.00
n.C30	queen_eggs - rep_worker_dg	8.94	0.51	63	17.41	0.00
n.C30	queen_eggs - rep_worker_eggs	-0.07	0.35	63	-0.20	1.00
n.C30	rep_worker_chc - rep_worker_dg	0.00	0.66	63	0.00	1.00
n.C30	rep_worker_chc - rep_worker_eggs	-9.01	0.54	63	-16.80	0.00
n.C30	rep_worker_dg - rep_worker_eggs	-9.01	0.54	63	-16.80	0.00
n.C31	queen_chc - queen_dg	0.00	1.96	63	0.00	1.00
n.C31	queen_chc - queen_eggs	-4.32	1.72	63	-2.52	1.00
n.C31	queen_chc - rep_worker_chc	0.00	2.07	63	0.00	1.00
n.C31	queen_chc - rep_worker_dg	0.00	2.07	63	0.00	1.00
n.C31	queen_chc - rep_worker_eggs	-6.63	1.77	63	-3.74	0.26
n.C31	queen_dg - queen_eggs	-4.32	1.29	63	-3.35	0.91
n.C31	queen_dg - rep_worker_chc	0.00	1.73	63	0.00	1.00
n.C31	queen_dg - rep_worker_dg	0.00	1.73	63	0.00	1.00
n.C31	queen_dg - rep_worker_eggs	-6.63	1.36	63	-4.87	0.01
n.C31	queen_eggs - rep_worker_chc	4.32	1.45	63	2.99	1.00
n.C31	queen_eggs - rep_worker_dg	4.32	1.45	63	2.99	1.00
n.C31	queen_eggs - rep_worker_eggs	-2.31	0.98	63	-2.37	1.00
n.C31	rep_worker_chc - rep_worker_dg	0.00	1.85	63	0.00	1.00
n.C31	rep_worker_chc - rep_worker_eggs	-6.63	1.51	63	-4.39	0.03
n.C31	rep_worker_dg - rep_worker_eggs	-6.63	1.51	63	-4.39	0.03
11..9.MeC23	queen_chc - queen_dg	0.00	0.63	63	0.00	1.00
11..9.MeC23	queen_chc - queen_eggs	0.00	0.55	63	0.00	1.00
11..9.MeC23	queen_chc - rep_worker_chc	-3.32	0.66	63	-5.02	0.00
11..9.MeC23	queen_chc - rep_worker_dg	0.00	0.66	63	0.00	1.00
11..9.MeC23	queen_chc - rep_worker_eggs	0.00	0.57	63	0.00	1.00
11..9.MeC23	queen_dg - queen_eggs	0.00	0.41	63	0.00	1.00
11..9.MeC23	queen_dg - rep_worker_chc	-3.32	0.55	63	-6.00	0.00
11..9.MeC23	queen_dg - rep_worker_dg	0.00	0.55	63	0.00	1.00
11..9.MeC23	queen_dg - rep_worker_eggs	0.00	0.44	63	0.00	1.00
11..9.MeC23	queen_eggs - rep_worker_chc	-3.32	0.46	63	-7.18	0.00
11..9.MeC23	queen_eggs - rep_worker_dg	0.00	0.46	63	0.00	1.00
11..9.MeC23	queen_eggs - rep_worker_eggs	0.00	0.31	63	0.00	1.00
11..9.MeC23	rep_worker_chc - rep_worker_dg	3.32	0.59	63	5.61	0.00
11..9.MeC23	rep_worker_chc - rep_worker_eggs	3.32	0.48	63	6.87	0.00
11..9.MeC23	rep_worker_dg - rep_worker_eggs	0.00	0.48	63	0.00	1.00
12..10.MeC24	queen_chc - queen_dg	-11.00	1.24	63	-8.89	0.00
12..10.MeC24	queen_chc - queen_eggs	-6.72	1.08	63	-6.21	0.00
12..10.MeC24	queen_chc - rep_worker_chc	0.00	1.30	63	0.00	1.00
12..10.MeC24	queen_chc - rep_worker_dg	-8.61	1.30	63	-6.61	0.00
12..10.MeC24	queen_chc - rep_worker_eggs	-7.62	1.12	63	-6.83	0.00
12..10.MeC24	queen_dg - queen_eggs	4.27	0.81	63	5.26	0.00
12..10.MeC24	queen_dg - rep_worker_chc	11.00	1.09	63	10.08	0.00
12..10.MeC24	queen_dg - rep_worker_dg	2.38	1.09	63	2.18	1.00
12..10.MeC24	queen_dg - rep_worker_eggs	3.37	0.86	63	3.93	0.14
12..10.MeC24	queen_eggs - rep_worker_chc	6.72	0.91	63	7.38	0.00
12..10.MeC24	queen_eggs - rep_worker_dg	-1.89	0.91	63	-2.08	1.00
12..10.MeC24	queen_eggs - rep_worker_eggs	-0.90	0.61	63	-1.47	1.00

12..10.MeC24	rep_worker_chc - rep_worker_dg	-8.61	1.17	63	-7.39	0.00
12..10.MeC24	rep_worker_chc - rep_worker_eggs	-7.62	0.95	63	-8.01	0.00
12..10.MeC24	rep_worker_dg - rep_worker_eggs	0.99	0.95	63	1.04	1.00
12..10.MeC26	queen_chc - queen_dg	-2.48	0.20	63	-12.57	0.00
12..10.MeC26	queen_chc - queen_eggs	9.59	0.17	63	55.58	0.00
12..10.MeC26	queen_chc - rep_worker_chc	-2.13	0.21	63	-10.26	0.00
12..10.MeC26	queen_chc - rep_worker_dg	-1.76	0.21	63	-8.46	0.00
12..10.MeC26	queen_chc - rep_worker_eggs	9.59	0.18	63	53.87	0.00
12..10.MeC26	queen_dg - queen_eggs	12.07	0.13	63	93.10	0.00
12..10.MeC26	queen_dg - rep_worker_chc	0.35	0.17	63	1.99	1.00
12..10.MeC26	queen_dg - rep_worker_dg	0.72	0.17	63	4.14	0.07
12..10.MeC26	queen_dg - rep_worker_eggs	12.07	0.14	63	88.19	0.00
12..10.MeC26	queen_eggs - rep_worker_chc	-11.72	0.15	63	-80.65	0.00
12..10.MeC26	queen_eggs - rep_worker_dg	-11.35	0.15	63	-78.08	0.00
12..10.MeC26	queen_eggs - rep_worker_eggs	0.00	0.10	63	0.00	1.00
12..10.MeC26	rep_worker_chc - rep_worker_dg	0.37	0.19	63	2.01	1.00
12..10.MeC26	rep_worker_chc - rep_worker_eggs	11.72	0.15	63	77.22	0.00
12..10.MeC26	rep_worker_dg - rep_worker_eggs	11.35	0.15	63	74.75	0.00
12..10.MeC28	queen_chc - queen_dg	8.60	0.38	63	22.68	0.00
12..10.MeC28	queen_chc - queen_eggs	-1.69	0.33	63	-5.11	0.00
12..10.MeC28	queen_chc - rep_worker_chc	-1.80	0.40	63	-4.49	0.02
12..10.MeC28	queen_chc - rep_worker_dg	8.60	0.40	63	21.52	0.00
12..10.MeC28	queen_chc - rep_worker_eggs	-1.90	0.34	63	-5.56	0.00
12..10.MeC28	queen_dg - queen_eggs	-10.29	0.25	63	-41.31	0.00
12..10.MeC28	queen_dg - rep_worker_chc	-10.39	0.33	63	-31.09	0.00
12..10.MeC28	queen_dg - rep_worker_dg	0.00	0.33	63	0.00	1.00
12..10.MeC28	queen_dg - rep_worker_eggs	-10.50	0.26	63	-39.92	0.00
12..10.MeC28	queen_eggs - rep_worker_chc	-0.10	0.28	63	-0.36	1.00
12..10.MeC28	queen_eggs - rep_worker_dg	10.29	0.28	63	36.84	0.00
12..10.MeC28	queen_eggs - rep_worker_eggs	-0.21	0.19	63	-1.11	1.00
12..10.MeC28	rep_worker_chc - rep_worker_dg	10.39	0.36	63	29.08	0.00
12..10.MeC28	rep_worker_chc - rep_worker_eggs	-0.11	0.29	63	-0.37	1.00
12..10.MeC28	rep_worker_dg - rep_worker_eggs	-10.50	0.29	63	-35.99	0.00
12..11..10.MeC24	queen_chc - queen_dg	6.64	0.12	63	54.35	0.00
12..11..10.MeC24	queen_chc - queen_eggs	6.64	0.11	63	62.13	0.00
12..11..10.MeC24	queen_chc - rep_worker_chc	-0.44	0.13	63	-3.40	0.76
12..11..10.MeC24	queen_chc - rep_worker_dg	6.64	0.13	63	51.56	0.00
12..11..10.MeC24	queen_chc - rep_worker_eggs	6.64	0.11	63	60.21	0.00
12..11..10.MeC24	queen_dg - queen_eggs	0.00	0.08	63	0.00	1.00
12..11..10.MeC24	queen_dg - rep_worker_chc	-7.08	0.11	63	-65.70	0.00
12..11..10.MeC24	queen_dg - rep_worker_dg	0.00	0.11	63	0.00	1.00
12..11..10.MeC24	queen_dg - rep_worker_eggs	0.00	0.08	63	0.00	1.00
12..11..10.MeC24	queen_eggs - rep_worker_chc	-7.08	0.09	63	-78.62	0.00
12..11..10.MeC24	queen_eggs - rep_worker_dg	0.00	0.09	63	0.00	1.00
12..11..10.MeC24	queen_eggs - rep_worker_eggs	0.00	0.06	63	0.00	1.00
12..11..10.MeC24	rep_worker_chc - rep_worker_dg	7.08	0.12	63	61.46	0.00
12..11..10.MeC24	rep_worker_chc - rep_worker_eggs	7.08	0.09	63	75.27	0.00
12..11..10.MeC24	rep_worker_dg - rep_worker_eggs	0.00	0.09	63	0.00	1.00

12..11..10.MeC26	queen_chc - queen_dg	0.00	0.26	63	0.00	1.00
12..11..10.MeC26	queen_chc - queen_eggs	-10.99	0.23	63	-48.03	0.00
12..11..10.MeC26	queen_chc - rep_worker_chc	0.00	0.28	63	0.00	1.00
12..11..10.MeC26	queen_chc - rep_worker_dg	0.00	0.28	63	0.00	1.00
12..11..10.MeC26	queen_chc - rep_worker_eggs	-11.18	0.24	63	-47.34	0.00
12..11..10.MeC26	queen_dg - queen_eggs	-10.99	0.17	63	-63.92	0.00
12..11..10.MeC26	queen_dg - rep_worker_chc	0.00	0.23	63	0.00	1.00
12..11..10.MeC26	queen_dg - rep_worker_dg	0.00	0.23	63	0.00	1.00
12..11..10.MeC26	queen_dg - rep_worker_eggs	-11.18	0.18	63	-61.58	0.00
12..11..10.MeC26	queen_eggs - rep_worker_chc	10.99	0.19	63	57.01	0.00
12..11..10.MeC26	queen_eggs - rep_worker_dg	10.99	0.19	63	57.01	0.00
12..11..10.MeC26	queen_eggs - rep_worker_eggs	-0.19	0.13	63	-1.43	1.00
12..11..10.MeC26	rep_worker_chc - rep_worker_dg	0.00	0.25	63	0.00	1.00
12..11..10.MeC26	rep_worker_chc - rep_worker_eggs	-11.18	0.20	63	-55.51	0.00
12..11..10.MeC26	rep_worker_dg - rep_worker_eggs	-11.18	0.20	63	-55.51	0.00
12.16.diMeC28	queen_chc - queen_dg	8.00	1.29	63	6.20	0.00
12.16.diMeC28	queen_chc - queen_eggs	0.02	1.13	63	0.02	1.00
12.16.diMeC28	queen_chc - rep_worker_chc	-0.29	1.36	63	-0.22	1.00
12.16.diMeC28	queen_chc - rep_worker_dg	8.00	1.36	63	5.88	0.00
12.16.diMeC28	queen_chc - rep_worker_eggs	-0.89	1.16	63	-0.76	1.00
12.16.diMeC28	queen_dg - queen_eggs	-7.97	0.85	63	-9.40	0.00
12.16.diMeC28	queen_dg - rep_worker_chc	-8.29	1.14	63	-7.29	0.00
12.16.diMeC28	queen_dg - rep_worker_dg	0.00	1.14	63	0.00	1.00
12.16.diMeC28	queen_dg - rep_worker_eggs	-8.88	0.90	63	-9.92	0.00
12.16.diMeC28	queen_eggs - rep_worker_chc	-0.32	0.95	63	-0.33	1.00
12.16.diMeC28	queen_eggs - rep_worker_dg	7.97	0.95	63	8.38	0.00
12.16.diMeC28	queen_eggs - rep_worker_eggs	-0.91	0.64	63	-1.42	1.00
12.16.diMeC28	rep_worker_chc - rep_worker_dg	8.29	1.22	63	6.82	0.00
12.16.diMeC28	rep_worker_chc - rep_worker_eggs	-0.59	0.99	63	-0.60	1.00
12.16.diMeC28	rep_worker_dg - rep_worker_eggs	-8.88	0.99	63	-8.94	0.00
13..11..9..7.MeC25	queen_chc - queen_dg	-2.28	0.32	63	-7.10	0.00
13..11..9..7.MeC25	queen_chc - queen_eggs	-1.62	0.28	63	-5.77	0.00
13..11..9..7.MeC25	queen_chc - rep_worker_chc	-2.25	0.34	63	-6.66	0.00
13..11..9..7.MeC25	queen_chc - rep_worker_dg	-1.82	0.34	63	-5.38	0.00
13..11..9..7.MeC25	queen_chc - rep_worker_eggs	-1.76	0.29	63	-6.07	0.00
13..11..9..7.MeC25	queen_dg - queen_eggs	0.66	0.21	63	3.13	1.00
13..11..9..7.MeC25	queen_dg - rep_worker_chc	0.03	0.28	63	0.09	1.00
13..11..9..7.MeC25	queen_dg - rep_worker_dg	0.46	0.28	63	1.62	1.00
13..11..9..7.MeC25	queen_dg - rep_worker_eggs	0.52	0.22	63	2.34	1.00
13..11..9..7.MeC25	queen_eggs - rep_worker_chc	-0.63	0.24	63	-2.68	1.00
13..11..9..7.MeC25	queen_eggs - rep_worker_dg	-0.20	0.24	63	-0.85	1.00
13..11..9..7.MeC25	queen_eggs - rep_worker_eggs	-0.14	0.16	63	-0.87	1.00
13..11..9..7.MeC25	rep_worker_chc - rep_worker_dg	0.43	0.30	63	1.43	1.00
13..11..9..7.MeC25	rep_worker_chc - rep_worker_eggs	0.50	0.25	63	2.01	1.00
13..11..9..7.MeC25	rep_worker_dg - rep_worker_eggs	0.06	0.25	63	0.25	1.00
13..11..9..7.MeC27	queen_chc - queen_dg	13.20	0.37	63	35.64	0.00
13..11..9..7.MeC27	queen_chc - queen_eggs	-0.88	0.32	63	-2.73	1.00
13..11..9..7.MeC27	queen_chc - rep_worker_chc	-1.56	0.39	63	-3.99	0.12

13..11..9..7.MeC27	queen_chc - rep_worker_dg	13.20	0.39	63	33.81	0.00
13..11..9..7.MeC27	queen_chc - rep_worker_eggs	-0.80	0.33	63	-2.39	1.00
13..11..9..7.MeC27	queen_dg - queen_eggs	-14.08	0.24	63	-57.85	0.00
13..11..9..7.MeC27	queen_dg - rep_worker_chc	-14.75	0.33	63	-45.18	0.00
13..11..9..7.MeC27	queen_dg - rep_worker_dg	0.00	0.33	63	0.00	1.00
13..11..9..7.MeC27	queen_dg - rep_worker_eggs	-14.00	0.26	63	-54.47	0.00
13..11..9..7.MeC27	queen_eggs - rep_worker_chc	-0.67	0.27	63	-2.46	1.00
13..11..9..7.MeC27	queen_eggs - rep_worker_dg	14.08	0.27	63	51.60	0.00
13..11..9..7.MeC27	queen_eggs - rep_worker_eggs	0.09	0.18	63	0.47	1.00
13..11..9..7.MeC27	rep_worker_chc - rep_worker_dg	14.75	0.35	63	42.26	0.00
13..11..9..7.MeC27	rep_worker_chc - rep_worker_eggs	0.76	0.29	63	2.66	1.00
13..11..9..7.MeC27	rep_worker_dg - rep_worker_eggs	-14.00	0.29	63	-49.10	0.00
13..11..9.MeC27	queen_chc - queen_dg	-11.26	0.19	63	-59.90	0.00
13..11..9.MeC27	queen_chc - queen_eggs	0.00	0.16	63	0.00	1.00
13..11..9.MeC27	queen_chc - rep_worker_chc	0.00	0.20	63	0.00	1.00
13..11..9.MeC27	queen_chc - rep_worker_dg	-10.94	0.20	63	-55.21	0.00
13..11..9.MeC27	queen_chc - rep_worker_eggs	0.00	0.17	63	0.00	1.00
13..11..9.MeC27	queen_dg - queen_eggs	11.26	0.12	63	91.12	0.00
13..11..9.MeC27	queen_dg - rep_worker_chc	11.26	0.17	63	67.92	0.00
13..11..9.MeC27	queen_dg - rep_worker_dg	0.32	0.17	63	1.93	1.00
13..11..9.MeC27	queen_dg - rep_worker_eggs	11.26	0.13	63	86.32	0.00
13..11..9.MeC27	queen_eggs - rep_worker_chc	0.00	0.14	63	0.00	1.00
13..11..9.MeC27	queen_eggs - rep_worker_dg	-10.94	0.14	63	-78.96	0.00
13..11..9.MeC27	queen_eggs - rep_worker_eggs	0.00	0.09	63	0.00	1.00
13..11..9.MeC27	rep_worker_chc - rep_worker_dg	-10.94	0.18	63	-61.72	0.00
13..11..9.MeC27	rep_worker_chc - rep_worker_eggs	0.00	0.14	63	0.00	1.00
13..11..9.MeC27	rep_worker_dg - rep_worker_eggs	10.94	0.14	63	75.60	0.00
13..11..9.MeC29	queen_chc - queen_dg	-10.53	0.21	63	-49.77	0.00
13..11..9.MeC29	queen_chc - queen_eggs	0.00	0.19	63	0.00	1.00
13..11..9.MeC29	queen_chc - rep_worker_chc	0.00	0.22	63	0.00	1.00
13..11..9.MeC29	queen_chc - rep_worker_dg	-10.18	0.22	63	-45.62	0.00
13..11..9.MeC29	queen_chc - rep_worker_eggs	0.00	0.19	63	0.00	1.00
13..11..9.MeC29	queen_dg - queen_eggs	10.53	0.14	63	75.72	0.00
13..11..9.MeC29	queen_dg - rep_worker_chc	10.53	0.19	63	56.43	0.00
13..11..9.MeC29	queen_dg - rep_worker_dg	0.36	0.19	63	1.90	1.00
13..11..9.MeC29	queen_dg - rep_worker_eggs	10.53	0.15	63	71.73	0.00
13..11..9.MeC29	queen_eggs - rep_worker_chc	0.00	0.16	63	0.00	1.00
13..11..9.MeC29	queen_eggs - rep_worker_dg	-10.18	0.16	63	-65.25	0.00
13..11..9.MeC29	queen_eggs - rep_worker_eggs	0.00	0.11	63	0.00	1.00
13..11..9.MeC29	rep_worker_chc - rep_worker_dg	-10.18	0.20	63	-51.01	0.00
13..11..9.MeC29	rep_worker_chc - rep_worker_eggs	0.00	0.16	63	0.00	1.00
13..11..9.MeC29	rep_worker_dg - rep_worker_eggs	10.18	0.16	63	62.47	0.00
13.17.diMeC33	queen_chc - queen_dg	-4.81	1.28	63	-3.76	0.25
13.17.diMeC33	queen_chc - queen_eggs	0.00	1.12	63	0.00	1.00
13.17.diMeC33	queen_chc - rep_worker_chc	0.00	1.35	63	0.00	1.00
13.17.diMeC33	queen_chc - rep_worker_dg	-1.69	1.35	63	-1.25	1.00
13.17.diMeC33	queen_chc - rep_worker_eggs	0.00	1.16	63	0.00	1.00
13.17.diMeC33	queen_dg - queen_eggs	4.81	0.84	63	5.72	0.00

13.17.diMeC33	queen_dg - rep_worker_chc	4.81	1.13	63	4.26	0.05
13.17.diMeC33	queen_dg - rep_worker_dg	3.13	1.13	63	2.77	1.00
13.17.diMeC33	queen_dg - rep_worker_eggs	4.81	0.89	63	5.42	0.00
13.17.diMeC33	queen_eggs - rep_worker_chc	0.00	0.94	63	0.00	1.00
13.17.diMeC33	queen_eggs - rep_worker_dg	-1.69	0.94	63	-1.79	1.00
13.17.diMeC33	queen_eggs - rep_worker_eggs	0.00	0.64	63	0.00	1.00
13.17.diMeC33	rep_worker_chc - rep_worker_dg	-1.69	1.21	63	-1.40	1.00
13.17.diMeC33	rep_worker_chc - rep_worker_eggs	0.00	0.99	63	0.00	1.00
13.17.diMeC33	rep_worker_dg - rep_worker_eggs	1.69	0.99	63	1.71	1.00
15..13..11..9..7.MeC29	queen_chc - queen_dg	10.19	0.47	63	21.82	0.00
15..13..11..9..7.MeC29	queen_chc - queen_eggs	-1.05	0.41	63	-2.57	1.00
15..13..11..9..7.MeC29	queen_chc - rep_worker_chc	-1.44	0.49	63	-2.93	1.00
15..13..11..9..7.MeC29	queen_chc - rep_worker_dg	10.19	0.49	63	20.70	0.00
15..13..11..9..7.MeC29	queen_chc - rep_worker_eggs	-1.53	0.42	63	-3.62	0.39
15..13..11..9..7.MeC29	queen_dg - queen_eggs	-11.24	0.31	63	-36.61	0.00
15..13..11..9..7.MeC29	queen_dg - rep_worker_chc	-11.63	0.41	63	-28.25	0.00
15..13..11..9..7.MeC29	queen_dg - rep_worker_dg	0.00	0.41	63	0.00	1.00
15..13..11..9..7.MeC29	queen_dg - rep_worker_eggs	-11.71	0.32	63	-36.15	0.00
15..13..11..9..7.MeC29	queen_eggs - rep_worker_chc	-0.40	0.34	63	-1.15	1.00
15..13..11..9..7.MeC29	queen_eggs - rep_worker_dg	11.24	0.34	63	32.65	0.00
15..13..11..9..7.MeC29	queen_eggs - rep_worker_eggs	-0.48	0.23	63	-2.06	1.00
15..13..11..9..7.MeC29	rep_worker_chc - rep_worker_dg	11.63	0.44	63	26.42	0.00
15..13..11..9..7.MeC29	rep_worker_chc - rep_worker_eggs	-0.08	0.36	63	-0.23	1.00
15..13..11..9..7.MeC29	rep_worker_dg - rep_worker_eggs	-11.71	0.36	63	-32.59	0.00
15..13..11..9.MeC31	queen_chc - queen_dg	6.64	0.17	63	39.78	0.00
15..13..11..9.MeC31	queen_chc - queen_eggs	6.64	0.15	63	45.47	0.00
15..13..11..9.MeC31	queen_chc - rep_worker_chc	-1.35	0.18	63	-7.67	0.00
15..13..11..9.MeC31	queen_chc - rep_worker_dg	6.64	0.18	63	37.74	0.00
15..13..11..9.MeC31	queen_chc - rep_worker_eggs	6.64	0.15	63	44.07	0.00
15..13..11..9.MeC31	queen_dg - queen_eggs	0.00	0.11	63	0.00	1.00
15..13..11..9.MeC31	queen_dg - rep_worker_chc	-7.99	0.15	63	-54.27	0.00
15..13..11..9.MeC31	queen_dg - rep_worker_dg	0.00	0.15	63	0.00	1.00
15..13..11..9.MeC31	queen_dg - rep_worker_eggs	0.00	0.12	63	0.00	1.00
15..13..11..9.MeC31	queen_eggs - rep_worker_chc	-7.99	0.12	63	-64.94	0.00
15..13..11..9.MeC31	queen_eggs - rep_worker_dg	0.00	0.12	63	0.00	1.00
15..13..11..9.MeC31	queen_eggs - rep_worker_eggs	0.00	0.08	63	0.00	1.00
15..13..11..9.MeC31	rep_worker_chc - rep_worker_dg	7.99	0.16	63	50.77	0.00
15..13..11..9.MeC31	rep_worker_chc - rep_worker_eggs	7.99	0.13	63	62.18	0.00
15..13..11..9.MeC31	rep_worker_dg - rep_worker_eggs	0.00	0.13	63	0.00	1.00
15..13.MeC31	queen_chc - queen_dg	-5.93	1.38	63	-4.29	0.04
15..13.MeC31	queen_chc - queen_eggs	0.00	1.21	63	0.00	1.00
15..13.MeC31	queen_chc - rep_worker_chc	0.00	1.46	63	0.00	1.00
15..13.MeC31	queen_chc - rep_worker_dg	-4.83	1.46	63	-3.32	1.00
15..13.MeC31	queen_chc - rep_worker_eggs	0.00	1.25	63	0.00	1.00
15..13.MeC31	queen_dg - queen_eggs	5.93	0.91	63	6.53	0.00
15..13.MeC31	queen_dg - rep_worker_chc	5.93	1.22	63	4.87	0.01
15..13.MeC31	queen_dg - rep_worker_dg	1.10	1.22	63	0.91	1.00
15..13.MeC31	queen_dg - rep_worker_eggs	5.93	0.96	63	6.19	0.00

15..13.MeC31	queen_eggs - rep_worker_chc	0.00	1.02	63	0.00	1.00
15..13.MeC31	queen_eggs - rep_worker_dg	-4.83	1.02	63	-4.74	0.01
15..13.MeC31	queen_eggs - rep_worker_eggs	0.00	0.69	63	0.00	1.00
15..13.MeC31	rep_worker_chc - rep_worker_dg	-4.83	1.30	63	-3.71	0.29
15..13.MeC31	rep_worker_chc - rep_worker_eggs	0.00	1.06	63	0.00	1.00
15..13.MeC31	rep_worker_dg - rep_worker_eggs	4.83	1.06	63	4.54	0.02
3.MeC23	queen_chc - queen_dg	-3.39	1.85	63	-1.83	1.00
3.MeC23	queen_chc - queen_eggs	5.91	1.62	63	3.66	0.35
3.MeC23	queen_chc - rep_worker_chc	1.20	1.95	63	0.61	1.00
3.MeC23	queen_chc - rep_worker_dg	-7.24	1.95	63	-3.72	0.29
3.MeC23	queen_chc - rep_worker_eggs	4.80	1.67	63	2.88	1.00
3.MeC23	queen_dg - queen_eggs	9.30	1.21	63	7.66	0.00
3.MeC23	queen_dg - rep_worker_chc	4.58	1.63	63	2.81	1.00
3.MeC23	queen_dg - rep_worker_dg	-3.85	1.63	63	-2.36	1.00
3.MeC23	queen_dg - rep_worker_eggs	8.19	1.28	63	6.39	0.00
3.MeC23	queen_eggs - rep_worker_chc	-4.71	1.36	63	-3.46	0.64
3.MeC23	queen_eggs - rep_worker_dg	-13.15	1.36	63	-9.65	0.00
3.MeC23	queen_eggs - rep_worker_eggs	-1.11	0.92	63	-1.21	1.00
3.MeC23	rep_worker_chc - rep_worker_dg	-8.43	1.74	63	-4.84	0.01
3.MeC23	rep_worker_chc - rep_worker_eggs	3.60	1.42	63	2.53	1.00
3.MeC23	rep_worker_dg - rep_worker_eggs	12.04	1.42	63	8.46	0.00
3.MeC25	queen_chc - queen_dg	1.19	0.35	63	3.43	0.71
3.MeC25	queen_chc - queen_eggs	-0.06	0.30	63	-0.19	1.00
3.MeC25	queen_chc - rep_worker_chc	-0.04	0.36	63	-0.12	1.00
3.MeC25	queen_chc - rep_worker_dg	0.21	0.36	63	0.57	1.00
3.MeC25	queen_chc - rep_worker_eggs	0.43	0.31	63	1.36	1.00
3.MeC25	queen_dg - queen_eggs	-1.24	0.23	63	-5.47	0.00
3.MeC25	queen_dg - rep_worker_chc	-1.23	0.31	63	-4.03	0.10
3.MeC25	queen_dg - rep_worker_dg	-0.98	0.31	63	-3.21	1.00
3.MeC25	queen_dg - rep_worker_eggs	-0.76	0.24	63	-3.17	1.00
3.MeC25	queen_eggs - rep_worker_chc	0.01	0.26	63	0.06	1.00
3.MeC25	queen_eggs - rep_worker_dg	0.27	0.26	63	1.04	1.00
3.MeC25	queen_eggs - rep_worker_eggs	0.48	0.17	63	2.81	1.00
3.MeC25	rep_worker_chc - rep_worker_dg	0.25	0.33	63	0.77	1.00
3.MeC25	rep_worker_chc - rep_worker_eggs	0.47	0.27	63	1.76	1.00
3.MeC25	rep_worker_dg - rep_worker_eggs	0.22	0.27	63	0.82	1.00
3.MeC27	queen_chc - queen_dg	-13.31	0.34	63	-39.31	0.00
3.MeC27	queen_chc - queen_eggs	-13.59	0.30	63	-45.86	0.00
3.MeC27	queen_chc - rep_worker_chc	0.00	0.36	63	0.00	1.00
3.MeC27	queen_chc - rep_worker_dg	-13.72	0.36	63	-38.43	0.00
3.MeC27	queen_chc - rep_worker_eggs	-13.16	0.31	63	-43.03	0.00
3.MeC27	queen_dg - queen_eggs	-0.28	0.22	63	-1.24	1.00
3.MeC27	queen_dg - rep_worker_chc	13.31	0.30	63	44.57	0.00
3.MeC27	queen_dg - rep_worker_dg	-0.41	0.30	63	-1.37	1.00
3.MeC27	queen_dg - rep_worker_eggs	0.16	0.24	63	0.67	1.00
3.MeC27	queen_eggs - rep_worker_chc	13.59	0.25	63	54.44	0.00
3.MeC27	queen_eggs - rep_worker_dg	-0.13	0.25	63	-0.53	1.00
3.MeC27	queen_eggs - rep_worker_eggs	0.43	0.17	63	2.58	1.00

3.MeC27	rep_worker_chc - rep_worker_dg	-13.72	0.32	63	-42.97	0.00
3.MeC27	rep_worker_chc - rep_worker_eggs	-13.16	0.26	63	-50.46	0.00
3.MeC27	rep_worker_dg - rep_worker_eggs	0.57	0.26	63	2.17	1.00
3.MeC29	queen_chc - queen_dg	-2.38	1.30	63	-1.83	1.00
3.MeC29	queen_chc - queen_eggs	-6.72	1.14	63	-5.92	0.00
3.MeC29	queen_chc - rep_worker_chc	-1.66	1.37	63	-1.21	1.00
3.MeC29	queen_chc - rep_worker_dg	-2.76	1.37	63	-2.01	1.00
3.MeC29	queen_chc - rep_worker_eggs	-6.69	1.17	63	-5.71	0.00
3.MeC29	queen_dg - queen_eggs	-4.34	0.85	63	-5.08	0.00
3.MeC29	queen_dg - rep_worker_chc	0.72	1.15	63	0.63	1.00
3.MeC29	queen_dg - rep_worker_dg	-0.38	1.15	63	-0.33	1.00
3.MeC29	queen_dg - rep_worker_eggs	-4.31	0.90	63	-4.78	0.01
3.MeC29	queen_eggs - rep_worker_chc	5.06	0.96	63	5.29	0.00
3.MeC29	queen_eggs - rep_worker_dg	3.96	0.96	63	4.14	0.07
3.MeC29	queen_eggs - rep_worker_eggs	0.03	0.65	63	0.04	1.00
3.MeC29	rep_worker_chc - rep_worker_dg	-1.10	1.22	63	-0.89	1.00
3.MeC29	rep_worker_chc - rep_worker_eggs	-5.03	1.00	63	-5.03	0.00
3.MeC29	rep_worker_dg - rep_worker_eggs	-3.94	1.00	63	-3.94	0.14
3.MeC31	queen_chc - queen_dg	-13.25	0.31	63	-43.19	0.00
3.MeC31	queen_chc - queen_eggs	0.00	0.27	63	0.00	1.00
3.MeC31	queen_chc - rep_worker_chc	0.00	0.32	63	0.00	1.00
3.MeC31	queen_chc - rep_worker_dg	-12.94	0.32	63	-40.02	0.00
3.MeC31	queen_chc - rep_worker_eggs	0.00	0.28	63	0.00	1.00
3.MeC31	queen_dg - queen_eggs	13.25	0.20	63	65.70	0.00
3.MeC31	queen_dg - rep_worker_chc	13.25	0.27	63	48.97	0.00
3.MeC31	queen_dg - rep_worker_dg	0.31	0.27	63	1.14	1.00
3.MeC31	queen_dg - rep_worker_eggs	13.25	0.21	63	62.24	0.00
3.MeC31	queen_eggs - rep_worker_chc	0.00	0.23	63	0.00	1.00
3.MeC31	queen_eggs - rep_worker_dg	-12.94	0.23	63	-57.23	0.00
3.MeC31	queen_eggs - rep_worker_eggs	0.00	0.15	63	0.00	1.00
3.MeC31	rep_worker_chc - rep_worker_dg	-12.94	0.29	63	-44.74	0.00
3.MeC31	rep_worker_chc - rep_worker_eggs	0.00	0.24	63	0.00	1.00
3.MeC31	rep_worker_dg - rep_worker_eggs	12.94	0.24	63	54.79	0.00
4.MeC24	queen_chc - queen_dg	6.64	0.49	63	13.60	0.00
4.MeC24	queen_chc - queen_eggs	6.64	0.43	63	15.54	0.00
4.MeC24	queen_chc - rep_worker_chc	0.93	0.52	63	1.80	1.00
4.MeC24	queen_chc - rep_worker_dg	6.64	0.52	63	12.90	0.00
4.MeC24	queen_chc - rep_worker_eggs	6.64	0.44	63	15.06	0.00
4.MeC24	queen_dg - queen_eggs	0.00	0.32	63	0.00	1.00
4.MeC24	queen_dg - rep_worker_chc	-5.72	0.43	63	-13.26	0.00
4.MeC24	queen_dg - rep_worker_dg	0.00	0.43	63	0.00	1.00
4.MeC24	queen_dg - rep_worker_eggs	0.00	0.34	63	0.00	1.00
4.MeC24	queen_eggs - rep_worker_chc	-5.71	0.36	63	-15.87	0.00
4.MeC24	queen_eggs - rep_worker_dg	0.00	0.36	63	0.00	1.00
4.MeC24	queen_eggs - rep_worker_eggs	0.00	0.24	63	0.00	1.00
4.MeC24	rep_worker_chc - rep_worker_dg	5.72	0.46	63	12.41	0.00
4.MeC24	rep_worker_chc - rep_worker_eggs	5.72	0.38	63	15.19	0.00
4.MeC24	rep_worker_dg - rep_worker_eggs	0.00	0.38	63	0.00	1.00

4.MeC26	queen_chc - queen_dg	9.30	0.24	63	38.58	0.00
4.MeC26	queen_chc - queen_eggs	-0.83	0.21	63	-3.94	0.14
4.MeC26	queen_chc - rep_worker_chc	-0.80	0.25	63	-3.15	1.00
4.MeC26	queen_chc - rep_worker_dg	9.30	0.25	63	36.60	0.00
4.MeC26	queen_chc - rep_worker_eggs	-0.81	0.22	63	-3.73	0.27
4.MeC26	queen_dg - queen_eggs	-10.13	0.16	63	-63.94	0.00
4.MeC26	queen_dg - rep_worker_chc	-10.10	0.21	63	-47.52	0.00
4.MeC26	queen_dg - rep_worker_dg	0.00	0.21	63	0.00	1.00
4.MeC26	queen_dg - rep_worker_eggs	-10.11	0.17	63	-60.46	0.00
4.MeC26	queen_eggs - rep_worker_chc	0.03	0.18	63	0.16	1.00
4.MeC26	queen_eggs - rep_worker_dg	10.13	0.18	63	57.03	0.00
4.MeC26	queen_eggs - rep_worker_eggs	0.02	0.12	63	0.15	1.00
4.MeC26	rep_worker_chc - rep_worker_dg	10.10	0.23	63	44.45	0.00
4.MeC26	rep_worker_chc - rep_worker_eggs	-0.01	0.19	63	-0.06	1.00
4.MeC26	rep_worker_dg - rep_worker_eggs	-10.11	0.19	63	-54.50	0.00
5.MeC25	queen_chc - queen_dg	8.00	0.75	63	10.65	0.00
5.MeC25	queen_chc - queen_eggs	-0.02	0.66	63	-0.03	1.00
5.MeC25	queen_chc - rep_worker_chc	-1.07	0.79	63	-1.35	1.00
5.MeC25	queen_chc - rep_worker_dg	8.00	0.79	63	10.10	0.00
5.MeC25	queen_chc - rep_worker_eggs	-0.35	0.68	63	-0.51	1.00
5.MeC25	queen_dg - queen_eggs	-8.02	0.49	63	-16.24	0.00
5.MeC25	queen_dg - rep_worker_chc	-9.07	0.66	63	-13.69	0.00
5.MeC25	queen_dg - rep_worker_dg	0.00	0.66	63	0.00	1.00
5.MeC25	queen_dg - rep_worker_eggs	-8.34	0.52	63	-16.01	0.00
5.MeC25	queen_eggs - rep_worker_chc	-1.05	0.55	63	-1.90	1.00
5.MeC25	queen_eggs - rep_worker_dg	8.02	0.55	63	14.48	0.00
5.MeC25	queen_eggs - rep_worker_eggs	-0.33	0.37	63	-0.87	1.00
5.MeC25	rep_worker_chc - rep_worker_dg	9.07	0.71	63	12.80	0.00
5.MeC25	rep_worker_chc - rep_worker_eggs	0.72	0.58	63	1.25	1.00
5.MeC25	rep_worker_dg - rep_worker_eggs	-8.34	0.58	63	-14.43	0.00
7..5.MeC27	queen_chc - queen_dg	-12.37	0.16	63	-75.08	0.00
7..5.MeC27	queen_chc - queen_eggs	0.00	0.14	63	0.00	1.00
7..5.MeC27	queen_chc - rep_worker_chc	0.00	0.17	63	0.00	1.00
7..5.MeC27	queen_chc - rep_worker_dg	-11.52	0.17	63	-66.32	0.00
7..5.MeC27	queen_chc - rep_worker_eggs	0.00	0.15	63	0.00	1.00
7..5.MeC27	queen_dg - queen_eggs	12.38	0.11	63	114.21	0.00
7..5.MeC27	queen_dg - rep_worker_chc	12.37	0.15	63	85.13	0.00
7..5.MeC27	queen_dg - rep_worker_dg	0.85	0.15	63	5.87	0.00
7..5.MeC27	queen_dg - rep_worker_eggs	12.38	0.11	63	108.20	0.00
7..5.MeC27	queen_eggs - rep_worker_chc	0.00	0.12	63	0.00	1.00
7..5.MeC27	queen_eggs - rep_worker_dg	-11.52	0.12	63	-94.84	0.00
7..5.MeC27	queen_eggs - rep_worker_eggs	0.00	0.08	63	0.00	1.00
7..5.MeC27	rep_worker_chc - rep_worker_dg	-11.52	0.16	63	-74.14	0.00
7..5.MeC27	rep_worker_chc - rep_worker_eggs	0.00	0.13	63	0.00	1.00
7..5.MeC27	rep_worker_dg - rep_worker_eggs	11.52	0.13	63	90.81	0.00
7.MeC29	queen_chc - queen_dg	-9.05	0.87	63	-10.36	0.00
7.MeC29	queen_chc - queen_eggs	0.00	0.76	63	0.00	1.00
7.MeC29	queen_chc - rep_worker_chc	0.00	0.92	63	0.00	1.00

7.MeC29	queen_chc - rep_worker_dg	-6.46	0.92	63	-7.01	0.00
7.MeC29	queen_chc - rep_worker_eggs	0.00	0.79	63	0.00	1.00
7.MeC29	queen_dg - queen_eggs	9.05	0.57	63	15.76	0.00
7.MeC29	queen_dg - rep_worker_chc	9.05	0.77	63	11.74	0.00
7.MeC29	queen_dg - rep_worker_dg	2.59	0.77	63	3.36	0.87
7.MeC29	queen_dg - rep_worker_eggs	9.05	0.61	63	14.93	0.00
7.MeC29	queen_eggs - rep_worker_chc	0.00	0.64	63	0.00	1.00
7.MeC29	queen_eggs - rep_worker_dg	-6.46	0.64	63	-10.03	0.00
7.MeC29	queen_eggs - rep_worker_eggs	0.00	0.43	63	0.00	1.00
7.MeC29	rep_worker_chc - rep_worker_dg	-6.46	0.82	63	-7.84	0.00
7.MeC29	rep_worker_chc - rep_worker_eggs	0.00	0.67	63	0.00	1.00
7.MeC29	rep_worker_dg - rep_worker_eggs	6.46	0.67	63	9.60	0.00
7.MeC31	queen_chc - queen_dg	8.59	0.09	63	91.24	0.00
7.MeC31	queen_chc - queen_eggs	8.59	0.08	63	104.28	0.00
7.MeC31	queen_chc - rep_worker_chc	-0.08	0.10	63	-0.80	1.00
7.MeC31	queen_chc - rep_worker_dg	8.59	0.10	63	86.56	0.00
7.MeC31	queen_chc - rep_worker_eggs	8.59	0.08	63	101.08	0.00
7.MeC31	queen_dg - queen_eggs	0.00	0.06	63	0.00	1.00
7.MeC31	queen_dg - rep_worker_chc	-8.67	0.08	63	-104.41	0.00
7.MeC31	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
7.MeC31	queen_dg - rep_worker_eggs	0.00	0.07	63	0.00	1.00
7.MeC31	queen_eggs - rep_worker_chc	-8.67	0.07	63	-124.93	0.00
7.MeC31	queen_eggs - rep_worker_dg	0.00	0.07	63	0.00	1.00
7.MeC31	queen_eggs - rep_worker_eggs	0.00	0.05	63	0.00	1.00
7.MeC31	rep_worker_chc - rep_worker_dg	8.67	0.09	63	97.67	0.00
7.MeC31	rep_worker_chc - rep_worker_eggs	8.67	0.07	63	119.61	0.00
7.MeC31	rep_worker_dg - rep_worker_eggs	0.00	0.07	63	0.00	1.00
7..diMeC33	queen_chc - queen_dg	6.64	0.10	63	69.68	0.00
7..diMeC33	queen_chc - queen_eggs	6.64	0.08	63	79.65	0.00
7..diMeC33	queen_chc - rep_worker_chc	-0.36	0.10	63	-3.55	0.49
7..diMeC33	queen_chc - rep_worker_dg	6.64	0.10	63	66.11	0.00
7..diMeC33	queen_chc - rep_worker_eggs	6.64	0.09	63	77.20	0.00
7..diMeC33	queen_dg - queen_eggs	0.00	0.06	63	0.00	1.00
7..diMeC33	queen_dg - rep_worker_chc	-7.00	0.08	63	-83.26	0.00
7..diMeC33	queen_dg - rep_worker_dg	0.00	0.08	63	0.00	1.00
7..diMeC33	queen_dg - rep_worker_eggs	0.00	0.07	63	0.00	1.00
7..diMeC33	queen_eggs - rep_worker_chc	-7.00	0.07	63	-99.62	0.00
7..diMeC33	queen_eggs - rep_worker_dg	0.00	0.07	63	0.00	1.00
7..diMeC33	queen_eggs - rep_worker_eggs	0.00	0.05	63	0.00	1.00
7..diMeC33	rep_worker_chc - rep_worker_dg	7.00	0.09	63	77.88	0.00
7..diMeC33	rep_worker_chc - rep_worker_eggs	7.00	0.07	63	95.38	0.00
7..diMeC33	rep_worker_dg - rep_worker_eggs	0.00	0.07	63	0.00	1.00
9.13...11.15.diMeC27	queen_chc - queen_dg	14.06	0.33	63	42.10	0.00
9.13...11.15.diMeC27	queen_chc - queen_eggs	2.37	0.29	63	8.10	0.00
9.13...11.15.diMeC27	queen_chc - rep_worker_chc	-0.03	0.35	63	-0.08	1.00
9.13...11.15.diMeC27	queen_chc - rep_worker_dg	14.06	0.35	63	39.94	0.00
9.13...11.15.diMeC27	queen_chc - rep_worker_eggs	2.31	0.30	63	7.68	0.00
9.13...11.15.diMeC27	queen_dg - queen_eggs	-11.69	0.22	63	-53.26	0.00

9.13...11.15.diMeC27	queen_dg - rep_worker_chc	-14.09	0.29	63	-47.84	0.00
9.13...11.15.diMeC27	queen_dg - rep_worker_dg	0.00	0.29	63	0.00	1.00
9.13...11.15.diMeC27	queen_dg - rep_worker_eggs	-11.74	0.23	63	-50.68	0.00
9.13...11.15.diMeC27	queen_eggs - rep_worker_chc	-2.40	0.25	63	-9.74	0.00
9.13...11.15.diMeC27	queen_eggs - rep_worker_dg	11.69	0.25	63	47.51	0.00
9.13...11.15.diMeC27	queen_eggs - rep_worker_eggs	-0.05	0.17	63	-0.32	1.00
9.13...11.15.diMeC27	rep_worker_chc - rep_worker_dg	14.09	0.31	63	44.75	0.00
9.13...11.15.diMeC27	rep_worker_chc - rep_worker_eggs	2.34	0.26	63	9.12	0.00
9.13...11.15.diMeC27	rep_worker_dg - rep_worker_eggs	-11.74	0.26	63	-45.69	0.00
9.13.diMeC29	queen_chc - queen_dg	11.58	0.06	63	205.58	0.00
9.13.diMeC29	queen_chc - queen_eggs	11.58	0.05	63	234.98	0.00
9.13.diMeC29	queen_chc - rep_worker_chc	0.03	0.06	63	0.46	1.00
9.13.diMeC29	queen_chc - rep_worker_dg	11.58	0.06	63	195.03	0.00
9.13.diMeC29	queen_chc - rep_worker_eggs	11.58	0.05	63	227.75	0.00
9.13.diMeC29	queen_dg - queen_eggs	0.00	0.04	63	0.00	1.00
9.13.diMeC29	queen_dg - rep_worker_chc	-11.56	0.05	63	-232.56	0.00
9.13.diMeC29	queen_dg - rep_worker_dg	0.00	0.05	63	0.00	1.00
9.13.diMeC29	queen_dg - rep_worker_eggs	0.00	0.04	63	0.00	1.00
9.13.diMeC29	queen_eggs - rep_worker_chc	-11.56	0.04	63	-278.27	0.00
9.13.diMeC29	queen_eggs - rep_worker_dg	0.00	0.04	63	0.00	1.00
9.13.diMeC29	queen_eggs - rep_worker_eggs	0.00	0.03	63	0.00	1.00
9.13.diMeC29	rep_worker_chc - rep_worker_dg	11.56	0.05	63	217.54	0.00
9.13.diMeC29	rep_worker_chc - rep_worker_eggs	11.56	0.04	63	266.43	0.00
9.13.diMeC29	rep_worker_dg - rep_worker_eggs	0.00	0.04	63	0.00	1.00

Table S23: Pairwise comparisons considering the chemical compounds of each group of sample (CHC, eggs or *Dufour's* gland) and each group of female (queen and reproductive worker) in *Vespa crabro*. chc = cuticular hydrocarbons, rep = reproductive worker, dg = *Dufour's* gland, padj = p value adjusted. All the values highlighted in red correspond to significant values $p < 0.05^*$.

compound	contrast	estimate	SE	df	t.ratio	padj
C21.1	cut_queens - cut_workers	-3.02	0.38	113	-7.90	0.00
C21.1	cut_queens - dufour_queens	3.23	0.49	113	6.61	0.00
C21.1	cut_queens - dufour_workers	3.23	0.42	113	7.64	0.00
C21.1	cut_queens - eggs_queens	-3.60	0.38	113	-9.47	0.00
C21.1	cut_queens - eggs_workers	-2.98	0.43	113	-6.88	0.00
C21.1	cut_workers - dufour_queens	6.25	0.38	113	16.33	0.00
C21.1	cut_workers - dufour_workers	6.25	0.29	113	21.21	0.00
C21.1	cut_workers - eggs_queens	-0.58	0.23	113	-2.51	1.00
C21.1	cut_workers - eggs_workers	0.04	0.31	113	0.14	1.00
C21.1	dufour_queens - dufour_workers	0.00	0.42	113	0.00	1.00
C21.1	dufour_queens - eggs_queens	-6.83	0.38	113	-17.97	0.00
C21.1	dufour_queens - eggs_workers	-6.21	0.43	113	-14.34	0.00
C21.1	dufour_workers - eggs_queens	-6.83	0.29	113	-23.46	0.00
C21.1	dufour_workers - eggs_workers	-6.21	0.36	113	-17.37	0.00
C21.1	eggs_queens - eggs_workers	0.62	0.31	113	2.02	1.00
C23.1	cut_queens - cut_workers	-2.47	0.41	113	-6.07	0.00
C23.1	cut_queens - dufour_queens	0.33	0.52	113	0.64	1.00

C23.1	cut_queens - dufour_workers	-1.51	0.45	113	-3.36	1.00
C23.1	cut_queens - eggs_queens	-1.59	0.40	113	-3.93	0.14
C23.1	cut_queens - eggs_workers	-0.82	0.46	113	-1.78	1.00
C23.1	cut_workers - dufour_queens	2.80	0.41	113	6.89	0.00
C23.1	cut_workers - dufour_workers	0.96	0.31	113	3.06	1.00
C23.1	cut_workers - eggs_queens	0.88	0.24	113	3.63	0.43
C23.1	cut_workers - eggs_workers	1.65	0.33	113	5.03	0.00
C23.1	dufour_queens - dufour_workers	-1.84	0.45	113	-4.10	0.08
C23.1	dufour_queens - eggs_queens	-1.92	0.40	113	-4.75	0.01
C23.1	dufour_queens - eggs_workers	-1.15	0.46	113	-2.50	1.00
C23.1	dufour_workers - eggs_queens	-0.08	0.31	113	-0.25	1.00
C23.1	dufour_workers - eggs_workers	0.69	0.38	113	1.83	1.00
C23.1	eggs_queens - eggs_workers	0.77	0.32	113	2.37	1.00
C25.1	cut_queens - cut_workers	-1.55	0.21	113	-7.44	0.00
C25.1	cut_queens - dufour_queens	1.20	0.27	113	4.54	0.01
C25.1	cut_queens - dufour_workers	-1.22	0.23	113	-5.33	0.00
C25.1	cut_queens - eggs_queens	-0.56	0.21	113	-2.70	1.00
C25.1	cut_queens - eggs_workers	0.19	0.24	113	0.80	1.00
C25.1	cut_workers - dufour_queens	2.75	0.21	113	13.23	0.00
C25.1	cut_workers - dufour_workers	0.32	0.16	113	2.02	1.00
C25.1	cut_workers - eggs_queens	0.99	0.12	113	7.96	0.00
C25.1	cut_workers - eggs_workers	1.74	0.17	113	10.34	0.00
C25.1	dufour_queens - dufour_workers	-2.43	0.23	113	-10.57	0.00
C25.1	dufour_queens - eggs_queens	-1.76	0.21	113	-8.53	0.00
C25.1	dufour_queens - eggs_workers	-1.02	0.24	113	-4.32	0.03
C25.1	dufour_workers - eggs_queens	0.67	0.16	113	4.21	0.05
C25.1	dufour_workers - eggs_workers	1.41	0.19	113	7.27	0.00
C25.1	eggs_queens - eggs_workers	0.75	0.17	113	4.49	0.02
C27.1	cut_queens - cut_workers	-1.46	0.39	113	-3.76	0.27
C27.1	cut_queens - dufour_queens	3.58	0.49	113	7.25	0.00
C27.1	cut_queens - dufour_workers	0.99	0.43	113	2.30	1.00
C27.1	cut_queens - eggs_queens	-0.44	0.38	113	-1.13	1.00
C27.1	cut_queens - eggs_workers	0.21	0.44	113	0.48	1.00
C27.1	cut_workers - dufour_queens	5.04	0.39	113	13.00	0.00
C27.1	cut_workers - dufour_workers	2.44	0.30	113	8.19	0.00
C27.1	cut_workers - eggs_queens	1.02	0.23	113	4.40	0.02
C27.1	cut_workers - eggs_workers	1.67	0.31	113	5.33	0.00
C27.1	dufour_queens - dufour_workers	-2.60	0.43	113	-6.06	0.00
C27.1	dufour_queens - eggs_queens	-4.02	0.38	113	-10.45	0.00
C27.1	dufour_queens - eggs_workers	-3.37	0.44	113	-7.69	0.00
C27.1	dufour_workers - eggs_queens	-1.42	0.29	113	-4.83	0.00
C27.1	dufour_workers - eggs_workers	-0.78	0.36	113	-2.14	1.00
C27.1	eggs_queens - eggs_workers	0.65	0.31	113	2.10	1.00
C29.1	cut_queens - cut_workers	0.00	0.33	113	0.00	1.00
C29.1	cut_queens - dufour_queens	-5.26	0.42	113	-12.49	0.00
C29.1	cut_queens - dufour_workers	-6.22	0.36	113	-17.07	0.00
C29.1	cut_queens - eggs_queens	-8.10	0.33	113	-24.74	0.00
C29.1	cut_queens - eggs_workers	-8.90	0.37	113	-23.84	0.00
C29.1	cut_workers - dufour_queens	-5.26	0.33	113	-15.94	0.00
C29.1	cut_workers - dufour_workers	-6.22	0.25	113	-24.50	0.00
C29.1	cut_workers - eggs_queens	-8.10	0.20	113	-41.07	0.00
C29.1	cut_workers - eggs_workers	-8.90	0.27	113	-33.41	0.00
C29.1	dufour_queens - dufour_workers	-0.97	0.36	113	-2.65	1.00

C29.1	dufour_queens - eggs_queens	-2.84	0.33	113	-8.68	0.00
C29.1	dufour_queens - eggs_workers	-3.64	0.37	113	-9.75	0.00
C29.1	dufour_workers - eggs_queens	-1.88	0.25	113	-7.48	0.00
C29.1	dufour_workers - eggs_workers	-2.67	0.31	113	-8.67	0.00
C29.1	eggs_queens - eggs_workers	-0.79	0.26	113	-3.02	1.00
n.C18	cut_queens - cut_workers	0.00	0.26	113	0.00	1.00
n.C18	cut_queens - dufour_queens	0.00	0.33	113	0.00	1.00
n.C18	cut_queens - dufour_workers	0.00	0.28	113	0.00	1.00
n.C18	cut_queens - eggs_queens	-7.24	0.25	113	-28.38	0.00
n.C18	cut_queens - eggs_workers	-7.63	0.29	113	-26.28	0.00
n.C18	cut_workers - dufour_queens	0.00	0.26	113	0.00	1.00
n.C18	cut_workers - dufour_workers	0.00	0.20	113	0.00	1.00
n.C18	cut_workers - eggs_queens	-7.24	0.15	113	-47.12	0.00
n.C18	cut_workers - eggs_workers	-7.63	0.21	113	-36.83	0.00
n.C18	dufour_queens - dufour_workers	0.00	0.28	113	0.00	1.00
n.C18	dufour_queens - eggs_queens	-7.24	0.25	113	-28.38	0.00
n.C18	dufour_queens - eggs_workers	-7.63	0.29	113	-26.27	0.00
n.C18	dufour_workers - eggs_queens	-7.24	0.20	113	-37.04	0.00
n.C18	dufour_workers - eggs_workers	-7.63	0.24	113	-31.82	0.00
n.C18	eggs_queens - eggs_workers	-0.40	0.20	113	-1.94	1.00
n.C19	cut_queens - cut_workers	0.00	0.18	113	0.00	1.00
n.C19	cut_queens - dufour_queens	0.00	0.23	113	0.00	1.00
n.C19	cut_queens - dufour_workers	0.00	0.20	113	0.00	1.00
n.C19	cut_queens - eggs_queens	-5.89	0.18	113	-33.00	0.00
n.C19	cut_queens - eggs_workers	-5.92	0.20	113	-29.12	0.00
n.C19	cut_workers - dufour_queens	0.00	0.18	113	0.00	1.00
n.C19	cut_workers - dufour_workers	0.00	0.14	113	0.00	1.00
n.C19	cut_workers - eggs_queens	-5.89	0.11	113	-54.79	0.00
n.C19	cut_workers - eggs_workers	-5.92	0.15	113	-40.81	0.00
n.C19	dufour_queens - dufour_workers	0.00	0.20	113	0.00	1.00
n.C19	dufour_queens - eggs_queens	-5.89	0.18	113	-33.00	0.00
n.C19	dufour_queens - eggs_workers	-5.92	0.20	113	-29.11	0.00
n.C19	dufour_workers - eggs_queens	-5.89	0.14	113	-43.07	0.00
n.C19	dufour_workers - eggs_workers	-5.92	0.17	113	-35.26	0.00
n.C19	eggs_queens - eggs_workers	-0.03	0.14	113	-0.22	1.00
n.C20	cut_queens - cut_workers	0.00	0.28	113	0.00	1.00
n.C20	cut_queens - dufour_queens	0.00	0.35	113	0.00	1.00
n.C20	cut_queens - dufour_workers	0.00	0.31	113	0.00	1.00
n.C20	cut_queens - eggs_queens	-10.02	0.28	113	-36.31	0.00
n.C20	cut_queens - eggs_workers	-10.28	0.31	113	-32.69	0.00
n.C20	cut_workers - dufour_queens	0.00	0.28	113	0.00	1.00
n.C20	cut_workers - dufour_workers	0.00	0.21	113	0.00	1.00
n.C20	cut_workers - eggs_queens	-10.02	0.17	113	-60.28	0.00
n.C20	cut_workers - eggs_workers	-10.28	0.22	113	-45.82	0.00
n.C20	dufour_queens - dufour_workers	0.00	0.31	113	0.00	1.00
n.C20	dufour_queens - eggs_queens	-10.02	0.28	113	-36.30	0.00
n.C20	dufour_queens - eggs_workers	-10.27	0.31	113	-32.69	0.00
n.C20	dufour_workers - eggs_queens	-10.02	0.21	113	-47.39	0.00
n.C20	dufour_workers - eggs_workers	-10.27	0.26	113	-39.59	0.00
n.C20	eggs_queens - eggs_workers	-0.26	0.22	113	-1.17	1.00
n.C21	cut_queens - cut_workers	-1.25	0.34	113	-3.71	0.33
n.C21	cut_queens - dufour_queens	-0.97	0.43	113	-2.26	1.00
n.C21	cut_queens - dufour_workers	-1.41	0.37	113	-3.78	0.25

n.C21	cut_queens - eggs_queens	-1.61	0.33	113	-4.82	0.00
n.C21	cut_queens - eggs_workers	-1.94	0.38	113	-5.10	0.00
n.C21	cut_workers - dufour_queens	0.28	0.34	113	0.82	1.00
n.C21	cut_workers - dufour_workers	-0.16	0.26	113	-0.61	1.00
n.C21	cut_workers - eggs_queens	-0.36	0.20	113	-1.80	1.00
n.C21	cut_workers - eggs_workers	-0.70	0.27	113	-2.56	1.00
n.C21	dufour_queens - dufour_workers	-0.44	0.37	113	-1.17	1.00
n.C21	dufour_queens - eggs_queens	-0.64	0.33	113	-1.91	1.00
n.C21	dufour_queens - eggs_workers	-0.97	0.38	113	-2.55	1.00
n.C21	dufour_workers - eggs_queens	-0.20	0.26	113	-0.80	1.00
n.C21	dufour_workers - eggs_workers	-0.54	0.31	113	-1.70	1.00
n.C21	eggs_queens - eggs_workers	-0.33	0.27	113	-1.24	1.00
n.C22	cut_queens - cut_workers	-0.73	0.39	113	-1.86	1.00
n.C22	cut_queens - dufour_queens	-1.20	0.50	113	-2.39	1.00
n.C22	cut_queens - dufour_workers	-2.69	0.43	113	-6.18	0.00
n.C22	cut_queens - eggs_queens	-5.18	0.39	113	-13.27	0.00
n.C22	cut_queens - eggs_workers	-5.57	0.44	113	-12.51	0.00
n.C22	cut_workers - dufour_queens	-0.47	0.39	113	-1.19	1.00
n.C22	cut_workers - dufour_workers	-1.95	0.30	113	-6.46	0.00
n.C22	cut_workers - eggs_queens	-4.45	0.24	113	-18.93	0.00
n.C22	cut_workers - eggs_workers	-4.83	0.32	113	-15.23	0.00
n.C22	dufour_queens - dufour_workers	-1.49	0.43	113	-3.42	0.85
n.C22	dufour_queens - eggs_queens	-3.98	0.39	113	-10.20	0.00
n.C22	dufour_queens - eggs_workers	-4.37	0.44	113	-9.82	0.00
n.C22	dufour_workers - eggs_queens	-2.49	0.30	113	-8.34	0.00
n.C22	dufour_workers - eggs_workers	-2.88	0.37	113	-7.84	0.00
n.C22	eggs_queens - eggs_workers	-0.38	0.31	113	-1.23	1.00
n.C23	cut_queens - cut_workers	0.09	0.20	113	0.45	1.00
n.C23	cut_queens - dufour_queens	-0.28	0.25	113	-1.10	1.00
n.C23	cut_queens - dufour_workers	-0.40	0.22	113	-1.81	1.00
n.C23	cut_queens - eggs_queens	0.04	0.20	113	0.20	1.00
n.C23	cut_queens - eggs_workers	0.14	0.22	113	0.62	1.00
n.C23	cut_workers - dufour_queens	-0.37	0.20	113	-1.85	1.00
n.C23	cut_workers - dufour_workers	-0.49	0.15	113	-3.18	1.00
n.C23	cut_workers - eggs_queens	-0.05	0.12	113	-0.42	1.00
n.C23	cut_workers - eggs_workers	0.05	0.16	113	0.31	1.00
n.C23	dufour_queens - dufour_workers	-0.12	0.22	113	-0.54	1.00
n.C23	dufour_queens - eggs_queens	0.32	0.20	113	1.62	1.00
n.C23	dufour_queens - eggs_workers	0.42	0.22	113	1.86	1.00
n.C23	dufour_workers - eggs_queens	0.44	0.15	113	2.89	1.00
n.C23	dufour_workers - eggs_workers	0.54	0.19	113	2.89	1.00
n.C23	eggs_queens - eggs_workers	0.10	0.16	113	0.63	1.00
n.C24	cut_queens - cut_workers	1.65	0.24	113	6.77	0.00
n.C24	cut_queens - dufour_queens	-0.90	0.31	113	-2.89	1.00
n.C24	cut_queens - dufour_workers	0.50	0.27	113	1.87	1.00
n.C24	cut_queens - eggs_queens	-0.13	0.24	113	-0.56	1.00
n.C24	cut_queens - eggs_workers	-0.20	0.28	113	-0.73	1.00
n.C24	cut_workers - dufour_queens	-2.55	0.24	113	-10.46	0.00
n.C24	cut_workers - dufour_workers	-1.15	0.19	113	-6.12	0.00
n.C24	cut_workers - eggs_queens	-1.78	0.15	113	-12.25	0.00
n.C24	cut_workers - eggs_workers	-1.85	0.20	113	-9.42	0.00
n.C24	dufour_queens - dufour_workers	1.40	0.27	113	5.20	0.00
n.C24	dufour_queens - eggs_queens	0.76	0.24	113	3.16	1.00

n.C24	dufour_queens - eggs_workers	0.70	0.28	113	2.53	1.00
n.C24	dufour_workers - eggs_queens	-0.64	0.19	113	-3.44	0.81
n.C24	dufour_workers - eggs_workers	-0.70	0.23	113	-3.09	1.00
n.C24	eggs_queens - eggs_workers	-0.07	0.19	113	-0.34	1.00
n.C25	cut_queens - cut_workers	1.12	0.15	113	7.46	0.00
n.C25	cut_queens - dufour_queens	0.76	0.19	113	3.96	0.13
n.C25	cut_queens - dufour_workers	0.39	0.17	113	2.35	1.00
n.C25	cut_queens - eggs_queens	0.61	0.15	113	4.10	0.08
n.C25	cut_queens - eggs_workers	0.81	0.17	113	4.77	0.01
n.C25	cut_workers - dufour_queens	-0.36	0.15	113	-2.40	1.00
n.C25	cut_workers - dufour_workers	-0.73	0.12	113	-6.31	0.00
n.C25	cut_workers - eggs_queens	-0.51	0.09	113	-5.67	0.00
n.C25	cut_workers - eggs_workers	-0.31	0.12	113	-2.56	1.00
n.C25	dufour_queens - dufour_workers	-0.37	0.17	113	-2.22	1.00
n.C25	dufour_queens - eggs_queens	-0.15	0.15	113	-1.00	1.00
n.C25	dufour_queens - eggs_workers	0.05	0.17	113	0.30	1.00
n.C25	dufour_workers - eggs_queens	0.22	0.11	113	1.93	1.00
n.C25	dufour_workers - eggs_workers	0.42	0.14	113	2.99	1.00
n.C25	eggs_queens - eggs_workers	0.20	0.12	113	1.66	1.00
n.C26	cut_queens - cut_workers	2.37	0.25	113	9.52	0.00
n.C26	cut_queens - dufour_queens	0.69	0.32	113	2.16	1.00
n.C26	cut_queens - dufour_workers	1.42	0.28	113	5.16	0.00
n.C26	cut_queens - eggs_queens	0.36	0.25	113	1.47	1.00
n.C26	cut_queens - eggs_workers	-0.16	0.28	113	-0.55	1.00
n.C26	cut_workers - dufour_queens	-1.68	0.25	113	-6.76	0.00
n.C26	cut_workers - dufour_workers	-0.95	0.19	113	-4.96	0.00
n.C26	cut_workers - eggs_queens	-2.00	0.15	113	-13.47	0.00
n.C26	cut_workers - eggs_workers	-2.53	0.20	113	-12.57	0.00
n.C26	dufour_queens - dufour_workers	0.73	0.28	113	2.66	1.00
n.C26	dufour_queens - eggs_queens	-0.32	0.25	113	-1.31	1.00
n.C26	dufour_queens - eggs_workers	-0.84	0.28	113	-3.00	1.00
n.C26	dufour_workers - eggs_queens	-1.05	0.19	113	-5.57	0.00
n.C26	dufour_workers - eggs_workers	-1.57	0.23	113	-6.77	0.00
n.C26	eggs_queens - eggs_workers	-0.52	0.20	113	-2.62	1.00
n.C27	cut_queens - cut_workers	1.69	0.27	113	6.22	0.00
n.C27	cut_queens - dufour_queens	-0.15	0.35	113	-0.43	1.00
n.C27	cut_queens - dufour_workers	4.43	0.30	113	14.72	0.00
n.C27	cut_queens - eggs_queens	0.72	0.27	113	2.65	1.00
n.C27	cut_queens - eggs_workers	-0.39	0.31	113	-1.27	1.00
n.C27	cut_workers - dufour_queens	-1.84	0.27	113	-6.77	0.00
n.C27	cut_workers - dufour_workers	2.73	0.21	113	13.04	0.00
n.C27	cut_workers - eggs_queens	-0.98	0.16	113	-6.00	0.00
n.C27	cut_workers - eggs_workers	-2.09	0.22	113	-9.49	0.00
n.C27	dufour_queens - dufour_workers	4.58	0.30	113	15.22	0.00
n.C27	dufour_queens - eggs_queens	0.87	0.27	113	3.21	1.00
n.C27	dufour_queens - eggs_workers	-0.24	0.31	113	-0.78	1.00
n.C27	dufour_workers - eggs_queens	-3.71	0.21	113	-17.92	0.00
n.C27	dufour_workers - eggs_workers	-4.82	0.25	113	-18.95	0.00
n.C27	eggs_queens - eggs_workers	-1.11	0.22	113	-5.10	0.00
n.C28	cut_queens - cut_workers	0.99	0.26	113	3.85	0.20
n.C28	cut_queens - dufour_queens	-0.49	0.33	113	-1.47	1.00
n.C28	cut_queens - dufour_workers	6.77	0.29	113	23.69	0.00
n.C28	cut_queens - eggs_queens	-2.98	0.26	113	-11.61	0.00

n.C28	cut_queens - eggs_workers	-4.14	0.29	113	-14.17	0.00
n.C28	cut_workers - dufour_queens	-1.48	0.26	113	-5.72	0.00
n.C28	cut_workers - dufour_workers	5.78	0.20	113	29.00	0.00
n.C28	cut_workers - eggs_queens	-3.97	0.15	113	-25.70	0.00
n.C28	cut_workers - eggs_workers	-5.14	0.21	113	-24.62	0.00
n.C28	dufour_queens - dufour_workers	7.26	0.29	113	25.39	0.00
n.C28	dufour_queens - eggs_queens	-2.49	0.26	113	-9.71	0.00
n.C28	dufour_queens - eggs_workers	-3.66	0.29	113	-12.51	0.00
n.C28	dufour_workers - eggs_queens	-9.75	0.20	113	-49.58	0.00
n.C28	dufour_workers - eggs_workers	-10.92	0.24	113	-45.19	0.00
n.C28	eggs_queens - eggs_workers	-1.17	0.21	113	-5.65	0.00
n.C29	cut_queens - cut_workers	2.89	0.54	113	5.38	0.00
n.C29	cut_queens - dufour_queens	-0.08	0.68	113	-0.12	1.00
n.C29	cut_queens - dufour_workers	6.57	0.59	113	11.08	0.00
n.C29	cut_queens - eggs_queens	1.27	0.53	113	2.38	1.00
n.C29	cut_queens - eggs_workers	-0.74	0.61	113	-1.23	1.00
n.C29	cut_workers - dufour_queens	-2.97	0.54	113	-5.54	0.00
n.C29	cut_workers - dufour_workers	3.68	0.41	113	8.92	0.00
n.C29	cut_workers - eggs_queens	-1.62	0.32	113	-5.05	0.00
n.C29	cut_workers - eggs_workers	-3.63	0.43	113	-8.39	0.00
n.C29	dufour_queens - dufour_workers	6.65	0.59	113	11.23	0.00
n.C29	dufour_queens - eggs_queens	1.35	0.53	113	2.54	1.00
n.C29	dufour_queens - eggs_workers	-0.66	0.61	113	-1.09	1.00
n.C29	dufour_workers - eggs_queens	-5.30	0.41	113	-13.00	0.00
n.C29	dufour_workers - eggs_workers	-7.31	0.50	113	-14.60	0.00
n.C29	eggs_queens - eggs_workers	-2.01	0.43	113	-4.70	0.01
n.C30	cut_queens - cut_workers	0.00	0.08	113	0.00	1.00
n.C30	cut_queens - dufour_queens	-8.06	0.10	113	-79.03	0.00
n.C30	cut_queens - dufour_workers	0.00	0.09	113	0.00	1.00
n.C30	cut_queens - eggs_queens	0.00	0.08	113	0.00	1.00
n.C30	cut_queens - eggs_workers	0.00	0.09	113	0.00	1.00
n.C30	cut_workers - dufour_queens	-8.06	0.08	113	-100.83	0.00
n.C30	cut_workers - dufour_workers	0.00	0.06	113	0.00	1.00
n.C30	cut_workers - eggs_queens	0.00	0.05	113	0.00	1.00
n.C30	cut_workers - eggs_workers	0.00	0.06	113	0.00	1.00
n.C30	dufour_queens - dufour_workers	8.06	0.09	113	91.25	0.00
n.C30	dufour_queens - eggs_queens	8.06	0.08	113	101.58	0.00
n.C30	dufour_queens - eggs_workers	8.06	0.09	113	89.15	0.00
n.C30	dufour_workers - eggs_queens	0.00	0.06	113	0.00	1.00
n.C30	dufour_workers - eggs_workers	0.00	0.07	113	0.00	1.00
n.C30	eggs_queens - eggs_workers	0.00	0.06	113	0.00	1.00
n.C31	cut_queens - cut_workers	0.00	0.10	113	0.00	1.00
n.C31	cut_queens - dufour_queens	-9.48	0.12	113	-78.16	0.00
n.C31	cut_queens - dufour_workers	0.00	0.11	113	0.00	1.00
n.C31	cut_queens - eggs_queens	0.00	0.09	113	0.00	1.00
n.C31	cut_queens - eggs_workers	0.00	0.11	113	0.00	1.00
n.C31	cut_workers - dufour_queens	-9.48	0.10	113	-99.73	0.00
n.C31	cut_workers - dufour_workers	0.00	0.07	113	0.00	1.00
n.C31	cut_workers - eggs_queens	0.00	0.06	113	0.00	1.00
n.C31	cut_workers - eggs_workers	0.00	0.08	113	0.00	1.00
n.C31	dufour_queens - dufour_workers	9.48	0.11	113	90.26	0.00
n.C31	dufour_queens - eggs_queens	9.48	0.09	113	100.47	0.00
n.C31	dufour_queens - eggs_workers	9.48	0.11	113	88.18	0.00

n.C31	dufour_workers - eggs_queens	0.00	0.07	113	0.00	1.00
n.C31	dufour_workers - eggs_workers	0.00	0.09	113	0.00	1.00
n.C31	eggs_queens - eggs_workers	0.00	0.08	113	0.00	1.00
n.C32	cut_queens - cut_workers	0.00	0.07	113	0.00	1.00
n.C32	cut_queens - dufour_queens	-6.40	0.09	113	-67.99	0.00
n.C32	cut_queens - dufour_workers	0.00	0.08	113	0.00	1.00
n.C32	cut_queens - eggs_queens	0.00	0.07	113	0.00	1.00
n.C32	cut_queens - eggs_workers	0.00	0.08	113	0.00	1.00
n.C32	cut_workers - dufour_queens	-6.40	0.07	113	-86.75	0.00
n.C32	cut_workers - dufour_workers	0.00	0.06	113	0.00	1.00
n.C32	cut_workers - eggs_queens	0.00	0.04	113	0.00	1.00
n.C32	cut_workers - eggs_workers	0.00	0.06	113	0.00	1.00
n.C32	dufour_queens - dufour_workers	6.40	0.08	113	78.51	0.00
n.C32	dufour_queens - eggs_queens	6.40	0.07	113	87.39	0.00
n.C32	dufour_queens - eggs_workers	6.40	0.08	113	76.70	0.00
n.C32	dufour_workers - eggs_queens	0.00	0.06	113	0.00	1.00
n.C32	dufour_workers - eggs_workers	0.00	0.07	113	0.00	1.00
n.C32	eggs_queens - eggs_workers	0.00	0.06	113	0.00	1.00
n.C33	cut_queens - cut_workers	0.00	0.10	113	0.00	1.00
n.C33	cut_queens - dufour_queens	-6.97	0.13	113	-54.24	0.00
n.C33	cut_queens - dufour_workers	0.00	0.11	113	0.00	1.00
n.C33	cut_queens - eggs_queens	0.00	0.10	113	0.00	1.00
n.C33	cut_queens - eggs_workers	0.00	0.11	113	0.00	1.00
n.C33	cut_workers - dufour_queens	-6.97	0.10	113	-69.21	0.00
n.C33	cut_workers - dufour_workers	0.00	0.08	113	0.00	1.00
n.C33	cut_workers - eggs_queens	0.00	0.06	113	0.00	1.00
n.C33	cut_workers - eggs_workers	0.00	0.08	113	0.00	1.00
n.C33	dufour_queens - dufour_workers	6.97	0.11	113	62.63	0.00
n.C33	dufour_queens - eggs_queens	6.97	0.10	113	69.72	0.00
n.C33	dufour_queens - eggs_workers	6.97	0.11	113	61.19	0.00
n.C33	dufour_workers - eggs_queens	0.00	0.08	113	0.00	1.00
n.C33	dufour_workers - eggs_workers	0.00	0.09	113	0.00	1.00
n.C33	eggs_queens - eggs_workers	0.00	0.08	113	0.00	1.00
n.C35	cut_queens - cut_workers	0.00	0.08	113	0.00	1.00
n.C35	cut_queens - dufour_queens	-5.93	0.10	113	-60.09	0.00
n.C35	cut_queens - dufour_workers	0.00	0.09	113	0.00	1.00
n.C35	cut_queens - eggs_queens	0.00	0.08	113	0.00	1.00
n.C35	cut_queens - eggs_workers	0.00	0.09	113	0.00	1.00
n.C35	cut_workers - dufour_queens	-5.93	0.08	113	-76.67	0.00
n.C35	cut_workers - dufour_workers	0.00	0.06	113	0.00	1.00
n.C35	cut_workers - eggs_queens	0.00	0.05	113	0.00	1.00
n.C35	cut_workers - eggs_workers	0.00	0.06	113	0.00	1.00
n.C35	dufour_queens - dufour_workers	5.93	0.09	113	69.38	0.00
n.C35	dufour_queens - eggs_queens	5.93	0.08	113	77.24	0.00
n.C35	dufour_queens - eggs_workers	5.93	0.09	113	67.79	0.00
n.C35	dufour_workers - eggs_queens	0.00	0.06	113	0.00	1.00
n.C35	dufour_workers - eggs_workers	0.00	0.07	113	0.00	1.00
n.C35	eggs_queens - eggs_workers	0.00	0.06	113	0.00	1.00
unknown	cut_queens - cut_workers	0.00	0.25	113	0.00	1.00
unknown	cut_queens - dufour_queens	0.00	0.31	113	0.00	1.00
unknown	cut_queens - dufour_workers	0.00	0.27	113	0.00	1.00
unknown	cut_queens - eggs_queens	-8.20	0.24	113	-33.51	0.00
unknown	cut_queens - eggs_workers	-8.40	0.28	113	-30.11	0.00

unknown	cut_workers - dufour_queens	0.00	0.25	113	0.00	1.00
unknown	cut_workers - dufour_workers	0.00	0.19	113	0.00	1.00
unknown	cut_workers - eggs_queens	-8.20	0.15	113	-55.64	0.00
unknown	cut_workers - eggs_workers	-8.40	0.20	113	-42.19	0.00
unknown	dufour_queens - dufour_workers	0.00	0.27	113	0.00	1.00
unknown	dufour_queens - eggs_queens	-8.20	0.24	113	-33.51	0.00
unknown	dufour_queens - eggs_workers	-8.40	0.28	113	-30.10	0.00
unknown	dufour_workers - eggs_queens	-8.20	0.19	113	-43.74	0.00
unknown	dufour_workers - eggs_workers	-8.40	0.23	113	-36.46	0.00
unknown	eggs_queens - eggs_workers	-0.19	0.20	113	-0.99	1.00
unknown.1	cut_queens - cut_workers	-0.57	0.12	113	-4.63	0.01
unknown.1	cut_queens - dufour_queens	6.25	0.16	113	39.82	0.00
unknown.1	cut_queens - dufour_workers	6.25	0.14	113	45.98	0.00
unknown.1	cut_queens - eggs_queens	6.25	0.12	113	51.18	0.00
unknown.1	cut_queens - eggs_workers	6.25	0.14	113	44.92	0.00
unknown.1	cut_workers - dufour_queens	6.82	0.12	113	55.43	0.00
unknown.1	cut_workers - dufour_workers	6.82	0.09	113	71.98	0.00
unknown.1	cut_workers - eggs_queens	6.82	0.07	113	92.72	0.00
unknown.1	cut_workers - eggs_workers	6.82	0.10	113	68.69	0.00
unknown.1	dufour_queens - dufour_workers	0.00	0.14	113	0.00	1.00
unknown.1	dufour_queens - eggs_queens	0.00	0.12	113	0.01	1.00
unknown.1	dufour_queens - eggs_workers	0.00	0.14	113	0.01	1.00
unknown.1	dufour_workers - eggs_queens	0.00	0.09	113	0.00	1.00
unknown.1	dufour_workers - eggs_workers	0.00	0.11	113	0.00	1.00
unknown.1	eggs_queens - eggs_workers	0.00	0.10	113	0.00	1.00
unknown.2	cut_queens - cut_workers	1.52	0.19	113	7.97	0.00
unknown.2	cut_queens - dufour_queens	5.55	0.24	113	22.88	0.00
unknown.2	cut_queens - dufour_workers	5.55	0.21	113	26.43	0.00
unknown.2	cut_queens - eggs_queens	5.55	0.19	113	29.42	0.00
unknown.2	cut_queens - eggs_workers	5.55	0.21	113	25.82	0.00
unknown.2	cut_workers - dufour_queens	4.03	0.19	113	21.23	0.00
unknown.2	cut_workers - dufour_workers	4.04	0.15	113	27.57	0.00
unknown.2	cut_workers - eggs_queens	4.04	0.11	113	35.51	0.00
unknown.2	cut_workers - eggs_workers	4.04	0.15	113	26.31	0.00
unknown.2	dufour_queens - dufour_workers	0.00	0.21	113	0.00	1.00
unknown.2	dufour_queens - eggs_queens	0.00	0.19	113	0.00	1.00
unknown.2	dufour_queens - eggs_workers	0.00	0.21	113	0.00	1.00
unknown.2	dufour_workers - eggs_queens	0.00	0.14	113	0.00	1.00
unknown.2	dufour_workers - eggs_workers	0.00	0.18	113	0.00	1.00
unknown.2	eggs_queens - eggs_workers	0.00	0.15	113	0.00	1.00
unknown.3	cut_queens - cut_workers	4.74	0.28	113	16.66	0.00
unknown.3	cut_queens - dufour_queens	8.29	0.36	113	22.82	0.00
unknown.3	cut_queens - dufour_workers	8.29	0.31	113	26.35	0.00
unknown.3	cut_queens - eggs_queens	8.29	0.28	113	29.34	0.00
unknown.3	cut_queens - eggs_workers	8.29	0.32	113	25.75	0.00
unknown.3	cut_workers - dufour_queens	3.55	0.28	113	12.45	0.00
unknown.3	cut_workers - dufour_workers	3.55	0.22	113	16.17	0.00
unknown.3	cut_workers - eggs_queens	3.55	0.17	113	20.83	0.00
unknown.3	cut_workers - eggs_workers	3.55	0.23	113	15.44	0.00
unknown.3	dufour_queens - dufour_workers	0.00	0.31	113	0.00	1.00
unknown.3	dufour_queens - eggs_queens	0.00	0.28	113	0.00	1.00
unknown.3	dufour_queens - eggs_workers	0.00	0.32	113	0.00	1.00
unknown.3	dufour_workers - eggs_queens	0.00	0.22	113	0.00	1.00

unknown.3	dufour_workers - eggs_workers	0.00	0.27	113	0.00	1.00
unknown.3	eggs_queens - eggs_workers	0.00	0.23	113	0.00	1.00
unknown.4	cut_queens - cut_workers	3.93	0.29	113	13.34	0.00
unknown.4	cut_queens - dufour_queens	8.39	0.38	113	22.30	0.00
unknown.4	cut_queens - dufour_workers	8.39	0.33	113	25.75	0.00
unknown.4	cut_queens - eggs_queens	8.39	0.29	113	28.67	0.00
unknown.4	cut_queens - eggs_workers	8.39	0.33	113	25.16	0.00
unknown.4	cut_workers - dufour_queens	4.46	0.29	113	15.12	0.00
unknown.4	cut_workers - dufour_workers	4.46	0.23	113	19.64	0.00
unknown.4	cut_workers - eggs_queens	4.46	0.18	113	25.30	0.00
unknown.4	cut_workers - eggs_workers	4.46	0.24	113	18.74	0.00
unknown.4	dufour_queens - dufour_workers	0.00	0.33	113	0.00	1.00
unknown.4	dufour_queens - eggs_queens	0.00	0.29	113	0.00	1.00
unknown.4	dufour_queens - eggs_workers	0.00	0.33	113	0.00	1.00
unknown.4	dufour_workers - eggs_queens	0.00	0.22	113	0.00	1.00
unknown.4	dufour_workers - eggs_workers	0.00	0.28	113	0.00	1.00
unknown.4	eggs_queens - eggs_workers	0.00	0.24	113	0.00	1.00
10.MeC24	cut_queens - cut_workers	0.00	0.24	113	0.00	1.00
10.MeC24	cut_queens - dufour_queens	0.00	0.30	113	0.00	1.00
10.MeC24	cut_queens - dufour_workers	0.00	0.26	113	0.00	1.00
10.MeC24	cut_queens - eggs_queens	-6.28	0.23	113	-26.82	0.00
10.MeC24	cut_queens - eggs_workers	-6.49	0.27	113	-24.30	0.00
10.MeC24	cut_workers - dufour_queens	0.00	0.24	113	0.00	1.00
10.MeC24	cut_workers - dufour_workers	0.00	0.18	113	0.00	1.00
10.MeC24	cut_workers - eggs_queens	-6.28	0.14	113	-44.53	0.00
10.MeC24	cut_workers - eggs_workers	-6.49	0.19	113	-34.06	0.00
10.MeC24	dufour_queens - dufour_workers	0.00	0.26	113	0.00	1.00
10.MeC24	dufour_queens - eggs_queens	-6.28	0.23	113	-26.82	0.00
10.MeC24	dufour_queens - eggs_workers	-6.49	0.27	113	-24.30	0.00
10.MeC24	dufour_workers - eggs_queens	-6.28	0.18	113	-35.01	0.00
10.MeC24	dufour_workers - eggs_workers	-6.49	0.22	113	-29.43	0.00
10.MeC24	eggs_queens - eggs_workers	-0.20	0.19	113	-1.08	1.00
11..9.MeC23	cut_queens - cut_workers	0.00	0.24	113	0.00	1.00
11..9.MeC23	cut_queens - dufour_queens	-7.26	0.31	113	-23.39	0.00
11..9.MeC23	cut_queens - dufour_workers	-5.54	0.27	113	-20.61	0.00
11..9.MeC23	cut_queens - eggs_queens	-5.14	0.24	113	-21.30	0.00
11..9.MeC23	cut_queens - eggs_workers	-5.84	0.28	113	-21.24	0.00
11..9.MeC23	cut_workers - dufour_queens	-7.26	0.24	113	-29.85	0.00
11..9.MeC23	cut_workers - dufour_workers	-5.54	0.19	113	-29.57	0.00
11..9.MeC23	cut_workers - eggs_queens	-5.14	0.15	113	-35.37	0.00
11..9.MeC23	cut_workers - eggs_workers	-5.84	0.20	113	-29.76	0.00
11..9.MeC23	dufour_queens - dufour_workers	1.72	0.27	113	6.40	0.00
11..9.MeC23	dufour_queens - eggs_queens	2.12	0.24	113	8.77	0.00
11..9.MeC23	dufour_queens - eggs_workers	1.42	0.28	113	5.15	0.00
11..9.MeC23	dufour_workers - eggs_queens	0.40	0.19	113	2.14	1.00
11..9.MeC23	dufour_workers - eggs_workers	-0.30	0.23	113	-1.33	1.00
11..9.MeC23	eggs_queens - eggs_workers	-0.70	0.19	113	-3.60	0.47
11.13...11.15.diMeC27	cut_queens - cut_workers	0.00	0.33	113	0.00	1.00
11.13...11.15.diMeC27	cut_queens - dufour_queens	0.00	0.42	113	0.00	1.00
11.13...11.15.diMeC27	cut_queens - dufour_workers	-6.94	0.36	113	-19.20	0.00
11.13...11.15.diMeC27	cut_queens - eggs_queens	-6.53	0.32	113	-20.13	0.00
11.13...11.15.diMeC27	cut_queens - eggs_workers	-7.01	0.37	113	-18.95	0.00
11.13...11.15.diMeC27	cut_workers - dufour_queens	0.00	0.33	113	0.00	1.00

11.13...11.15.diMeC27	cut_workers - dufour_workers	-6.94	0.25	113	-27.55	0.00
11.13...11.15.diMeC27	cut_workers - eggs_queens	-6.53	0.20	113	-33.42	0.00
11.13...11.15.diMeC27	cut_workers - eggs_workers	-7.01	0.26	113	-26.55	0.00
11.13...11.15.diMeC27	dufour_queens - dufour_workers	-6.94	0.36	113	-19.20	0.00
11.13...11.15.diMeC27	dufour_queens - eggs_queens	-6.53	0.32	113	-20.12	0.00
11.13...11.15.diMeC27	dufour_queens - eggs_workers	-7.01	0.37	113	-18.94	0.00
11.13...11.15.diMeC27	dufour_workers - eggs_queens	0.41	0.25	113	1.63	1.00
11.13...11.15.diMeC27	dufour_workers - eggs_workers	-0.07	0.31	113	-0.22	1.00
11.13...11.15.diMeC27	eggs_queens - eggs_workers	-0.47	0.26	113	-1.82	1.00
11.15.diMeC27	cut_queens - cut_workers	0.00	0.11	113	0.00	1.00
11.15.diMeC27	cut_queens - dufour_queens	-6.54	0.15	113	-44.61	0.00
11.15.diMeC27	cut_queens - dufour_workers	0.00	0.13	113	0.00	1.00
11.15.diMeC27	cut_queens - eggs_queens	0.00	0.11	113	0.00	1.00
11.15.diMeC27	cut_queens - eggs_workers	0.00	0.13	113	0.00	1.00
11.15.diMeC27	cut_workers - dufour_queens	-6.54	0.11	113	-56.92	0.00
11.15.diMeC27	cut_workers - dufour_workers	0.00	0.09	113	0.00	1.00
11.15.diMeC27	cut_workers - eggs_queens	0.00	0.07	113	0.00	1.00
11.15.diMeC27	cut_workers - eggs_workers	0.00	0.09	113	0.00	1.00
11.15.diMeC27	dufour_queens - dufour_workers	6.54	0.13	113	51.51	0.00
11.15.diMeC27	dufour_queens - eggs_queens	6.54	0.11	113	57.34	0.00
11.15.diMeC27	dufour_queens - eggs_workers	6.54	0.13	113	50.33	0.00
11.15.diMeC27	dufour_workers - eggs_queens	0.00	0.09	113	0.00	1.00
11.15.diMeC27	dufour_workers - eggs_workers	0.00	0.11	113	0.00	1.00
11.15.diMeC27	eggs_queens - eggs_workers	0.00	0.09	113	0.00	1.00
11.17.diMeC29	cut_queens - cut_workers	1.20	0.30	113	4.06	0.09
11.17.diMeC29	cut_queens - dufour_queens	7.36	0.38	113	19.52	0.00
11.17.diMeC29	cut_queens - dufour_workers	7.37	0.33	113	22.54	0.00
11.17.diMeC29	cut_queens - eggs_queens	7.37	0.29	113	25.09	0.00
11.17.diMeC29	cut_queens - eggs_workers	7.37	0.33	113	22.02	0.00
11.17.diMeC29	cut_workers - dufour_queens	6.16	0.30	113	20.84	0.00
11.17.diMeC29	cut_workers - dufour_workers	6.17	0.23	113	27.07	0.00
11.17.diMeC29	cut_workers - eggs_queens	6.17	0.18	113	34.87	0.00
11.17.diMeC29	cut_workers - eggs_workers	6.17	0.24	113	25.83	0.00
11.17.diMeC29	dufour_queens - dufour_workers	0.00	0.33	113	0.00	1.00
11.17.diMeC29	dufour_queens - eggs_queens	0.00	0.29	113	0.00	1.00
11.17.diMeC29	dufour_queens - eggs_workers	0.00	0.33	113	0.00	1.00
11.17.diMeC29	dufour_workers - eggs_queens	0.00	0.22	113	0.00	1.00
11.17.diMeC29	dufour_workers - eggs_workers	0.00	0.28	113	0.00	1.00
11.17.diMeC29	eggs_queens - eggs_workers	0.00	0.24	113	0.00	1.00
12..11..10.MeC24	cut_queens - cut_workers	0.00	0.10	113	0.00	1.00
12..11..10.MeC24	cut_queens - dufour_queens	-5.05	0.13	113	-38.51	0.00
12..11..10.MeC24	cut_queens - dufour_workers	0.00	0.11	113	0.00	1.00
12..11..10.MeC24	cut_queens - eggs_queens	0.00	0.10	113	0.00	1.00
12..11..10.MeC24	cut_queens - eggs_workers	0.00	0.12	113	0.00	1.00
12..11..10.MeC24	cut_workers - dufour_queens	-5.05	0.10	113	-49.14	0.00
12..11..10.MeC24	cut_workers - dufour_workers	0.00	0.08	113	0.00	1.00
12..11..10.MeC24	cut_workers - eggs_queens	0.00	0.06	113	0.00	1.00
12..11..10.MeC24	cut_workers - eggs_workers	0.00	0.08	113	0.00	1.00
12..11..10.MeC24	dufour_queens - dufour_workers	5.05	0.11	113	44.47	0.00
12..11..10.MeC24	dufour_queens - eggs_queens	5.05	0.10	113	49.50	0.00
12..11..10.MeC24	dufour_queens - eggs_workers	5.05	0.12	113	43.45	0.00
12..11..10.MeC24	dufour_workers - eggs_queens	0.00	0.08	113	0.00	1.00
12..11..10.MeC24	dufour_workers - eggs_workers	0.00	0.10	113	0.00	1.00

12..11..10.MeC24	eggs_queens - eggs_workers	0.00	0.08	113	0.00	1.00
13...12...11...10.MeC26	cut_queens - cut_workers	1.77	0.31	113	5.68	0.00
13...12...11...10.MeC26	cut_queens - dufour_queens	-0.43	0.40	113	-1.08	1.00
13...12...11...10.MeC26	cut_queens - dufour_workers	7.20	0.34	113	20.95	0.00
13...12...11...10.MeC26	cut_queens - eggs_queens	-0.73	0.31	113	-2.38	1.00
13...12...11...10.MeC26	cut_queens - eggs_workers	-1.09	0.35	113	-3.10	1.00
13...12...11...10.MeC26	cut_workers - dufour_queens	-2.20	0.31	113	-7.06	0.00
13...12...11...10.MeC26	cut_workers - dufour_workers	5.43	0.24	113	22.68	0.00
13...12...11...10.MeC26	cut_workers - eggs_queens	-2.50	0.19	113	-13.45	0.00
13...12...11...10.MeC26	cut_workers - eggs_workers	-2.86	0.25	113	-11.39	0.00
13...12...11...10.MeC26	dufour_queens - dufour_workers	7.63	0.34	113	22.20	0.00
13...12...11...10.MeC26	dufour_queens - eggs_queens	-0.31	0.31	113	-0.99	1.00
13...12...11...10.MeC26	dufour_queens - eggs_workers	-0.66	0.35	113	-1.88	1.00
13...12...11...10.MeC26	dufour_workers - eggs_queens	-7.94	0.24	113	-33.54	0.00
13...12...11...10.MeC26	dufour_workers - eggs_workers	-8.29	0.29	113	-28.55	0.00
13...12...11...10.MeC26	eggs_queens - eggs_workers	-0.36	0.25	113	-1.44	1.00
13..11..9.MeC25	cut_queens - cut_workers	1.10	0.33	113	3.32	1.00
13..11..9.MeC25	cut_queens - dufour_queens	1.60	0.42	113	3.77	0.26
13..11..9.MeC25	cut_queens - dufour_workers	-1.56	0.37	113	-4.24	0.04
13..11..9.MeC25	cut_queens - eggs_queens	-0.05	0.33	113	-0.15	1.00
13..11..9.MeC25	cut_queens - eggs_workers	-0.06	0.38	113	-0.16	1.00
13..11..9.MeC25	cut_workers - dufour_queens	0.50	0.33	113	1.50	1.00
13..11..9.MeC25	cut_workers - dufour_workers	-2.66	0.26	113	-10.40	0.00
13..11..9.MeC25	cut_workers - eggs_queens	-1.15	0.20	113	-5.80	0.00
13..11..9.MeC25	cut_workers - eggs_workers	-1.16	0.27	113	-4.33	0.03
13..11..9.MeC25	dufour_queens - dufour_workers	-3.16	0.37	113	-8.60	0.00
13..11..9.MeC25	dufour_queens - eggs_queens	-1.65	0.33	113	-5.00	0.00
13..11..9.MeC25	dufour_queens - eggs_workers	-1.66	0.38	113	-4.41	0.02
13..11..9.MeC25	dufour_workers - eggs_queens	1.51	0.25	113	5.97	0.00
13..11..9.MeC25	dufour_workers - eggs_workers	1.50	0.31	113	4.83	0.00
13..11..9.MeC25	eggs_queens - eggs_workers	-0.01	0.26	113	-0.03	1.00
13..11.MeC27	cut_queens - cut_workers	4.00	0.39	113	10.13	0.00
13..11.MeC27	cut_queens - dufour_queens	-0.68	0.50	113	-1.36	1.00
13..11.MeC27	cut_queens - dufour_workers	-1.44	0.44	113	-3.30	1.00
13..11.MeC27	cut_queens - eggs_queens	-0.35	0.39	113	-0.90	1.00
13..11.MeC27	cut_queens - eggs_workers	-0.75	0.45	113	-1.67	1.00
13..11.MeC27	cut_workers - dufour_queens	-4.68	0.39	113	-11.86	0.00
13..11.MeC27	cut_workers - dufour_workers	-5.44	0.30	113	-17.89	0.00
13..11.MeC27	cut_workers - eggs_queens	-4.35	0.24	113	-18.44	0.00
13..11.MeC27	cut_workers - eggs_workers	-4.74	0.32	113	-14.90	0.00
13..11.MeC27	dufour_queens - dufour_workers	-0.76	0.44	113	-1.73	1.00
13..11.MeC27	dufour_queens - eggs_queens	0.33	0.39	113	0.84	1.00
13..11.MeC27	dufour_queens - eggs_workers	-0.06	0.45	113	-0.14	1.00
13..11.MeC27	dufour_workers - eggs_queens	1.09	0.30	113	3.62	0.44
13..11.MeC27	dufour_workers - eggs_workers	0.69	0.37	113	1.88	1.00
13..11.MeC27	eggs_queens - eggs_workers	-0.39	0.31	113	-1.25	1.00
13.17.diMeC29	cut_queens - cut_workers	-0.98	0.55	113	-1.80	1.00
13.17.diMeC29	cut_queens - dufour_queens	-5.93	0.70	113	-8.48	0.00
13.17.diMeC29	cut_queens - dufour_workers	2.70	0.61	113	4.46	0.02
13.17.diMeC29	cut_queens - eggs_queens	2.70	0.54	113	4.96	0.00
13.17.diMeC29	cut_queens - eggs_workers	2.70	0.62	113	4.36	0.03
13.17.diMeC29	cut_workers - dufour_queens	-4.94	0.55	113	-9.02	0.00
13.17.diMeC29	cut_workers - dufour_workers	3.69	0.42	113	8.73	0.00

13.17.diMeC29	cut_workers - eggs_queens	3.69	0.33	113	11.24	0.00
13.17.diMeC29	cut_workers - eggs_workers	3.69	0.44	113	8.33	0.00
13.17.diMeC29	dufour_queens - dufour_workers	8.63	0.61	113	14.24	0.00
13.17.diMeC29	dufour_queens - eggs_queens	8.63	0.54	113	15.86	0.00
13.17.diMeC29	dufour_queens - eggs_workers	8.63	0.62	113	13.92	0.00
13.17.diMeC29	dufour_workers - eggs_queens	0.00	0.42	113	0.00	1.00
13.17.diMeC29	dufour_workers - eggs_workers	0.00	0.51	113	0.00	1.00
13.17.diMeC29	eggs_queens - eggs_workers	0.00	0.44	113	0.00	1.00
13.17.diMeC31	cut_queens - cut_workers	0.00	0.15	113	0.00	1.00
13.17.diMeC31	cut_queens - dufour_queens	-8.17	0.19	113	-42.66	0.00
13.17.diMeC31	cut_queens - dufour_workers	0.00	0.17	113	0.00	1.00
13.17.diMeC31	cut_queens - eggs_queens	0.00	0.15	113	0.00	1.00
13.17.diMeC31	cut_queens - eggs_workers	0.00	0.17	113	0.00	1.00
13.17.diMeC31	cut_workers - dufour_queens	-8.17	0.15	113	-54.43	0.00
13.17.diMeC31	cut_workers - dufour_workers	0.00	0.12	113	0.00	1.00
13.17.diMeC31	cut_workers - eggs_queens	0.00	0.09	113	0.00	1.00
13.17.diMeC31	cut_workers - eggs_workers	0.00	0.12	113	0.00	1.00
13.17.diMeC31	dufour_queens - dufour_workers	8.17	0.17	113	49.26	0.00
13.17.diMeC31	dufour_queens - eggs_queens	8.17	0.15	113	54.84	0.00
13.17.diMeC31	dufour_queens - eggs_workers	8.17	0.17	113	48.13	0.00
13.17.diMeC31	dufour_workers - eggs_queens	0.00	0.11	113	0.00	1.00
13.17.diMeC31	dufour_workers - eggs_workers	0.00	0.14	113	0.00	1.00
13.17.diMeC31	eggs_queens - eggs_workers	0.00	0.12	113	0.00	1.00
13.17.diMeC33	cut_queens - cut_workers	0.00	0.19	113	0.00	1.00
13.17.diMeC33	cut_queens - dufour_queens	-6.73	0.24	113	-27.53	0.00
13.17.diMeC33	cut_queens - dufour_workers	0.00	0.21	113	0.00	1.00
13.17.diMeC33	cut_queens - eggs_queens	0.00	0.19	113	0.00	1.00
13.17.diMeC33	cut_queens - eggs_workers	0.00	0.22	113	0.00	1.00
13.17.diMeC33	cut_workers - dufour_queens	-6.73	0.19	113	-35.13	0.00
13.17.diMeC33	cut_workers - dufour_workers	0.00	0.15	113	0.00	1.00
13.17.diMeC33	cut_workers - eggs_queens	0.00	0.11	113	0.00	1.00
13.17.diMeC33	cut_workers - eggs_workers	0.00	0.15	113	0.00	1.00
13.17.diMeC33	dufour_queens - dufour_workers	6.73	0.21	113	31.79	0.00
13.17.diMeC33	dufour_queens - eggs_queens	6.73	0.19	113	35.39	0.00
13.17.diMeC33	dufour_queens - eggs_workers	6.73	0.22	113	31.06	0.00
13.17.diMeC33	dufour_workers - eggs_queens	0.00	0.15	113	0.00	1.00
13.17.diMeC33	dufour_workers - eggs_workers	0.00	0.18	113	0.00	1.00
13.17.diMeC33	eggs_queens - eggs_workers	0.00	0.15	113	0.00	1.00
14..12.MeC30	cut_queens - cut_workers	0.00	0.14	113	0.00	1.00
14..12.MeC30	cut_queens - dufour_queens	-7.15	0.17	113	-41.36	0.00
14..12.MeC30	cut_queens - dufour_workers	0.00	0.15	113	0.00	1.00
14..12.MeC30	cut_queens - eggs_queens	0.00	0.13	113	0.00	1.00
14..12.MeC30	cut_queens - eggs_workers	0.00	0.15	113	0.00	1.00
14..12.MeC30	cut_workers - dufour_queens	-7.15	0.14	113	-52.77	0.00
14..12.MeC30	cut_workers - dufour_workers	0.00	0.10	113	0.00	1.00
14..12.MeC30	cut_workers - eggs_queens	0.00	0.08	113	0.00	1.00
14..12.MeC30	cut_workers - eggs_workers	0.00	0.11	113	0.00	1.00
14..12.MeC30	dufour_queens - dufour_workers	7.15	0.15	113	47.76	0.00
14..12.MeC30	dufour_queens - eggs_queens	7.15	0.13	113	53.16	0.00
14..12.MeC30	dufour_queens - eggs_workers	7.15	0.15	113	46.66	0.00
14..12.MeC30	dufour_workers - eggs_queens	0.00	0.10	113	0.00	1.00
14..12.MeC30	dufour_workers - eggs_workers	0.00	0.13	113	0.00	1.00
14..12.MeC30	eggs_queens - eggs_workers	0.00	0.11	113	0.00	1.00

14..13..12..11.MeC28	cut_queens - cut_workers	0.00	0.12	113	0.00	1.00
14..13..12..11.MeC28	cut_queens - dufour_queens	-7.34	0.15	113	-49.56	0.00
14..13..12..11.MeC28	cut_queens - dufour_workers	0.00	0.13	113	0.00	1.00
14..13..12..11.MeC28	cut_queens - eggs_queens	0.00	0.12	113	0.00	1.00
14..13..12..11.MeC28	cut_queens - eggs_workers	0.00	0.13	113	0.00	1.00
14..13..12..11.MeC28	cut_workers - dufour_queens	-7.34	0.12	113	-63.23	0.00
14..13..12..11.MeC28	cut_workers - dufour_workers	0.00	0.09	113	0.00	1.00
14..13..12..11.MeC28	cut_workers - eggs_queens	0.00	0.07	113	0.00	1.00
14..13..12..11.MeC28	cut_workers - eggs_workers	0.00	0.09	113	0.00	1.00
14..13..12..11.MeC28	dufour_queens - dufour_workers	7.34	0.13	113	57.23	0.00
14..13..12..11.MeC28	dufour_queens - eggs_queens	7.34	0.12	113	63.70	0.00
14..13..12..11.MeC28	dufour_queens - eggs_workers	7.34	0.13	113	55.91	0.00
14..13..12..11.MeC28	dufour_workers - eggs_queens	0.00	0.09	113	0.00	1.00
14..13..12..11.MeC28	dufour_workers - eggs_workers	0.00	0.11	113	0.00	1.00
14..13..12..11.MeC28	eggs_queens - eggs_workers	0.00	0.09	113	0.00	1.00
15..13..11..7.MeC31	cut_queens - cut_workers	0.00	0.24	113	0.00	1.00
15..13..11..7.MeC31	cut_queens - dufour_queens	-9.53	0.31	113	-30.83	0.00
15..13..11..7.MeC31	cut_queens - dufour_workers	-5.09	0.27	113	-19.02	0.00
15..13..11..7.MeC31	cut_queens - eggs_queens	0.00	0.24	113	0.00	1.00
15..13..11..7.MeC31	cut_queens - eggs_workers	0.00	0.27	113	0.00	1.00
15..13..11..7.MeC31	cut_workers - dufour_queens	-9.53	0.24	113	-39.34	0.00
15..13..11..7.MeC31	cut_workers - dufour_workers	-5.09	0.19	113	-27.29	0.00
15..13..11..7.MeC31	cut_workers - eggs_queens	0.00	0.14	113	0.00	1.00
15..13..11..7.MeC31	cut_workers - eggs_workers	0.00	0.20	113	0.00	1.00
15..13..11..7.MeC31	dufour_queens - dufour_workers	4.44	0.27	113	16.58	0.00
15..13..11..7.MeC31	dufour_queens - eggs_queens	9.53	0.24	113	39.63	0.00
15..13..11..7.MeC31	dufour_queens - eggs_workers	9.53	0.27	113	34.78	0.00
15..13..11..7.MeC31	dufour_workers - eggs_queens	5.09	0.18	113	27.64	0.00
15..13..11..7.MeC31	dufour_workers - eggs_workers	5.09	0.23	113	22.51	0.00
15..13..11..7.MeC31	eggs_queens - eggs_workers	0.00	0.19	113	0.00	1.00
15..13..11.MeC29	cut_queens - cut_workers	2.70	0.50	113	5.39	0.00
15..13..11.MeC29	cut_queens - dufour_queens	-0.69	0.64	113	-1.08	1.00
15..13..11.MeC29	cut_queens - dufour_workers	3.77	0.55	113	6.82	0.00
15..13..11.MeC29	cut_queens - eggs_queens	-0.34	0.50	113	-0.69	1.00
15..13..11.MeC29	cut_queens - eggs_workers	-0.64	0.57	113	-1.12	1.00
15..13..11.MeC29	cut_workers - dufour_queens	-3.39	0.50	113	-6.78	0.00
15..13..11.MeC29	cut_workers - dufour_workers	1.07	0.38	113	2.79	1.00
15..13..11.MeC29	cut_workers - eggs_queens	-3.04	0.30	113	-10.17	0.00
15..13..11.MeC29	cut_workers - eggs_workers	-3.33	0.40	113	-8.26	0.00
15..13..11.MeC29	dufour_queens - dufour_workers	4.46	0.55	113	8.08	0.00
15..13..11.MeC29	dufour_queens - eggs_queens	0.35	0.50	113	0.70	1.00
15..13..11.MeC29	dufour_queens - eggs_workers	0.06	0.57	113	0.10	1.00
15..13..11.MeC29	dufour_workers - eggs_queens	-4.11	0.38	113	-10.81	0.00
15..13..11.MeC29	dufour_workers - eggs_workers	-4.40	0.47	113	-9.43	0.00
15..13..11.MeC29	eggs_queens - eggs_workers	-0.29	0.40	113	-0.73	1.00
17..15..13.MeC33	cut_queens - cut_workers	0.00	0.10	113	0.00	1.00
17..15..13.MeC33	cut_queens - dufour_queens	-7.20	0.13	113	-54.14	0.00
17..15..13.MeC33	cut_queens - dufour_workers	0.00	0.12	113	0.00	1.00
17..15..13.MeC33	cut_queens - eggs_queens	0.00	0.10	113	0.00	1.00
17..15..13.MeC33	cut_queens - eggs_workers	0.00	0.12	113	0.00	1.00
17..15..13.MeC33	cut_workers - dufour_queens	-7.20	0.10	113	-69.07	0.00
17..15..13.MeC33	cut_workers - dufour_workers	0.00	0.08	113	0.00	1.00
17..15..13.MeC33	cut_workers - eggs_queens	0.00	0.06	113	0.00	1.00

17..15..13.MeC33	cut_workers - eggs_workers	0.00	0.08	113	0.00	1.00
17..15..13.MeC33	dufour_queens - dufour_workers	7.20	0.12	113	62.51	0.00
17..15..13.MeC33	dufour_queens - eggs_queens	7.20	0.10	113	69.58	0.00
17..15..13.MeC33	dufour_queens - eggs_workers	7.20	0.12	113	61.07	0.00
17..15..13.MeC33	dufour_workers - eggs_queens	0.00	0.08	113	0.00	1.00
17..15..13.MeC33	dufour_workers - eggs_workers	0.00	0.10	113	0.00	1.00
17..15..13.MeC33	eggs_queens - eggs_workers	0.00	0.08	113	0.00	1.00
3.MeC23	cut_queens - cut_workers	-1.13	0.38	113	-3.01	1.00
3.MeC23	cut_queens - dufour_queens	-1.00	0.48	113	-2.09	1.00
3.MeC23	cut_queens - dufour_workers	6.26	0.42	113	15.07	0.00
3.MeC23	cut_queens - eggs_queens	-0.74	0.37	113	-1.99	1.00
3.MeC23	cut_queens - eggs_workers	0.31	0.43	113	0.74	1.00
3.MeC23	cut_workers - dufour_queens	0.13	0.38	113	0.35	1.00
3.MeC23	cut_workers - dufour_workers	7.39	0.29	113	25.54	0.00
3.MeC23	cut_workers - eggs_queens	0.39	0.22	113	1.73	1.00
3.MeC23	cut_workers - eggs_workers	1.45	0.30	113	4.76	0.01
3.MeC23	dufour_queens - dufour_workers	7.26	0.42	113	17.48	0.00
3.MeC23	dufour_queens - eggs_queens	0.26	0.37	113	0.69	1.00
3.MeC23	dufour_queens - eggs_workers	1.32	0.43	113	3.09	1.00
3.MeC23	dufour_workers - eggs_queens	-7.01	0.29	113	-24.50	0.00
3.MeC23	dufour_workers - eggs_workers	-5.95	0.35	113	-16.94	0.00
3.MeC23	eggs_queens - eggs_workers	1.06	0.30	113	3.53	0.61
3.MeC25	cut_queens - cut_workers	-0.09	0.20	113	-0.45	1.00
3.MeC25	cut_queens - dufour_queens	-0.77	0.25	113	-3.07	1.00
3.MeC25	cut_queens - dufour_workers	0.13	0.22	113	0.61	1.00
3.MeC25	cut_queens - eggs_queens	-0.01	0.20	113	-0.05	1.00
3.MeC25	cut_queens - eggs_workers	0.91	0.22	113	4.10	0.08
3.MeC25	cut_workers - dufour_queens	-0.68	0.20	113	-3.47	0.72
3.MeC25	cut_workers - dufour_workers	0.22	0.15	113	1.46	1.00
3.MeC25	cut_workers - eggs_queens	0.08	0.12	113	0.67	1.00
3.MeC25	cut_workers - eggs_workers	1.00	0.16	113	6.30	0.00
3.MeC25	dufour_queens - dufour_workers	0.91	0.22	113	4.16	0.06
3.MeC25	dufour_queens - eggs_queens	0.76	0.20	113	3.90	0.16
3.MeC25	dufour_queens - eggs_workers	1.69	0.22	113	7.57	0.00
3.MeC25	dufour_workers - eggs_queens	-0.14	0.15	113	-0.95	1.00
3.MeC25	dufour_workers - eggs_workers	0.78	0.18	113	4.25	0.04
3.MeC25	eggs_queens - eggs_workers	0.92	0.16	113	5.87	0.00
3.MeC26	cut_queens - cut_workers	0.00	0.04	113	0.00	1.00
3.MeC26	cut_queens - dufour_queens	-11.38	0.05	113	-216.65	0.00
3.MeC26	cut_queens - dufour_workers	0.00	0.05	113	0.00	1.00
3.MeC26	cut_queens - eggs_queens	0.00	0.04	113	0.00	1.00
3.MeC26	cut_queens - eggs_workers	0.00	0.05	113	0.00	1.00
3.MeC26	cut_workers - dufour_queens	-11.38	0.04	113	-276.42	0.00
3.MeC26	cut_workers - dufour_workers	0.00	0.03	113	-0.01	1.00
3.MeC26	cut_workers - eggs_queens	0.00	0.02	113	0.00	1.00
3.MeC26	cut_workers - eggs_workers	0.00	0.03	113	0.00	1.00
3.MeC26	dufour_queens - dufour_workers	11.38	0.05	113	250.16	0.00
3.MeC26	dufour_queens - eggs_queens	11.38	0.04	113	278.47	0.00
3.MeC26	dufour_queens - eggs_workers	11.38	0.05	113	244.41	0.00
3.MeC26	dufour_workers - eggs_queens	0.00	0.03	113	0.00	1.00
3.MeC26	dufour_workers - eggs_workers	0.00	0.04	113	0.00	1.00
3.MeC26	eggs_queens - eggs_workers	0.00	0.03	113	0.00	1.00
3.MeC27	cut_queens - cut_workers	1.06	0.33	113	3.26	1.00

3.MeC27	cut_queens - dufour_queens	-0.86	0.42	113	-2.08	1.00
3.MeC27	cut_queens - dufour_workers	6.52	0.36	113	18.12	0.00
3.MeC27	cut_queens - eggs_queens	0.33	0.32	113	1.03	1.00
3.MeC27	cut_queens - eggs_workers	1.10	0.37	113	2.98	1.00
3.MeC27	cut_workers - dufour_queens	-1.92	0.33	113	-5.91	0.00
3.MeC27	cut_workers - dufour_workers	5.46	0.25	113	21.77	0.00
3.MeC27	cut_workers - eggs_queens	-0.73	0.19	113	-3.73	0.29
3.MeC27	cut_workers - eggs_workers	0.04	0.26	113	0.14	1.00
3.MeC27	dufour_queens - dufour_workers	7.39	0.36	113	20.52	0.00
3.MeC27	dufour_queens - eggs_queens	1.20	0.32	113	3.70	0.33
3.MeC27	dufour_queens - eggs_workers	1.96	0.37	113	5.32	0.00
3.MeC27	dufour_workers - eggs_queens	-6.19	0.25	113	-24.98	0.00
3.MeC27	dufour_workers - eggs_workers	-5.43	0.30	113	-17.84	0.00
3.MeC27	eggs_queens - eggs_workers	0.76	0.26	113	2.94	1.00
3.MeC28	cut_queens - cut_workers	0.00	0.07	113	0.00	1.00
3.MeC28	cut_queens - dufour_queens	-8.30	0.09	113	-92.32	0.00
3.MeC28	cut_queens - dufour_workers	0.00	0.08	113	0.00	1.00
3.MeC28	cut_queens - eggs_queens	0.00	0.07	113	0.00	1.00
3.MeC28	cut_queens - eggs_workers	0.00	0.08	113	0.00	1.00
3.MeC28	cut_workers - dufour_queens	-8.30	0.07	113	-117.79	0.00
3.MeC28	cut_workers - dufour_workers	0.00	0.05	113	0.00	1.00
3.MeC28	cut_workers - eggs_queens	0.00	0.04	113	0.00	1.00
3.MeC28	cut_workers - eggs_workers	0.00	0.06	113	0.00	1.00
3.MeC28	dufour_queens - dufour_workers	8.30	0.08	113	106.60	0.00
3.MeC28	dufour_queens - eggs_queens	8.30	0.07	113	118.66	0.00
3.MeC28	dufour_queens - eggs_workers	8.30	0.08	113	104.15	0.00
3.MeC28	dufour_workers - eggs_queens	0.00	0.05	113	0.00	1.00
3.MeC28	dufour_workers - eggs_workers	0.00	0.07	113	0.00	1.00
3.MeC28	eggs_queens - eggs_workers	0.00	0.06	113	0.00	1.00
3.MeC29	cut_queens - cut_workers	3.71	0.40	113	9.23	0.00
3.MeC29	cut_queens - dufour_queens	-1.93	0.51	113	-3.76	0.27
3.MeC29	cut_queens - dufour_workers	3.66	0.44	113	8.24	0.00
3.MeC29	cut_queens - eggs_queens	9.53	0.40	113	23.90	0.00
3.MeC29	cut_queens - eggs_workers	9.53	0.45	113	20.98	0.00
3.MeC29	cut_workers - dufour_queens	-5.63	0.40	113	-14.02	0.00
3.MeC29	cut_workers - dufour_workers	-0.05	0.31	113	-0.15	1.00
3.MeC29	cut_workers - eggs_queens	5.82	0.24	113	24.25	0.00
3.MeC29	cut_workers - eggs_workers	5.82	0.32	113	17.96	0.00
3.MeC29	dufour_queens - dufour_workers	5.59	0.44	113	12.58	0.00
3.MeC29	dufour_queens - eggs_queens	11.46	0.40	113	28.73	0.00
3.MeC29	dufour_queens - eggs_workers	11.46	0.45	113	25.22	0.00
3.MeC29	dufour_workers - eggs_queens	5.87	0.31	113	19.22	0.00
3.MeC29	dufour_workers - eggs_workers	5.87	0.38	113	15.65	0.00
3.MeC29	eggs_queens - eggs_workers	0.00	0.32	113	0.00	1.00
3.MeC31	cut_queens - cut_workers	0.00	0.04	113	0.00	1.00
3.MeC31	cut_queens - dufour_queens	-9.55	0.06	113	-171.89	0.00
3.MeC31	cut_queens - dufour_workers	0.00	0.05	113	0.00	1.00
3.MeC31	cut_queens - eggs_queens	0.00	0.04	113	0.00	1.00
3.MeC31	cut_queens - eggs_workers	0.00	0.05	113	0.00	1.00
3.MeC31	cut_workers - dufour_queens	-9.55	0.04	113	-219.31	0.00
3.MeC31	cut_workers - dufour_workers	0.00	0.03	113	-0.01	1.00
3.MeC31	cut_workers - eggs_queens	0.00	0.03	113	0.00	1.00
3.MeC31	cut_workers - eggs_workers	0.00	0.04	113	0.00	1.00

3.MeC31	dufour_queens - dufour_workers	9.55	0.05	113	198.48	0.00
3.MeC31	dufour_queens - eggs_queens	9.55	0.04	113	220.94	0.00
3.MeC31	dufour_queens - eggs_workers	9.55	0.05	113	193.92	0.00
3.MeC31	dufour_workers - eggs_queens	0.00	0.03	113	0.00	1.00
3.MeC31	dufour_workers - eggs_workers	0.00	0.04	113	0.00	1.00
3.MeC31	eggs_queens - eggs_workers	0.00	0.03	113	0.00	1.00
3..diMeC30	cut_queens - cut_workers	0.00	0.08	113	0.00	1.00
3..diMeC30	cut_queens - dufour_queens	-5.88	0.10	113	-58.05	0.00
3..diMeC30	cut_queens - dufour_workers	0.00	0.09	113	0.00	1.00
3..diMeC30	cut_queens - eggs_queens	0.00	0.08	113	0.00	1.00
3..diMeC30	cut_queens - eggs_workers	0.00	0.09	113	0.00	1.00
3..diMeC30	cut_workers - dufour_queens	-5.88	0.08	113	-74.07	0.00
3..diMeC30	cut_workers - dufour_workers	0.00	0.06	113	0.00	1.00
3..diMeC30	cut_workers - eggs_queens	0.00	0.05	113	0.00	1.00
3..diMeC30	cut_workers - eggs_workers	0.00	0.06	113	0.00	1.00
3..diMeC30	dufour_queens - dufour_workers	5.88	0.09	113	67.03	0.00
3..diMeC30	dufour_queens - eggs_queens	5.88	0.08	113	74.62	0.00
3..diMeC30	dufour_queens - eggs_workers	5.88	0.09	113	65.49	0.00
3..diMeC30	dufour_workers - eggs_queens	0.00	0.06	113	0.00	1.00
3..diMeC30	dufour_workers - eggs_workers	0.00	0.07	113	0.00	1.00
3..diMeC30	eggs_queens - eggs_workers	0.00	0.06	113	0.00	1.00
4.MeC24	cut_queens - cut_workers	0.41	0.19	113	2.11	1.00
4.MeC24	cut_queens - dufour_queens	5.03	0.25	113	20.31	0.00
4.MeC24	cut_queens - dufour_workers	5.03	0.21	113	23.46	0.00
4.MeC24	cut_queens - eggs_queens	-1.05	0.19	113	-5.45	0.00
4.MeC24	cut_queens - eggs_workers	-0.96	0.22	113	-4.37	0.03
4.MeC24	cut_workers - dufour_queens	4.62	0.19	113	23.81	0.00
4.MeC24	cut_workers - dufour_workers	4.62	0.15	113	30.92	0.00
4.MeC24	cut_workers - eggs_queens	-1.46	0.12	113	-12.58	0.00
4.MeC24	cut_workers - eggs_workers	-1.37	0.16	113	-8.73	0.00
4.MeC24	dufour_queens - dufour_workers	0.00	0.21	113	0.00	1.00
4.MeC24	dufour_queens - eggs_queens	-6.08	0.19	113	-31.56	0.00
4.MeC24	dufour_queens - eggs_workers	-5.99	0.22	113	-27.28	0.00
4.MeC24	dufour_workers - eggs_queens	-6.08	0.15	113	-41.20	0.00
4.MeC24	dufour_workers - eggs_workers	-5.99	0.18	113	-33.04	0.00
4.MeC24	eggs_queens - eggs_workers	0.09	0.15	113	0.59	1.00
4.MeC26	cut_queens - cut_workers	0.00	0.28	113	0.00	1.00
4.MeC26	cut_queens - dufour_queens	-9.04	0.36	113	-25.09	0.00
4.MeC26	cut_queens - dufour_workers	-3.12	0.31	113	-10.00	0.00
4.MeC26	cut_queens - eggs_queens	-6.66	0.28	113	-23.75	0.00
4.MeC26	cut_queens - eggs_workers	-6.77	0.32	113	-21.19	0.00
4.MeC26	cut_workers - dufour_queens	-9.04	0.28	113	-32.01	0.00
4.MeC26	cut_workers - dufour_workers	-3.12	0.22	113	-14.35	0.00
4.MeC26	cut_workers - eggs_queens	-6.66	0.17	113	-39.43	0.00
4.MeC26	cut_workers - eggs_workers	-6.77	0.23	113	-29.70	0.00
4.MeC26	dufour_queens - dufour_workers	5.92	0.31	113	18.97	0.00
4.MeC26	dufour_queens - eggs_queens	2.38	0.28	113	8.50	0.00
4.MeC26	dufour_queens - eggs_workers	2.27	0.32	113	7.11	0.00
4.MeC26	dufour_workers - eggs_queens	-3.54	0.21	113	-16.47	0.00
4.MeC26	dufour_workers - eggs_workers	-3.65	0.26	113	-13.83	0.00
4.MeC26	eggs_queens - eggs_workers	-0.11	0.23	113	-0.49	1.00
4.MeC28	cut_queens - cut_workers	0.00	0.21	113	0.00	1.00
4.MeC28	cut_queens - dufour_queens	-8.09	0.27	113	-29.97	0.00

4.MeC28	cut_queens - dufour_workers	0.00	0.23	113	0.00	1.00
4.MeC28	cut_queens - eggs_queens	-6.60	0.21	113	-31.41	0.00
4.MeC28	cut_queens - eggs_workers	-6.99	0.24	113	-29.20	0.00
4.MeC28	cut_workers - dufour_queens	-8.09	0.21	113	-38.24	0.00
4.MeC28	cut_workers - dufour_workers	0.00	0.16	113	0.00	1.00
4.MeC28	cut_workers - eggs_queens	-6.60	0.13	113	-52.16	0.00
4.MeC28	cut_workers - eggs_workers	-6.99	0.17	113	-40.93	0.00
4.MeC28	dufour_queens - dufour_workers	8.09	0.23	113	34.61	0.00
4.MeC28	dufour_queens - eggs_queens	1.49	0.21	113	7.11	0.00
4.MeC28	dufour_queens - eggs_workers	1.10	0.24	113	4.61	0.01
4.MeC28	dufour_workers - eggs_queens	-6.60	0.16	113	-41.00	0.00
4.MeC28	dufour_workers - eggs_workers	-6.99	0.20	113	-35.37	0.00
4.MeC28	eggs_queens - eggs_workers	-0.39	0.17	113	-2.32	1.00
5.MeC23	cut_queens - cut_workers	0.00	0.29	113	0.00	1.00
5.MeC23	cut_queens - dufour_queens	-4.82	0.37	113	-12.95	0.00
5.MeC23	cut_queens - dufour_workers	-4.47	0.32	113	-13.86	0.00
5.MeC23	cut_queens - eggs_queens	-5.93	0.29	113	-20.48	0.00
5.MeC23	cut_queens - eggs_workers	-6.40	0.33	113	-19.42	0.00
5.MeC23	cut_workers - dufour_queens	-4.82	0.29	113	-16.52	0.00
5.MeC23	cut_workers - dufour_workers	-4.47	0.22	113	-19.89	0.00
5.MeC23	cut_workers - eggs_queens	-5.93	0.17	113	-34.01	0.00
5.MeC23	cut_workers - eggs_workers	-6.40	0.24	113	-27.21	0.00
5.MeC23	dufour_queens - dufour_workers	0.35	0.32	113	1.09	1.00
5.MeC23	dufour_queens - eggs_queens	-1.11	0.29	113	-3.84	0.20
5.MeC23	dufour_queens - eggs_workers	-1.59	0.33	113	-4.81	0.00
5.MeC23	dufour_workers - eggs_queens	-1.46	0.22	113	-6.60	0.00
5.MeC23	dufour_workers - eggs_workers	-1.94	0.27	113	-7.11	0.00
5.MeC23	eggs_queens - eggs_workers	-0.47	0.23	113	-2.04	1.00
5.MeC25	cut_queens - cut_workers	0.56	0.36	113	1.53	1.00
5.MeC25	cut_queens - dufour_queens	1.96	0.46	113	4.22	0.05
5.MeC25	cut_queens - dufour_workers	0.56	0.40	113	1.39	1.00
5.MeC25	cut_queens - eggs_queens	0.14	0.36	113	0.39	1.00
5.MeC25	cut_queens - eggs_workers	0.90	0.41	113	2.18	1.00
5.MeC25	cut_workers - dufour_queens	1.40	0.36	113	3.85	0.19
5.MeC25	cut_workers - dufour_workers	0.00	0.28	113	0.01	1.00
5.MeC25	cut_workers - eggs_queens	-0.41	0.22	113	-1.91	1.00
5.MeC25	cut_workers - eggs_workers	0.34	0.29	113	1.15	1.00
5.MeC25	dufour_queens - dufour_workers	-1.40	0.40	113	-3.48	0.70
5.MeC25	dufour_queens - eggs_queens	-1.81	0.36	113	-5.03	0.00
5.MeC25	dufour_queens - eggs_workers	-1.06	0.41	113	-2.58	1.00
5.MeC25	dufour_workers - eggs_queens	-0.42	0.28	113	-1.51	1.00
5.MeC25	dufour_workers - eggs_workers	0.34	0.34	113	0.99	1.00
5.MeC25	eggs_queens - eggs_workers	0.75	0.29	113	2.60	1.00
5.MeC27	cut_queens - cut_workers	0.00	0.30	113	0.00	1.00
5.MeC27	cut_queens - dufour_queens	-8.93	0.38	113	-23.43	0.00
5.MeC27	cut_queens - dufour_workers	-6.30	0.33	113	-19.08	0.00
5.MeC27	cut_queens - eggs_queens	-7.70	0.30	113	-25.96	0.00
5.MeC27	cut_queens - eggs_workers	-7.47	0.34	113	-22.10	0.00
5.MeC27	cut_workers - dufour_queens	-8.93	0.30	113	-29.89	0.00
5.MeC27	cut_workers - dufour_workers	-6.30	0.23	113	-27.37	0.00
5.MeC27	cut_workers - eggs_queens	-7.70	0.18	113	-43.10	0.00
5.MeC27	cut_workers - eggs_workers	-7.47	0.24	113	-30.97	0.00
5.MeC27	dufour_queens - dufour_workers	2.63	0.33	113	7.97	0.00

5.MeC27	dufour_queens - eggs_queens	1.23	0.30	113	4.15	0.06
5.MeC27	dufour_queens - eggs_workers	1.46	0.34	113	4.33	0.03
5.MeC27	dufour_workers - eggs_queens	-1.40	0.23	113	-6.16	0.00
5.MeC27	dufour_workers - eggs_workers	-1.17	0.28	113	-4.19	0.06
5.MeC27	eggs_queens - eggs_workers	0.23	0.24	113	0.97	1.00
5.MeC29	cut_queens - cut_workers	0.00	0.08	113	0.00	1.00
5.MeC29	cut_queens - dufour_queens	-6.22	0.10	113	-63.04	0.00
5.MeC29	cut_queens - dufour_workers	0.00	0.09	113	0.00	1.00
5.MeC29	cut_queens - eggs_queens	0.00	0.08	113	0.00	1.00
5.MeC29	cut_queens - eggs_workers	0.00	0.09	113	0.00	1.00
5.MeC29	cut_workers - dufour_queens	-6.22	0.08	113	-80.43	0.00
5.MeC29	cut_workers - dufour_workers	0.00	0.06	113	0.00	1.00
5.MeC29	cut_workers - eggs_queens	0.00	0.05	113	0.00	1.00
5.MeC29	cut_workers - eggs_workers	0.00	0.06	113	0.00	1.00
5.MeC29	dufour_queens - dufour_workers	6.22	0.09	113	72.79	0.00
5.MeC29	dufour_queens - eggs_queens	6.22	0.08	113	81.03	0.00
5.MeC29	dufour_queens - eggs_workers	6.22	0.09	113	71.12	0.00
5.MeC29	dufour_workers - eggs_queens	0.00	0.06	113	0.00	1.00
5.MeC29	dufour_workers - eggs_workers	0.00	0.07	113	0.00	1.00
5.MeC29	eggs_queens - eggs_workers	0.00	0.06	113	0.00	1.00
6...4.MeC26	cut_queens - cut_workers	0.67	0.27	113	2.51	1.00
6...4.MeC26	cut_queens - dufour_queens	0.95	0.34	113	2.80	1.00
6...4.MeC26	cut_queens - dufour_workers	0.96	0.30	113	3.23	1.00
6...4.MeC26	cut_queens - eggs_queens	0.96	0.27	113	3.60	0.47
6...4.MeC26	cut_queens - eggs_workers	0.96	0.30	113	3.16	1.00
6...4.MeC26	cut_workers - dufour_queens	0.28	0.27	113	1.06	1.00
6...4.MeC26	cut_workers - dufour_workers	0.28	0.21	113	1.38	1.00
6...4.MeC26	cut_workers - eggs_queens	0.28	0.16	113	1.78	1.00
6...4.MeC26	cut_workers - eggs_workers	0.28	0.22	113	1.32	1.00
6...4.MeC26	dufour_queens - dufour_workers	0.00	0.30	113	0.00	1.00
6...4.MeC26	dufour_queens - eggs_queens	0.00	0.27	113	0.00	1.00
6...4.MeC26	dufour_queens - eggs_workers	0.00	0.30	113	0.00	1.00
6...4.MeC26	dufour_workers - eggs_queens	0.00	0.20	113	0.00	1.00
6...4.MeC26	dufour_workers - eggs_workers	0.00	0.25	113	0.00	1.00
6...4.MeC26	eggs_queens - eggs_workers	0.00	0.21	113	0.00	1.00
7.MeC23	cut_queens - cut_workers	0.63	0.31	113	2.06	1.00
7.MeC23	cut_queens - dufour_queens	6.57	0.39	113	16.77	0.00
7.MeC23	cut_queens - dufour_workers	1.16	0.34	113	3.41	0.88
7.MeC23	cut_queens - eggs_queens	0.79	0.30	113	2.60	1.00
7.MeC23	cut_queens - eggs_workers	0.94	0.35	113	2.71	1.00
7.MeC23	cut_workers - dufour_queens	5.94	0.31	113	19.33	0.00
7.MeC23	cut_workers - dufour_workers	0.53	0.24	113	2.23	1.00
7.MeC23	cut_workers - eggs_queens	0.16	0.18	113	0.88	1.00
7.MeC23	cut_workers - eggs_workers	0.31	0.25	113	1.25	1.00
7.MeC23	dufour_queens - dufour_workers	-5.41	0.34	113	-15.94	0.00
7.MeC23	dufour_queens - eggs_queens	-5.78	0.30	113	-18.95	0.00
7.MeC23	dufour_queens - eggs_workers	-5.63	0.35	113	-16.20	0.00
7.MeC23	dufour_workers - eggs_queens	-0.37	0.23	113	-1.56	1.00
7.MeC23	dufour_workers - eggs_workers	-0.22	0.29	113	-0.76	1.00
7.MeC23	eggs_queens - eggs_workers	0.15	0.25	113	0.60	1.00
7.MeC24	cut_queens - cut_workers	0.00	0.11	113	0.00	1.00
7.MeC24	cut_queens - dufour_queens	-5.59	0.14	113	-40.87	0.00
7.MeC24	cut_queens - dufour_workers	0.00	0.12	113	0.00	1.00

7.MeC24	cut_queens - eggs_queens	0.00	0.11	113	0.00	1.00
7.MeC24	cut_queens - eggs_workers	0.00	0.12	113	0.00	1.00
7.MeC24	cut_workers - dufour_queens	-5.59	0.11	113	-52.15	0.00
7.MeC24	cut_workers - dufour_workers	0.00	0.08	113	0.00	1.00
7.MeC24	cut_workers - eggs_queens	0.00	0.06	113	0.00	1.00
7.MeC24	cut_workers - eggs_workers	0.00	0.09	113	0.00	1.00
7.MeC24	dufour_queens - dufour_workers	5.59	0.12	113	47.19	0.00
7.MeC24	dufour_queens - eggs_queens	5.59	0.11	113	52.53	0.00
7.MeC24	dufour_queens - eggs_workers	5.59	0.12	113	46.11	0.00
7.MeC24	dufour_workers - eggs_queens	0.00	0.08	113	0.00	1.00
7.MeC24	dufour_workers - eggs_workers	0.00	0.10	113	0.00	1.00
7.MeC24	eggs_queens - eggs_workers	0.00	0.09	113	0.00	1.00
7.MeC25	cut_queens - cut_workers	1.38	0.40	113	3.46	0.74
7.MeC25	cut_queens - dufour_queens	-0.15	0.51	113	-0.29	1.00
7.MeC25	cut_queens - dufour_workers	0.37	0.44	113	0.83	1.00
7.MeC25	cut_queens - eggs_queens	0.11	0.40	113	0.29	1.00
7.MeC25	cut_queens - eggs_workers	1.05	0.45	113	2.33	1.00
7.MeC25	cut_workers - dufour_queens	-1.53	0.40	113	-3.84	0.20
7.MeC25	cut_workers - dufour_workers	-1.02	0.31	113	-3.31	1.00
7.MeC25	cut_workers - eggs_queens	-1.27	0.24	113	-5.32	0.00
7.MeC25	cut_workers - eggs_workers	-0.33	0.32	113	-1.03	1.00
7.MeC25	dufour_queens - dufour_workers	0.52	0.44	113	1.17	1.00
7.MeC25	dufour_queens - eggs_queens	0.26	0.40	113	0.66	1.00
7.MeC25	dufour_queens - eggs_workers	1.20	0.45	113	2.66	1.00
7.MeC25	dufour_workers - eggs_queens	-0.25	0.30	113	-0.83	1.00
7.MeC25	dufour_workers - eggs_workers	0.69	0.37	113	1.84	1.00
7.MeC25	eggs_queens - eggs_workers	0.94	0.32	113	2.95	1.00
7.MeC26	cut_queens - cut_workers	0.00	0.06	113	0.00	1.00
7.MeC26	cut_queens - dufour_queens	-5.20	0.08	113	-67.64	0.00
7.MeC26	cut_queens - dufour_workers	0.00	0.07	113	0.00	1.00
7.MeC26	cut_queens - eggs_queens	0.00	0.06	113	0.00	1.00
7.MeC26	cut_queens - eggs_workers	0.00	0.07	113	0.00	1.00
7.MeC26	cut_workers - dufour_queens	-5.20	0.06	113	-86.30	0.00
7.MeC26	cut_workers - dufour_workers	0.00	0.05	113	0.00	1.00
7.MeC26	cut_workers - eggs_queens	0.00	0.04	113	0.00	1.00
7.MeC26	cut_workers - eggs_workers	0.00	0.05	113	0.00	1.00
7.MeC26	dufour_queens - dufour_workers	5.20	0.07	113	78.10	0.00
7.MeC26	dufour_queens - eggs_queens	5.20	0.06	113	86.94	0.00
7.MeC26	dufour_queens - eggs_workers	5.20	0.07	113	76.31	0.00
7.MeC26	dufour_workers - eggs_queens	0.00	0.05	113	0.00	1.00
7.MeC26	dufour_workers - eggs_workers	0.00	0.06	113	0.00	1.00
7.MeC26	eggs_queens - eggs_workers	0.00	0.05	113	0.00	1.00
7.MeC27	cut_queens - cut_workers	-0.01	0.41	113	-0.02	1.00
7.MeC27	cut_queens - dufour_queens	-0.51	0.53	113	-0.98	1.00
7.MeC27	cut_queens - dufour_workers	0.35	0.45	113	0.76	1.00
7.MeC27	cut_queens - eggs_queens	0.10	0.41	113	0.25	1.00
7.MeC27	cut_queens - eggs_workers	0.63	0.47	113	1.34	1.00
7.MeC27	cut_workers - dufour_queens	-0.51	0.41	113	-1.23	1.00
7.MeC27	cut_workers - dufour_workers	0.35	0.32	113	1.12	1.00
7.MeC27	cut_workers - eggs_queens	0.11	0.25	113	0.44	1.00
7.MeC27	cut_workers - eggs_workers	0.63	0.33	113	1.90	1.00
7.MeC27	dufour_queens - dufour_workers	0.86	0.45	113	1.89	1.00
7.MeC27	dufour_queens - eggs_queens	0.62	0.41	113	1.51	1.00

7.MeC27	dufour_queens - eggs_workers	1.14	0.47	113	2.45	1.00
7.MeC27	dufour_workers - eggs_queens	-0.25	0.31	113	-0.78	1.00
7.MeC27	dufour_workers - eggs_workers	0.28	0.38	113	0.72	1.00
7.MeC27	eggs_queens - eggs_workers	0.52	0.33	113	1.59	1.00
7.MeC29	cut_queens - cut_workers	0.00	0.12	113	0.00	1.00
7.MeC29	cut_queens - dufour_queens	-6.72	0.16	113	-43.18	0.00
7.MeC29	cut_queens - dufour_workers	0.00	0.13	113	0.00	1.00
7.MeC29	cut_queens - eggs_queens	0.00	0.12	113	0.00	1.00
7.MeC29	cut_queens - eggs_workers	0.00	0.14	113	0.00	1.00
7.MeC29	cut_workers - dufour_queens	-6.72	0.12	113	-55.09	0.00
7.MeC29	cut_workers - dufour_workers	0.00	0.09	113	0.00	1.00
7.MeC29	cut_workers - eggs_queens	0.00	0.07	113	0.00	1.00
7.MeC29	cut_workers - eggs_workers	0.00	0.10	113	0.00	1.00
7.MeC29	dufour_queens - dufour_workers	6.72	0.13	113	49.86	0.00
7.MeC29	dufour_queens - eggs_queens	6.72	0.12	113	55.50	0.00
7.MeC29	dufour_queens - eggs_workers	6.72	0.14	113	48.71	0.00
7.MeC29	dufour_workers - eggs_queens	0.00	0.09	113	0.00	1.00
7.MeC29	dufour_workers - eggs_workers	0.00	0.11	113	0.00	1.00
7.MeC29	eggs_queens - eggs_workers	0.00	0.10	113	0.00	1.00

Table S24: Percentage similarity analysis (SIMPER – Bray-Curtis 999 permutations) showing the five most important hydrocarbons for group differentiation (egg samples across the five species). SD = standard deviation; Av = overall average; Sig. Level = Significance Level; dm = *Dolichovespula media*; ds = *Dolichovespula saxonica*; vc = *Vespa crabro*; vg = *Vespa germanica*.

Contrast: dm_queen_ds_queen							
Compounds	Average	SD	Ratio	av dm	av ds	p-value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.065	0.017	3.897	20.934	8.225	0.001	***
3-MeC27	0.045	0.016	2.852	14.498	5.672	0.001	***
C29:1-1	0.027	0.007	4.014	0.000	5.477	0.001	***
C31-1	0.023	0.006	3.748	0.000	4.688	0.001	***
C29-1	0.023	0.006	3.682	4.594	0.000	0.001	***
Contrast: dm_queen_vg_queen							
Compounds	Average	SD	Ratio	av dm	av vg	p-value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.090	0.021	4.195	20.934	3.018	0.001	***
13-;11-;9-;7-MeC27	0.051	0.025	2.029	9.586	18.989	0.001	***
n-C27	0.041	0.024	1.755	7.864	15.528	0.001	***
3-MeC29	0.040	0.009	4.713	11.258	3.984	0.001	***
n-C25	0.039	0.012	3.175	0.637	8.482	0.001	***
Contrast: ds_queen_vg_queen							
Compounds	Average	SD	Ratio	av ds	av vg	p-value	Sig. Level
13-;11-;9-;7-MeC27	0.069	0.028	2.425	5.509	18.989	0.001	***
3-MeC29	0.042	0.018	2.287	11.597	3.984	0.001	***
3-MeC27	0.039	0.016	2.454	5.672	13.139	0.001	***
3-MeC25	0.039	0.020	1.925	0.660	8.384	0.001	***
n-C27	0.038	0.023	1.656	8.723	15.528	0.003	**
Contrast: dm_queen_vc_queen							
Compounds	Average	SD	Ratio	av dm	av vc	p-value	Sig. Level
C25:1-3	0.137	0.054	2.545	0.000	27.500	0.001	***

n-C25	0.116	0.026	4.447	0.637	23.893	0.001	***
15-;13-;11-;9-;7-MeC29	0.097	0.020	4.836	20.934	1.519	0.001	***
3-MeC29	0.056	0.006	9.024	11.258	0.000	0.001	***
3-MeC27	0.050	0.016	3.040	14.498	4.612	0.001	***
Contrast: ds_queen_vc_queen							
Compounds	Average	SD	Ratio	av ds	av vc	p-value	Sig. Level
C25:1-3	0.138	0.054	2.543	0.000	27.500	0.001	***
n-C25	0.105	0.026	3.999	2.847	23.893	0.001	***
3-MeC29	0.058	0.017	3.323	11.597	0.000	0.001	***
n-C29	0.042	0.017	2.518	9.976	2.098	0.001	***
15-;13-;11-;9-;7-MeC29	0.034	0.012	2.872	8.225	1.519	0.966	ns
Contrast: vg_queen_vc_queen							
Compounds	Average	SD	Ratio	av vg	av vc	p-value	Sig. Level
C25:1-3	0.137	0.054	2.545	0.000	7.500	0.001	***
13-;11-;9-;7-MeC27	0.095	0.031	3.074	18.989	0.000	0.001	***
n-C25	0.077	0.029	2.677	8.482	3.893	0.001	***
n-C27	0.052	0.027	1.935	15.528	7.819	0.001	***
3-MeC27	0.044	0.017	2.605	13.139	4.612	0.001	***
Contrast: dm_worker_ds_worker							
Compounds	Average	SD	Ratio	av dm	av ds	p-value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.046	0.030	1.508	16.100	8.767	0.054	ns
n-C29	0.030	0.022	1.324	12.623	9.790	0.791	ns
C29:1-1	0.029	0.008	3.642	0.000	5.767	0.001	***
C31-1	0.025	0.007	3.542	0.000	4.979	0.001	***
3-MeC27	0.024	0.015	1.620	9.492	5.111	0.001	***
Contrast: dm_worker_vg_worker							
Compounds	Average	SD	Ratio	av dm	av vg	p-value	Sig. Level
15-;13-;11-;9-;7-MeC29	0.063	0.038	1.681	16.100	3.681	0.001	***
13-;11-;9-;7-MeC27	0.048	0.026	1.858	9.409	17.884	0.001	***
n-C27	0.043	0.029	1.471	10.564	17.243	0.002	**
n-C29	0.043	0.029	1.458	12.623	5.397	0.001	***
n-C25	0.040	0.018	2.209	0.695	8.669	0.001	***
Contrast: ds_worker_vg_worker							
Compounds	Average	SD	Ratio	av ds	av vg	p-value	Sig. Level
13-;11-;9-;7-MeC27	0.060	0.029	2.064	6.161	17.884	0.001	***
n-C27	0.048	0.029	1.682	8.209	17.243	0.001	***
n-C25	0.029	0.018	1.621	2.847	8.669	0.001	***
C29:1-1	0.029	0.008	3.641	5.767	0.000	0.001	***
n-C29	0.026	0.017	1.564	9.790	5.397	0.962	ns
Contrast: dm_worker_vc_worker							
Compounds	Average	SD	Ratio	av dm	av vc	p-value	Sig. Level
n-C25	0.107	0.044	2.430	0.695	22.051	0.001	***
C25:1-3	0.082	0.040	2.077	0.000	16.448	0.001	***
15-;13-;11-;9-;7-MeC29	0.073	0.039	1.850	16.100	1.673	0.001	***
n-C27	0.048	0.037	1.292	10.564	16.603	0.006	**
13-;11-;9-;7-MeC27	0.047	0.014	3.305	9.409	0.000	0.050	*
Contrast: ds_worker_vc_worker							
Compounds	Average	SD	Ratio	av ds	av vc	p-value	Sig. Level
n-C25	0.096	0.044	2.186	2.847	22.051	0.001	***

C25:1-3	0.082	0.040	2.076	0.000	16.448	0.001	***
n-C27	0.049	0.041	1.188	8.209	16.603	0.016	*
3-MeC29	0.039	0.010	4.100	7.800	0.000	0.001	***
15-;13-;11-;9-;7-MeC29	0.036	0.014	2.645	8.767	1.673	0.796	ns
Contrast: vg_worker_vc_worker							
Compounds	Average	SD	Ratio	av vg	av vc	p-value	Sig. Level
13-;11-;9-;7-MeC27	0.089	0.031	2.898	17.884	0.000	0.001	***
C25:1-3	0.082	0.040	2.077	0.000	16.448	0.001	***
n-C25	0.069	0.044	1.549	8.669	22.051	0.001	***
n-C27	0.048	0.032	1.525	17.243	16.603	0.007	**
3-MeC27	0.034	0.016	2.146	9.753	3.056	0.001	***

CHAPTER 5: Supplemental Information

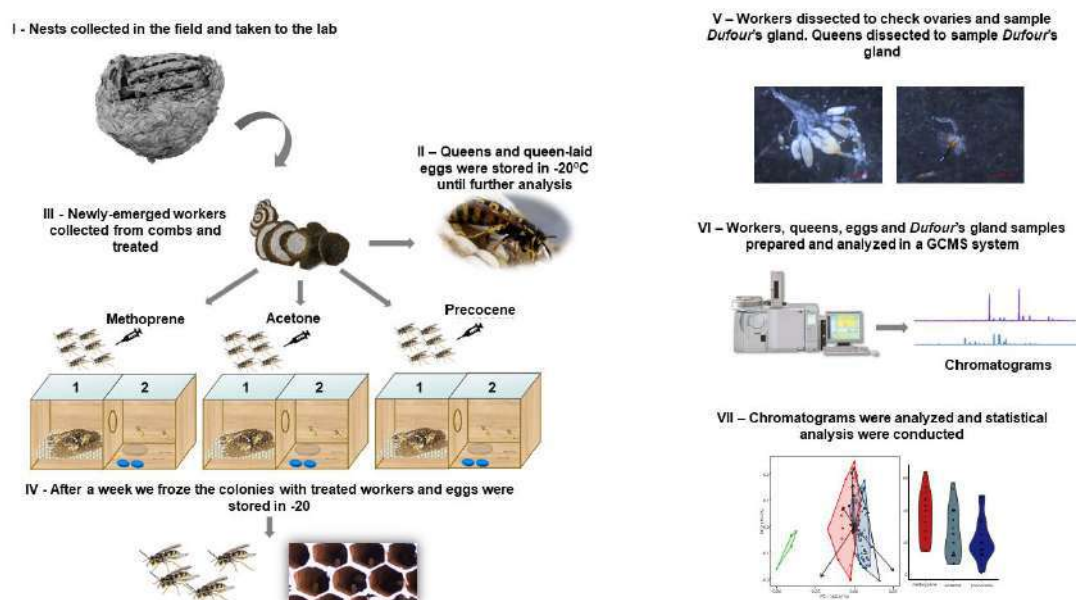


Figure S1: Experimental setup used to conduct in the present work. I - Nests containing the queen, workers and combs full of immature were collected in the field and taken to the laboratory. II - Once in the lab, we stored queens and queen-laid eggs in -20°C until further analysis. III - We collected newly-emerged wasps from combs and treated them with (1) solvent, (2) methoprene or (3) precocene. IV - Upon treatments, we kept workers in experimental boxes for a week (1 = box containing comb for workers lay eggs; 2 = foraging box). After a week, all the alive workers plus the combs containing eggs were stored in -20°C until further analysis. V - We dissected workers to access their ovary activation and to sample their Dufour's gland. We also dissected queens to sample their Dufour's gland. VI - We prepared and analyzed samples from worker and queen body surface, eggs and Dufour's gland content in a Gas Chromatography coupled with a Mass Spectrometer system (GCMS). VII - We analyzed the chromatograms and performed statistical analysis.

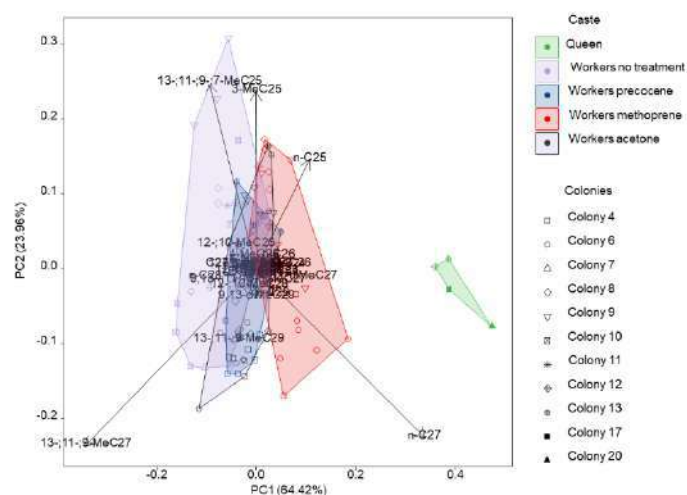


Figure S2: Principal component analysis (PCA) showing cuticular hydrocarbons differences in *Vespula germanica*. The symbols indicate the origin of the colonies and colors correspond to groups of females. Females are primarily separated according to their caste, however, methoprene treated workers represent the intermediate group between the queens and the remaining groups of workers.

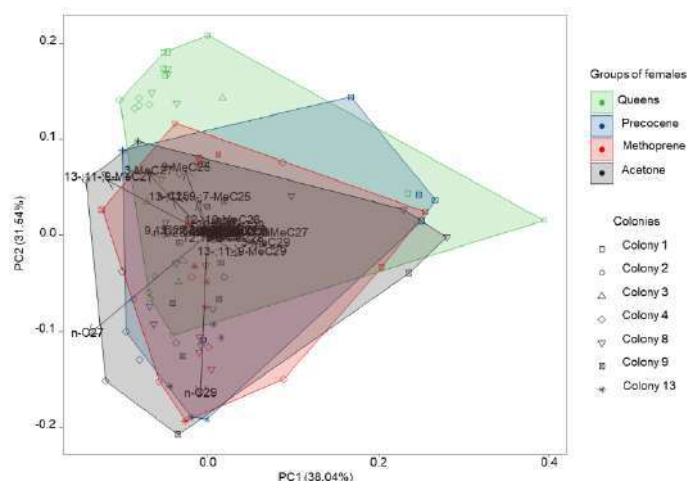


Figure S3: Principal component analysis (PCA) showing groups distribution of the hydrocarbons found in the surface of eggs in *Vespula germanica*. The symbols indicate the origin of the colonies and colors correspond to groups of females. In the x-axis is shown the principal component 1 (PC1), whereas the y-axis corresponds to principal component 2 (PC2). Chemical compounds depicted represent the ones highlighted by the similarity analysis (SIMPER).

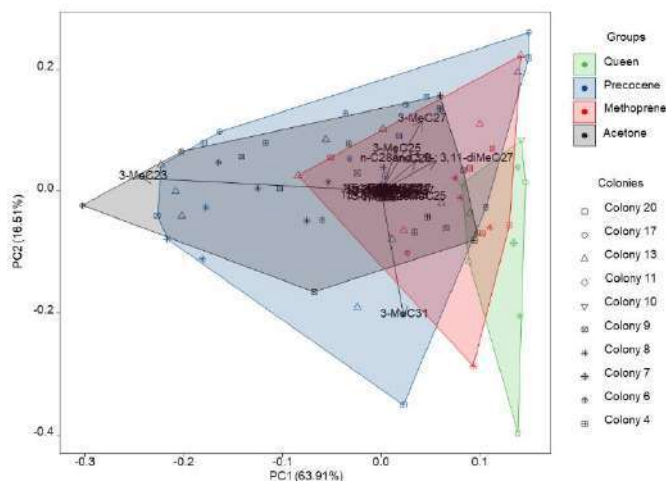


Figure S4: Principal component analysis (PCA) showing groups distribution of the hydrocarbons found in the *Dufour's* gland of *Vespula germanica*. The symbols indicate the origin of the colonies and colors correspond to groups of females. In the x-axis is shown the principal component 1 (PC1), whereas the y-axis corresponds to principal component 2 (PC2). Chemical compounds depicted represent the ones highlighted by the similarity analysis (SIMPER).

Table S1: Cuticular hydrocarbons identified in the samples of queens and treated workers of *Vespula germanica*. Peaknr = peak number, RT = retention time, RI = retention index.

Cuticular hydrocarbons of <i>Vespula germanica</i>				
peak nr	RT	RI	compound	diagnostic ions
1	18.76	2200	n-C22	310
2	19.79	2300	n-C23	324
3	20.19	2331	11-;9-MeC23	141/169/197/225
4	20.34	2344	5-MeC23	85/281
5	20.56	2366	3-MeC23	57/309
6	20.85	2400	n-C24	338
7	21.23	2428	12-;11-;10-MeC24	155/169/183/197/211/225
8	21.47	2451	4-MeC24	71/309
9	21.63	2467	C25:1	350
10	21.90	2500	n-C25	352
11	22.29	2528	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281
12	22.45	2543	5-MeC25	85/309
13	22.69	2565	3-MeC25	57/337
14	22.99	2600	n-C26	366
15	23.37	2627	12-;10-MeC26	155/183/225/253
16	23.65	2652	4-MeC26	71/337
17	23.83	2668	C27:1and 3-MeC26	378 + 57/351
18	24.10	2700	n-C27	380
19	24.50	2729	13-;11-;9-MeC27	141/169/197/225/253/281
20	24.97	2770	9,13-; 11,15-diMeC27	141/211/225/295/169/197/239/267
21	25.32	2800	n-C28 + 3,9-; 3,11-diMeC27	394 + 57/155/183/253/281/379
22	25.70	2835	12-;10-MeC28	155/183/253/281
23	26.06	2866	12,16-diMeC28	183/197/253/267
24	26.21	2879	C29:1	406
25	26.47	2900	n-C29	408
26	26.87	2937	13-;11-;9-MeC29	141/169/197/253/281/309
27	27.35	2979	9,13-diMeC29	141/211/253/323
28	28.25	3058	3-MeC29	57/393
29	29.32	3153	15-;13-MeC31	197/225/253/281
30	29.70	3187	7-MeC31	113/365
31	31.82	3380	7,x-diMeC33	113

Table S2: Hydrocarbons identified in the surface of eggs laid by queens and treated workers of *Vespula germanica*. Peaknr = peak number, RT = retention time, RI = retention index.

Hydrocarbons found in the eggs of <i>Vespula germanica</i>				
peaknr	RT	RI	compound	diagnostic ions
1	17.71	2100	n-C21	296
2	19.85	2300	n-C23	324
3	20.40	2348	3-MeC23	57/309
4	20.91	2400	n-C24	338

5	21.28	2430	12-;10-MeC24	197/183/155/225
6	21.69	2469	C25:1	350
7	21.95	2500	n-C25	352
8	22.34	2530	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281
9	22.49	2544	5-MeC25	85/309
10	22.74	2567	3-MeC25	57/337
11	23.04	2600	n-C26	366
12	23.43	2629	12-;10-MeC26	155/183/225/253
13	23.73	2656	4-MeC26	71/337
14	23.88	2670	C27:1and 3-MeC26	378 + 57/351
15	24.16	2700	n-C27	380
16	24.55	2730	13-;11-;9-MeC27	141/169/197/225/253/281
17	24.92	2762	9,13-; 11,15-diMeC27	141/211/225/295/169/197/239/267
18	25.01	2771	3-MeC27	57/365
19	25.34	2800	n-C28 and 3,9-; 3,11-diMeC27	394 + 57/155/183/253/281/379
20	25.73	2834	12-;10-MeC28	155/183/253/281
21	26.05	2862	12,16-diMeC28	183/197/253/267
22	26.22	2877	C29:1	406
23	26.49	2900	n-C29	408
24	26.88	2935	13-;11-;9-MeC29	141/169/197/253/281/309
25	27.25	2968	3-MeC29	57/393
26	27.68	3000	n-C30	422
27	28.64	3100	n-C31	436

Table S3: Hydrocarbons identified in the *Dufour's* gland of queens and treated workers of *Vespula germanica*. Peaknr = peak number, RT = retention time, RI = retention index.

Hydrocarbons found in the <i>Dufour's</i> gland of <i>Vespula germanica</i>				
peaknr	RT	RI	compound	diagnostic ions
1	19.85	2300	n-C23	324
2	20.44	2353	3-MeC23	57/309
3	20.89	2400	n-C24	338
4	21.30	2434	12-;10-MeC24	197/183/155/225
5	21.95	2500	n-C25	352
6	22.29	2527	13-;11-;9-;7-MeC25	197/169/225/141/253/113/281
7	22.76	2571	3-MeC25	57/337
8	23.09	2600	n-C26	366
9	23.39	2628	12-;10-MeC26	155/183/225/253
10	23.77	2662	C27:1	378
11	24.07	2700	n-C27	380
12	24.24	2705	13-;11-;9-MeC27	141/169/197/225/253/281
13	24.53	2731	7-;5-MeC27	113/309/85/337
14	24.97	2770	3-MeC27	57/365
15	25.39	2800	n-C28and 3,9-; 3,11-diMeC27	394 + 57/155/183/253/281/379
16	26.10	2870	C29:1	406
17	26.40	2900	n-C29	408
18	26.61	2915	13-;11-;9-MeC29	141/169/197/253/281/309
19	26.88	2938	7-MeC29	113/337
20	27.02	2950	3-MeC29	57/393
21	28.98	3121	15-;13-MeC31	197/225/253/281

22	29.51	3168	3-MeC31	57/421
23	31.54	3371	13,17-diMeC33	197/253/267/323

Table S4: Percentage similarity analysis (SIMPER – Bray-Curtis 999 permutations) showing the ten most important hydrocarbons for group differentiation, cuticular hydrocarbons, eggs and *Dufour's* gland. SD = standard deviation; Av = overall average.

Cuticular hydrocarbons							
	average	sd	ratio	Av. queens	Av. acetone	p	significance
<i>n</i> -C27	0.090	0.017	5.433	31.582	13.532	0.001	***
13-;11-;9-MeC27	0.088	0.016	5.405	9.445	27.030	0.001	***
<i>n</i> -C25	0.033	0.013	2.494	13.567	7.036	0.001	***
13-;11-;9-;7-MeC25	0.029	0.010	3.015	1.625	7.382	0.001	***
<i>n</i> -C26	0.014	0.003	5.167	5.028	2.236	0.001	***
13-;11-;9-MeC29	0.013	0.005	2.590	1.185	3.768	0.001	***
12-;10-MeC26	0.012	0.001	9.551	0.775	3.231	0.001	***
3-MeC25	0.010	0.007	1.471	7.383	6.450	0.737	n.s.
9,13-;11,15-diMeC27	0.008	0.006	1.397	17.132	16.784	0.219	n.s.
<i>n</i> -C29	0.006	0.002	3.200	2.320	1.144	0.002	**
	average	sd	ratio	Av. queens	Av. methoprene	p	significance
<i>n</i> -C27	0.081	0.023	3.482	31.582	15.464	0.001	***
13-;11-;9-MeC27	0.067	0.010	6.556	9.445	22.852	0.001	***
13-;11-;9-;7-MeC25	0.027	0.010	2.623	1.625	7.053	0.001	***
<i>n</i> -C25	0.027	0.012	2.267	13.567	8.157	0.001	***
<i>n</i> -C26	0.013	0.003	5.315	5.028	2.360	0.001	***
3-MeC25	0.012	0.008	1.538	7.383	7.030	0.294	n.s.
9,13-;11,15-diMeC27	0.011	0.008	1.346	17.132	15.828	0.016	*
13-;11-;9-MeC29	0.010	0.004	2.502	1.185	3.232	0.001	***
12-;10-MeC26	0.010	0.003	3.706	0.775	2.783	0.001	***
C27:1 + 3-MeC26	0.004	0.004	1.165	0.828	1.690	0.056	n.s.
	average	sd	ratio	Av. queens	Av. precocene	p	significance
<i>n</i> -C27	0.089	0.017	5.266	31.582	13.752	0.001	***
13-;11-;9-MeC27	0.087	0.012	7.355	9.445	26.913	0.001	***
13-;11-;9-;7-MeC25	0.029	0.007	4.392	1.625	7.512	0.001	***
<i>n</i> -C25	0.029	0.012	2.536	13.567	7.717	0.001	***
<i>n</i> -C26	0.014	0.003	5.402	5.028	2.310	0.001	***
13-;11-;9-MeC29	0.013	0.004	3.176	1.185	3.701	0.001	***
12-;10-MeC26	0.012	0.001	10.224	0.775	3.258	0.001	***
3-MeC25	0.009	0.006	1.501	7.383	6.239	0.803	n.s.
9,13-;11,15-diMeC27	0.008	0.007	1.299	17.132	16.208	0.257	n.s.
<i>n</i> -C29	0.006	0.001	4.373	2.320	1.040	0.001	***
	average	sd	ratio	Av. acetone	Av. methoprene	p	significance
13-;11-;9-MeC27	0.023	0.015	1.572	27.030	22.852	0.631	n.s.
<i>n</i> -C27	0.017	0.013	1.369	13.532	15.464	0.826	n.s.
3-MeC25	0.012	0.008	1.504	6.450	7.030	0.006	**
13-;11-;9-;7-MeC25	0.012	0.008	1.451	7.382	7.053	0.722	n.s.

n-C25	0.010	0.007	1.403	7.036	8.157	0.748	n.S.
9,13-; 11,15-diMeC27	0.009	0.006	1.421	16.784	15.828	0.003	**
13-;11-;9-MeC29	0.006	0.004	1.428	3.768	3.232	0.677	n.S.
C27:1 + 3-MeC26	0.003	0.004	0.982	1.116	1.690	0.001	**
n-C29	0.003	0.003	1.172	1.144	1.615	0.018	*
n-C23	0.003	0.005	0.628	0.187	0.756	0.003	***
	average	sd	ratio	Av. acetone	Av. precocene	p	significance
13-;11-;9-MeC27	0.015	0.012	1.302	27.030	26.913	1.000	n.S.
13-;11-;9-;7-MeC25	0.010	0.006	1.490	7.382	7.512	1.000	n.S.
n-C25	0.009	0.006	1.462	7.036	7.717	0.960	n.S.
3-MeC25	0.009	0.006	1.381	6.450	6.239	1.000	n.S.
n-C27	0.009	0.006	1.328	13.532	13.752	1.000	n.S.
9,13-;11,15-diMeC27	0.007	0.005	1.423	16.784	16.208	0.994	n.S.
13-;11-;9-MeC29	0.005	0.003	1.455	3.768	3.701	0.967	n.S.
9,13-diMeC29	0.003	0.002	1.286	2.952	2.738	0.656	n.S.
n-C26	0.002	0.001	1.362	2.236	2.310	0.995	n.S.
C27:1 + 3-MeC26	0.002	0.001	1.419	1.116	1.404	0.996	n.S.
	average	sd	ratio	Av. methoprene	Av. precocene	p	significance
13-;11-;9-MeC27	0.021	0.013	1.676	22.852	26.913	0.859	n.S.
n-C27	0.017	0.012	1.378	15.464	13.752	0.869	n.S.
3-MeC25	0.012	0.008	1.494	7.030	6.239	0.017	*
13-;11-;9-;7-MeC25	0.010	0.007	1.414	7.053	7.512	0.991	n.S.
9,13-;11,15-diMeC27	0.008	0.005	1.580	15.828	16.208	0.292	n.S.
n-C25	0.007	0.006	1.274	8.157	7.717	0.999	n.S.
13-;11-;9-MeC29	0.005	0.004	1.331	3.232	3.701	0.995	n.S.
n-C29	0.003	0.003	1.144	1.615	1.040	0.010	**
n-C23	0.003	0.005	0.658	0.756	0.211	0.001	**
15-;13-MeC31	0.003	0.004	0.726	0.796	0.256	0.001	***
Eggs							
	average	Sd	ratio	Av. queens	Av. acetone	p	significance
n-C27	0.039	0.028	1.394	15.529	18.562	0.186	n.s
n-C29	0.034	0.026	1.296	3.631	8.541	0.379	n.s
13-;11-;9-MeC27	0.033	0.027	1.237	18.989	15.493	0.074	n.s
3-MeC27	0.028	0.018	1.562	13.140	8.716	0.001	***
3-MeC25	0.021	0.019	1.102	8.385	4.852	0.004	**
n-C25	0.019	0.013	1.414	8.484	6.639	0.001	***
3-MeC29	0.015	0.018	0.818	3.985	4.515	0.139	n.s
13-;11-;9-MeC29	0.012	0.010	1.162	3.020	3.748	0.073	n.s
13-;11-;9-;7-MeC25	0.011	0.008	1.260	5.437	4.376	0.092	n.s
4-MeC26	0.010	0.031	0.309	1.151	2.743	0.096	n.s
	average	sd	ratio	Av. queens	Av. methoprene	p	significance
n-C29	0.039	0.026	1.479	3.631	10.498	0.002	**
n-C27	0.033	0.025	1.297	15.529	16.267	0.885	n.s
13-;11-;9-MeC27	0.030	0.024	1.253	18.989	16.229	0.429	n.s
3-MeC27	0.024	0.015	1.611	13.140	9.775	0.011	*
3-MeC25	0.022	0.019	1.129	8.385	5.050	0.002	**

<i>n</i> -C25	0.016	0.011	1.489	8.484	6.125	0.097	n.s
13-;11-;9-MeC29	0.013	0.010	1.242	3.020	4.593	0.010	**
3-MeC29	0.013	0.021	0.611	3.985	4.635	0.501	n.s
13-;11-;9-;7-MeC25	0.011	0.009	1.304	5.437	4.506	0.009	**
9,13-;11,15-diMeC27	0.009	0.011	0.878	3.567	4.720	0.293	n.s
	average	sd	ratio	Av. queens	Av. precocene	p	significance
<i>n</i> -C29	0.039	0.025	1.521	3.631	10.253	0.005	**
<i>n</i> -C27	0.035	0.025	1.403	15.529	17.110	0.656	n.s
13-;11-;9-MeC27	0.034	0.027	1.255	18.989	15.991	0.031	*
3-MeC27	0.026	0.016	1.644	13.140	8.879	0.002	***
3-MeC25	0.020	0.019	1.078	8.385	4.836	0.005	**
<i>n</i> -C25	0.017	0.011	1.521	8.484	5.677	0.007	**
3-MeC29	0.011	0.017	0.686	3.985	4.531	0.719	n.s
13-;11-;9-MeC29	0.011	0.008	1.389	3.020	4.276	0.308	n.s
13-;11-;9-;7-MeC25	0.011	0.008	1.268	5.437	4.493	0.097	n.s
9,13-;11,15-diMeC27	0.009	0.006	1.414	3.567	4.237	0.512	n.s
	average	sd	ratio	Av. acetone	Av. methoprene	p	significance
<i>n</i> -C27	0.039	0.029	1.359	18.562	16.267	0.161	n.s
<i>n</i> -C29	0.033	0.024	1.356	8.541	10.499	0.568	n.s
13-;11-;9-MeC27	0.023	0.020	1.132	15.493	16.229	0.964	n.s
3-MeC27	0.017	0.013	1.294	8.716	9.776	0.965	n.s
3-MeC29	0.015	0.015	0.980	4.515	4.635	0.198	n.s
<i>n</i> -C25	0.013	0.015	0.912	6.639	6.126	0.695	n.s
3-MeC25	0.012	0.011	1.116	4.852	5.050	0.949	n.s
13-;11-;9-MeC29	0.012	0.009	1.279	3.748	4.593	0.193	n.s
4-MeC26	0.010	0.031	0.322	2.743	1.251	0.049	*
	average	sd	ratio	Av. acetone	Av. precocene	p	significance
<i>n</i> -C27	0.038	0.030	1.278	18.562	17.110	0.195	n.s
<i>n</i> -C29	0.033	0.023	1.407	8.541	10.253	0.582	n.s
13-;11-;9-MeC27	0.028	0.023	1.215	15.493	15.991	0.629	n.s
3-MeC27	0.016	0.013	1.230	8.716	8.879	0.990	n.s
3-MeC29	0.013	0.010	1.298	4.515	4.531	0.406	n.s
<i>n</i> -C25	0.013	0.015	0.827	6.639	5.677	0.761	n.s
4-MeC26	0.010	0.031	0.330	2.743	1.297	0.020	*
13-;11-;9-MeC29	0.010	0.007	1.477	3.748	4.276	0.643	n.s
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.010	0.011	0.852	3.216	3.332	0.031	*
3-MeC25	0.009	0.009	1.055	4.852	4.836	1.000	n.s
	average	sd	ratio	Av. methoprene	Av. precocene	p	significance
<i>n</i> -C27	0.035	0.028	1.251	16.267	17.110	0.665	n.s
<i>n</i> -C29	0.030	0.022	1.379	10.499	10.253	0.933	n.s
13-;11-;9-MeC27	0.025	0.021	1.202	16.229	15.991	0.932	n.s
3-MeC27	0.014	0.012	1.210	9.776	8.879	1.000	n.s
3-MeC25	0.011	0.009	1.144	5.050	4.836	0.993	n.s
3-MeC29	0.010	0.014	0.718	4.635	4.531	0.857	n.s
<i>n</i> -C25	0.009	0.010	0.952	6.126	5.677	0.999	n.s

9,13-;11,15-diMeC27	0.009	0.010	0.873	4.721	4.237	0.410	n.s
13-;11-;9-;7-MeC25	0.008	0.006	1.337	4.507	4.493	0.947	n.s
13-;11-;9-MeC29	0.007	0.008	0.959	4.593	4.276	1.000	n.s

Dufour gland							
	average	sd	ratio	Av. queens	Av. acetone	p	significance
3-MeC23	0.122	0.076	1.596	2.121	26.449	0.010	**
3-MeC31	0.050	0.053	0.952	13.836	7.488	0.120	n.s.
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.047	0.029	1.644	21.646	13.114	0.001	**
<i>n</i> -C26	0.030	0.019	1.541	11.014	6.533	0.007	**
3-MeC27	0.028	0.020	1.356	10.878	12.667	0.963	n.s.
3-MeC25	0.019	0.015	1.279	3.324	6.744	0.783	n.s.
13-;11-;9-;7-MeC25	0.016	0.013	1.231	8.245	6.441	0.776	n.s.
12-;10-MeC26	0.013	0.011	1.168	4.895	2.796	0.002	**
7-;5-MeC27	0.013	0.013	0.961	5.844	4.020	0.681	n.s.
<i>n</i> -C25	0.010	0.008	1.237	2.275	2.570	0.236	n.s.

	average	sd	ratio	Av. queens	Av. methoprene	p	significance
3-MeC31	0.055	0.051	1.086	13.836	9.735	0.061	n.s.
3-MeC23	0.047	0.044	1.063	2.121	11.117	1.000	n.s.
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.036	0.024	1.491	21.646	16.232	0.087	n.s.
3-MeC27	0.031	0.026	1.155	10.878	14.291	0.807	n.s.
3-MeC25	0.026	0.013	1.923	3.324	8.479	0.074	n.s.
<i>n</i> -C26	0.023	0.015	1.528	11.014	9.930	0.507	n.s.
13-;11-;9-;7-MeC25	0.019	0.021	0.905	8.245	9.326	0.497	n.s.
7-;5-MeC27	0.019	0.021	0.894	5.844	7.023	0.207	n.s.
12-;10-MeC26	0.011	0.010	1.190	4.895	3.553	0.041	*
12-;10-MeC24	0.009	0.008	1.055	2.374	0.629	0.015	*

	average	sd	ratio	Av. queens	Av. precocene	p	significance
3-MeC23	0.124	0.088	1.403	2.121	26.460	0.013	*
3-MeC31	0.057	0.058	0.983	13.836	6.862	0.035	*
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.047	0.033	1.428	21.646	13.668	0.001	**
3-MeC27	0.039	0.033	1.175	10.878	14.963	0.321	n.s.
<i>n</i> -C26	0.030	0.021	1.486	11.014	7.370	0.004	**
3-MeC25	0.026	0.022	1.202	3.324	8.280	0.052	n.s.
13-;11-;9-;7-MeC25	0.021	0.023	0.933	8.245	6.368	0.328	n.s.
7-;5-MeC27	0.017	0.016	1.025	5.844	3.858	0.311	n.s.
12-;10-MeC26	0.014	0.012	1.173	4.895	2.309	0.002	**
<i>n</i> -C25	0.010	0.010	1.035	2.275	1.959	0.227	n.s.

	average	sd	ratio	Av. acetone	Av. methoprene	p	significance
3-MeC23	0.093	0.071	1.318	26.449	11.117	0.645	n.s.
3-MeC31	0.037	0.031	1.206	7.488	9.735	0.736	n.s.
3-MeC27	0.031	0.026	1.195	12.667	14.291	0.909	n.s.
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.022	0.016	1.359	13.114	16.232	0.999	n.s.
<i>n</i> -C26	0.022	0.015	1.478	6.533	9.930	0.767	n.s.
13-;11-;9-;7-MeC25	0.021	0.023	0.916	6.441	9.326	0.348	n.s.
7-;5-MeC27	0.018	0.022	0.819	4.020	7.023	0.119	n.s.

3-MeC25	0.018	0.013	1.356	6.744	8.479	0.962	n.s.
<i>n</i> -C25	0.008	0.007	1.082	2.570	1.436	0.751	n.s.
3-MeC29	0.007	0.009	0.834	0.742	1.332	0.024	*
	average	sd	ratio	Av. acetone	Av. precocene	p	significance
3-MeC23	0.096	0.068	1.413	26.449	26.460	0.509	n.s.
3-MeC27	0.039	0.032	1.252	12.667	14.963	0.130	n.s.
3-MeC31	0.034	0.035	0.961	7.488	6.862	0.922	n.s.
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.028	0.018	1.542	13.114	13.668	0.851	n.s.
3-MeC25	0.022	0.018	1.260	6.744	8.280	0.168	n.s.
<i>n</i> -C26	0.021	0.017	1.273	6.533	7.370	0.925	n.s.
13-;11-;9-;7-MeC25	0.017	0.023	0.739	6.441	6.368	0.794	n.s.
7-;5-MeC27	0.011	0.013	0.805	4.020	3.858	0.974	n.s.
<i>n</i> -C25	0.010	0.009	1.032	2.570	1.959	0.232	n.s.
C29:1	0.007	0.006	1.092	1.826	1.151	0.252	n.s.
	average	sd	ratio	Av. methoprene	Av. precocene	p	significance
3-MeC23	0.101	0.075	1.341	11.117	26.460	0.175	n.s.
3-MeC31	0.043	0.040	1.091	9.735	6.862	0.326	n.s.
3-MeC27	0.040	0.033	1.237	14.291	14.962	0.154	n.s.
<i>n</i> -C28 + 3,9-;3,11-diMeC27	0.029	0.020	1.435	16.232	13.668	0.654	n.s.
13-;11-;9-;7-MeC25	0.026	0.029	0.903	9.326	6.368	0.026	*
<i>n</i> -C26	0.024	0.015	1.577	9.930	7.370	0.244	n.s.
7-;5-MeC27	0.022	0.023	0.929	7.023	3.857	0.002	**
3-MeC25	0.021	0.015	1.389	8.479	8.279	0.520	n.s.
12-;10-MeC26	0.008	0.005	1.575	3.553	2.308	0.592	n.s.
<i>n</i> -C25	0.007	0.009	0.843	1.436	1.959	0.922	n.s.

Table S5: Pairwise comparisons considering the chemical compounds of each group of sample (CHC, eggs or *Dufour's* gland) and each group of female (queen, workers treated with methoprene, workers treated with precocene and workers treated with acetone) in *Vespa germanica*. ace = acetone, met = methoprene, pre = precocene, chc = cuticular hydrocarbons, dg = *Dufour's* gland, padj = p value adjusted. All the values highlighted in red correspond to significant values $p < 0.05^*$.

compound	contrast	estimate	SE	df	t.ratio	p.value	padj
C25.1	ace_chc - ace_dg	5.321	0.349	229.0	15.248	0.000	0.000
C25.1	ace_chc - ace_egg	5.321	0.370	229.0	14.376	0.000	0.000
C25.1	ace_chc - met_chc	-2.072	0.365	229.0	-5.673	0.000	0.000
C25.1	ace_chc - met_dg	5.321	0.403	229.0	13.205	0.000	0.000
C25.1	ace_chc - met_egg	5.321	0.356	229.0	14.927	0.000	0.000
C25.1	ace_chc - pre_chc	-0.349	0.349	229.0	-0.999	0.319	1.000
C25.1	ace_chc - pre_dg	5.321	0.353	229.0	15.091	0.000	0.000
C25.1	ace_chc - pre_egg	5.321	0.353	229.0	15.092	0.000	0.000
C25.1	ace_chc - queen_chc	-1.323	0.664	229.0	-1.992	0.048	1.000
C25.1	ace_chc - queen_dg	5.321	0.501	229.0	10.617	0.000	0.000
C25.1	ace_chc - queen_egg	5.321	0.342	229.0	15.539	0.000	0.000
C25.1	ace_dg - ace_egg	0.000	0.370	229.0	0.000	1.000	1.000
C25.1	ace_dg - met_chc	-7.393	0.365	229.0	-20.243	0.000	0.000
C25.1	ace_dg - met_dg	0.000	0.403	229.0	-0.001	1.000	1.000
C25.1	ace_dg - met_egg	0.000	0.356	229.0	0.000	1.000	1.000
C25.1	ace_dg - pre_chc	-5.670	0.349	229.0	-16.247	0.000	0.000
C25.1	ace_dg - pre_dg	0.000	0.353	229.0	0.000	1.000	1.000

C25.1	ace_dg - pre_egg	0.000	0.353	229.0	0.000	1.000	1.000
C25.1	ace_dg - queen_chc	-6.644	0.664	229.0	-10.000	0.000	0.000
C25.1	ace_dg - queen_dg	0.000	0.501	229.0	0.000	1.000	1.000
C25.1	ace_dg - queen_egg	0.000	0.342	229.0	0.000	1.000	1.000
C25.1	ace_egg - met_chc	-7.393	0.385	229.0	-19.179	0.000	0.000
C25.1	ace_egg - met_dg	0.000	0.421	229.0	-0.001	0.999	1.000
C25.1	ace_egg - met_egg	0.000	0.377	229.0	0.000	1.000	1.000
C25.1	ace_egg - pre_chc	-5.670	0.370	229.0	-15.318	0.000	0.000
C25.1	ace_egg - pre_dg	0.000	0.374	229.0	0.000	1.000	1.000
C25.1	ace_egg - pre_egg	0.000	0.374	229.0	0.000	1.000	1.000
C25.1	ace_egg - queen_chc	-6.645	0.676	229.0	-9.832	0.000	0.000
C25.1	ace_egg - queen_dg	0.000	0.516	229.0	-0.001	0.999	1.000
C25.1	ace_egg - queen_egg	0.000	0.364	229.0	0.000	1.000	1.000
C25.1	met_chc - met_dg	7.393	0.417	229.0	17.724	0.000	0.000
C25.1	met_chc - met_egg	7.393	0.372	229.0	19.853	0.000	0.000
C25.1	met_chc - pre_chc	1.723	0.365	229.0	4.719	0.000	0.012
C25.1	met_chc - pre_dg	7.393	0.369	229.0	20.053	0.000	0.000
C25.1	met_chc - pre_egg	7.393	0.369	229.0	20.053	0.000	0.000
C25.1	met_chc - queen_chc	0.748	0.673	229.0	1.112	0.267	1.000
C25.1	met_chc - queen_dg	7.393	0.513	229.0	14.422	0.000	0.000
C25.1	met_chc - queen_egg	7.393	0.359	229.0	20.595	0.000	0.000
C25.1	met_dg - met_egg	0.000	0.409	229.0	0.001	0.999	1.000
C25.1	met_dg - pre_chc	-5.669	0.403	229.0	-14.070	0.000	0.000
C25.1	met_dg - pre_dg	0.000	0.406	229.0	0.000	1.000	1.000
C25.1	met_dg - pre_egg	0.000	0.406	229.0	0.001	1.000	1.000
C25.1	met_dg - queen_chc	-6.644	0.694	229.0	-9.570	0.000	0.000
C25.1	met_dg - queen_dg	0.000	0.540	229.0	0.000	1.000	1.000
C25.1	met_dg - queen_egg	0.000	0.397	229.0	0.001	0.999	1.000
C25.1	met_egg - pre_chc	-5.670	0.356	229.0	-15.905	0.000	0.000
C25.1	met_egg - pre_dg	0.000	0.360	229.0	0.000	1.000	1.000
C25.1	met_egg - pre_egg	0.000	0.360	229.0	0.000	1.000	1.000
C25.1	met_egg - queen_chc	-6.644	0.668	229.0	-9.941	0.000	0.000
C25.1	met_egg - queen_dg	0.000	0.506	229.0	-0.001	1.000	1.000
C25.1	met_egg - queen_egg	0.000	0.350	229.0	0.000	1.000	1.000
C25.1	pre_chc - pre_dg	5.670	0.353	229.0	16.080	0.000	0.000
C25.1	pre_chc - pre_egg	5.670	0.353	229.0	16.080	0.000	0.000
C25.1	pre_chc - queen_chc	-0.975	0.664	229.0	-1.467	0.144	1.000
C25.1	pre_chc - queen_dg	5.669	0.501	229.0	11.312	0.000	0.000
C25.1	pre_chc - queen_egg	5.670	0.342	229.0	16.557	0.000	0.000
C25.1	pre_dg - pre_egg	0.000	0.356	229.0	0.000	1.000	1.000
C25.1	pre_dg - queen_chc	-6.644	0.666	229.0	-9.972	0.000	0.000
C25.1	pre_dg - queen_dg	0.000	0.504	229.0	0.000	1.000	1.000
C25.1	pre_dg - queen_egg	0.000	0.346	229.0	0.000	1.000	1.000
C25.1	pre_egg - queen_chc	-6.644	0.666	229.0	-9.972	0.000	0.000
C25.1	pre_egg - queen_dg	0.000	0.504	229.0	0.000	1.000	1.000
C25.1	pre_egg - queen_egg	0.000	0.346	229.0	0.000	1.000	1.000
C25.1	queen_chc - queen_dg	6.644	0.756	229.0	8.794	0.000	0.000
C25.1	queen_chc - queen_egg	6.644	0.661	229.0	10.052	0.000	0.000
C25.1	queen_dg - queen_egg	0.000	0.497	229.0	0.001	0.999	1.000
C25.1.2	ace_chc - ace_dg	0.000	0.538	229.0	0.001	0.999	1.000
C25.1.2	ace_chc - ace_egg	-5.555	0.570	229.0	-9.741	0.000	0.000
C25.1.2	ace_chc - met_chc	0.000	0.563	229.0	0.000	1.000	1.000
C25.1.2	ace_chc - met_dg	0.000	0.621	229.0	0.000	1.000	1.000
C25.1.2	ace_chc - met_egg	-7.127	0.549	229.0	-12.977	0.000	0.000
C25.1.2	ace_chc - pre_chc	0.000	0.538	229.0	0.000	1.000	1.000
C25.1.2	ace_chc - pre_dg	0.000	0.543	229.0	0.001	0.999	1.000
C25.1.2	ace_chc - pre_egg	-6.428	0.543	229.0	-11.834	0.000	0.000
C25.1.2	ace_chc - queen_chc	0.000	1.024	229.0	0.000	1.000	1.000
C25.1.2	ace_chc - queen_dg	0.000	0.772	229.0	0.000	1.000	1.000
C25.1.2	ace_chc - queen_egg	-7.203	0.528	229.0	-13.653	0.000	0.000
C25.1.2	ace_dg - ace_egg	-5.555	0.570	229.0	-9.742	0.000	0.000
C25.1.2	ace_dg - met_chc	0.000	0.563	229.0	-0.001	0.999	1.000
C25.1.2	ace_dg - met_dg	0.000	0.621	229.0	0.000	1.000	1.000
C25.1.2	ace_dg - met_egg	-7.127	0.549	229.0	-12.978	0.000	0.000
C25.1.2	ace_dg - pre_chc	0.000	0.538	229.0	-0.001	0.999	1.000
C25.1.2	ace_dg - pre_dg	0.000	0.543	229.0	0.000	1.000	1.000
C25.1.2	ace_dg - pre_egg	-6.429	0.543	229.0	-11.835	0.000	0.000
C25.1.2	ace_dg - queen_chc	-0.001	1.024	229.0	-0.001	1.000	1.000

C25.1.2	ace_dg - queen_dg	0.000	0.772	229.0	0.000	1.000	1.000
C25.1.2	ace_dg - queen_egg	-7.203	0.528	229.0	-13.654	0.000	0.000
C25.1.2	ace_egg - met_chc	5.555	0.594	229.0	9.354	0.000	0.000
C25.1.2	ace_egg - met_dg	5.555	0.649	229.0	8.556	0.000	0.000
C25.1.2	ace_egg - met_egg	-1.572	0.581	229.0	-2.705	0.007	1.000
C25.1.2	ace_egg - pre_chc	5.555	0.570	229.0	9.741	0.000	0.000
C25.1.2	ace_egg - pre_dg	5.555	0.575	229.0	9.653	0.000	0.000
C25.1.2	ace_egg - pre_egg	-0.873	0.575	229.0	-1.517	0.131	1.000
C25.1.2	ace_egg - queen_chc	5.555	1.041	229.0	5.335	0.000	0.001
C25.1.2	ace_egg - queen_dg	5.555	0.795	229.0	6.986	0.000	0.000
C25.1.2	ace_egg - queen_egg	-1.648	0.561	229.0	-2.939	0.004	1.000
C25.1.2	met_chc - met_dg	0.000	0.643	229.0	0.000	1.000	1.000
C25.1.2	met_chc - met_egg	-7.127	0.574	229.0	-12.423	0.000	0.000
C25.1.2	met_chc - pre_chc	0.000	0.563	229.0	0.000	1.000	1.000
C25.1.2	met_chc - pre_dg	0.000	0.568	229.0	0.001	1.000	1.000
C25.1.2	met_chc - pre_egg	-6.428	0.568	229.0	-11.318	0.000	0.000
C25.1.2	met_chc - queen_chc	0.000	1.037	229.0	0.000	1.000	1.000
C25.1.2	met_chc - queen_dg	0.000	0.790	229.0	0.000	1.000	1.000
C25.1.2	met_chc - queen_egg	-7.203	0.553	229.0	-13.024	0.000	0.000
C25.1.2	met_dg - met_egg	-7.127	0.631	229.0	-11.298	0.000	0.000
C25.1.2	met_dg - pre_chc	0.000	0.621	229.0	0.000	1.000	1.000
C25.1.2	met_dg - pre_dg	0.000	0.626	229.0	0.000	1.000	1.000
C25.1.2	met_dg - pre_egg	-6.428	0.626	229.0	-10.275	0.000	0.000
C25.1.2	met_dg - queen_chc	0.000	1.070	229.0	0.000	1.000	1.000
C25.1.2	met_dg - queen_dg	0.000	0.832	229.0	0.000	1.000	1.000
C25.1.2	met_dg - queen_egg	-7.203	0.612	229.0	-11.768	0.000	0.000
C25.1.2	met_egg - pre_chc	7.127	0.549	229.0	12.977	0.000	0.000
C25.1.2	met_egg - pre_dg	7.127	0.555	229.0	12.850	0.000	0.000
C25.1.2	met_egg - pre_egg	0.699	0.555	229.0	1.260	0.209	1.000
C25.1.2	met_egg - queen_chc	7.127	1.030	229.0	6.921	0.000	0.000
C25.1.2	met_egg - queen_dg	7.127	0.780	229.0	9.135	0.000	0.000
C25.1.2	met_egg - queen_egg	-0.076	0.539	229.0	-0.141	0.888	1.000
C25.1.2	pre_chc - pre_dg	0.000	0.543	229.0	0.001	0.999	1.000
C25.1.2	pre_chc - pre_egg	-6.428	0.543	229.0	-11.834	0.000	0.000
C25.1.2	pre_chc - queen_chc	0.000	1.024	229.0	0.000	1.000	1.000
C25.1.2	pre_chc - queen_dg	0.000	0.772	229.0	0.000	1.000	1.000
C25.1.2	pre_chc - queen_egg	-7.203	0.528	229.0	-13.653	0.000	0.000
C25.1.2	pre_dg - pre_egg	-6.428	0.549	229.0	-11.716	0.000	0.000
C25.1.2	pre_dg - queen_chc	0.000	1.027	229.0	0.000	1.000	1.000
C25.1.2	pre_dg - queen_dg	0.000	0.776	229.0	0.000	1.000	1.000
C25.1.2	pre_dg - queen_egg	-7.203	0.533	229.0	-13.508	0.000	0.000
C25.1.2	pre_egg - queen_chc	6.428	1.027	229.0	6.262	0.000	0.000
C25.1.2	pre_egg - queen_dg	6.428	0.776	229.0	8.284	0.000	0.000
C25.1.2	pre_egg - queen_egg	-0.775	0.533	229.0	-1.453	0.148	1.000
C25.1.2	queen_chc - queen_dg	0.000	1.164	229.0	0.000	1.000	1.000
C25.1.2	queen_chc - queen_egg	-7.203	1.018	229.0	-7.073	0.000	0.000
C25.1.2	queen_dg - queen_egg	-7.203	0.765	229.0	-9.414	0.000	0.000
C27.1	ace_chc - ace_dg	-3.614	0.640	229.0	-5.646	0.000	0.000
C27.1	ace_chc - ace_egg	0.001	0.679	229.0	0.001	0.999	1.000
C27.1	ace_chc - met_chc	0.000	0.670	229.0	0.000	1.000	1.000
C27.1	ace_chc - met_dg	-1.816	0.739	229.0	-2.457	0.015	1.000
C27.1	ace_chc - met_egg	0.000	0.654	229.0	0.001	0.999	1.000
C27.1	ace_chc - pre_chc	0.000	0.640	229.0	0.000	1.000	1.000
C27.1	ace_chc - pre_dg	-2.517	0.647	229.0	-3.892	0.000	0.379
C27.1	ace_chc - pre_egg	0.000	0.647	229.0	0.001	0.999	1.000
C27.1	ace_chc - queen_chc	0.000	1.219	229.0	0.000	1.000	1.000
C27.1	ace_chc - queen_dg	-10.484	0.919	229.0	-11.405	0.000	0.000
C27.1	ace_chc - queen_egg	0.001	0.628	229.0	0.001	0.999	1.000
C27.1	ace_dg - ace_egg	3.614	0.679	229.0	5.323	0.000	0.001
C27.1	ace_dg - met_chc	3.614	0.670	229.0	5.395	0.000	0.000
C27.1	ace_dg - met_dg	1.797	0.739	229.0	2.432	0.016	1.000
C27.1	ace_dg - met_egg	3.614	0.654	229.0	5.527	0.000	0.000
C27.1	ace_dg - pre_chc	3.614	0.640	229.0	5.646	0.000	0.000
C27.1	ace_dg - pre_dg	1.097	0.647	229.0	1.696	0.091	1.000
C27.1	ace_dg - pre_egg	3.614	0.647	229.0	5.588	0.000	0.000
C27.1	ace_dg - queen_chc	3.613	1.219	229.0	2.965	0.003	1.000
C27.1	ace_dg - queen_dg	-6.871	0.919	229.0	-7.474	0.000	0.000
C27.1	ace_dg - queen_egg	3.614	0.628	229.0	5.754	0.000	0.000

C27.1	ace_egg - met_chc	-0.001	0.707	229.0	-0.001	0.999	1.000
C27.1	ace_egg - met_dg	-1.817	0.773	229.0	-2.350	0.020	1.000
C27.1	ace_egg - met_egg	0.000	0.692	229.0	0.000	1.000	1.000
C27.1	ace_egg - pre_chc	-0.001	0.679	229.0	-0.001	0.999	1.000
C27.1	ace_egg - pre_dg	-2.517	0.685	229.0	-3.674	0.000	0.864
C27.1	ace_egg - pre_egg	0.000	0.685	229.0	0.000	1.000	1.000
C27.1	ace_egg - queen_chc	-0.001	1.239	229.0	-0.001	1.000	1.000
C27.1	ace_egg - queen_dg	-10.485	0.947	229.0	-11.075	0.000	0.000
C27.1	ace_egg - queen_egg	0.000	0.668	229.0	0.000	1.000	1.000
C27.1	met_chc - met_dg	-1.816	0.765	229.0	-2.374	0.018	1.000
C27.1	met_chc - met_egg	0.000	0.683	229.0	0.001	0.999	1.000
C27.1	met_chc - pre_chc	0.000	0.670	229.0	0.000	1.000	1.000
C27.1	met_chc - pre_dg	-2.517	0.676	229.0	-3.722	0.000	0.723
C27.1	met_chc - pre_egg	0.000	0.676	229.0	0.001	1.000	1.000
C27.1	met_chc - queen_chc	0.000	1.235	229.0	0.000	1.000	1.000
C27.1	met_chc - queen_dg	-10.484	0.940	229.0	-11.151	0.000	0.000
C27.1	met_chc - queen_egg	0.001	0.658	229.0	0.001	0.999	1.000
C27.1	met_dg - met_egg	1.817	0.751	229.0	2.419	0.016	1.000
C27.1	met_dg - pre_chc	1.816	0.739	229.0	2.457	0.015	1.000
C27.1	met_dg - pre_dg	-0.701	0.745	229.0	-0.941	0.348	1.000
C27.1	met_dg - pre_egg	1.817	0.745	229.0	2.439	0.015	1.000
C27.1	met_dg - queen_chc	1.816	1.273	229.0	1.426	0.155	1.000
C27.1	met_dg - queen_dg	-8.668	0.991	229.0	-8.749	0.000	0.000
C27.1	met_dg - queen_egg	1.817	0.729	229.0	2.493	0.013	1.000
C27.1	met_egg - pre_chc	-0.001	0.654	229.0	-0.001	0.999	1.000
C27.1	met_egg - pre_dg	-2.517	0.660	229.0	-3.812	0.000	0.515
C27.1	met_egg - pre_egg	0.000	0.660	229.0	0.000	1.000	1.000
C27.1	met_egg - queen_chc	-0.001	1.226	229.0	0.000	1.000	1.000
C27.1	met_egg - queen_dg	-10.485	0.929	229.0	-11.288	0.000	0.000
C27.1	met_egg - queen_egg	0.000	0.642	229.0	0.000	1.000	1.000
C27.1	pre_chc - pre_dg	-2.517	0.647	229.0	-3.892	0.000	0.379
C27.1	pre_chc - pre_egg	0.000	0.647	229.0	0.001	0.999	1.000
C27.1	pre_chc - queen_chc	0.000	1.219	229.0	0.000	1.000	1.000
C27.1	pre_chc - queen_dg	-10.484	0.919	229.0	-11.405	0.000	0.000
C27.1	pre_chc - queen_egg	0.001	0.628	229.0	0.001	0.999	1.000
C27.1	pre_dg - pre_egg	2.517	0.653	229.0	3.853	0.000	0.440
C27.1	pre_dg - queen_chc	2.517	1.222	229.0	2.059	0.041	1.000
C27.1	pre_dg - queen_dg	-7.968	0.924	229.0	-8.624	0.000	0.000
C27.1	pre_dg - queen_egg	2.517	0.635	229.0	3.965	0.000	0.285
C27.1	pre_egg - queen_chc	-0.001	1.222	229.0	0.000	1.000	1.000
C27.1	pre_egg - queen_dg	-10.485	0.924	229.0	-11.349	0.000	0.000
C27.1	pre_egg - queen_egg	0.000	0.635	229.0	0.000	1.000	1.000
C27.1	queen_chc - queen_dg	-10.484	1.386	229.0	-7.565	0.000	0.000
C27.1	queen_chc - queen_egg	0.001	1.212	229.0	0.001	1.000	1.000
C27.1	queen_dg - queen_egg	10.485	0.911	229.0	11.510	0.000	0.000
C27.1and.3.MeC26	ace_chc - ace_dg	10.093	0.139	229.0	72.370	0.000	0.000
C27.1and.3.MeC26	ace_chc - ace_egg	0.451	0.148	229.0	3.046	0.003	1.000
C27.1and.3.MeC26	ace_chc - met_chc	-0.511	0.146	229.0	-3.503	0.001	1.000
C27.1and.3.MeC26	ace_chc - met_dg	10.093	0.161	229.0	62.673	0.000	0.000
C27.1and.3.MeC26	ace_chc - met_egg	0.059	0.142	229.0	0.415	0.679	1.000
C27.1and.3.MeC26	ace_chc - pre_chc	-0.338	0.139	229.0	-2.426	0.016	1.000
C27.1and.3.MeC26	ace_chc - pre_dg	10.093	0.141	229.0	71.627	0.000	0.000
C27.1and.3.MeC26	ace_chc - pre_egg	0.159	0.141	229.0	1.126	0.261	1.000
C27.1and.3.MeC26	ace_chc - queen_chc	0.472	0.266	229.0	1.778	0.077	1.000
C27.1and.3.MeC26	ace_chc - queen_dg	10.093	0.200	229.0	50.391	0.000	0.000
C27.1and.3.MeC26	ace_chc - queen_egg	0.037	0.137	229.0	0.269	0.788	1.000
C27.1and.3.MeC26	ace_dg - ace_egg	-9.642	0.148	229.0	-65.185	0.000	0.000
C27.1and.3.MeC26	ace_dg - met_chc	-10.604	0.146	229.0	-72.655	0.000	0.000
C27.1and.3.MeC26	ace_dg - met_dg	0.000	0.161	229.0	-0.001	0.999	1.000
C27.1and.3.MeC26	ace_dg - met_egg	-10.034	0.142	229.0	-70.432	0.000	0.000
C27.1and.3.MeC26	ace_dg - pre_chc	-10.431	0.139	229.0	-74.796	0.000	0.000
C27.1and.3.MeC26	ace_dg - pre_dg	0.000	0.141	229.0	-0.001	1.000	1.000
C27.1and.3.MeC26	ace_dg - pre_egg	-9.934	0.141	229.0	-70.501	0.000	0.000
C27.1and.3.MeC26	ace_dg - queen_chc	-9.621	0.266	229.0	-36.233	0.000	0.000
C27.1and.3.MeC26	ace_dg - queen_dg	0.000	0.200	229.0	-0.001	0.999	1.000
C27.1and.3.MeC26	ace_dg - queen_egg	-10.056	0.137	229.0	-73.480	0.000	0.000
C27.1and.3.MeC26	ace_egg - met_chc	-0.962	0.154	229.0	-6.244	0.000	0.000
C27.1and.3.MeC26	ace_egg - met_dg	9.642	0.168	229.0	57.251	0.000	0.000

C27.1and.3.MeC26	ace_egg - met_egg	-0.392	0.151	229.0	-2.597	0.010	1.000
C27.1and.3.MeC26	ace_egg - pre_chc	-0.789	0.148	229.0	-5.333	0.000	0.001
C27.1and.3.MeC26	ace_egg - pre_dg	9.642	0.149	229.0	64.589	0.000	0.000
C27.1and.3.MeC26	ace_egg - pre_egg	-0.292	0.149	229.0	-1.955	0.052	1.000
C27.1and.3.MeC26	ace_egg - queen_chc	0.021	0.270	229.0	0.079	0.937	1.000
C27.1and.3.MeC26	ace_egg - queen_dg	9.642	0.206	229.0	46.745	0.000	0.000
C27.1and.3.MeC26	ace_egg - queen_egg	-0.414	0.145	229.0	-2.845	0.005	1.000
C27.1and.3.MeC26	met_chc - met_dg	10.604	0.167	229.0	63.615	0.000	0.000
C27.1and.3.MeC26	met_chc - met_egg	0.570	0.149	229.0	3.832	0.000	0.477
C27.1and.3.MeC26	met_chc - pre_chc	0.173	0.146	229.0	1.185	0.237	1.000
C27.1and.3.MeC26	met_chc - pre_dg	10.604	0.147	229.0	71.973	0.000	0.000
C27.1and.3.MeC26	met_chc - pre_egg	0.670	0.147	229.0	4.547	0.000	0.026
C27.1and.3.MeC26	met_chc - queen_chc	0.983	0.269	229.0	3.655	0.000	0.925
C27.1and.3.MeC26	met_chc - queen_dg	10.604	0.205	229.0	51.762	0.000	0.000
C27.1and.3.MeC26	met_chc - queen_egg	0.548	0.143	229.0	3.820	0.000	0.499
C27.1and.3.MeC26	met_dg - met_egg	-10.034	0.164	229.0	-61.315	0.000	0.000
C27.1and.3.MeC26	met_dg - pre_chc	-10.431	0.161	229.0	-64.774	0.000	0.000
C27.1and.3.MeC26	met_dg - pre_dg	0.000	0.162	229.0	0.001	0.999	1.000
C27.1and.3.MeC26	met_dg - pre_egg	-9.934	0.162	229.0	-61.211	0.000	0.000
C27.1and.3.MeC26	met_dg - queen_chc	-9.621	0.277	229.0	-34.673	0.000	0.000
C27.1and.3.MeC26	met_dg - queen_dg	0.000	0.216	229.0	0.000	1.000	1.000
C27.1and.3.MeC26	met_dg - queen_egg	-10.056	0.159	229.0	-63.330	0.000	0.000
C27.1and.3.MeC26	met_egg - pre_chc	-0.397	0.142	229.0	-2.789	0.006	1.000
C27.1and.3.MeC26	met_egg - pre_dg	10.034	0.144	229.0	69.739	0.000	0.000
C27.1and.3.MeC26	met_egg - pre_egg	0.100	0.144	229.0	0.693	0.489	1.000
C27.1and.3.MeC26	met_egg - queen_chc	0.413	0.267	229.0	1.546	0.124	1.000
C27.1and.3.MeC26	met_egg - queen_dg	10.034	0.202	229.0	49.576	0.000	0.000
C27.1and.3.MeC26	met_egg - queen_egg	-0.022	0.140	229.0	-0.159	0.874	1.000
C27.1and.3.MeC26	pre_chc - pre_dg	10.431	0.141	229.0	74.028	0.000	0.000
C27.1and.3.MeC26	pre_chc - pre_egg	0.497	0.141	229.0	3.527	0.001	1.000
C27.1and.3.MeC26	pre_chc - queen_chc	0.810	0.266	229.0	3.051	0.003	1.000
C27.1and.3.MeC26	pre_chc - queen_dg	10.431	0.200	229.0	52.080	0.000	0.000
C27.1and.3.MeC26	pre_chc - queen_egg	0.375	0.137	229.0	2.741	0.007	1.000
C27.1and.3.MeC26	pre_dg - pre_egg	-9.934	0.142	229.0	-69.792	0.000	0.000
C27.1and.3.MeC26	pre_dg - queen_chc	-9.621	0.266	229.0	-36.129	0.000	0.000
C27.1and.3.MeC26	pre_dg - queen_dg	0.000	0.201	229.0	-0.001	0.999	1.000
C27.1and.3.MeC26	pre_dg - queen_egg	-10.056	0.138	229.0	-72.697	0.000	0.000
C27.1and.3.MeC26	pre_egg - queen_chc	0.313	0.266	229.0	1.176	0.241	1.000
C27.1and.3.MeC26	pre_egg - queen_dg	9.934	0.201	229.0	49.350	0.000	0.000
C27.1and.3.MeC26	pre_egg - queen_egg	-0.122	0.138	229.0	-0.881	0.379	1.000
C27.1and.3.MeC26	queen_chc - queen_dg	9.621	0.302	229.0	31.862	0.000	0.000
C27.1and.3.MeC26	queen_chc - queen_egg	-0.435	0.264	229.0	-1.647	0.101	1.000
C27.1and.3.MeC26	queen_dg - queen_egg	-10.056	0.198	229.0	-50.664	0.000	0.000
C29.1	ace_chc - ace_dg	8.668	0.085	229.0	101.475	0.000	0.000
C29.1	ace_chc - ace_egg	8.668	0.091	229.0	95.673	0.000	0.000
C29.1	ace_chc - met_chc	-0.322	0.089	229.0	-3.597	0.000	1.000
C29.1	ace_chc - met_dg	8.668	0.099	229.0	87.877	0.000	0.000
C29.1	ace_chc - met_egg	8.668	0.087	229.0	99.339	0.000	0.000
C29.1	ace_chc - pre_chc	-0.192	0.085	229.0	-2.248	0.026	1.000
C29.1	ace_chc - pre_dg	8.668	0.086	229.0	100.433	0.000	0.000
C29.1	ace_chc - pre_egg	8.668	0.086	229.0	100.434	0.000	0.000
C29.1	ace_chc - queen_chc	0.346	0.163	229.0	2.125	0.035	1.000
C29.1	ace_chc - queen_dg	8.668	0.123	229.0	70.656	0.000	0.000
C29.1	ace_chc - queen_egg	8.668	0.084	229.0	103.409	0.000	0.000
C29.1	ace_dg - ace_egg	0.000	0.091	229.0	0.001	0.999	1.000
C29.1	ace_dg - met_chc	-8.990	0.089	229.0	-100.559	0.000	0.000
C29.1	ace_dg - met_dg	0.000	0.099	229.0	-0.002	0.998	1.000
C29.1	ace_dg - met_egg	0.000	0.087	229.0	0.000	1.000	1.000
C29.1	ace_dg - pre_chc	-8.860	0.085	229.0	-103.723	0.000	0.000
C29.1	ace_dg - pre_dg	0.000	0.086	229.0	-0.001	0.999	1.000
C29.1	ace_dg - pre_egg	0.000	0.086	229.0	0.000	1.000	1.000
C29.1	ace_dg - queen_chc	-8.323	0.163	229.0	-51.172	0.000	0.000
C29.1	ace_dg - queen_dg	0.000	0.123	229.0	-0.002	0.998	1.000
C29.1	ace_dg - queen_egg	0.000	0.084	229.0	0.001	0.999	1.000
C29.1	ace_egg - met_chc	-8.990	0.094	229.0	-95.271	0.000	0.000
C29.1	ace_egg - met_dg	0.000	0.103	229.0	-0.003	0.997	1.000
C29.1	ace_egg - met_egg	0.000	0.092	229.0	-0.001	0.999	1.000
C29.1	ace_egg - pre_chc	-8.860	0.091	229.0	-97.792	0.000	0.000

C29.1	ace_egg - pre_dg	0.000	0.091	229.0	-0.002	0.998	1.000
C29.1	ace_egg - pre_egg	0.000	0.091	229.0	-0.001	0.999	1.000
C29.1	ace_egg - queen_chc	-8.323	0.165	229.0	-50.313	0.000	0.000
C29.1	ace_egg - queen_dg	0.000	0.126	229.0	-0.003	0.998	1.000
C29.1	ace_egg - queen_egg	0.000	0.089	229.0	0.000	1.000	1.000
C29.1	met_chc - met_dg	8.990	0.102	229.0	88.047	0.000	0.000
C29.1	met_chc - met_egg	8.990	0.091	229.0	98.621	0.000	0.000
C29.1	met_chc - pre_chc	0.130	0.089	229.0	1.449	0.149	1.000
C29.1	met_chc - pre_dg	8.990	0.090	229.0	99.615	0.000	0.000
C29.1	met_chc - pre_egg	8.990	0.090	229.0	99.616	0.000	0.000
C29.1	met_chc - queen_chc	0.667	0.165	229.0	4.049	0.000	0.204
C29.1	met_chc - queen_dg	8.990	0.125	229.0	71.642	0.000	0.000
C29.1	met_chc - queen_egg	8.990	0.088	229.0	102.305	0.000	0.000
C29.1	met_dg - met_egg	0.000	0.100	229.0	0.003	0.998	1.000
C29.1	met_dg - pre_chc	-8.860	0.099	229.0	-89.824	0.000	0.000
C29.1	met_dg - pre_dg	0.000	0.099	229.0	0.002	0.999	1.000
C29.1	met_dg - pre_egg	0.000	0.099	229.0	0.002	0.998	1.000
C29.1	met_dg - queen_chc	-8.323	0.170	229.0	-48.969	0.000	0.000
C29.1	met_dg - queen_dg	0.000	0.132	229.0	0.000	1.000	1.000
C29.1	met_dg - queen_egg	0.000	0.097	229.0	0.003	0.997	1.000
C29.1	met_egg - pre_chc	-8.860	0.087	229.0	-101.539	0.000	0.000
C29.1	met_egg - pre_dg	0.000	0.088	229.0	-0.001	0.999	1.000
C29.1	met_egg - pre_egg	0.000	0.088	229.0	-0.001	1.000	1.000
C29.1	met_egg - queen_chc	-8.323	0.164	229.0	-50.868	0.000	0.000
C29.1	met_egg - queen_dg	0.000	0.124	229.0	-0.002	0.998	1.000
C29.1	met_egg - queen_egg	0.000	0.086	229.0	0.001	0.999	1.000
C29.1	pre_chc - pre_dg	8.860	0.086	229.0	102.658	0.000	0.000
C29.1	pre_chc - pre_egg	8.860	0.086	229.0	102.659	0.000	0.000
C29.1	pre_chc - queen_chc	0.538	0.163	229.0	3.305	0.001	1.000
C29.1	pre_chc - queen_dg	8.860	0.123	229.0	72.221	0.000	0.000
C29.1	pre_chc - queen_egg	8.860	0.084	229.0	105.700	0.000	0.000
C29.1	pre_dg - pre_egg	0.000	0.087	229.0	0.001	0.999	1.000
C29.1	pre_dg - queen_chc	-8.323	0.163	229.0	-51.025	0.000	0.000
C29.1	pre_dg - queen_dg	0.000	0.123	229.0	-0.001	0.999	1.000
C29.1	pre_dg - queen_egg	0.000	0.085	229.0	0.002	0.998	1.000
C29.1	pre_egg - queen_chc	-8.323	0.163	229.0	-51.026	0.000	0.000
C29.1	pre_egg - queen_dg	0.000	0.123	229.0	-0.002	0.999	1.000
C29.1	pre_egg - queen_egg	0.000	0.085	229.0	0.001	0.999	1.000
C29.1	queen_chc - queen_dg	8.323	0.185	229.0	44.999	0.000	0.000
C29.1	queen_chc - queen_egg	8.323	0.162	229.0	51.436	0.000	0.000
C29.1	queen_dg - queen_egg	0.000	0.122	229.0	0.003	0.998	1.000
C29.1.2	ace_chc - ace_dg	0.000	0.194	229.0	0.002	0.998	1.000
C29.1.2	ace_chc - ace_egg	-9.332	0.206	229.0	-45.368	0.000	0.000
C29.1.2	ace_chc - met_chc	0.000	0.203	229.0	0.000	1.000	1.000
C29.1.2	ace_chc - met_dg	0.000	0.224	229.0	0.001	0.999	1.000
C29.1.2	ace_chc - met_egg	-9.607	0.198	229.0	-48.492	0.000	0.000
C29.1.2	ace_chc - pre_chc	0.000	0.194	229.0	0.000	1.000	1.000
C29.1.2	ace_chc - pre_dg	0.000	0.196	229.0	0.002	0.999	1.000
C29.1.2	ace_chc - pre_egg	-9.461	0.196	229.0	-48.282	0.000	0.000
C29.1.2	ace_chc - queen_chc	0.000	0.369	229.0	0.000	1.000	1.000
C29.1.2	ace_chc - queen_dg	0.000	0.279	229.0	0.001	0.999	1.000
C29.1.2	ace_chc - queen_egg	-9.129	0.190	229.0	-47.967	0.000	0.000
C29.1.2	ace_dg - ace_egg	-9.333	0.206	229.0	-45.370	0.000	0.000
C29.1.2	ace_dg - met_chc	0.000	0.203	229.0	-0.002	0.998	1.000
C29.1.2	ace_dg - met_dg	0.000	0.224	229.0	-0.001	0.999	1.000
C29.1.2	ace_dg - met_egg	-9.607	0.198	229.0	-48.494	0.000	0.000
C29.1.2	ace_dg - pre_chc	0.000	0.194	229.0	-0.002	0.998	1.000
C29.1.2	ace_dg - pre_dg	0.000	0.196	229.0	0.000	1.000	1.000
C29.1.2	ace_dg - pre_egg	-9.461	0.196	229.0	-48.284	0.000	0.000
C29.1.2	ace_dg - queen_chc	-0.001	0.369	229.0	-0.001	0.999	1.000
C29.1.2	ace_dg - queen_dg	0.000	0.279	229.0	-0.001	0.999	1.000
C29.1.2	ace_dg - queen_egg	-9.129	0.190	229.0	-47.969	0.000	0.000
C29.1.2	ace_egg - met_chc	9.332	0.214	229.0	43.562	0.000	0.000
C29.1.2	ace_egg - met_dg	9.332	0.234	229.0	39.848	0.000	0.000
C29.1.2	ace_egg - met_egg	-0.274	0.210	229.0	-1.309	0.192	1.000
C29.1.2	ace_egg - pre_chc	9.332	0.206	229.0	45.368	0.000	0.000
C29.1.2	ace_egg - pre_dg	9.333	0.208	229.0	44.956	0.000	0.000
C29.1.2	ace_egg - pre_egg	-0.128	0.208	229.0	-0.619	0.537	1.000

C29.1.2	ace_egg - queen_chc	9.332	0.376	229.0	24.849	0.000	0.000
C29.1.2	ace_egg - queen_dg	9.332	0.287	229.0	32.536	0.000	0.000
C29.1.2	ace_egg - queen_egg	0.204	0.202	229.0	1.007	0.315	1.000
C29.1.2	met_chc - met_dg	0.000	0.232	229.0	0.001	0.999	1.000
C29.1.2	met_chc - met_egg	-9.607	0.207	229.0	-46.420	0.000	0.000
C29.1.2	met_chc - pre_chc	0.000	0.203	229.0	0.000	1.000	1.000
C29.1.2	met_chc - pre_dg	0.000	0.205	229.0	0.002	0.999	1.000
C29.1.2	met_chc - pre_egg	-9.461	0.205	229.0	-46.176	0.000	0.000
C29.1.2	met_chc - queen_chc	0.000	0.374	229.0	0.000	1.000	1.000
C29.1.2	met_chc - queen_dg	0.000	0.285	229.0	0.001	0.999	1.000
C29.1.2	met_chc - queen_egg	-9.129	0.199	229.0	-45.758	0.000	0.000
C29.1.2	met_dg - met_egg	-9.607	0.228	229.0	-42.217	0.000	0.000
C29.1.2	met_dg - pre_chc	0.000	0.224	229.0	-0.001	0.999	1.000
C29.1.2	met_dg - pre_dg	0.000	0.226	229.0	0.001	0.999	1.000
C29.1.2	met_dg - pre_egg	-9.461	0.226	229.0	-41.922	0.000	0.000
C29.1.2	met_dg - queen_chc	0.000	0.386	229.0	-0.001	0.999	1.000
C29.1.2	met_dg - queen_dg	0.000	0.300	229.0	0.000	1.000	1.000
C29.1.2	met_dg - queen_egg	-9.129	0.221	229.0	-41.343	0.000	0.000
C29.1.2	met_egg - pre_chc	9.607	0.198	229.0	48.492	0.000	0.000
C29.1.2	met_egg - pre_dg	9.607	0.200	229.0	48.017	0.000	0.000
C29.1.2	met_egg - pre_egg	0.146	0.200	229.0	0.729	0.467	1.000
C29.1.2	met_egg - queen_chc	9.606	0.371	229.0	25.862	0.000	0.000
C29.1.2	met_egg - queen_dg	9.607	0.281	229.0	34.135	0.000	0.000
C29.1.2	met_egg - queen_egg	0.478	0.195	229.0	2.457	0.015	1.000
C29.1.2	pre_chc - pre_dg	0.000	0.196	229.0	0.002	0.998	1.000
C29.1.2	pre_chc - pre_egg	-9.461	0.196	229.0	-48.282	0.000	0.000
C29.1.2	pre_chc - queen_chc	0.000	0.369	229.0	0.000	1.000	1.000
C29.1.2	pre_chc - queen_dg	0.000	0.279	229.0	0.001	0.999	1.000
C29.1.2	pre_chc - queen_egg	-9.129	0.190	229.0	-47.967	0.000	0.000
C29.1.2	pre_dg - pre_egg	-9.461	0.198	229.0	-47.799	0.000	0.000
C29.1.2	pre_dg - queen_chc	0.000	0.370	229.0	-0.001	0.999	1.000
C29.1.2	pre_dg - queen_dg	0.000	0.280	229.0	-0.001	1.000	1.000
C29.1.2	pre_dg - queen_egg	-9.129	0.192	229.0	-47.458	0.000	0.000
C29.1.2	pre_egg - queen_chc	9.461	0.370	229.0	25.548	0.000	0.000
C29.1.2	pre_egg - queen_dg	9.461	0.280	229.0	33.798	0.000	0.000
C29.1.2	pre_egg - queen_egg	0.332	0.192	229.0	1.726	0.086	1.000
C29.1.2	queen_chc - queen_dg	0.000	0.420	229.0	0.001	0.999	1.000
C29.1.2	queen_chc - queen_egg	-9.129	0.367	229.0	-24.850	0.000	0.000
C29.1.2	queen_dg - queen_egg	-9.129	0.276	229.0	-33.075	0.000	0.000
C29.1.3	ace_chc - ace_dg	-10.080	0.355	229.0	-28.390	0.000	0.000
C29.1.3	ace_chc - ace_egg	0.001	0.377	229.0	0.001	0.999	1.000
C29.1.3	ace_chc - met_chc	0.000	0.372	229.0	0.000	1.000	1.000
C29.1.3	ace_chc - met_dg	-10.259	0.410	229.0	-25.022	0.000	0.000
C29.1.3	ace_chc - met_egg	0.000	0.363	229.0	0.001	0.999	1.000
C29.1.3	ace_chc - pre_chc	0.000	0.355	229.0	0.000	1.000	1.000
C29.1.3	ace_chc - pre_dg	-9.091	0.359	229.0	-25.340	0.000	0.000
C29.1.3	ace_chc - pre_egg	0.000	0.359	229.0	0.001	0.999	1.000
C29.1.3	ace_chc - queen_chc	0.000	0.676	229.0	0.000	1.000	1.000
C29.1.3	ace_chc - queen_dg	-10.395	0.510	229.0	-20.386	0.000	0.000
C29.1.3	ace_chc - queen_egg	0.001	0.348	229.0	0.002	0.999	1.000
C29.1.3	ace_dg - ace_egg	10.081	0.377	229.0	26.768	0.000	0.000
C29.1.3	ace_dg - ace_chc	10.080	0.372	229.0	27.128	0.000	0.000
C29.1.3	ace_dg - met_dg	-0.179	0.410	229.0	-0.435	0.664	1.000
C29.1.3	ace_dg - met_egg	10.081	0.363	229.0	27.794	0.000	0.000
C29.1.3	ace_dg - pre_chc	10.080	0.355	229.0	28.390	0.000	0.000
C29.1.3	ace_dg - pre_dg	0.990	0.359	229.0	2.759	0.006	1.000
C29.1.3	ace_dg - pre_egg	10.081	0.359	229.0	28.100	0.000	0.000
C29.1.3	ace_dg - queen_chc	10.080	0.676	229.0	14.911	0.000	0.000
C29.1.3	ace_dg - queen_dg	-0.315	0.510	229.0	-0.618	0.537	1.000
C29.1.3	ace_dg - queen_egg	10.081	0.348	229.0	28.932	0.000	0.000
C29.1.3	ace_egg - met_chc	-0.001	0.392	229.0	-0.001	0.999	1.000
C29.1.3	ace_egg - met_dg	-10.259	0.429	229.0	-23.927	0.000	0.000
C29.1.3	ace_egg - met_egg	0.000	0.384	229.0	0.000	1.000	1.000
C29.1.3	ace_egg - pre_chc	-0.001	0.377	229.0	-0.002	0.999	1.000
C29.1.3	ace_egg - pre_dg	-9.091	0.380	229.0	-23.920	0.000	0.000
C29.1.3	ace_egg - pre_egg	0.000	0.380	229.0	0.000	1.000	1.000
C29.1.3	ace_egg - queen_chc	-0.001	0.688	229.0	-0.001	0.999	1.000
C29.1.3	ace_egg - queen_dg	-10.396	0.525	229.0	-19.796	0.000	0.000

C29.1.3	ace_egg - queen_egg	0.000	0.370	229.0	0.000	1.000	1.000
C29.1.3	met_chc - met_dg	-10.259	0.424	229.0	-24.174	0.000	0.000
C29.1.3	met_chc - met_egg	0.000	0.379	229.0	0.001	0.999	1.000
C29.1.3	met_chc - pre_chc	0.000	0.372	229.0	0.000	1.000	1.000
C29.1.3	met_chc - pre_dg	-9.091	0.375	229.0	-24.235	0.000	0.000
C29.1.3	met_chc - pre_egg	0.000	0.375	229.0	0.001	0.999	1.000
C29.1.3	met_chc - queen_chc	0.000	0.685	229.0	0.000	1.000	1.000
C29.1.3	met_chc - queen_dg	-10.396	0.522	229.0	-19.931	0.000	0.000
C29.1.3	met_chc - queen_egg	0.001	0.365	229.0	0.001	0.999	1.000
C29.1.3	met_dg - met_egg	10.259	0.417	229.0	24.625	0.000	0.000
C29.1.3	met_dg - pre_chc	10.259	0.410	229.0	25.022	0.000	0.000
C29.1.3	met_dg - pre_dg	1.168	0.413	229.0	2.827	0.005	1.000
C29.1.3	met_dg - pre_egg	10.259	0.413	229.0	24.830	0.000	0.000
C29.1.3	met_dg - queen_chc	10.259	0.706	229.0	14.522	0.000	0.000
C29.1.3	met_dg - queen_dg	-0.137	0.550	229.0	-0.248	0.804	1.000
C29.1.3	met_dg - queen_egg	10.259	0.404	229.0	25.378	0.000	0.000
C29.1.3	met_egg - pre_chc	-0.001	0.363	229.0	-0.001	0.999	1.000
C29.1.3	met_egg - pre_dg	-9.091	0.366	229.0	-24.819	0.000	0.000
C29.1.3	met_egg - pre_egg	0.000	0.366	229.0	0.000	1.000	1.000
C29.1.3	met_egg - queen_chc	-0.001	0.680	229.0	-0.001	0.999	1.000
C29.1.3	met_egg - queen_dg	-10.396	0.515	229.0	-20.176	0.000	0.000
C29.1.3	met_egg - queen_egg	0.000	0.356	229.0	0.000	1.000	1.000
C29.1.3	pre_chc - pre_dg	-9.091	0.359	229.0	-25.340	0.000	0.000
C29.1.3	pre_chc - pre_egg	0.000	0.359	229.0	0.001	0.999	1.000
C29.1.3	pre_chc - queen_chc	0.000	0.676	229.0	0.000	1.000	1.000
C29.1.3	pre_chc - queen_dg	-10.395	0.510	229.0	-20.386	0.000	0.000
C29.1.3	pre_chc - queen_egg	0.001	0.348	229.0	0.002	0.999	1.000
C29.1.3	pre_dg - pre_egg	9.091	0.362	229.0	25.087	0.000	0.000
C29.1.3	pre_dg - queen_chc	9.091	0.678	229.0	13.409	0.000	0.000
C29.1.3	pre_dg - queen_dg	-1.305	0.512	229.0	-2.546	0.012	1.000
C29.1.3	pre_dg - queen_egg	9.091	0.352	229.0	25.814	0.000	0.000
C29.1.3	pre_egg - queen_chc	-0.001	0.678	229.0	-0.001	0.999	1.000
C29.1.3	pre_egg - queen_dg	-10.396	0.512	229.0	-20.285	0.000	0.000
C29.1.3	pre_egg - queen_egg	0.000	0.352	229.0	0.000	1.000	1.000
C29.1.3	queen_chc - queen_dg	-10.395	0.769	229.0	-13.522	0.000	0.000
C29.1.3	queen_chc - queen_egg	0.001	0.673	229.0	0.001	0.999	1.000
C29.1.3	queen_dg - queen_egg	10.396	0.505	229.0	20.573	0.000	0.000
n.C21	ace_chc - ace_dg	0.000	0.610	229.0	0.001	0.999	1.000
n.C21	ace_chc - ace_egg	-6.603	0.648	229.0	-10.198	0.000	0.000
n.C21	ace_chc - met_chc	0.000	0.639	229.0	0.000	1.000	1.000
n.C21	ace_chc - met_dg	0.000	0.705	229.0	0.000	1.000	1.000
n.C21	ace_chc - met_egg	-8.733	0.624	229.0	-14.003	0.000	0.000
n.C21	ace_chc - pre_chc	0.000	0.610	229.0	0.000	1.000	1.000
n.C21	ace_chc - pre_dg	0.000	0.617	229.0	0.001	1.000	1.000
n.C21	ace_chc - pre_egg	-7.159	0.617	229.0	-11.607	0.000	0.000
n.C21	ace_chc - queen_chc	0.000	1.162	229.0	0.000	1.000	1.000
n.C21	ace_chc - queen_dg	0.000	0.877	229.0	0.000	1.000	1.000
n.C21	ace_chc - queen_egg	-5.949	0.599	229.0	-9.930	0.000	0.000
n.C21	ace_dg - ace_egg	-6.604	0.648	229.0	-10.198	0.000	0.000
n.C21	ace_dg - met_chc	0.000	0.639	229.0	-0.001	0.999	1.000
n.C21	ace_dg - met_dg	0.000	0.705	229.0	0.000	1.000	1.000
n.C21	ace_dg - met_egg	-8.733	0.624	229.0	-14.004	0.000	0.000
n.C21	ace_dg - pre_chc	0.000	0.610	229.0	-0.001	0.999	1.000
n.C21	ace_dg - pre_dg	0.000	0.617	229.0	0.000	1.000	1.000
n.C21	ace_dg - pre_egg	-7.160	0.617	229.0	-11.608	0.000	0.000
n.C21	ace_dg - queen_chc	-0.001	1.162	229.0	0.000	1.000	1.000
n.C21	ace_dg - queen_dg	0.000	0.877	229.0	0.000	1.000	1.000
n.C21	ace_dg - queen_egg	-5.949	0.599	229.0	-9.931	0.000	0.000
n.C21	ace_egg - met_chc	6.603	0.674	229.0	9.792	0.000	0.000
n.C21	ace_egg - met_dg	6.603	0.737	229.0	8.957	0.000	0.000
n.C21	ace_egg - met_egg	-2.129	0.660	229.0	-3.227	0.001	1.000
n.C21	ace_egg - pre_chc	6.603	0.648	229.0	10.197	0.000	0.000
n.C21	ace_egg - pre_dg	6.604	0.653	229.0	10.105	0.000	0.000
n.C21	ace_egg - pre_egg	-0.556	0.653	229.0	-0.851	0.396	1.000
n.C21	ace_egg - queen_chc	6.603	1.182	229.0	5.585	0.000	0.000
n.C21	ace_egg - queen_dg	6.603	0.903	229.0	7.313	0.000	0.000
n.C21	ace_egg - queen_egg	0.654	0.637	229.0	1.027	0.305	1.000
n.C21	met_chc - met_dg	0.000	0.730	229.0	0.000	1.000	1.000

n.C21	met_chc - met_egg	-8.733	0.651	229.0	-13.405	0.000	0.000
n.C21	met_chc - pre_chc	0.000	0.639	229.0	0.000	1.000	1.000
n.C21	met_chc - pre_dg	0.000	0.645	229.0	0.001	1.000	1.000
n.C21	met_chc - pre_egg	-7.159	0.645	229.0	-11.101	0.000	0.000
n.C21	met_chc - queen_chc	0.000	1.178	229.0	0.000	1.000	1.000
n.C21	met_chc - queen_dg	0.000	0.897	229.0	0.000	1.000	1.000
n.C21	met_chc - queen_egg	-5.949	0.628	229.0	-9.473	0.000	0.000
n.C21	met_dg - met_egg	-8.733	0.716	229.0	-12.191	0.000	0.000
n.C21	met_dg - pre_chc	0.000	0.705	229.0	0.000	1.000	1.000
n.C21	met_dg - pre_dg	0.000	0.710	229.0	0.000	1.000	1.000
n.C21	met_dg - pre_egg	-7.160	0.710	229.0	-10.078	0.000	0.000
n.C21	met_dg - queen_chc	0.000	1.215	229.0	0.000	1.000	1.000
n.C21	met_dg - queen_dg	0.000	0.945	229.0	0.000	1.000	1.000
n.C21	met_dg - queen_egg	-5.949	0.695	229.0	-8.559	0.000	0.000
n.C21	met_egg - pre_chc	8.733	0.624	229.0	14.003	0.000	0.000
n.C21	met_egg - pre_dg	8.733	0.630	229.0	13.866	0.000	0.000
n.C21	met_egg - pre_egg	1.573	0.630	229.0	2.498	0.013	1.000
n.C21	met_egg - queen_chc	8.733	1.169	229.0	7.468	0.000	0.000
n.C21	met_egg - queen_dg	8.733	0.886	229.0	9.857	0.000	0.000
n.C21	met_egg - queen_egg	2.784	0.612	229.0	4.545	0.000	0.026
n.C21	pre_chc - pre_dg	0.000	0.617	229.0	0.001	0.999	1.000
n.C21	pre_chc - pre_egg	-7.159	0.617	229.0	-11.607	0.000	0.000
n.C21	pre_chc - queen_chc	0.000	1.162	229.0	0.000	1.000	1.000
n.C21	pre_chc - queen_dg	0.000	0.877	229.0	0.000	1.000	1.000
n.C21	pre_chc - queen_egg	-5.949	0.599	229.0	-9.930	0.000	0.000
n.C21	pre_dg - pre_egg	-7.160	0.623	229.0	-11.491	0.000	0.000
n.C21	pre_dg - queen_chc	0.000	1.166	229.0	0.000	1.000	1.000
n.C21	pre_dg - queen_dg	0.000	0.881	229.0	0.000	1.000	1.000
n.C21	pre_dg - queen_egg	-5.949	0.606	229.0	-9.825	0.000	0.000
n.C21	pre_egg - queen_chc	7.159	1.166	229.0	6.142	0.000	0.000
n.C21	pre_egg - queen_dg	7.160	0.881	229.0	8.125	0.000	0.000
n.C21	pre_egg - queen_egg	1.211	0.606	229.0	1.999	0.047	1.000
n.C21	queen_chc - queen_dg	0.000	1.322	229.0	0.000	1.000	1.000
n.C21	queen_chc - queen_egg	-5.949	1.156	229.0	-5.144	0.000	0.002
n.C21	queen_dg - queen_egg	-5.949	0.869	229.0	-6.847	0.000	0.000
n.C22	ace_chc - ace_dg	2.993	0.504	229.0	5.937	0.000	0.000
n.C22	ace_chc - ace_egg	2.993	0.535	229.0	5.597	0.000	0.000
n.C22	ace_chc - met_chc	-3.373	0.528	229.0	-6.394	0.000	0.000
n.C22	ace_chc - met_dg	2.992	0.582	229.0	5.141	0.000	0.002
n.C22	ace_chc - met_egg	2.993	0.515	229.0	5.812	0.000	0.000
n.C22	ace_chc - pre_chc	0.768	0.504	229.0	1.523	0.129	1.000
n.C22	ace_chc - pre_dg	2.993	0.509	229.0	5.876	0.000	0.000
n.C22	ace_chc - pre_egg	2.993	0.509	229.0	5.876	0.000	0.000
n.C22	ace_chc - queen_chc	-3.652	0.960	229.0	-3.805	0.000	0.529
n.C22	ace_chc - queen_dg	2.992	0.724	229.0	4.133	0.000	0.146
n.C22	ace_chc - queen_egg	2.993	0.495	229.0	6.050	0.000	0.000
n.C22	ace_dg - ace_egg	0.000	0.535	229.0	0.000	1.000	1.000
n.C22	ace_dg - met_chc	-6.366	0.528	229.0	-12.066	0.000	0.000
n.C22	ace_dg - met_dg	0.000	0.582	229.0	0.000	1.000	1.000
n.C22	ace_dg - met_egg	0.000	0.515	229.0	0.000	1.000	1.000
n.C22	ace_dg - pre_chc	-2.225	0.504	229.0	-4.414	0.000	0.045
n.C22	ace_dg - pre_dg	0.000	0.509	229.0	0.000	1.000	1.000
n.C22	ace_dg - pre_egg	0.000	0.509	229.0	0.000	1.000	1.000
n.C22	ace_dg - queen_chc	-6.644	0.960	229.0	-6.923	0.000	0.000
n.C22	ace_dg - queen_dg	0.000	0.724	229.0	0.000	1.000	1.000
n.C22	ace_dg - queen_egg	0.000	0.495	229.0	0.000	1.000	1.000
n.C22	ace_egg - met_chc	-6.366	0.557	229.0	-11.432	0.000	0.000
n.C22	ace_egg - met_dg	0.000	0.609	229.0	-0.001	1.000	1.000
n.C22	ace_egg - met_egg	0.000	0.545	229.0	0.000	1.000	1.000
n.C22	ace_egg - pre_chc	-2.225	0.535	229.0	-4.161	0.000	0.130
n.C22	ace_egg - pre_dg	0.000	0.540	229.0	0.000	1.000	1.000
n.C22	ace_egg - pre_egg	0.000	0.540	229.0	0.000	1.000	1.000
n.C22	ace_egg - queen_chc	-6.645	0.976	229.0	-6.807	0.000	0.000
n.C22	ace_egg - queen_dg	0.000	0.746	229.0	0.000	1.000	1.000
n.C22	ace_egg - queen_egg	0.000	0.526	229.0	0.000	1.000	1.000
n.C22	met_chc - met_dg	6.365	0.603	229.0	10.565	0.000	0.000
n.C22	met_chc - met_egg	6.366	0.538	229.0	11.834	0.000	0.000
n.C22	met_chc - pre_chc	4.141	0.528	229.0	7.849	0.000	0.000

n.C22	met_chc - pre_dg	6.366	0.533	229.0	11.953	0.000	0.000
n.C22	met_chc - pre_egg	6.366	0.533	229.0	11.953	0.000	0.000
n.C22	met_chc - queen_chc	-0.279	0.972	229.0	-0.287	0.775	1.000
n.C22	met_chc - queen_dg	6.365	0.740	229.0	8.596	0.000	0.000
n.C22	met_chc - queen_egg	6.366	0.519	229.0	12.276	0.000	0.000
n.C22	met_dg - met_egg	0.000	0.591	229.0	0.000	1.000	1.000
n.C22	met_dg - pre_chc	-2.225	0.582	229.0	-3.822	0.000	0.496
n.C22	met_dg - pre_dg	0.000	0.587	229.0	0.000	1.000	1.000
n.C22	met_dg - pre_egg	0.000	0.587	229.0	0.000	1.000	1.000
n.C22	met_dg - queen_chc	-6.644	1.003	229.0	-6.625	0.000	0.000
n.C22	met_dg - queen_dg	0.000	0.780	229.0	0.000	1.000	1.000
n.C22	met_dg - queen_egg	0.000	0.574	229.0	0.001	1.000	1.000
n.C22	met_egg - pre_chc	-2.225	0.515	229.0	-4.321	0.000	0.067
n.C22	met_egg - pre_dg	0.000	0.520	229.0	0.000	1.000	1.000
n.C22	met_egg - pre_egg	0.000	0.520	229.0	0.000	1.000	1.000
n.C22	met_egg - queen_chc	-6.644	0.966	229.0	-6.882	0.000	0.000
n.C22	met_egg - queen_dg	0.000	0.732	229.0	0.000	1.000	1.000
n.C22	met_egg - queen_egg	0.000	0.506	229.0	0.000	1.000	1.000
n.C22	pre_chc - pre_dg	2.225	0.509	229.0	4.368	0.000	0.055
n.C22	pre_chc - pre_egg	2.225	0.509	229.0	4.368	0.000	0.055
n.C22	pre_chc - queen_chc	-4.420	0.960	229.0	-4.605	0.000	0.020
n.C22	pre_chc - queen_dg	2.225	0.724	229.0	3.073	0.002	1.000
n.C22	pre_chc - queen_egg	2.225	0.495	229.0	4.498	0.000	0.032
n.C22	pre_dg - pre_egg	0.000	0.514	229.0	0.000	1.000	1.000
n.C22	pre_dg - queen_chc	-6.644	0.963	229.0	-6.903	0.000	0.000
n.C22	pre_dg - queen_dg	0.000	0.728	229.0	0.000	1.000	1.000
n.C22	pre_dg - queen_egg	0.000	0.500	229.0	0.000	1.000	1.000
n.C22	pre_egg - queen_chc	-6.644	0.963	229.0	-6.903	0.000	0.000
n.C22	pre_egg - queen_dg	0.000	0.728	229.0	0.000	1.000	1.000
n.C22	pre_egg - queen_egg	0.000	0.500	229.0	0.000	1.000	1.000
n.C22	queen_chc - queen_dg	6.644	1.091	229.0	6.088	0.000	0.000
n.C22	queen_chc - queen_egg	6.644	0.955	229.0	6.959	0.000	0.000
n.C22	queen_dg - queen_egg	0.000	0.717	229.0	0.000	1.000	1.000
n.C23	ace_chc - ace_dg	-1.444	0.665	229.0	-2.170	0.031	1.000
n.C23	ace_chc - ace_egg	-1.411	0.706	229.0	-1.999	0.047	1.000
n.C23	ace_chc - met_chc	-1.300	0.696	229.0	-1.868	0.063	1.000
n.C23	ace_chc - met_dg	-1.559	0.768	229.0	-2.030	0.044	1.000
n.C23	ace_chc - met_egg	-2.538	0.680	229.0	-3.734	0.000	0.692
n.C23	ace_chc - pre_chc	-0.013	0.665	229.0	-0.019	0.985	1.000
n.C23	ace_chc - pre_dg	0.262	0.672	229.0	0.389	0.698	1.000
n.C23	ace_chc - pre_egg	-2.041	0.672	229.0	-3.037	0.003	1.000
n.C23	ace_chc - queen_chc	-0.290	1.267	229.0	-0.229	0.819	1.000
n.C23	ace_chc - queen_dg	-1.309	0.956	229.0	-1.370	0.172	1.000
n.C23	ace_chc - queen_egg	-1.397	0.653	229.0	-2.140	0.033	1.000
n.C23	ace_dg - ace_egg	0.033	0.706	229.0	0.047	0.963	1.000
n.C23	ace_dg - met_chc	0.143	0.696	229.0	0.206	0.837	1.000
n.C23	ace_dg - met_dg	-0.115	0.768	229.0	-0.150	0.881	1.000
n.C23	ace_dg - met_egg	-1.094	0.680	229.0	-1.609	0.109	1.000
n.C23	ace_dg - pre_chc	1.431	0.665	229.0	2.151	0.033	1.000
n.C23	ace_dg - pre_dg	1.705	0.672	229.0	2.537	0.012	1.000
n.C23	ace_dg - pre_egg	-0.598	0.672	229.0	-0.889	0.375	1.000
n.C23	ace_dg - queen_chc	1.154	1.267	229.0	0.911	0.363	1.000
n.C23	ace_dg - queen_dg	0.135	0.956	229.0	0.141	0.888	1.000
n.C23	ace_dg - queen_egg	0.046	0.653	229.0	0.071	0.944	1.000
n.C23	ace_egg - met_chc	0.110	0.735	229.0	0.150	0.881	1.000
n.C23	ace_egg - met_dg	-0.149	0.803	229.0	-0.185	0.853	1.000
n.C23	ace_egg - met_egg	-1.127	0.719	229.0	-1.567	0.119	1.000
n.C23	ace_egg - pre_chc	1.398	0.706	229.0	1.981	0.049	1.000
n.C23	ace_egg - pre_dg	1.672	0.712	229.0	2.348	0.020	1.000
n.C23	ace_egg - pre_egg	-0.631	0.712	229.0	-0.886	0.377	1.000
n.C23	ace_egg - queen_chc	1.121	1.288	229.0	0.870	0.385	1.000
n.C23	ace_egg - queen_dg	0.102	0.984	229.0	0.103	0.918	1.000
n.C23	ace_egg - queen_egg	0.013	0.694	229.0	0.019	0.985	1.000
n.C23	met_chc - met_dg	-0.259	0.795	229.0	-0.325	0.745	1.000
n.C23	met_chc - met_egg	-1.237	0.710	229.0	-1.743	0.083	1.000
n.C23	met_chc - pre_chc	1.288	0.696	229.0	1.849	0.066	1.000
n.C23	met_chc - pre_dg	1.562	0.703	229.0	2.222	0.027	1.000
n.C23	met_chc - pre_egg	-0.741	0.703	229.0	-1.054	0.293	1.000

n.C23	met_chc - queen_chc	1.011	1.283	229.0	0.788	0.432	1.000
n.C23	met_chc - queen_dg	-0.008	0.977	229.0	-0.009	0.993	1.000
n.C23	met_chc - queen_egg	-0.097	0.684	229.0	-0.142	0.887	1.000
n.C23	met_dg - met_egg	-0.978	0.781	229.0	-1.253	0.211	1.000
n.C23	met_dg - pre_chc	1.546	0.768	229.0	2.013	0.045	1.000
n.C23	met_dg - pre_dg	1.821	0.774	229.0	2.352	0.020	1.000
n.C23	met_dg - pre_egg	-0.482	0.774	229.0	-0.623	0.534	1.000
n.C23	met_dg - queen_chc	1.270	1.324	229.0	0.959	0.339	1.000
n.C23	met_dg - queen_dg	0.250	1.030	229.0	0.243	0.808	1.000
n.C23	met_dg - queen_egg	0.162	0.758	229.0	0.214	0.831	1.000
n.C23	met_egg - pre_chc	2.525	0.680	229.0	3.715	0.000	0.742
n.C23	met_egg - pre_dg	2.799	0.686	229.0	4.078	0.000	0.182
n.C23	met_egg - pre_egg	0.496	0.686	229.0	0.723	0.470	1.000
n.C23	met_egg - queen_chc	2.248	1.274	229.0	1.764	0.079	1.000
n.C23	met_egg - queen_dg	1.229	0.966	229.0	1.273	0.204	1.000
n.C23	met_egg - queen_egg	1.140	0.667	229.0	1.708	0.089	1.000
n.C23	pre_chc - pre_dg	0.274	0.672	229.0	0.408	0.683	1.000
n.C23	pre_chc - pre_egg	-2.028	0.672	229.0	-3.017	0.003	1.000
n.C23	pre_chc - queen_chc	-0.277	1.267	229.0	-0.218	0.827	1.000
n.C23	pre_chc - queen_dg	-1.296	0.956	229.0	-1.356	0.176	1.000
n.C23	pre_chc - queen_egg	-1.385	0.653	229.0	-2.121	0.035	1.000
n.C23	pre_dg - pre_egg	-2.303	0.679	229.0	-3.391	0.001	1.000
n.C23	pre_dg - queen_chc	-0.551	1.270	229.0	-0.434	0.665	1.000
n.C23	pre_dg - queen_dg	-1.570	0.960	229.0	-1.635	0.103	1.000
n.C23	pre_dg - queen_egg	-1.659	0.660	229.0	-2.514	0.013	1.000
n.C23	pre_egg - queen_chc	1.752	1.270	229.0	1.379	0.169	1.000
n.C23	pre_egg - queen_dg	0.733	0.960	229.0	0.763	0.446	1.000
n.C23	pre_egg - queen_egg	0.644	0.660	229.0	0.976	0.330	1.000
n.C23	queen_chc - queen_dg	-1.019	1.441	229.0	-0.708	0.480	1.000
n.C23	queen_chc - queen_egg	-1.108	1.260	229.0	-0.879	0.380	1.000
n.C23	queen_dg - queen_egg	-0.089	0.947	229.0	-0.094	0.925	1.000
n.C24	ace_chc - ace_dg	2.210	0.754	229.0	2.930	0.004	1.000
n.C24	ace_chc - ace_egg	-0.779	0.800	229.0	-0.974	0.331	1.000
n.C24	ace_chc - met_chc	-0.487	0.790	229.0	-0.617	0.538	1.000
n.C24	ace_chc - met_dg	4.594	0.871	229.0	5.273	0.000	0.001
n.C24	ace_chc - met_egg	-0.366	0.771	229.0	-0.475	0.635	1.000
n.C24	ace_chc - pre_chc	-0.026	0.754	229.0	-0.034	0.973	1.000
n.C24	ace_chc - pre_dg	3.648	0.762	229.0	4.785	0.000	0.009
n.C24	ace_chc - pre_egg	-0.612	0.762	229.0	-0.803	0.423	1.000
n.C24	ace_chc - queen_chc	-1.096	1.436	229.0	-0.763	0.446	1.000
n.C24	ace_chc - queen_dg	2.997	1.083	229.0	2.766	0.006	1.000
n.C24	ace_chc - queen_egg	-0.636	0.740	229.0	-0.859	0.391	1.000
n.C24	ace_dg - ace_egg	-2.989	0.800	229.0	-3.736	0.000	0.686
n.C24	ace_dg - met_chc	-2.697	0.790	229.0	-3.416	0.001	1.000
n.C24	ace_dg - met_dg	2.384	0.871	229.0	2.736	0.007	1.000
n.C24	ace_dg - met_egg	-2.576	0.771	229.0	-3.343	0.001	1.000
n.C24	ace_dg - pre_chc	-2.236	0.754	229.0	-2.964	0.003	1.000
n.C24	ace_dg - pre_dg	1.437	0.762	229.0	1.886	0.061	1.000
n.C24	ace_dg - pre_egg	-2.823	0.762	229.0	-3.703	0.000	0.775
n.C24	ace_dg - queen_chc	-3.307	1.436	229.0	-2.302	0.022	1.000
n.C24	ace_dg - queen_dg	0.786	1.083	229.0	0.726	0.469	1.000
n.C24	ace_dg - queen_egg	-2.846	0.740	229.0	-3.844	0.000	0.455
n.C24	ace_egg - met_chc	0.292	0.833	229.0	0.350	0.726	1.000
n.C24	ace_egg - met_dg	5.373	0.911	229.0	5.897	0.000	0.000
n.C24	ace_egg - met_egg	0.413	0.816	229.0	0.507	0.613	1.000
n.C24	ace_egg - pre_chc	0.754	0.800	229.0	0.942	0.347	1.000
n.C24	ace_egg - pre_dg	4.427	0.808	229.0	5.482	0.000	0.000
n.C24	ace_egg - pre_egg	0.167	0.808	229.0	0.207	0.837	1.000
n.C24	ace_egg - queen_chc	-0.317	1.461	229.0	-0.217	0.828	1.000
n.C24	ace_egg - queen_dg	3.776	1.116	229.0	3.384	0.001	1.000
n.C24	ace_egg - queen_egg	0.144	0.787	229.0	0.182	0.855	1.000
n.C24	met_chc - met_dg	5.081	0.902	229.0	5.635	0.000	0.000
n.C24	met_chc - met_egg	0.121	0.805	229.0	0.151	0.880	1.000
n.C24	met_chc - pre_chc	0.462	0.790	229.0	0.585	0.559	1.000
n.C24	met_chc - pre_dg	4.135	0.797	229.0	5.188	0.000	0.001
n.C24	met_chc - pre_egg	-0.125	0.797	229.0	-0.157	0.875	1.000
n.C24	met_chc - queen_chc	-0.609	1.455	229.0	-0.419	0.676	1.000
n.C24	met_chc - queen_dg	3.484	1.108	229.0	3.144	0.002	1.000

n.C24	met_chc - queen_egg	-0.148	0.776	229.0	-0.191	0.849	1.000
n.C24	met_dg - met_egg	-4.960	0.885	229.0	-5.603	0.000	0.000
n.C24	met_dg - pre_chc	-4.619	0.871	229.0	-5.303	0.000	0.001
n.C24	met_dg - pre_dg	-0.946	0.878	229.0	-1.078	0.282	1.000
n.C24	met_dg - pre_egg	-5.206	0.878	229.0	-5.930	0.000	0.000
n.C24	met_dg - queen_chc	-5.690	1.501	229.0	-3.791	0.000	0.558
n.C24	met_dg - queen_dg	-1.597	1.168	229.0	-1.368	0.173	1.000
n.C24	met_dg - queen_egg	-5.229	0.859	229.0	-6.088	0.000	0.000
n.C24	met_egg - pre_chc	0.340	0.771	229.0	0.442	0.659	1.000
n.C24	met_egg - pre_dg	4.014	0.778	229.0	5.157	0.000	0.002
n.C24	met_egg - pre_egg	-0.246	0.778	229.0	-0.317	0.752	1.000
n.C24	met_egg - queen_chc	-0.730	1.445	229.0	-0.505	0.614	1.000
n.C24	met_egg - queen_dg	3.363	1.095	229.0	3.071	0.002	1.000
n.C24	met_egg - queen_egg	-0.270	0.757	229.0	-0.356	0.722	1.000
n.C24	pre_chc - pre_dg	3.673	0.762	229.0	4.819	0.000	0.008
n.C24	pre_chc - pre_egg	-0.587	0.762	229.0	-0.770	0.442	1.000
n.C24	pre_chc - queen_chc	-1.071	1.436	229.0	-0.745	0.457	1.000
n.C24	pre_chc - queen_dg	3.022	1.083	229.0	2.789	0.006	1.000
n.C24	pre_chc - queen_egg	-0.610	0.740	229.0	-0.824	0.411	1.000
n.C24	pre_dg - pre_egg	-4.260	0.770	229.0	-5.532	0.000	0.000
n.C24	pre_dg - queen_chc	-4.744	1.441	229.0	-3.293	0.001	1.000
n.C24	pre_dg - queen_dg	-0.651	1.089	229.0	-0.598	0.551	1.000
n.C24	pre_dg - queen_egg	-4.283	0.748	229.0	-5.724	0.000	0.000
n.C24	pre_egg - queen_chc	-0.484	1.441	229.0	-0.336	0.737	1.000
n.C24	pre_egg - queen_dg	3.609	1.089	229.0	3.314	0.001	1.000
n.C24	pre_egg - queen_egg	-0.023	0.748	229.0	-0.031	0.975	1.000
n.C24	queen_chc - queen_dg	4.093	1.633	229.0	2.506	0.013	1.000
n.C24	queen_chc - queen_egg	0.461	1.429	229.0	0.322	0.747	1.000
n.C24	queen_dg - queen_egg	-3.632	1.074	229.0	-3.383	0.001	1.000
n.C25	ace_chc - ace_dg	1.698	0.228	229.0	7.454	0.000	0.000
n.C25	ace_chc - ace_egg	0.183	0.242	229.0	0.759	0.449	1.000
n.C25	ace_chc - met_chc	-0.238	0.238	229.0	-0.996	0.320	1.000
n.C25	ace_chc - met_dg	2.653	0.263	229.0	10.084	0.000	0.000
n.C25	ace_chc - met_egg	0.225	0.233	229.0	0.965	0.335	1.000
n.C25	ace_chc - pre_chc	-0.159	0.228	229.0	-0.696	0.487	1.000
n.C25	ace_chc - pre_dg	2.425	0.230	229.0	10.534	0.000	0.000
n.C25	ace_chc - pre_egg	0.381	0.230	229.0	1.655	0.099	1.000
n.C25	ace_chc - queen_chc	-0.978	0.434	229.0	-2.253	0.025	1.000
n.C25	ace_chc - queen_dg	2.170	0.327	229.0	6.630	0.000	0.000
n.C25	ace_chc - queen_egg	-0.228	0.224	229.0	-1.021	0.308	1.000
n.C25	ace_dg - ace_egg	-1.515	0.242	229.0	-6.269	0.000	0.000
n.C25	ace_dg - met_chc	-1.936	0.238	229.0	-8.119	0.000	0.000
n.C25	ace_dg - met_dg	0.955	0.263	229.0	3.629	0.000	1.000
n.C25	ace_dg - met_egg	-1.474	0.233	229.0	-6.332	0.000	0.000
n.C25	ace_dg - pre_chc	-1.857	0.228	229.0	-8.150	0.000	0.000
n.C25	ace_dg - pre_dg	0.727	0.230	229.0	3.157	0.002	1.000
n.C25	ace_dg - pre_egg	-1.318	0.230	229.0	-5.723	0.000	0.000
n.C25	ace_dg - queen_chc	-2.676	0.434	229.0	-6.168	0.000	0.000
n.C25	ace_dg - queen_dg	0.471	0.327	229.0	1.439	0.151	1.000
n.C25	ace_dg - queen_egg	-1.927	0.224	229.0	-8.617	0.000	0.000
n.C25	ace_egg - met_chc	-0.421	0.252	229.0	-1.673	0.096	1.000
n.C25	ace_egg - met_dg	2.470	0.275	229.0	8.976	0.000	0.000
n.C25	ace_egg - met_egg	0.041	0.246	229.0	0.168	0.867	1.000
n.C25	ace_egg - pre_chc	-0.342	0.242	229.0	-1.415	0.158	1.000
n.C25	ace_egg - pre_dg	2.242	0.244	229.0	9.191	0.000	0.000
n.C25	ace_egg - pre_egg	0.198	0.244	229.0	0.810	0.419	1.000
n.C25	ace_egg - queen_chc	-1.161	0.441	229.0	-2.631	0.009	1.000
n.C25	ace_egg - queen_dg	1.986	0.337	229.0	5.893	0.000	0.000
n.C25	ace_egg - queen_egg	-0.412	0.238	229.0	-1.732	0.085	1.000
n.C25	met_chc - met_dg	2.891	0.272	229.0	10.615	0.000	0.000
n.C25	met_chc - met_egg	0.462	0.243	229.0	1.901	0.059	1.000
n.C25	met_chc - pre_chc	0.079	0.238	229.0	0.331	0.741	1.000
n.C25	met_chc - pre_dg	2.663	0.241	229.0	11.062	0.000	0.000
n.C25	met_chc - pre_egg	0.619	0.241	229.0	2.569	0.011	1.000
n.C25	met_chc - queen_chc	-0.740	0.440	229.0	-1.684	0.094	1.000
n.C25	met_chc - queen_dg	2.407	0.335	229.0	7.192	0.000	0.000
n.C25	met_chc - queen_egg	0.009	0.234	229.0	0.039	0.969	1.000
n.C25	met_dg - met_egg	-2.429	0.267	229.0	-9.083	0.000	0.000

n.C25	met_dg - pre_chc	-2.812	0.263	229.0	-10.687	0.000	0.000
n.C25	met_dg - pre_dg	-0.228	0.265	229.0	-0.860	0.391	1.000
n.C25	met_dg - pre_egg	-2.272	0.265	229.0	-8.570	0.000	0.000
n.C25	met_dg - queen_chc	-3.631	0.453	229.0	-8.009	0.000	0.000
n.C25	met_dg - queen_dg	-0.484	0.353	229.0	-1.372	0.171	1.000
n.C25	met_dg - queen_egg	-2.882	0.259	229.0	-11.108	0.000	0.000
n.C25	met_egg - pre_chc	-0.383	0.233	229.0	-1.647	0.101	1.000
n.C25	met_egg - pre_dg	2.201	0.235	229.0	9.361	0.000	0.000
n.C25	met_egg - pre_egg	0.156	0.235	229.0	0.664	0.507	1.000
n.C25	met_egg - queen_chc	-1.202	0.436	229.0	-2.755	0.006	1.000
n.C25	met_egg - queen_dg	1.945	0.331	229.0	5.881	0.000	0.000
n.C25	met_egg - queen_egg	-0.453	0.229	229.0	-1.982	0.049	1.000
n.C25	pre_chc - pre_dg	2.584	0.230	229.0	11.223	0.000	0.000
n.C25	pre_chc - pre_egg	0.540	0.230	229.0	2.344	0.020	1.000
n.C25	pre_chc - queen_chc	-0.819	0.434	229.0	-1.888	0.060	1.000
n.C25	pre_chc - queen_dg	2.328	0.327	229.0	7.115	0.000	0.000
n.C25	pre_chc - queen_egg	-0.070	0.224	229.0	-0.312	0.755	1.000
n.C25	pre_dg - pre_egg	-2.044	0.233	229.0	-8.790	0.000	0.000
n.C25	pre_dg - queen_chc	-3.403	0.435	229.0	-7.821	0.000	0.000
n.C25	pre_dg - queen_dg	-0.256	0.329	229.0	-0.777	0.438	1.000
n.C25	pre_dg - queen_egg	-2.654	0.226	229.0	-11.741	0.000	0.000
n.C25	pre_egg - queen_chc	-1.359	0.435	229.0	-3.122	0.002	1.000
n.C25	pre_egg - queen_dg	1.789	0.329	229.0	5.438	0.000	0.000
n.C25	pre_egg - queen_egg	-0.609	0.226	229.0	-2.696	0.008	1.000
n.C25	queen_chc - queen_dg	3.147	0.493	229.0	6.379	0.000	0.000
n.C25	queen_chc - queen_egg	0.749	0.432	229.0	1.736	0.084	1.000
n.C25	queen_dg - queen_egg	-2.398	0.324	229.0	-7.394	0.000	0.000
n.C26	ace_chc - ace_dg	-1.365	0.151	229.0	-9.034	0.000	0.000
n.C26	ace_chc - ace_egg	-0.131	0.160	229.0	-0.819	0.413	1.000
n.C26	ace_chc - met_chc	-0.083	0.158	229.0	-0.528	0.598	1.000
n.C26	ace_chc - met_dg	-2.108	0.174	229.0	-12.081	0.000	0.000
n.C26	ace_chc - met_egg	0.070	0.154	229.0	0.451	0.652	1.000
n.C26	ace_chc - pre_chc	-0.052	0.151	229.0	-0.347	0.729	1.000
n.C26	ace_chc - pre_dg	-1.488	0.153	229.0	-9.749	0.000	0.000
n.C26	ace_chc - pre_egg	-0.140	0.153	229.0	-0.919	0.359	1.000
n.C26	ace_chc - queen_chc	-1.183	0.288	229.0	-4.114	0.000	0.157
n.C26	ace_chc - queen_dg	-2.145	0.217	229.0	-9.888	0.000	0.000
n.C26	ace_chc - queen_egg	-0.153	0.148	229.0	-1.032	0.303	1.000
n.C26	ace_dg - ace_egg	1.234	0.160	229.0	7.698	0.000	0.000
n.C26	ace_dg - met_chc	1.281	0.158	229.0	8.104	0.000	0.000
n.C26	ace_dg - met_dg	-0.743	0.174	229.0	-4.258	0.000	0.088
n.C26	ace_dg - met_egg	1.434	0.154	229.0	9.295	0.000	0.000
n.C26	ace_dg - pre_chc	1.312	0.151	229.0	8.686	0.000	0.000
n.C26	ace_dg - pre_dg	-0.123	0.153	229.0	-0.808	0.420	1.000
n.C26	ace_dg - pre_egg	1.225	0.153	229.0	8.022	0.000	0.000
n.C26	ace_dg - queen_chc	0.181	0.288	229.0	0.631	0.529	1.000
n.C26	ace_dg - queen_dg	-0.781	0.217	229.0	-3.598	0.000	1.000
n.C26	ace_dg - queen_egg	1.212	0.148	229.0	8.174	0.000	0.000
n.C26	ace_egg - met_chc	0.048	0.167	229.0	0.287	0.775	1.000
n.C26	ace_egg - met_dg	-1.976	0.182	229.0	-10.832	0.000	0.000
n.C26	ace_egg - met_egg	0.201	0.163	229.0	1.230	0.220	1.000
n.C26	ace_egg - pre_chc	0.079	0.160	229.0	0.492	0.623	1.000
n.C26	ace_egg - pre_dg	-1.357	0.162	229.0	-8.390	0.000	0.000
n.C26	ace_egg - pre_egg	-0.009	0.162	229.0	-0.056	0.956	1.000
n.C26	ace_egg - queen_chc	-1.052	0.293	229.0	-3.596	0.000	1.000
n.C26	ace_egg - queen_dg	-2.014	0.223	229.0	-9.014	0.000	0.000
n.C26	ace_egg - queen_egg	-0.022	0.158	229.0	-0.138	0.890	1.000
n.C26	met_chc - met_dg	-2.024	0.181	229.0	-11.209	0.000	0.000
n.C26	met_chc - met_egg	0.153	0.161	229.0	0.949	0.343	1.000
n.C26	met_chc - pre_chc	0.031	0.158	229.0	0.196	0.845	1.000
n.C26	met_chc - pre_dg	-1.405	0.160	229.0	-8.801	0.000	0.000
n.C26	met_chc - pre_egg	-0.057	0.160	229.0	-0.356	0.722	1.000
n.C26	met_chc - queen_chc	-1.100	0.291	229.0	-3.775	0.000	0.593
n.C26	met_chc - queen_dg	-2.062	0.222	229.0	-9.291	0.000	0.000
n.C26	met_chc - queen_egg	-0.070	0.155	229.0	-0.448	0.655	1.000
n.C26	met_dg - met_egg	2.177	0.177	229.0	12.282	0.000	0.000
n.C26	met_dg - pre_chc	2.055	0.174	229.0	11.780	0.000	0.000
n.C26	met_dg - pre_dg	0.619	0.176	229.0	3.523	0.001	1.000

n.C26	met_dg - pre_egg	1.967	0.176	229.0	11.190	0.000	0.000
n.C26	met_dg - queen_chc	0.924	0.301	229.0	3.075	0.002	1.000
n.C26	met_dg - queen_dg	-0.038	0.234	229.0	-0.162	0.872	1.000
n.C26	met_dg - queen_egg	1.955	0.172	229.0	11.363	0.000	0.000
n.C26	met_egg - pre_chc	-0.122	0.154	229.0	-0.791	0.430	1.000
n.C26	met_egg - pre_dg	-1.558	0.156	229.0	-9.995	0.000	0.000
n.C26	met_egg - pre_egg	-0.210	0.156	229.0	-1.347	0.179	1.000
n.C26	met_egg - queen_chc	-1.253	0.289	229.0	-4.330	0.000	0.065
n.C26	met_egg - queen_dg	-2.215	0.219	229.0	-10.103	0.000	0.000
n.C26	met_egg - queen_egg	-0.223	0.152	229.0	-1.469	0.143	1.000
n.C26	pre_chc - pre_dg	-1.436	0.153	229.0	-9.406	0.000	0.000
n.C26	pre_chc - pre_egg	-0.088	0.153	229.0	-0.575	0.566	1.000
n.C26	pre_chc - queen_chc	-1.131	0.288	229.0	-3.932	0.000	0.325
n.C26	pre_chc - queen_dg	-2.093	0.217	229.0	-9.646	0.000	0.000
n.C26	pre_chc - queen_egg	-0.101	0.148	229.0	-0.678	0.498	1.000
n.C26	pre_dg - pre_egg	1.348	0.154	229.0	8.742	0.000	0.000
n.C26	pre_dg - queen_chc	0.305	0.288	229.0	1.057	0.292	1.000
n.C26	pre_dg - queen_dg	-0.657	0.218	229.0	-3.014	0.003	1.000
n.C26	pre_dg - queen_egg	1.335	0.150	229.0	8.910	0.000	0.000
n.C26	pre_egg - queen_chc	-1.043	0.288	229.0	-3.616	0.000	1.000
n.C26	pre_egg - queen_dg	-2.005	0.218	229.0	-9.195	0.000	0.000
n.C26	pre_egg - queen_egg	-0.013	0.150	229.0	-0.085	0.932	1.000
n.C26	queen_chc - queen_dg	-0.962	0.327	229.0	-2.941	0.004	1.000
n.C26	queen_chc - queen_egg	1.030	0.286	229.0	3.601	0.000	1.000
n.C26	queen_dg - queen_egg	1.992	0.215	229.0	9.266	0.000	0.000
n.C27	ace_chc - ace_dg	5.430	0.605	229.0	8.983	0.000	0.000
n.C27	ace_chc - ace_egg	-0.294	0.641	229.0	-0.458	0.647	1.000
n.C27	ace_chc - met_chc	-0.163	0.633	229.0	-0.258	0.797	1.000
n.C27	ace_chc - met_dg	6.846	0.698	229.0	9.808	0.000	0.000
n.C27	ace_chc - met_egg	-0.041	0.618	229.0	-0.067	0.947	1.000
n.C27	ace_chc - pre_chc	-0.021	0.605	229.0	-0.035	0.973	1.000
n.C27	ace_chc - pre_dg	6.378	0.611	229.0	10.442	0.000	0.000
n.C27	ace_chc - pre_egg	-0.157	0.611	229.0	-0.257	0.798	1.000
n.C27	ace_chc - queen_chc	-1.225	1.151	229.0	-1.064	0.288	1.000
n.C27	ace_chc - queen_dg	3.642	0.868	229.0	4.196	0.000	0.113
n.C27	ace_chc - queen_egg	-0.082	0.593	229.0	-0.139	0.890	1.000
n.C27	ace_dg - ace_egg	-5.724	0.641	229.0	-8.927	0.000	0.000
n.C27	ace_dg - met_chc	-5.593	0.633	229.0	-8.841	0.000	0.000
n.C27	ace_dg - met_dg	1.416	0.698	229.0	2.029	0.044	1.000
n.C27	ace_dg - met_egg	-5.472	0.618	229.0	-8.861	0.000	0.000
n.C27	ace_dg - pre_chc	-5.451	0.605	229.0	-9.017	0.000	0.000
n.C27	ace_dg - pre_dg	0.947	0.611	229.0	1.551	0.122	1.000
n.C27	ace_dg - pre_egg	-5.587	0.611	229.0	-9.147	0.000	0.000
n.C27	ace_dg - queen_chc	-6.655	1.151	229.0	-5.782	0.000	0.000
n.C27	ace_dg - queen_dg	-1.788	0.868	229.0	-2.059	0.041	1.000
n.C27	ace_dg - queen_egg	-5.513	0.593	229.0	-9.293	0.000	0.000
n.C27	ace_egg - met_chc	0.131	0.668	229.0	0.196	0.845	1.000
n.C27	ace_egg - met_dg	7.140	0.730	229.0	9.781	0.000	0.000
n.C27	ace_egg - met_egg	0.253	0.653	229.0	0.386	0.699	1.000
n.C27	ace_egg - pre_chc	0.273	0.641	229.0	0.426	0.671	1.000
n.C27	ace_egg - pre_dg	6.671	0.647	229.0	10.310	0.000	0.000
n.C27	ace_egg - pre_egg	0.137	0.647	229.0	0.212	0.832	1.000
n.C27	ace_egg - queen_chc	-0.931	1.171	229.0	-0.795	0.427	1.000
n.C27	ace_egg - queen_dg	3.936	0.894	229.0	4.403	0.000	0.048
n.C27	ace_egg - queen_egg	0.211	0.631	229.0	0.335	0.738	1.000
n.C27	met_chc - met_dg	7.009	0.723	229.0	9.701	0.000	0.000
n.C27	met_chc - met_egg	0.122	0.645	229.0	0.189	0.850	1.000
n.C27	met_chc - pre_chc	0.142	0.633	229.0	0.225	0.822	1.000
n.C27	met_chc - pre_dg	6.541	0.639	229.0	10.242	0.000	0.000
n.C27	met_chc - pre_egg	0.006	0.639	229.0	0.010	0.992	1.000
n.C27	met_chc - queen_chc	-1.062	1.166	229.0	-0.911	0.364	1.000
n.C27	met_chc - queen_dg	3.806	0.888	229.0	4.286	0.000	0.078
n.C27	met_chc - queen_egg	0.081	0.622	229.0	0.130	0.897	1.000
n.C27	met_dg - met_egg	-6.888	0.709	229.0	-9.710	0.000	0.000
n.C27	met_dg - pre_chc	-6.867	0.698	229.0	-9.838	0.000	0.000
n.C27	met_dg - pre_dg	-0.469	0.703	229.0	-0.666	0.506	1.000
n.C27	met_dg - pre_egg	-7.003	0.703	229.0	-9.955	0.000	0.000
n.C27	met_dg - queen_chc	-8.071	1.203	229.0	-6.711	0.000	0.000

n.C27	met_dg - queen_dg	-3.204	0.936	229.0	-3.424	0.001	1.000
n.C27	met_dg - queen_egg	-6.929	0.688	229.0	-10.067	0.000	0.000
n.C27	met_egg - pre_chc	0.020	0.618	229.0	0.033	0.974	1.000
n.C27	met_egg - pre_dg	6.419	0.624	229.0	10.292	0.000	0.000
n.C27	met_egg - pre_egg	-0.115	0.624	229.0	-0.185	0.853	1.000
n.C27	met_egg - queen_chc	-1.183	1.158	229.0	-1.022	0.308	1.000
n.C27	met_egg - queen_dg	3.684	0.877	229.0	4.199	0.000	0.111
n.C27	met_egg - queen_egg	-0.041	0.606	229.0	-0.068	0.946	1.000
n.C27	pre_chc - pre_dg	6.399	0.611	229.0	10.476	0.000	0.000
n.C27	pre_chc - pre_egg	-0.136	0.611	229.0	-0.222	0.824	1.000
n.C27	pre_chc - queen_chc	-1.204	1.151	229.0	-1.046	0.297	1.000
n.C27	pre_chc - queen_dg	3.663	0.868	229.0	4.220	0.000	0.102
n.C27	pre_chc - queen_egg	-0.061	0.593	229.0	-0.104	0.918	1.000
n.C27	pre_dg - pre_egg	-6.534	0.617	229.0	-10.591	0.000	0.000
n.C27	pre_dg - queen_chc	-7.602	1.154	229.0	-6.586	0.000	0.000
n.C27	pre_dg - queen_dg	-2.735	0.873	229.0	-3.135	0.002	1.000
n.C27	pre_dg - queen_egg	-6.460	0.600	229.0	-10.774	0.000	0.000
n.C27	pre_egg - queen_chc	-1.068	1.154	229.0	-0.925	0.356	1.000
n.C27	pre_egg - queen_dg	3.799	0.873	229.0	4.354	0.000	0.059
n.C27	pre_egg - queen_egg	0.074	0.600	229.0	0.124	0.901	1.000
n.C27	queen_chc - queen_dg	4.867	1.309	229.0	3.719	0.000	0.731
n.C27	queen_chc - queen_egg	1.142	1.145	229.0	0.998	0.320	1.000
n.C27	queen_dg - queen_egg	-3.725	0.860	229.0	-4.329	0.000	0.065
n.C28...3.9...3.11.diMeC27	ace_chc - ace_dg	-2.846	0.140	229.0	-20.292	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_chc - ace_egg	-0.619	0.149	229.0	-4.161	0.000	0.130
n.C28...3.9...3.11.diMeC27	ace_chc - met_chc	-0.018	0.147	229.0	-0.126	0.900	1.000
n.C28...3.9...3.11.diMeC27	ace_chc - met_dg	-3.182	0.162	229.0	-19.648	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_chc - met_egg	-0.561	0.143	229.0	-3.917	0.000	0.344
n.C28...3.9...3.11.diMeC27	ace_chc - pre_chc	0.039	0.140	229.0	0.279	0.781	1.000
n.C28...3.9...3.11.diMeC27	ace_chc - pre_dg	-2.792	0.142	229.0	-19.703	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_chc - pre_egg	-0.761	0.142	229.0	-5.367	0.000	0.001
n.C28...3.9...3.11.diMeC27	ace_chc - queen_chc	-0.444	0.267	229.0	-1.662	0.098	1.000
n.C28...3.9...3.11.diMeC27	ace_chc - queen_dg	-3.555	0.201	229.0	-17.649	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_chc - queen_egg	-0.199	0.138	229.0	-1.446	0.149	1.000
n.C28...3.9...3.11.diMeC27	ace_dg - ace_egg	2.227	0.149	229.0	14.970	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_dg - met_chc	2.828	0.147	229.0	19.264	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_dg - met_dg	-0.336	0.162	229.0	-2.074	0.039	1.000
n.C28...3.9...3.11.diMeC27	ace_dg - met_egg	2.285	0.143	229.0	15.948	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_dg - pre_chc	2.886	0.140	229.0	20.571	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_dg - pre_dg	0.054	0.142	229.0	0.380	0.704	1.000
n.C28...3.9...3.11.diMeC27	ace_dg - pre_egg	2.086	0.142	229.0	14.717	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_dg - queen_chc	2.403	0.267	229.0	8.996	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_dg - queen_dg	-0.709	0.201	229.0	-3.519	0.001	1.000
n.C28...3.9...3.11.diMeC27	ace_dg - queen_egg	2.647	0.138	229.0	19.232	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_egg - met_chc	0.601	0.155	229.0	3.876	0.000	0.403
n.C28...3.9...3.11.diMeC27	ace_egg - met_dg	-2.563	0.169	229.0	-15.132	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_egg - met_egg	0.058	0.152	229.0	0.382	0.703	1.000
n.C28...3.9...3.11.diMeC27	ace_egg - pre_chc	0.658	0.149	229.0	4.424	0.000	0.044
n.C28...3.9...3.11.diMeC27	ace_egg - pre_dg	-2.173	0.150	229.0	-14.474	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_egg - pre_egg	-0.142	0.150	229.0	-0.942	0.347	1.000
n.C28...3.9...3.11.diMeC27	ace_egg - queen_chc	0.175	0.272	229.0	0.645	0.520	1.000
n.C28...3.9...3.11.diMeC27	ace_egg - queen_dg	-2.936	0.207	229.0	-14.153	0.000	0.000
n.C28...3.9...3.11.diMeC27	ace_egg - queen_egg	0.420	0.146	229.0	2.871	0.004	1.000
n.C28...3.9...3.11.diMeC27	met_chc - met_dg	-3.164	0.168	229.0	-18.871	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_chc - met_egg	-0.543	0.150	229.0	-3.626	0.000	1.000
n.C28...3.9...3.11.diMeC27	met_chc - pre_chc	0.058	0.147	229.0	0.392	0.695	1.000
n.C28...3.9...3.11.diMeC27	met_chc - pre_dg	-2.774	0.148	229.0	-18.719	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_chc - pre_egg	-0.742	0.148	229.0	-5.008	0.000	0.003
n.C28...3.9...3.11.diMeC27	met_chc - queen_chc	-0.425	0.271	229.0	-1.572	0.117	1.000
n.C28...3.9...3.11.diMeC27	met_chc - queen_dg	-3.537	0.206	229.0	-17.165	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_chc - queen_egg	-0.181	0.144	229.0	-1.251	0.212	1.000
n.C28...3.9...3.11.diMeC27	met_dg - met_egg	2.621	0.165	229.0	15.925	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_dg - pre_chc	3.221	0.162	229.0	19.889	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_dg - pre_dg	0.390	0.163	229.0	2.389	0.018	1.000
n.C28...3.9...3.11.diMeC27	met_dg - pre_egg	2.422	0.163	229.0	14.836	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_dg - queen_chc	2.739	0.279	229.0	9.813	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_dg - queen_dg	-0.373	0.217	229.0	-1.718	0.087	1.000
n.C28...3.9...3.11.diMeC27	met_dg - queen_egg	2.983	0.160	229.0	18.680	0.000	0.000

n.C28...3.9...3.11.diMeC27	met_egg - pre_chc	0.600	0.143	229.0	4.189	0.000	0.116
n.C28...3.9...3.11.diMeC27	met_egg - pre_dg	-2.231	0.145	229.0	-15.419	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_egg - pre_egg	-0.199	0.145	229.0	-1.378	0.170	1.000
n.C28...3.9...3.11.diMeC27	met_egg - queen_chc	0.117	0.269	229.0	0.437	0.663	1.000
n.C28...3.9...3.11.diMeC27	met_egg - queen_dg	-2.994	0.204	229.0	-14.709	0.000	0.000
n.C28...3.9...3.11.diMeC27	met_egg - queen_egg	0.362	0.141	229.0	2.573	0.011	1.000
n.C28...3.9...3.11.diMeC27	pre_chc - pre_dg	-2.832	0.142	229.0	-19.979	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_chc - pre_egg	-0.800	0.142	229.0	-5.643	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_chc - queen_chc	-0.483	0.267	229.0	-1.808	0.072	1.000
n.C28...3.9...3.11.diMeC27	pre_chc - queen_dg	-3.594	0.201	229.0	-17.843	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_chc - queen_egg	-0.238	0.138	229.0	-1.730	0.085	1.000
n.C28...3.9...3.11.diMeC27	pre_dg - pre_egg	2.032	0.143	229.0	14.193	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_dg - queen_chc	2.349	0.268	229.0	8.769	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_dg - queen_dg	-0.763	0.202	229.0	-3.768	0.000	0.608
n.C28...3.9...3.11.diMeC27	pre_dg - queen_egg	2.593	0.139	229.0	18.640	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_egg - queen_chc	0.317	0.268	229.0	1.183	0.238	1.000
n.C28...3.9...3.11.diMeC27	pre_egg - queen_dg	-2.795	0.202	229.0	-13.804	0.000	0.000
n.C28...3.9...3.11.diMeC27	pre_egg - queen_egg	0.562	0.139	229.0	4.036	0.000	0.215
n.C28...3.9...3.11.diMeC27	queen_chc - queen_dg	-3.111	0.304	229.0	-10.245	0.000	0.000
n.C28...3.9...3.11.diMeC27	queen_chc - queen_egg	0.245	0.266	229.0	0.921	0.358	1.000
n.C28...3.9...3.11.diMeC27	queen_dg - queen_egg	3.356	0.200	229.0	16.812	0.000	0.000
n.C29	ace_chc - ace_dg	5.261	0.790	229.0	6.659	0.000	0.000
n.C29	ace_chc - ace_egg	-1.993	0.838	229.0	-2.379	0.018	1.000
n.C29	ace_chc - met_chc	-0.420	0.827	229.0	-0.509	0.612	1.000
n.C29	ace_chc - met_dg	5.320	0.912	229.0	5.832	0.000	0.000
n.C29	ace_chc - met_egg	-3.041	0.807	229.0	-3.769	0.000	0.607
n.C29	ace_chc - pre_chc	0.120	0.790	229.0	0.151	0.880	1.000
n.C29	ace_chc - pre_dg	6.442	0.798	229.0	8.071	0.000	0.000
n.C29	ace_chc - pre_egg	-2.936	0.798	229.0	-3.678	0.000	0.850
n.C29	ace_chc - queen_chc	-1.070	1.504	229.0	-0.711	0.478	1.000
n.C29	ace_chc - queen_dg	5.591	1.134	229.0	4.928	0.000	0.005
n.C29	ace_chc - queen_egg	-0.836	0.775	229.0	-1.078	0.282	1.000
n.C29	ace_dg - ace_egg	-7.254	0.838	229.0	-8.657	0.000	0.000
n.C29	ace_dg - met_chc	-5.681	0.827	229.0	-6.872	0.000	0.000
n.C29	ace_dg - met_dg	0.059	0.912	229.0	0.065	0.949	1.000
n.C29	ace_dg - met_egg	-8.302	0.807	229.0	-10.288	0.000	0.000
n.C29	ace_dg - pre_chc	-5.141	0.790	229.0	-6.508	0.000	0.000
n.C29	ace_dg - pre_dg	1.181	0.798	229.0	1.480	0.140	1.000
n.C29	ace_dg - pre_egg	-8.196	0.798	229.0	-10.269	0.000	0.000
n.C29	ace_dg - queen_chc	-6.330	1.504	229.0	-4.209	0.000	0.107
n.C29	ace_dg - queen_dg	0.331	1.134	229.0	0.291	0.771	1.000
n.C29	ace_dg - queen_egg	-6.096	0.775	229.0	-7.864	0.000	0.000
n.C29	ace_egg - met_chc	1.573	0.873	229.0	1.802	0.073	1.000
n.C29	ace_egg - met_dg	7.313	0.954	229.0	7.666	0.000	0.000
n.C29	ace_egg - met_egg	-1.048	0.854	229.0	-1.227	0.221	1.000
n.C29	ace_egg - pre_chc	2.113	0.838	229.0	2.521	0.012	1.000
n.C29	ace_egg - pre_dg	8.435	0.846	229.0	9.975	0.000	0.000
n.C29	ace_egg - pre_egg	-0.943	0.846	229.0	-1.115	0.266	1.000
n.C29	ace_egg - queen_chc	0.923	1.530	229.0	0.604	0.547	1.000
n.C29	ace_egg - queen_dg	7.584	1.168	229.0	6.491	0.000	0.000
n.C29	ace_egg - queen_egg	1.157	0.824	229.0	1.404	0.162	1.000
n.C29	met_chc - met_dg	5.740	0.944	229.0	6.079	0.000	0.000
n.C29	met_chc - met_egg	-2.621	0.843	229.0	-3.109	0.002	1.000
n.C29	met_chc - pre_chc	0.540	0.827	229.0	0.653	0.514	1.000
n.C29	met_chc - pre_dg	6.862	0.835	229.0	8.223	0.000	0.000
n.C29	met_chc - pre_egg	-2.515	0.835	229.0	-3.014	0.003	1.000
n.C29	met_chc - queen_chc	-0.649	1.524	229.0	-0.426	0.670	1.000
n.C29	met_chc - queen_dg	6.012	1.160	229.0	5.181	0.000	0.001
n.C29	met_chc - queen_egg	-0.415	0.813	229.0	-0.511	0.610	1.000
n.C29	met_dg - met_egg	-8.361	0.927	229.0	-9.020	0.000	0.000
n.C29	met_dg - pre_chc	-5.200	0.912	229.0	-5.701	0.000	0.000
n.C29	met_dg - pre_dg	1.123	0.919	229.0	1.221	0.223	1.000
n.C29	met_dg - pre_egg	-8.255	0.919	229.0	-8.980	0.000	0.000
n.C29	met_dg - queen_chc	-6.389	1.572	229.0	-4.065	0.000	0.192
n.C29	met_dg - queen_dg	0.272	1.223	229.0	0.222	0.824	1.000
n.C29	met_dg - queen_egg	-6.155	0.899	229.0	-6.844	0.000	0.000
n.C29	met_egg - pre_chc	3.161	0.807	229.0	3.917	0.000	0.344
n.C29	met_egg - pre_dg	9.483	0.815	229.0	11.636	0.000	0.000

n.C29	met_egg - pre_egg	0.105	0.815	229.0	0.129	0.897	1.000
n.C29	met_egg - queen_chc	1.971	1.513	229.0	1.303	0.194	1.000
n.C29	met_egg - queen_dg	8.632	1.146	229.0	7.530	0.000	0.000
n.C29	met_egg - queen_egg	2.205	0.792	229.0	2.783	0.006	1.000
n.C29	pre_chc - pre_dg	6.322	0.798	229.0	7.922	0.000	0.000
n.C29	pre_chc - pre_egg	-3.055	0.798	229.0	-3.828	0.000	0.484
n.C29	pre_chc - queen_chc	-1.189	1.504	229.0	-0.791	0.430	1.000
n.C29	pre_chc - queen_dg	5.472	1.134	229.0	4.823	0.000	0.007
n.C29	pre_chc - queen_egg	-0.955	0.775	229.0	-1.233	0.219	1.000
n.C29	pre_dg - pre_egg	-9.378	0.806	229.0	-11.631	0.000	0.000
n.C29	pre_dg - queen_chc	-7.512	1.508	229.0	-4.980	0.000	0.004
n.C29	pre_dg - queen_dg	-0.851	1.140	229.0	-0.746	0.456	1.000
n.C29	pre_dg - queen_egg	-7.278	0.784	229.0	-9.289	0.000	0.000
n.C29	pre_egg - queen_chc	1.866	1.508	229.0	1.237	0.217	1.000
n.C29	pre_egg - queen_dg	8.527	1.140	229.0	7.478	0.000	0.000
n.C29	pre_egg - queen_egg	2.100	0.784	229.0	2.680	0.008	1.000
n.C29	queen_chc - queen_dg	6.661	1.710	229.0	3.895	0.000	0.375
n.C29	queen_dg - queen_egg	0.234	1.496	229.0	0.156	0.876	1.000
n.C29	queen_dg - queen_egg	-6.427	1.124	229.0	-5.717	0.000	0.000
n.C30	ace_chc - ace_dg	0.000	0.229	229.0	0.002	0.998	1.000
n.C30	ace_chc - ace_egg	-9.301	0.243	229.0	-38.269	0.000	0.000
n.C30	ace_chc - met_chc	0.000	0.240	229.0	0.000	1.000	1.000
n.C30	ace_chc - met_dg	0.000	0.265	229.0	0.001	0.999	1.000
n.C30	ace_chc - met_egg	-9.158	0.234	229.0	-39.124	0.000	0.000
n.C30	ace_chc - pre_chc	0.000	0.229	229.0	0.000	1.000	1.000
n.C30	ace_chc - pre_dg	0.000	0.232	229.0	0.002	0.999	1.000
n.C30	ace_chc - pre_egg	-9.499	0.232	229.0	-41.028	0.000	0.000
n.C30	ace_chc - queen_chc	0.000	0.436	229.0	0.000	1.000	1.000
n.C30	ace_chc - queen_dg	0.000	0.329	229.0	0.001	1.000	1.000
n.C30	ace_chc - queen_egg	-8.947	0.225	229.0	-39.790	0.000	0.000
n.C30	ace_dg - ace_egg	-9.302	0.243	229.0	-38.271	0.000	0.000
n.C30	ace_dg - met_chc	0.000	0.240	229.0	-0.002	0.999	1.000
n.C30	ace_dg - met_dg	0.000	0.265	229.0	-0.001	0.999	1.000
n.C30	ace_dg - met_egg	-9.158	0.234	229.0	-39.126	0.000	0.000
n.C30	ace_dg - pre_chc	0.000	0.229	229.0	-0.002	0.998	1.000
n.C30	ace_dg - pre_dg	0.000	0.232	229.0	0.000	1.000	1.000
n.C30	ace_dg - pre_egg	-9.499	0.232	229.0	-41.030	0.000	0.000
n.C30	ace_dg - queen_chc	-0.001	0.436	229.0	-0.001	0.999	1.000
n.C30	ace_dg - queen_dg	0.000	0.329	229.0	-0.001	0.999	1.000
n.C30	ace_dg - queen_egg	-8.948	0.225	229.0	-39.792	0.000	0.000
n.C30	ace_egg - met_chc	9.301	0.253	229.0	36.746	0.000	0.000
n.C30	ace_egg - met_dg	9.301	0.277	229.0	33.613	0.000	0.000
n.C30	ace_egg - met_egg	0.143	0.248	229.0	0.579	0.563	1.000
n.C30	ace_egg - pre_chc	9.301	0.243	229.0	38.269	0.000	0.000
n.C30	ace_egg - pre_dg	9.301	0.245	229.0	37.921	0.000	0.000
n.C30	ace_egg - pre_egg	-0.198	0.245	229.0	-0.805	0.421	1.000
n.C30	ace_egg - queen_chc	9.301	0.444	229.0	20.961	0.000	0.000
n.C30	ace_egg - queen_dg	9.301	0.339	229.0	27.445	0.000	0.000
n.C30	ace_egg - queen_egg	0.354	0.239	229.0	1.481	0.140	1.000
n.C30	met_chc - met_dg	0.000	0.274	229.0	0.001	0.999	1.000
n.C30	met_chc - met_egg	-9.158	0.245	229.0	-37.452	0.000	0.000
n.C30	met_chc - pre_chc	0.000	0.240	229.0	0.000	1.000	1.000
n.C30	met_chc - pre_dg	0.000	0.242	229.0	0.001	0.999	1.000
n.C30	met_chc - pre_egg	-9.499	0.242	229.0	-39.238	0.000	0.000
n.C30	met_chc - queen_chc	0.000	0.442	229.0	0.000	1.000	1.000
n.C30	met_chc - queen_dg	0.000	0.337	229.0	0.001	1.000	1.000
n.C30	met_chc - queen_egg	-8.947	0.236	229.0	-37.957	0.000	0.000
n.C30	met_dg - met_egg	-9.158	0.269	229.0	-34.061	0.000	0.000
n.C30	met_dg - pre_chc	0.000	0.265	229.0	-0.001	0.999	1.000
n.C30	met_dg - pre_dg	0.000	0.267	229.0	0.001	1.000	1.000
n.C30	met_dg - pre_egg	-9.499	0.267	229.0	-35.623	0.000	0.000
n.C30	met_dg - queen_chc	0.000	0.456	229.0	-0.001	0.999	1.000
n.C30	met_dg - queen_dg	0.000	0.355	229.0	0.000	1.000	1.000
n.C30	met_dg - queen_egg	-8.947	0.261	229.0	-34.295	0.000	0.000
n.C30	met_egg - pre_chc	9.158	0.234	229.0	39.124	0.000	0.000
n.C30	met_egg - pre_dg	9.158	0.236	229.0	38.741	0.000	0.000
n.C30	met_egg - pre_egg	-0.341	0.236	229.0	-1.442	0.151	1.000
n.C30	met_egg - queen_chc	9.158	0.439	229.0	20.866	0.000	0.000

n.C30	met_egg - queen_dg	9.158	0.333	229.0	27.540	0.000	0.000
n.C30	met_egg - queen_egg	0.211	0.230	229.0	0.916	0.360	1.000
n.C30	pre_chc - pre_dg	0.000	0.232	229.0	0.002	0.999	1.000
n.C30	pre_chc - pre_egg	-9.499	0.232	229.0	-41.028	0.000	0.000
n.C30	pre_chc - queen_chc	0.000	0.436	229.0	0.000	1.000	1.000
n.C30	pre_chc - queen_dg	0.000	0.329	229.0	0.001	0.999	1.000
n.C30	pre_chc - queen_egg	-8.947	0.225	229.0	-39.790	0.000	0.000
n.C30	pre_dg - pre_egg	-9.499	0.234	229.0	-40.617	0.000	0.000
n.C30	pre_dg - queen_chc	0.000	0.438	229.0	-0.001	0.999	1.000
n.C30	pre_dg - queen_dg	0.000	0.331	229.0	0.000	1.000	1.000
n.C30	pre_dg - queen_egg	-8.947	0.227	229.0	-39.368	0.000	0.000
n.C30	pre_egg - queen_chc	9.499	0.438	229.0	21.710	0.000	0.000
n.C30	pre_egg - queen_dg	9.499	0.331	229.0	28.720	0.000	0.000
n.C30	pre_egg - queen_egg	0.552	0.227	229.0	2.427	0.016	1.000
n.C30	queen_chc - queen_dg	0.000	0.496	229.0	0.001	0.999	1.000
n.C30	queen_chc - queen_egg	-8.947	0.434	229.0	-20.613	0.000	0.000
n.C30	queen_dg - queen_egg	-8.947	0.326	229.0	-27.436	0.000	0.000
n.C31	ace_chc - ace_dg	0.000	0.585	229.0	0.001	0.999	1.000
n.C31	ace_chc - ace_egg	-6.716	0.621	229.0	-10.818	0.000	0.000
n.C31	ace_chc - met_chc	0.000	0.613	229.0	0.000	1.000	1.000
n.C31	ace_chc - met_dg	0.000	0.676	229.0	0.000	1.000	1.000
n.C31	ace_chc - met_egg	-7.398	0.598	229.0	-12.374	0.000	0.000
n.C31	ace_chc - pre_chc	0.000	0.585	229.0	0.000	1.000	1.000
n.C31	ace_chc - pre_dg	0.000	0.591	229.0	0.001	1.000	1.000
n.C31	ace_chc - pre_egg	-7.682	0.591	229.0	-12.991	0.000	0.000
n.C31	ace_chc - queen_chc	0.000	1.114	229.0	0.000	1.000	1.000
n.C31	ace_chc - queen_dg	0.000	0.841	229.0	0.000	1.000	1.000
n.C31	ace_chc - queen_egg	-4.324	0.574	229.0	-7.529	0.000	0.000
n.C31	ace_dg - ace_egg	-6.716	0.621	229.0	-10.819	0.000	0.000
n.C31	ace_dg - met_chc	0.000	0.613	229.0	-0.001	0.999	1.000
n.C31	ace_dg - met_dg	0.000	0.676	229.0	0.000	1.000	1.000
n.C31	ace_dg - met_egg	-7.399	0.598	229.0	-12.374	0.000	0.000
n.C31	ace_dg - pre_chc	0.000	0.585	229.0	-0.001	0.999	1.000
n.C31	ace_dg - pre_dg	0.000	0.591	229.0	0.000	1.000	1.000
n.C31	ace_dg - pre_egg	-7.683	0.591	229.0	-12.991	0.000	0.000
n.C31	ace_dg - queen_chc	-0.001	1.114	229.0	0.000	1.000	1.000
n.C31	ace_dg - queen_dg	0.000	0.841	229.0	0.000	1.000	1.000
n.C31	ace_dg - queen_egg	-4.325	0.574	229.0	-7.530	0.000	0.000
n.C31	ace_egg - met_chc	6.716	0.647	229.0	10.387	0.000	0.000
n.C31	ace_egg - met_dg	6.716	0.707	229.0	9.502	0.000	0.000
n.C31	ace_egg - met_egg	-0.682	0.633	229.0	-1.078	0.282	1.000
n.C31	ace_egg - pre_chc	6.716	0.621	229.0	10.818	0.000	0.000
n.C31	ace_egg - pre_dg	6.716	0.627	229.0	10.720	0.000	0.000
n.C31	ace_egg - pre_egg	-0.966	0.627	229.0	-1.542	0.124	1.000
n.C31	ace_egg - queen_chc	6.716	1.133	229.0	5.925	0.000	0.000
n.C31	ace_egg - queen_dg	6.716	0.866	229.0	7.758	0.000	0.000
n.C31	ace_egg - queen_egg	2.391	0.611	229.0	3.917	0.000	0.344
n.C31	met_chc - met_dg	0.000	0.700	229.0	0.000	1.000	1.000
n.C31	met_chc - met_egg	-7.398	0.625	229.0	-11.845	0.000	0.000
n.C31	met_chc - pre_chc	0.000	0.613	229.0	0.000	1.000	1.000
n.C31	met_chc - pre_dg	0.000	0.618	229.0	0.001	1.000	1.000
n.C31	met_chc - pre_egg	-7.682	0.618	229.0	-12.424	0.000	0.000
n.C31	met_chc - queen_chc	0.000	1.129	229.0	0.000	1.000	1.000
n.C31	met_chc - queen_dg	0.000	0.860	229.0	0.000	1.000	1.000
n.C31	met_chc - queen_egg	-4.324	0.602	229.0	-7.182	0.000	0.000
n.C31	met_dg - met_egg	-7.398	0.687	229.0	-10.772	0.000	0.000
n.C31	met_dg - pre_chc	0.000	0.676	229.0	0.000	1.000	1.000
n.C31	met_dg - pre_dg	0.000	0.681	229.0	0.000	1.000	1.000
n.C31	met_dg - pre_egg	-7.682	0.681	229.0	-11.279	0.000	0.000
n.C31	met_dg - queen_chc	0.000	1.164	229.0	0.000	1.000	1.000
n.C31	met_dg - queen_dg	0.000	0.906	229.0	0.000	1.000	1.000
n.C31	met_dg - queen_egg	-4.325	0.666	229.0	-6.490	0.000	0.000
n.C31	met_egg - pre_chc	7.398	0.598	229.0	12.374	0.000	0.000
n.C31	met_egg - pre_dg	7.399	0.604	229.0	12.253	0.000	0.000
n.C31	met_egg - pre_egg	-0.284	0.604	229.0	-0.471	0.638	1.000
n.C31	met_egg - queen_chc	7.398	1.121	229.0	6.599	0.000	0.000
n.C31	met_egg - queen_dg	7.398	0.849	229.0	8.710	0.000	0.000
n.C31	met_egg - queen_egg	3.074	0.587	229.0	5.235	0.000	0.001

n.C31	pre_chc - pre_dg	0.000	0.591	229.0	0.001	0.999	1.000
n.C31	pre_chc - pre_egg	-7.682	0.591	229.0	-12.991	0.000	0.000
n.C31	pre_chc - queen_chc	0.000	1.114	229.0	0.000	1.000	1.000
n.C31	pre_chc - queen_dg	0.000	0.841	229.0	0.000	1.000	1.000
n.C31	pre_chc - queen_egg	-4.324	0.574	229.0	-7.529	0.000	0.000
n.C31	pre_dg - pre_egg	-7.683	0.597	229.0	-12.861	0.000	0.000
n.C31	pre_dg - queen_chc	0.000	1.118	229.0	0.000	1.000	1.000
n.C31	pre_dg - queen_dg	0.000	0.845	229.0	0.000	1.000	1.000
n.C31	pre_dg - queen_egg	-4.325	0.581	229.0	-7.450	0.000	0.000
n.C31	pre_egg - queen_chc	7.682	1.118	229.0	6.874	0.000	0.000
n.C31	pre_egg - queen_dg	7.682	0.845	229.0	9.094	0.000	0.000
n.C31	pre_egg - queen_egg	3.358	0.581	229.0	5.784	0.000	0.000
n.C31	queen_chc - queen_dg	0.000	1.267	229.0	0.000	1.000	1.000
n.C31	queen_chc - queen_egg	-4.324	1.109	229.0	-3.900	0.000	0.367
n.C31	queen_dg - queen_egg	-4.325	0.833	229.0	-5.192	0.000	0.001
11..9.MeC23	ace_chc - ace_dg	1.861	0.454	229.0	4.098	0.000	0.168
11..9.MeC23	ace_chc - ace_egg	1.861	0.482	229.0	3.864	0.000	0.422
11..9.MeC23	ace_chc - met_chc	-2.108	0.475	229.0	-4.435	0.000	0.041
11..9.MeC23	ace_chc - met_dg	1.860	0.524	229.0	3.548	0.000	1.000
11..9.MeC23	ace_chc - met_egg	1.861	0.464	229.0	4.012	0.000	0.237
11..9.MeC23	ace_chc - pre_chc	1.063	0.454	229.0	2.341	0.020	1.000
11..9.MeC23	ace_chc - pre_dg	1.861	0.459	229.0	4.056	0.000	0.199
11..9.MeC23	ace_chc - pre_egg	1.861	0.459	229.0	4.056	0.000	0.199
11..9.MeC23	ace_chc - queen_chc	1.860	0.865	229.0	2.152	0.032	1.000
11..9.MeC23	ace_chc - queen_dg	1.860	0.652	229.0	2.853	0.005	1.000
11..9.MeC23	ace_chc - queen_egg	1.861	0.446	229.0	4.176	0.000	0.122
11..9.MeC23	ace_dg - ace_egg	0.000	0.482	229.0	0.000	1.000	1.000
11..9.MeC23	ace_dg - met_chc	-3.968	0.475	229.0	-8.351	0.000	0.000
11..9.MeC23	ace_dg - met_dg	0.000	0.524	229.0	0.000	1.000	1.000
11..9.MeC23	ace_dg - met_egg	0.000	0.464	229.0	0.000	1.000	1.000
11..9.MeC23	ace_dg - pre_chc	-0.798	0.454	229.0	-1.757	0.080	1.000
11..9.MeC23	ace_dg - pre_dg	0.000	0.459	229.0	0.000	1.000	1.000
11..9.MeC23	ace_dg - pre_egg	0.000	0.459	229.0	0.000	1.000	1.000
11..9.MeC23	ace_dg - queen_chc	-0.001	0.865	229.0	-0.001	0.999	1.000
11..9.MeC23	ace_dg - queen_dg	0.000	0.652	229.0	0.000	1.000	1.000
11..9.MeC23	ace_dg - queen_egg	0.000	0.446	229.0	0.000	1.000	1.000
11..9.MeC23	ace_egg - met_chc	-3.968	0.502	229.0	-7.912	0.000	0.000
11..9.MeC23	ace_egg - met_dg	0.000	0.548	229.0	-0.001	1.000	1.000
11..9.MeC23	ace_egg - met_egg	0.000	0.491	229.0	0.000	1.000	1.000
11..9.MeC23	ace_egg - pre_chc	-0.798	0.482	229.0	-1.657	0.099	1.000
11..9.MeC23	ace_egg - pre_dg	0.000	0.486	229.0	0.000	1.000	1.000
11..9.MeC23	ace_egg - pre_egg	0.000	0.486	229.0	0.000	1.000	1.000
11..9.MeC23	ace_egg - queen_chc	-0.001	0.879	229.0	-0.001	0.999	1.000
11..9.MeC23	ace_egg - queen_dg	0.000	0.672	229.0	0.000	1.000	1.000
11..9.MeC23	ace_egg - queen_egg	0.000	0.474	229.0	0.000	1.000	1.000
11..9.MeC23	met_chc - met_dg	3.968	0.543	229.0	7.312	0.000	0.000
11..9.MeC23	met_chc - met_egg	3.968	0.485	229.0	8.190	0.000	0.000
11..9.MeC23	met_chc - pre_chc	3.171	0.475	229.0	6.672	0.000	0.000
11..9.MeC23	met_chc - pre_dg	3.968	0.480	229.0	8.272	0.000	0.000
11..9.MeC23	met_chc - pre_egg	3.968	0.480	229.0	8.273	0.000	0.000
11..9.MeC23	met_chc - queen_chc	3.968	0.876	229.0	4.530	0.000	0.028
11..9.MeC23	met_chc - queen_dg	3.968	0.667	229.0	5.949	0.000	0.000
11..9.MeC23	met_chc - queen_egg	3.968	0.467	229.0	8.496	0.000	0.000
11..9.MeC23	met_dg - met_egg	0.000	0.533	229.0	0.001	1.000	1.000
11..9.MeC23	met_dg - pre_chc	-0.798	0.524	229.0	-1.521	0.130	1.000
11..9.MeC23	met_dg - pre_dg	0.000	0.528	229.0	0.000	1.000	1.000
11..9.MeC23	met_dg - pre_egg	0.000	0.528	229.0	0.000	1.000	1.000
11..9.MeC23	met_dg - queen_chc	0.000	0.903	229.0	0.000	1.000	1.000
11..9.MeC23	met_dg - queen_dg	0.000	0.703	229.0	0.000	1.000	1.000
11..9.MeC23	met_dg - queen_egg	0.000	0.517	229.0	0.001	0.999	1.000
11..9.MeC23	met_egg - pre_chc	-0.798	0.464	229.0	-1.720	0.087	1.000
11..9.MeC23	met_egg - pre_dg	0.000	0.468	229.0	0.000	1.000	1.000
11..9.MeC23	met_egg - pre_egg	0.000	0.468	229.0	0.000	1.000	1.000
11..9.MeC23	met_egg - queen_chc	-0.001	0.870	229.0	-0.001	0.999	1.000
11..9.MeC23	met_egg - queen_dg	0.000	0.659	229.0	0.000	1.000	1.000
11..9.MeC23	met_egg - queen_egg	0.000	0.456	229.0	0.000	1.000	1.000
11..9.MeC23	pre_chc - pre_dg	0.798	0.459	229.0	1.739	0.083	1.000
11..9.MeC23	pre_chc - pre_egg	0.798	0.459	229.0	1.739	0.083	1.000

11..9.MeC23	pre_chc - queen_chc	0.797	0.865	229.0	0.922	0.357	1.000
11..9.MeC23	pre_chc - queen_dg	0.798	0.652	229.0	1.223	0.223	1.000
11..9.MeC23	pre_chc - queen_egg	0.798	0.446	229.0	1.791	0.075	1.000
11..9.MeC23	pre_dg - pre_egg	0.000	0.463	229.0	0.000	1.000	1.000
11..9.MeC23	pre_dg - queen_chc	0.000	0.867	229.0	-0.001	1.000	1.000
11..9.MeC23	pre_dg - queen_dg	0.000	0.655	229.0	0.000	1.000	1.000
11..9.MeC23	pre_dg - queen_egg	0.000	0.450	229.0	0.000	1.000	1.000
11..9.MeC23	pre_egg - queen_chc	-0.001	0.867	229.0	-0.001	1.000	1.000
11..9.MeC23	pre_egg - queen_dg	0.000	0.655	229.0	0.000	1.000	1.000
11..9.MeC23	pre_egg - queen_egg	0.000	0.450	229.0	0.000	1.000	1.000
11..9.MeC23	queen_chc - queen_dg	0.000	0.983	229.0	0.000	1.000	1.000
11..9.MeC23	queen_chc - queen_egg	0.001	0.860	229.0	0.001	0.999	1.000
11..9.MeC23	queen_dg - queen_egg	0.000	0.646	229.0	0.001	1.000	1.000
12..10.MeC24	ace_chc - ace_dg	-8.860	0.805	229.0	-11.001	0.000	0.000
12..10.MeC24	ace_chc - ace_egg	-6.689	0.854	229.0	-7.830	0.000	0.000
12..10.MeC24	ace_chc - met_chc	0.000	0.843	229.0	0.000	1.000	1.000
12..10.MeC24	ace_chc - met_dg	-7.543	0.930	229.0	-8.110	0.000	0.000
12..10.MeC24	ace_chc - met_egg	-5.579	0.823	229.0	-6.781	0.000	0.000
12..10.MeC24	ace_chc - pre_chc	0.000	0.805	229.0	0.000	1.000	1.000
12..10.MeC24	ace_chc - pre_dg	-7.114	0.814	229.0	-8.742	0.000	0.000
12..10.MeC24	ace_chc - pre_egg	-5.823	0.814	229.0	-7.156	0.000	0.000
12..10.MeC24	ace_chc - queen_chc	0.000	1.533	229.0	0.000	1.000	1.000
12..10.MeC24	ace_chc - queen_dg	-10.995	1.157	229.0	-9.505	0.000	0.000
12..10.MeC24	ace_chc - queen_egg	-6.726	0.790	229.0	-8.510	0.000	0.000
12..10.MeC24	ace_dg - ace_egg	2.171	0.854	229.0	2.542	0.012	1.000
12..10.MeC24	ace_dg - met_chc	8.860	0.843	229.0	10.512	0.000	0.000
12..10.MeC24	ace_dg - met_dg	1.317	0.930	229.0	1.417	0.158	1.000
12..10.MeC24	ace_dg - met_egg	3.281	0.823	229.0	3.989	0.000	0.260
12..10.MeC24	ace_dg - pre_chc	8.860	0.805	229.0	11.001	0.000	0.000
12..10.MeC24	ace_dg - pre_dg	1.746	0.814	229.0	2.146	0.033	1.000
12..10.MeC24	ace_dg - pre_egg	3.037	0.814	229.0	3.733	0.000	0.695
12..10.MeC24	ace_dg - queen_chc	8.860	1.533	229.0	5.778	0.000	0.000
12..10.MeC24	ace_dg - queen_dg	-2.135	1.157	229.0	-1.845	0.066	1.000
12..10.MeC24	ace_dg - queen_egg	2.134	0.790	229.0	2.701	0.007	1.000
12..10.MeC24	ace_egg - met_chc	6.689	0.890	229.0	7.519	0.000	0.000
12..10.MeC24	ace_egg - met_dg	-0.854	0.973	229.0	-0.878	0.381	1.000
12..10.MeC24	ace_egg - met_egg	1.110	0.871	229.0	1.275	0.203	1.000
12..10.MeC24	ace_egg - pre_chc	6.689	0.854	229.0	7.830	0.000	0.000
12..10.MeC24	ace_egg - pre_dg	-0.425	0.862	229.0	-0.493	0.623	1.000
12..10.MeC24	ace_egg - pre_egg	0.866	0.862	229.0	1.005	0.316	1.000
12..10.MeC24	ace_egg - queen_chc	6.689	1.560	229.0	4.289	0.000	0.077
12..10.MeC24	ace_egg - queen_dg	-4.306	1.191	229.0	-3.615	0.000	1.000
12..10.MeC24	ace_egg - queen_egg	-0.037	0.840	229.0	-0.044	0.965	1.000
12..10.MeC24	met_chc - met_dg	-7.543	0.963	229.0	-7.835	0.000	0.000
12..10.MeC24	met_chc - met_egg	-5.579	0.859	229.0	-6.491	0.000	0.000
12..10.MeC24	met_chc - pre_chc	0.000	0.843	229.0	0.000	1.000	1.000
12..10.MeC24	met_chc - pre_dg	-7.114	0.851	229.0	-8.361	0.000	0.000
12..10.MeC24	met_chc - pre_egg	-5.823	0.851	229.0	-6.843	0.000	0.000
12..10.MeC24	met_chc - queen_chc	0.000	1.553	229.0	0.000	1.000	1.000
12..10.MeC24	met_chc - queen_dg	-10.995	1.183	229.0	-9.293	0.000	0.000
12..10.MeC24	met_chc - queen_egg	-6.726	0.829	229.0	-8.118	0.000	0.000
12..10.MeC24	met_dg - met_egg	1.964	0.945	229.0	2.078	0.039	1.000
12..10.MeC24	met_dg - pre_chc	7.543	0.930	229.0	8.110	0.000	0.000
12..10.MeC24	met_dg - pre_dg	0.429	0.937	229.0	0.458	0.648	1.000
12..10.MeC24	met_dg - pre_egg	1.720	0.937	229.0	1.835	0.068	1.000
12..10.MeC24	met_dg - queen_chc	7.543	1.602	229.0	4.707	0.000	0.013
12..10.MeC24	met_dg - queen_dg	-3.452	1.247	229.0	-2.769	0.006	1.000
12..10.MeC24	met_dg - queen_egg	0.817	0.917	229.0	0.891	0.374	1.000
12..10.MeC24	met_egg - pre_chc	5.579	0.823	229.0	6.781	0.000	0.000
12..10.MeC24	met_egg - pre_dg	-1.535	0.831	229.0	-1.848	0.066	1.000
12..10.MeC24	met_egg - pre_egg	-0.244	0.831	229.0	-0.294	0.769	1.000
12..10.MeC24	met_egg - queen_chc	5.579	1.543	229.0	3.616	0.000	1.000
12..10.MeC24	met_egg - queen_dg	-5.416	1.169	229.0	-4.634	0.000	0.017
12..10.MeC24	met_egg - queen_egg	-1.147	0.808	229.0	-1.420	0.157	1.000
12..10.MeC24	pre_chc - pre_dg	-7.114	0.814	229.0	-8.742	0.000	0.000
12..10.MeC24	pre_chc - pre_egg	-5.823	0.814	229.0	-7.156	0.000	0.000
12..10.MeC24	pre_chc - queen_chc	0.000	1.533	229.0	0.000	1.000	1.000
12..10.MeC24	pre_chc - queen_dg	-10.995	1.157	229.0	-9.505	0.000	0.000

12..10.MeC24	pre_chc - queen_egg	-6.726	0.790	229.0	-8.510	0.000	0.000
12..10.MeC24	pre_dg - pre_egg	1.291	0.822	229.0	1.571	0.118	1.000
12..10.MeC24	pre_dg - queen_chc	7.114	1.538	229.0	4.626	0.000	0.018
12..10.MeC24	pre_dg - queen_dg	-3.881	1.163	229.0	-3.338	0.001	1.000
12..10.MeC24	pre_egg - queen_egg	0.388	0.799	229.0	0.486	0.628	1.000
12..10.MeC24	pre_egg - queen_chc	5.823	1.538	229.0	3.786	0.000	0.567
12..10.MeC24	pre_egg - queen_dg	-5.172	1.163	229.0	-4.449	0.000	0.039
12..10.MeC24	pre_egg - queen_egg	-0.903	0.799	229.0	-1.130	0.260	1.000
12..10.MeC24	queen_chc - queen_dg	-10.995	1.744	229.0	-6.305	0.000	0.000
12..10.MeC24	queen_chc - queen_egg	-6.726	1.526	229.0	-4.409	0.000	0.046
12..10.MeC24	queen_dg - queen_egg	4.269	1.146	229.0	3.724	0.000	0.716
12..10.MeC26	ace_chc - ace_dg	0.359	0.140	229.0	2.565	0.011	1.000
12..10.MeC26	ace_chc - ace_egg	0.825	0.148	229.0	5.562	0.000	0.000
12..10.MeC26	ace_chc - met_chc	0.241	0.146	229.0	1.646	0.101	1.000
12..10.MeC26	ace_chc - met_dg	-0.092	0.161	229.0	-0.569	0.570	1.000
12..10.MeC26	ace_chc - met_egg	0.861	0.143	229.0	6.030	0.000	0.000
12..10.MeC26	ace_chc - pre_chc	-0.013	0.140	229.0	-0.091	0.928	1.000
12..10.MeC26	ace_chc - pre_dg	0.597	0.141	229.0	4.228	0.000	0.099
12..10.MeC26	ace_chc - pre_egg	0.721	0.141	229.0	5.105	0.000	0.002
12..10.MeC26	ace_chc - queen_chc	2.066	0.266	229.0	7.761	0.000	0.000
12..10.MeC26	ace_chc - queen_dg	-0.412	0.201	229.0	-2.052	0.041	1.000
12..10.MeC26	ace_chc - queen_egg	0.662	0.137	229.0	4.825	0.000	0.007
12..10.MeC26	ace_dg - ace_egg	0.466	0.148	229.0	3.144	0.002	1.000
12..10.MeC26	ace_dg - met_chc	-0.118	0.146	229.0	-0.805	0.422	1.000
12..10.MeC26	ace_dg - met_dg	-0.451	0.161	229.0	-2.791	0.006	1.000
12..10.MeC26	ace_dg - met_egg	0.503	0.143	229.0	3.519	0.001	1.000
12..10.MeC26	ace_dg - pre_chc	-0.371	0.140	229.0	-2.656	0.008	1.000
12..10.MeC26	ace_dg - pre_dg	0.239	0.141	229.0	1.689	0.093	1.000
12..10.MeC26	ace_dg - pre_egg	0.363	0.141	229.0	2.566	0.011	1.000
12..10.MeC26	ace_dg - queen_chc	1.707	0.266	229.0	6.414	0.000	0.000
12..10.MeC26	ace_dg - queen_dg	-0.771	0.201	229.0	-3.839	0.000	0.465
12..10.MeC26	ace_dg - queen_egg	0.303	0.137	229.0	2.211	0.028	1.000
12..10.MeC26	ace_egg - met_chc	-0.584	0.154	229.0	-3.781	0.000	0.579
12..10.MeC26	ace_egg - met_dg	-0.917	0.169	229.0	-5.430	0.000	0.000
12..10.MeC26	ace_egg - met_egg	0.036	0.151	229.0	0.241	0.810	1.000
12..10.MeC26	ace_egg - pre_chc	-0.838	0.148	229.0	-5.648	0.000	0.000
12..10.MeC26	ace_egg - pre_dg	-0.228	0.150	229.0	-1.521	0.130	1.000
12..10.MeC26	ace_egg - pre_egg	-0.104	0.150	229.0	-0.693	0.489	1.000
12..10.MeC26	ace_egg - queen_chc	1.241	0.271	229.0	4.584	0.000	0.022
12..10.MeC26	ace_egg - queen_dg	-1.237	0.207	229.0	-5.982	0.000	0.000
12..10.MeC26	ace_egg - queen_egg	-0.163	0.146	229.0	-1.117	0.265	1.000
12..10.MeC26	met_chc - met_dg	-0.333	0.167	229.0	-1.992	0.048	1.000
12..10.MeC26	met_chc - met_egg	0.620	0.149	229.0	4.158	0.000	0.132
12..10.MeC26	met_chc - pre_chc	-0.254	0.146	229.0	-1.733	0.084	1.000
12..10.MeC26	met_chc - pre_dg	0.356	0.148	229.0	2.413	0.017	1.000
12..10.MeC26	met_chc - pre_egg	0.480	0.148	229.0	3.251	0.001	1.000
12..10.MeC26	met_chc - queen_chc	1.825	0.270	229.0	6.768	0.000	0.000
12..10.MeC26	met_chc - queen_dg	-0.653	0.205	229.0	-3.180	0.002	1.000
12..10.MeC26	met_chc - queen_egg	0.421	0.144	229.0	2.928	0.004	1.000
12..10.MeC26	met_dg - met_egg	0.953	0.164	229.0	5.810	0.000	0.000
12..10.MeC26	met_dg - pre_chc	0.079	0.161	229.0	0.491	0.624	1.000
12..10.MeC26	met_dg - pre_dg	0.689	0.163	229.0	4.236	0.000	0.096
12..10.MeC26	met_dg - pre_egg	0.813	0.163	229.0	4.997	0.000	0.003
12..10.MeC26	met_dg - queen_chc	2.158	0.278	229.0	7.758	0.000	0.000
12..10.MeC26	met_dg - queen_dg	-0.320	0.216	229.0	-1.480	0.140	1.000
12..10.MeC26	met_dg - queen_egg	0.754	0.159	229.0	4.736	0.000	0.011
12..10.MeC26	met_egg - pre_chc	-0.874	0.143	229.0	-6.119	0.000	0.000
12..10.MeC26	met_egg - pre_dg	-0.264	0.144	229.0	-1.830	0.069	1.000
12..10.MeC26	met_egg - pre_egg	-0.140	0.144	229.0	-0.971	0.332	1.000
12..10.MeC26	met_egg - queen_chc	1.205	0.268	229.0	4.499	0.000	0.032
12..10.MeC26	met_egg - queen_dg	-1.273	0.203	229.0	-6.276	0.000	0.000
12..10.MeC26	met_egg - queen_egg	-0.199	0.140	229.0	-1.421	0.157	1.000
12..10.MeC26	pre_chc - pre_dg	0.610	0.141	229.0	4.318	0.000	0.068
12..10.MeC26	pre_chc - pre_egg	0.734	0.141	229.0	5.195	0.000	0.001
12..10.MeC26	pre_chc - queen_chc	2.079	0.266	229.0	7.809	0.000	0.000
12..10.MeC26	pre_chc - queen_dg	-0.399	0.201	229.0	-1.989	0.048	1.000
12..10.MeC26	pre_chc - queen_egg	0.675	0.137	229.0	4.917	0.000	0.005
12..10.MeC26	pre_dg - pre_egg	0.124	0.143	229.0	0.868	0.386	1.000

12..10.MeC26	pre_dg - queen_chc	1.469	0.267	229.0	5.502	0.000	0.000
12..10.MeC26	pre_dg - queen_dg	-1.009	0.202	229.0	-5.002	0.000	0.003
12..10.MeC26	pre_dg - queen_egg	0.065	0.139	229.0	0.467	0.641	1.000
12..10.MeC26	pre_egg - queen_chc	1.345	0.267	229.0	5.038	0.000	0.003
12..10.MeC26	pre_egg - queen_dg	-1.133	0.202	229.0	-5.616	0.000	0.000
12..10.MeC26	pre_egg - queen_egg	-0.059	0.139	229.0	-0.427	0.670	1.000
12..10.MeC26	queen_chc - queen_dg	-2.478	0.303	229.0	-8.187	0.000	0.000
12..10.MeC26	queen_chc - queen_egg	-1.404	0.265	229.0	-5.301	0.000	0.001
12..10.MeC26	queen_dg - queen_egg	1.074	0.199	229.0	5.398	0.000	0.000
12..10.MeC28	ace_chc - ace_dg	10.470	0.149	229.0	70.359	0.000	0.000
12..10.MeC28	ace_chc - ace_egg	0.357	0.158	229.0	2.265	0.024	1.000
12..10.MeC28	ace_chc - met_chc	0.228	0.156	229.0	1.462	0.145	1.000
12..10.MeC28	ace_chc - met_dg	10.469	0.172	229.0	60.931	0.000	0.000
12..10.MeC28	ace_chc - met_egg	-0.027	0.152	229.0	-0.176	0.861	1.000
12..10.MeC28	ace_chc - pre_chc	-0.007	0.149	229.0	-0.044	0.965	1.000
12..10.MeC28	ace_chc - pre_dg	10.470	0.150	229.0	69.636	0.000	0.000
12..10.MeC28	ace_chc - pre_egg	0.072	0.150	229.0	0.477	0.634	1.000
12..10.MeC28	ace_chc - queen_chc	1.882	0.283	229.0	6.642	0.000	0.000
12..10.MeC28	ace_chc - queen_dg	10.469	0.214	229.0	48.990	0.000	0.000
12..10.MeC28	ace_chc - queen_egg	0.180	0.146	229.0	1.229	0.220	1.000
12..10.MeC28	ace_dg - ace_egg	-10.112	0.158	229.0	-64.070	0.000	0.000
12..10.MeC28	ace_dg - met_chc	-10.242	0.156	229.0	-65.768	0.000	0.000
12..10.MeC28	ace_dg - met_dg	0.000	0.172	229.0	-0.001	0.999	1.000
12..10.MeC28	ace_dg - met_egg	-10.496	0.152	229.0	-69.053	0.000	0.000
12..10.MeC28	ace_dg - pre_chc	-10.476	0.149	229.0	-70.402	0.000	0.000
12..10.MeC28	ace_dg - pre_dg	0.000	0.150	229.0	0.000	1.000	1.000
12..10.MeC28	ace_dg - pre_egg	-10.398	0.150	229.0	-69.160	0.000	0.000
12..10.MeC28	ace_dg - queen_chc	-8.588	0.283	229.0	-30.312	0.000	0.000
12..10.MeC28	ace_dg - queen_dg	0.000	0.214	229.0	-0.001	0.999	1.000
12..10.MeC28	ace_dg - queen_egg	-10.290	0.146	229.0	-70.469	0.000	0.000
12..10.MeC28	ace_egg - met_chc	-0.130	0.164	229.0	-0.790	0.430	1.000
12..10.MeC28	ace_egg - met_dg	10.112	0.180	229.0	56.272	0.000	0.000
12..10.MeC28	ace_egg - met_egg	-0.384	0.161	229.0	-2.389	0.018	1.000
12..10.MeC28	ace_egg - pre_chc	-0.364	0.158	229.0	-2.306	0.022	1.000
12..10.MeC28	ace_egg - pre_dg	10.112	0.159	229.0	63.484	0.000	0.000
12..10.MeC28	ace_egg - pre_egg	-0.286	0.159	229.0	-1.794	0.074	1.000
12..10.MeC28	ace_egg - queen_chc	1.524	0.288	229.0	5.290	0.000	0.001
12..10.MeC28	ace_egg - queen_dg	10.112	0.220	229.0	45.946	0.000	0.000
12..10.MeC28	ace_egg - queen_egg	-0.178	0.155	229.0	-1.146	0.253	1.000
12..10.MeC28	met_chc - met_dg	10.242	0.178	229.0	57.585	0.000	0.000
12..10.MeC28	met_chc - met_egg	-0.254	0.159	229.0	-1.602	0.111	1.000
12..10.MeC28	met_chc - pre_chc	-0.234	0.156	229.0	-1.503	0.134	1.000
12..10.MeC28	met_chc - pre_dg	10.242	0.157	229.0	65.151	0.000	0.000
12..10.MeC28	met_chc - pre_egg	-0.156	0.157	229.0	-0.992	0.322	1.000
12..10.MeC28	met_chc - queen_chc	1.654	0.287	229.0	5.764	0.000	0.000
12..10.MeC28	met_chc - queen_dg	10.242	0.219	229.0	46.856	0.000	0.000
12..10.MeC28	met_chc - queen_egg	-0.048	0.153	229.0	-0.314	0.754	1.000
12..10.MeC28	met_dg - met_egg	-10.496	0.175	229.0	-60.114	0.000	0.000
12..10.MeC28	met_dg - pre_chc	-10.476	0.172	229.0	-60.969	0.000	0.000
12..10.MeC28	met_dg - pre_dg	0.000	0.173	229.0	0.001	0.999	1.000
12..10.MeC28	met_dg - pre_egg	-10.398	0.173	229.0	-60.046	0.000	0.000
12..10.MeC28	met_dg - queen_chc	-8.588	0.296	229.0	-29.007	0.000	0.000
12..10.MeC28	met_dg - queen_dg	0.000	0.230	229.0	0.000	1.000	1.000
12..10.MeC28	met_dg - queen_egg	-10.290	0.169	229.0	-60.736	0.000	0.000
12..10.MeC28	met_egg - pre_chc	0.020	0.152	229.0	0.133	0.894	1.000
12..10.MeC28	met_egg - pre_dg	10.496	0.154	229.0	68.373	0.000	0.000
12..10.MeC28	met_egg - pre_egg	0.098	0.154	229.0	0.641	0.522	1.000
12..10.MeC28	met_egg - queen_chc	1.909	0.285	229.0	6.697	0.000	0.000
12..10.MeC28	met_egg - queen_dg	10.496	0.216	229.0	48.606	0.000	0.000
12..10.MeC28	met_egg - queen_egg	0.206	0.149	229.0	1.382	0.168	1.000
12..10.MeC28	pre_chc - pre_dg	10.476	0.150	229.0	69.680	0.000	0.000
12..10.MeC28	pre_chc - pre_egg	0.078	0.150	229.0	0.520	0.603	1.000
12..10.MeC28	pre_chc - queen_chc	1.888	0.283	229.0	6.665	0.000	0.000
12..10.MeC28	pre_chc - queen_dg	10.476	0.214	229.0	49.021	0.000	0.000
12..10.MeC28	pre_chc - queen_egg	0.186	0.146	229.0	1.274	0.204	1.000
12..10.MeC28	pre_dg - pre_egg	-10.398	0.152	229.0	-68.465	0.000	0.000
12..10.MeC28	pre_dg - queen_chc	-8.588	0.284	229.0	-30.225	0.000	0.000
12..10.MeC28	pre_dg - queen_dg	0.000	0.215	229.0	-0.001	0.999	1.000

12..10.MeC28	pre_dg - queen_egg	-10.290	0.148	229.0	-69.719	0.000	0.000
12..10.MeC28	pre_egg - queen_chc	1.810	0.284	229.0	6.371	0.000	0.000
12..10.MeC28	pre_egg - queen_dg	10.398	0.215	229.0	48.411	0.000	0.000
12..10.MeC28	pre_egg - queen_egg	0.108	0.148	229.0	0.731	0.466	1.000
12..10.MeC28	queen_chc - queen_dg	8.588	0.322	229.0	26.655	0.000	0.000
12..10.MeC28	queen_chc - queen_egg	-1.702	0.282	229.0	-6.039	0.000	0.000
12..10.MeC28	queen_dg - queen_egg	-10.290	0.212	229.0	-48.589	0.000	0.000
12..11..10.MeC24	ace_chc - ace_dg	7.013	0.092	229.0	76.341	0.000	0.000
12..11..10.MeC24	ace_chc - ace_egg	7.013	0.097	229.0	71.976	0.000	0.000
12..11..10.MeC24	ace_chc - met_chc	0.026	0.096	229.0	0.274	0.785	1.000
12..11..10.MeC24	ace_chc - met_dg	7.012	0.106	229.0	66.111	0.000	0.000
12..11..10.MeC24	ace_chc - met_egg	7.013	0.094	229.0	74.734	0.000	0.000
12..11..10.MeC24	ace_chc - pre_chc	0.144	0.092	229.0	1.570	0.118	1.000
12..11..10.MeC24	ace_chc - pre_dg	7.013	0.093	229.0	75.557	0.000	0.000
12..11..10.MeC24	ace_chc - pre_egg	7.013	0.093	229.0	75.557	0.000	0.000
12..11..10.MeC24	ace_chc - queen_chc	0.368	0.175	229.0	2.105	0.036	1.000
12..11..10.MeC24	ace_chc - queen_dg	7.012	0.132	229.0	53.155	0.000	0.000
12..11..10.MeC24	ace_chc - queen_egg	7.013	0.090	229.0	77.796	0.000	0.000
12..11..10.MeC24	ace_dg - ace_egg	0.000	0.097	229.0	0.001	0.999	1.000
12..11..10.MeC24	ace_dg - met_chc	-6.986	0.096	229.0	-72.672	0.000	0.000
12..11..10.MeC24	ace_dg - met_dg	0.000	0.106	229.0	-0.002	0.998	1.000
12..11..10.MeC24	ace_dg - met_egg	0.000	0.094	229.0	0.000	1.000	1.000
12..11..10.MeC24	ace_dg - pre_chc	-6.868	0.092	229.0	-74.770	0.000	0.000
12..11..10.MeC24	ace_dg - pre_dg	0.000	0.093	229.0	-0.001	0.999	1.000
12..11..10.MeC24	ace_dg - pre_egg	0.000	0.093	229.0	0.000	1.000	1.000
12..11..10.MeC24	ace_dg - queen_chc	-6.644	0.175	229.0	-37.991	0.000	0.000
12..11..10.MeC24	ace_dg - queen_dg	0.000	0.132	229.0	-0.002	0.999	1.000
12..11..10.MeC24	ace_dg - queen_egg	0.000	0.090	229.0	0.001	0.999	1.000
12..11..10.MeC24	ace_egg - met_chc	-6.986	0.101	229.0	-68.851	0.000	0.000
12..11..10.MeC24	ace_egg - met_dg	0.000	0.111	229.0	-0.003	0.998	1.000
12..11..10.MeC24	ace_egg - met_egg	0.000	0.099	229.0	-0.001	1.000	1.000
12..11..10.MeC24	ace_egg - pre_chc	-6.868	0.097	229.0	-70.495	0.000	0.000
12..11..10.MeC24	ace_egg - pre_dg	0.000	0.098	229.0	-0.002	0.999	1.000
12..11..10.MeC24	ace_egg - pre_egg	0.000	0.098	229.0	-0.001	0.999	1.000
12..11..10.MeC24	ace_egg - queen_chc	-6.645	0.178	229.0	-37.353	0.000	0.000
12..11..10.MeC24	ace_egg - queen_dg	0.000	0.136	229.0	-0.002	0.998	1.000
12..11..10.MeC24	ace_egg - queen_egg	0.000	0.096	229.0	0.000	1.000	1.000
12..11..10.MeC24	met_chc - met_dg	6.986	0.110	229.0	63.629	0.000	0.000
12..11..10.MeC24	met_chc - met_egg	6.986	0.098	229.0	71.272	0.000	0.000
12..11..10.MeC24	met_chc - pre_chc	0.118	0.096	229.0	1.227	0.221	1.000
12..11..10.MeC24	met_chc - pre_dg	6.986	0.097	229.0	71.990	0.000	0.000
12..11..10.MeC24	met_chc - pre_egg	6.986	0.097	229.0	71.991	0.000	0.000
12..11..10.MeC24	met_chc - queen_chc	0.342	0.177	229.0	1.930	0.055	1.000
12..11..10.MeC24	met_chc - queen_dg	6.986	0.135	229.0	51.774	0.000	0.000
12..11..10.MeC24	met_chc - queen_egg	6.986	0.094	229.0	73.934	0.000	0.000
12..11..10.MeC24	met_dg - met_egg	0.000	0.108	229.0	0.003	0.998	1.000
12..11..10.MeC24	met_dg - pre_chc	-6.868	0.106	229.0	-64.751	0.000	0.000
12..11..10.MeC24	met_dg - pre_dg	0.000	0.107	229.0	0.002	0.999	1.000
12..11..10.MeC24	met_dg - pre_egg	0.000	0.107	229.0	0.002	0.998	1.000
12..11..10.MeC24	met_dg - queen_chc	-6.644	0.183	229.0	-36.355	0.000	0.000
12..11..10.MeC24	met_dg - queen_dg	0.000	0.142	229.0	0.000	1.000	1.000
12..11..10.MeC24	met_dg - queen_egg	0.000	0.105	229.0	0.003	0.997	1.000
12..11..10.MeC24	met_egg - pre_chc	-6.868	0.094	229.0	-73.196	0.000	0.000
12..11..10.MeC24	met_egg - pre_dg	0.000	0.095	229.0	-0.001	0.999	1.000
12..11..10.MeC24	met_egg - pre_egg	0.000	0.095	229.0	-0.001	1.000	1.000
12..11..10.MeC24	met_egg - queen_chc	-6.644	0.176	229.0	-37.765	0.000	0.000
12..11..10.MeC24	met_egg - queen_dg	0.000	0.133	229.0	-0.002	0.998	1.000
12..11..10.MeC24	met_egg - queen_egg	0.000	0.092	229.0	0.001	1.000	1.000
12..11..10.MeC24	pre_chc - pre_dg	6.868	0.093	229.0	74.002	0.000	0.000
12..11..10.MeC24	pre_chc - pre_egg	6.868	0.093	229.0	74.003	0.000	0.000
12..11..10.MeC24	pre_chc - queen_chc	0.224	0.175	229.0	1.280	0.202	1.000
12..11..10.MeC24	pre_chc - queen_dg	6.868	0.132	229.0	52.061	0.000	0.000
12..11..10.MeC24	pre_chc - queen_egg	6.868	0.090	229.0	76.195	0.000	0.000
12..11..10.MeC24	pre_dg - pre_egg	0.000	0.094	229.0	0.001	0.999	1.000
12..11..10.MeC24	pre_dg - queen_chc	-6.644	0.175	229.0	-37.882	0.000	0.000
12..11..10.MeC24	pre_dg - queen_dg	0.000	0.133	229.0	-0.001	0.999	1.000
12..11..10.MeC24	pre_dg - queen_egg	0.000	0.091	229.0	0.002	0.999	1.000
12..11..10.MeC24	pre_egg - queen_chc	-6.644	0.175	229.0	-37.882	0.000	0.000

12..11..10.MeC24	pre_egg - queen_dg	0.000	0.133	229.0	-0.002	0.999	1.000
12..11..10.MeC24	pre_egg - queen_egg	0.000	0.091	229.0	0.001	0.999	1.000
12..11..10.MeC24	queen_chc - queen_dg	6.644	0.199	229.0	33.408	0.000	0.000
12..11..10.MeC24	queen_chc - queen_egg	6.644	0.174	229.0	38.187	0.000	0.000
12..11..10.MeC24	queen_dg - queen_egg	0.000	0.131	229.0	0.002	0.998	1.000
12.16.diMeC28	ace_chc - ace_dg	8.519	0.427	229.0	19.930	0.000	0.000
12.16.diMeC28	ace_chc - ace_egg	-0.281	0.453	229.0	-0.621	0.535	1.000
12.16.diMeC28	ace_chc - met_chc	0.098	0.447	229.0	0.219	0.827	1.000
12.16.diMeC28	ace_chc - met_dg	8.519	0.494	229.0	17.259	0.000	0.000
12.16.diMeC28	ace_chc - met_egg	-1.318	0.437	229.0	-3.019	0.003	1.000
12.16.diMeC28	ace_chc - pre_chc	0.122	0.427	229.0	0.285	0.776	1.000
12.16.diMeC28	ace_chc - pre_dg	8.519	0.432	229.0	19.725	0.000	0.000
12.16.diMeC28	ace_chc - pre_egg	-1.043	0.432	229.0	-2.414	0.017	1.000
12.16.diMeC28	ace_chc - queen_chc	0.541	0.814	229.0	0.665	0.507	1.000
12.16.diMeC28	ace_chc - queen_dg	8.519	0.614	229.0	13.877	0.000	0.000
12.16.diMeC28	ace_chc - queen_egg	0.542	0.419	229.0	1.292	0.198	1.000
12.16.diMeC28	ace_dg - ace_egg	-8.801	0.453	229.0	-19.411	0.000	0.000
12.16.diMeC28	ace_dg - met_chc	-8.421	0.447	229.0	-18.825	0.000	0.000
12.16.diMeC28	ace_dg - met_dg	0.000	0.494	229.0	0.000	1.000	1.000
12.16.diMeC28	ace_dg - met_egg	-9.837	0.437	229.0	-22.529	0.000	0.000
12.16.diMeC28	ace_dg - pre_chc	-8.397	0.427	229.0	-19.644	0.000	0.000
12.16.diMeC28	ace_dg - pre_dg	0.000	0.432	229.0	0.000	1.000	1.000
12.16.diMeC28	ace_dg - pre_egg	-9.562	0.432	229.0	-22.139	0.000	0.000
12.16.diMeC28	ace_dg - queen_chc	-7.978	0.814	229.0	-9.803	0.000	0.000
12.16.diMeC28	ace_dg - queen_dg	0.000	0.614	229.0	0.000	1.000	1.000
12.16.diMeC28	ace_dg - queen_egg	-7.977	0.419	229.0	-19.018	0.000	0.000
12.16.diMeC28	ace_egg - met_chc	0.379	0.472	229.0	0.803	0.423	1.000
12.16.diMeC28	ace_egg - met_dg	8.800	0.516	229.0	17.048	0.000	0.000
12.16.diMeC28	ace_egg - met_egg	-1.037	0.462	229.0	-2.244	0.026	1.000
12.16.diMeC28	ace_egg - pre_chc	0.403	0.453	229.0	0.890	0.375	1.000
12.16.diMeC28	ace_egg - pre_dg	8.801	0.458	229.0	19.233	0.000	0.000
12.16.diMeC28	ace_egg - pre_egg	-0.761	0.458	229.0	-1.664	0.098	1.000
12.16.diMeC28	ace_egg - queen_chc	0.822	0.828	229.0	0.994	0.321	1.000
12.16.diMeC28	ace_egg - queen_dg	8.800	0.632	229.0	13.920	0.000	0.000
12.16.diMeC28	ace_egg - queen_egg	0.823	0.446	229.0	1.846	0.066	1.000
12.16.diMeC28	met_chc - met_dg	8.421	0.511	229.0	16.482	0.000	0.000
12.16.diMeC28	met_chc - met_egg	-1.416	0.456	229.0	-3.105	0.002	1.000
12.16.diMeC28	met_chc - pre_chc	0.024	0.447	229.0	0.054	0.957	1.000
12.16.diMeC28	met_chc - pre_dg	8.421	0.452	229.0	18.648	0.000	0.000
12.16.diMeC28	met_chc - pre_egg	-1.141	0.452	229.0	-2.526	0.012	1.000
12.16.diMeC28	met_chc - queen_chc	0.443	0.824	229.0	0.538	0.591	1.000
12.16.diMeC28	met_chc - queen_dg	8.421	0.628	229.0	13.411	0.000	0.000
12.16.diMeC28	met_chc - queen_egg	0.444	0.440	229.0	1.009	0.314	1.000
12.16.diMeC28	met_dg - met_egg	-9.837	0.502	229.0	-19.613	0.000	0.000
12.16.diMeC28	met_dg - pre_chc	-8.397	0.494	229.0	-17.012	0.000	0.000
12.16.diMeC28	met_dg - pre_dg	0.000	0.497	229.0	0.000	1.000	1.000
12.16.diMeC28	met_dg - pre_egg	-9.562	0.497	229.0	-19.222	0.000	0.000
12.16.diMeC28	met_dg - queen_chc	-7.978	0.850	229.0	-9.381	0.000	0.000
12.16.diMeC28	met_dg - queen_dg	0.000	0.662	229.0	0.000	1.000	1.000
12.16.diMeC28	met_dg - queen_egg	-7.977	0.487	229.0	-16.391	0.000	0.000
12.16.diMeC28	met_egg - pre_chc	1.440	0.437	229.0	3.298	0.001	1.000
12.16.diMeC28	met_egg - pre_dg	9.837	0.441	229.0	22.307	0.000	0.000
12.16.diMeC28	met_egg - pre_egg	0.276	0.441	229.0	0.625	0.533	1.000
12.16.diMeC28	met_egg - queen_chc	1.859	0.819	229.0	2.271	0.024	1.000
12.16.diMeC28	met_egg - queen_dg	9.837	0.620	229.0	15.858	0.000	0.000
12.16.diMeC28	met_egg - queen_egg	1.860	0.429	229.0	4.337	0.000	0.063
12.16.diMeC28	pre_chc - pre_dg	8.397	0.432	229.0	19.443	0.000	0.000
12.16.diMeC28	pre_chc - pre_egg	-1.165	0.432	229.0	-2.697	0.008	1.000
12.16.diMeC28	pre_chc - queen_chc	0.419	0.814	229.0	0.515	0.607	1.000
12.16.diMeC28	pre_chc - queen_dg	8.397	0.614	229.0	13.678	0.000	0.000
12.16.diMeC28	pre_chc - queen_egg	0.420	0.419	229.0	1.001	0.318	1.000
12.16.diMeC28	pre_dg - pre_egg	-9.562	0.436	229.0	-21.917	0.000	0.000
12.16.diMeC28	pre_dg - queen_chc	-7.978	0.816	229.0	-9.775	0.000	0.000
12.16.diMeC28	pre_dg - queen_dg	0.000	0.617	229.0	0.000	1.000	1.000
12.16.diMeC28	pre_dg - queen_egg	-7.977	0.424	229.0	-18.815	0.000	0.000
12.16.diMeC28	pre_egg - queen_chc	1.584	0.816	229.0	1.940	0.054	1.000
12.16.diMeC28	pre_egg - queen_dg	9.562	0.617	229.0	15.497	0.000	0.000
12.16.diMeC28	pre_egg - queen_egg	1.584	0.424	229.0	3.737	0.000	0.683

12.16.diMeC28	queen_chc - queen_dg	7.978	0.925	229.0	8.620	0.000	0.000
12.16.diMeC28	queen_chc - queen_egg	0.001	0.810	229.0	0.001	0.999	1.000
12.16.diMeC28	queen_dg - queen_egg	-7.977	0.608	229.0	-13.113	0.000	0.000
13..11..9..7.MeC25	ace_chc - ace_dg	0.254	0.147	229.0	1.733	0.084	1.000
13..11..9..7.MeC25	ace_chc - ace_egg	0.766	0.155	229.0	4.928	0.000	0.005
13..11..9..7.MeC25	ace_chc - met_chc	0.088	0.153	229.0	0.575	0.566	1.000
13..11..9..7.MeC25	ace_chc - met_dg	-0.243	0.169	229.0	-1.437	0.152	1.000
13..11..9..7.MeC25	ace_chc - met_egg	0.770	0.150	229.0	5.142	0.000	0.002
13..11..9..7.MeC25	ace_chc - pre_chc	-0.049	0.147	229.0	-0.334	0.739	1.000
13..11..9..7.MeC25	ace_chc - pre_dg	0.405	0.148	229.0	2.733	0.007	1.000
13..11..9..7.MeC25	ace_chc - pre_egg	0.722	0.148	229.0	4.877	0.000	0.006
13..11..9..7.MeC25	ace_chc - queen_chc	2.138	0.279	229.0	7.659	0.000	0.000
13..11..9..7.MeC25	ace_chc - queen_dg	-0.143	0.211	229.0	-0.681	0.496	1.000
13..11..9..7.MeC25	ace_chc - queen_egg	0.517	0.144	229.0	3.594	0.000	1.000
13..11..9..7.MeC25	ace_dg - ace_egg	0.512	0.155	229.0	3.294	0.001	1.000
13..11..9..7.MeC25	ace_dg - met_chc	-0.166	0.153	229.0	-1.081	0.281	1.000
13..11..9..7.MeC25	ace_dg - met_dg	-0.497	0.169	229.0	-2.937	0.004	1.000
13..11..9..7.MeC25	ace_dg - met_egg	0.516	0.150	229.0	3.445	0.001	1.000
13..11..9..7.MeC25	ace_dg - pre_chc	-0.303	0.147	229.0	-2.067	0.040	1.000
13..11..9..7.MeC25	ace_dg - pre_dg	0.151	0.148	229.0	1.018	0.310	1.000
13..11..9..7.MeC25	ace_dg - pre_egg	0.468	0.148	229.0	3.162	0.002	1.000
13..11..9..7.MeC25	ace_dg - queen_chc	1.884	0.279	229.0	6.749	0.000	0.000
13..11..9..7.MeC25	ace_dg - queen_dg	-0.397	0.211	229.0	-1.888	0.060	1.000
13..11..9..7.MeC25	ace_dg - queen_egg	0.263	0.144	229.0	1.828	0.069	1.000
13..11..9..7.MeC25	ace_egg - met_chc	-0.678	0.162	229.0	-4.187	0.000	0.117
13..11..9..7.MeC25	ace_egg - met_dg	-1.009	0.177	229.0	-5.702	0.000	0.000
13..11..9..7.MeC25	ace_egg - met_egg	0.004	0.158	229.0	0.024	0.981	1.000
13..11..9..7.MeC25	ace_egg - pre_chc	-0.815	0.155	229.0	-5.243	0.000	0.001
13..11..9..7.MeC25	ace_egg - pre_dg	-0.361	0.157	229.0	-2.304	0.022	1.000
13..11..9..7.MeC25	ace_egg - pre_egg	-0.044	0.157	229.0	-0.280	0.780	1.000
13..11..9..7.MeC25	ace_egg - queen_chc	1.371	0.284	229.0	4.831	0.000	0.007
13..11..9..7.MeC25	ace_egg - queen_dg	-0.910	0.217	229.0	-4.195	0.000	0.113
13..11..9..7.MeC25	ace_egg - queen_egg	-0.249	0.153	229.0	-1.629	0.105	1.000
13..11..9..7.MeC25	met_chc - met_dg	-0.331	0.175	229.0	-1.892	0.060	1.000
13..11..9..7.MeC25	met_chc - met_egg	0.682	0.156	229.0	4.358	0.000	0.058
13..11..9..7.MeC25	met_chc - pre_chc	-0.137	0.153	229.0	-0.894	0.372	1.000
13..11..9..7.MeC25	met_chc - pre_dg	0.316	0.155	229.0	2.044	0.042	1.000
13..11..9..7.MeC25	met_chc - pre_egg	0.634	0.155	229.0	4.094	0.000	0.171
13..11..9..7.MeC25	met_chc - queen_chc	2.049	0.283	229.0	7.249	0.000	0.000
13..11..9..7.MeC25	met_chc - queen_dg	-0.232	0.215	229.0	-1.076	0.283	1.000
13..11..9..7.MeC25	met_chc - queen_egg	0.429	0.151	229.0	2.844	0.005	1.000
13..11..9..7.MeC25	met_dg - met_egg	1.013	0.172	229.0	5.890	0.000	0.000
13..11..9..7.MeC25	met_dg - pre_chc	0.194	0.169	229.0	1.147	0.252	1.000
13..11..9..7.MeC25	met_dg - pre_dg	0.648	0.171	229.0	3.798	0.000	0.542
13..11..9..7.MeC25	met_dg - pre_egg	0.965	0.171	229.0	5.660	0.000	0.000
13..11..9..7.MeC25	met_dg - queen_chc	2.381	0.292	229.0	8.164	0.000	0.000
13..11..9..7.MeC25	met_dg - queen_dg	0.100	0.227	229.0	0.440	0.661	1.000
13..11..9..7.MeC25	met_dg - queen_egg	0.760	0.167	229.0	4.555	0.000	0.025
13..11..9..7.MeC25	met_egg - pre_chc	-0.819	0.150	229.0	-5.469	0.000	0.000
13..11..9..7.MeC25	met_egg - pre_dg	-0.365	0.151	229.0	-2.415	0.017	1.000
13..11..9..7.MeC25	met_egg - pre_egg	-0.048	0.151	229.0	-0.315	0.753	1.000
13..11..9..7.MeC25	met_egg - queen_chc	1.368	0.281	229.0	4.872	0.000	0.006
13..11..9..7.MeC25	met_egg - queen_dg	-0.913	0.213	229.0	-4.293	0.000	0.075
13..11..9..7.MeC25	met_egg - queen_egg	-0.253	0.147	229.0	-1.720	0.087	1.000
13..11..9..7.MeC25	pre_chc - pre_dg	0.454	0.148	229.0	3.063	0.002	1.000
13..11..9..7.MeC25	pre_chc - pre_egg	0.771	0.148	229.0	5.208	0.000	0.001
13..11..9..7.MeC25	pre_chc - queen_chc	2.187	0.279	229.0	7.835	0.000	0.000
13..11..9..7.MeC25	pre_chc - queen_dg	-0.094	0.211	229.0	-0.449	0.654	1.000
13..11..9..7.MeC25	pre_chc - queen_egg	0.566	0.144	229.0	3.935	0.000	0.321
13..11..9..7.MeC25	pre_dg - pre_egg	0.318	0.150	229.0	2.123	0.035	1.000
13..11..9..7.MeC25	pre_dg - queen_chc	1.733	0.280	229.0	6.191	0.000	0.000
13..11..9..7.MeC25	pre_dg - queen_dg	-0.548	0.212	229.0	-2.591	0.010	1.000
13..11..9..7.MeC25	pre_dg - queen_egg	0.112	0.145	229.0	0.772	0.441	1.000
13..11..9..7.MeC25	pre_egg - queen_chc	1.415	0.280	229.0	5.057	0.000	0.003
13..11..9..7.MeC25	pre_egg - queen_dg	-0.866	0.212	229.0	-4.092	0.000	0.172
13..11..9..7.MeC25	pre_egg - queen_egg	-0.205	0.145	229.0	-1.412	0.159	1.000
13..11..9..7.MeC25	queen_chc - queen_dg	-2.281	0.317	229.0	-7.187	0.000	0.000
13..11..9..7.MeC25	queen_chc - queen_egg	-1.621	0.278	229.0	-5.837	0.000	0.000

13..11..9..7.MeC25	queen_dg - queen_egg	0.660	0.209	229.0	3.166	0.002	1.000
13..11..9.MeC27	ace_chc - ace_dg	4.780	0.257	229.0	18.596	0.000	0.000
13..11..9.MeC27	ace_chc - ace_egg	0.903	0.273	229.0	3.313	0.001	1.000
13..11..9.MeC27	ace_chc - met_chc	0.237	0.269	229.0	0.881	0.379	1.000
13..11..9.MeC27	ace_chc - met_dg	4.395	0.297	229.0	14.806	0.000	0.000
13..11..9.MeC27	ace_chc - met_egg	0.777	0.263	229.0	2.959	0.003	1.000
13..11..9.MeC27	ace_chc - pre_chc	0.001	0.257	229.0	0.005	0.996	1.000
13..11..9.MeC27	ace_chc - pre_dg	4.312	0.260	229.0	16.603	0.000	0.000
13..11..9.MeC27	ace_chc - pre_egg	0.883	0.260	229.0	3.399	0.001	1.000
13..11..9.MeC27	ace_chc - queen_chc	1.514	0.489	229.0	3.094	0.002	1.000
13..11..9.MeC27	ace_chc - queen_dg	3.448	0.369	229.0	9.340	0.000	0.000
13..11..9.MeC27	ace_chc - queen_egg	0.630	0.252	229.0	2.497	0.013	1.000
13..11..9.MeC27	ace_dg - ace_egg	-3.877	0.273	229.0	-14.219	0.000	0.000
13..11..9.MeC27	ace_dg - met_chc	-4.543	0.269	229.0	-16.888	0.000	0.000
13..11..9.MeC27	ace_dg - met_dg	-0.385	0.297	229.0	-1.298	0.196	1.000
13..11..9.MeC27	ace_dg - met_egg	-4.003	0.263	229.0	-15.245	0.000	0.000
13..11..9.MeC27	ace_dg - pre_chc	-4.779	0.257	229.0	-18.591	0.000	0.000
13..11..9.MeC27	ace_dg - pre_dg	-0.468	0.260	229.0	-1.802	0.073	1.000
13..11..9.MeC27	ace_dg - pre_egg	-3.898	0.260	229.0	-15.006	0.000	0.000
13..11..9.MeC27	ace_dg - queen_chc	-3.266	0.489	229.0	-6.673	0.000	0.000
13..11..9.MeC27	ace_dg - queen_dg	-1.332	0.369	229.0	-3.608	0.000	1.000
13..11..9.MeC27	ace_dg - queen_egg	-4.150	0.252	229.0	-16.453	0.000	0.000
13..11..9.MeC27	ace_egg - met_chc	-0.666	0.284	229.0	-2.346	0.020	1.000
13..11..9.MeC27	ace_egg - met_dg	3.492	0.310	229.0	11.248	0.000	0.000
13..11..9.MeC27	ace_egg - met_egg	-0.126	0.278	229.0	-0.454	0.650	1.000
13..11..9.MeC27	ace_egg - pre_chc	-0.902	0.273	229.0	-3.309	0.001	1.000
13..11..9.MeC27	ace_egg - pre_dg	3.409	0.275	229.0	12.388	0.000	0.000
13..11..9.MeC27	ace_egg - pre_egg	-0.021	0.275	229.0	-0.075	0.940	1.000
13..11..9.MeC27	ace_egg - queen_chc	0.611	0.498	229.0	1.227	0.221	1.000
13..11..9.MeC27	ace_egg - queen_dg	2.545	0.380	229.0	6.694	0.000	0.000
13..11..9.MeC27	ace_egg - queen_egg	-0.273	0.268	229.0	-1.020	0.309	1.000
13..11..9.MeC27	met_chc - met_dg	4.158	0.307	229.0	13.533	0.000	0.000
13..11..9.MeC27	met_chc - met_egg	0.540	0.274	229.0	1.969	0.050	1.000
13..11..9.MeC27	met_chc - pre_chc	-0.236	0.269	229.0	-0.876	0.382	1.000
13..11..9.MeC27	met_chc - pre_dg	4.075	0.272	229.0	15.005	0.000	0.000
13..11..9.MeC27	met_chc - pre_egg	0.646	0.272	229.0	2.377	0.018	1.000
13..11..9.MeC27	met_chc - queen_chc	1.277	0.496	229.0	2.576	0.011	1.000
13..11..9.MeC27	met_chc - queen_dg	3.211	0.378	229.0	8.504	0.000	0.000
13..11..9.MeC27	met_chc - queen_egg	0.393	0.264	229.0	1.486	0.139	1.000
13..11..9.MeC27	met_dg - met_egg	-3.618	0.302	229.0	-11.994	0.000	0.000
13..11..9.MeC27	met_dg - pre_chc	-4.394	0.297	229.0	-14.802	0.000	0.000
13..11..9.MeC27	met_dg - pre_dg	-0.083	0.299	229.0	-0.277	0.782	1.000
13..11..9.MeC27	met_dg - pre_egg	-3.512	0.299	229.0	-11.741	0.000	0.000
13..11..9.MeC27	met_dg - queen_chc	-2.881	0.511	229.0	-5.633	0.000	0.000
13..11..9.MeC27	met_dg - queen_dg	-0.947	0.398	229.0	-2.379	0.018	1.000
13..11..9.MeC27	met_dg - queen_egg	-3.765	0.293	229.0	-12.864	0.000	0.000
13..11..9.MeC27	met_egg - pre_chc	-0.776	0.263	229.0	-2.954	0.003	1.000
13..11..9.MeC27	met_egg - pre_dg	3.535	0.265	229.0	13.330	0.000	0.000
13..11..9.MeC27	met_egg - pre_egg	0.106	0.265	229.0	0.398	0.691	1.000
13..11..9.MeC27	met_egg - queen_chc	0.737	0.492	229.0	1.497	0.136	1.000
13..11..9.MeC27	met_egg - queen_dg	2.671	0.373	229.0	7.160	0.000	0.000
13..11..9.MeC27	met_egg - queen_egg	-0.147	0.258	229.0	-0.570	0.569	1.000
13..11..9.MeC27	pre_chc - pre_dg	4.311	0.260	229.0	16.598	0.000	0.000
13..11..9.MeC27	pre_chc - pre_egg	0.881	0.260	229.0	3.394	0.001	1.000
13..11..9.MeC27	pre_chc - queen_chc	1.513	0.489	229.0	3.091	0.002	1.000
13..11..9.MeC27	pre_chc - queen_dg	3.447	0.369	229.0	9.337	0.000	0.000
13..11..9.MeC27	pre_chc - queen_egg	0.629	0.252	229.0	2.492	0.013	1.000
13..11..9.MeC27	pre_dg - pre_egg	-3.429	0.262	229.0	-13.071	0.000	0.000
13..11..9.MeC27	pre_dg - queen_chc	-2.798	0.491	229.0	-5.700	0.000	0.000
13..11..9.MeC27	pre_dg - queen_dg	-0.864	0.371	229.0	-2.328	0.021	1.000
13..11..9.MeC27	pre_dg - queen_egg	-3.682	0.255	229.0	-14.441	0.000	0.000
13..11..9.MeC27	pre_egg - queen_chc	0.632	0.491	229.0	1.287	0.200	1.000
13..11..9.MeC27	pre_egg - queen_dg	2.566	0.371	229.0	6.915	0.000	0.000
13..11..9.MeC27	pre_egg - queen_egg	-0.253	0.255	229.0	-0.991	0.323	1.000
13..11..9.MeC27	queen_chc - queen_dg	1.934	0.557	229.0	3.475	0.001	1.000
13..11..9.MeC27	queen_chc - queen_egg	-0.884	0.487	229.0	-1.816	0.071	1.000
13..11..9.MeC27	queen_dg - queen_egg	-2.818	0.366	229.0	-7.703	0.000	0.000
13..11..9.MeC29	ace_chc - ace_dg	2.759	0.488	229.0	5.650	0.000	0.000

13..11..9.MeC29	ace_chc - ace_egg	0.236	0.518	229.0	0.456	0.649	1.000
13..11..9.MeC29	ace_chc - met_chc	0.210	0.511	229.0	0.412	0.681	1.000
13..11..9.MeC29	ace_chc - met_dg	2.835	0.564	229.0	5.028	0.000	0.003
13..11..9.MeC29	ace_chc - met_egg	-0.224	0.499	229.0	-0.448	0.655	1.000
13..11..9.MeC29	ace_chc - pre_chc	0.006	0.488	229.0	0.012	0.990	1.000
13..11..9.MeC29	ace_chc - pre_dg	4.127	0.493	229.0	8.363	0.000	0.000
13..11..9.MeC29	ace_chc - pre_egg	-0.174	0.493	229.0	-0.353	0.724	1.000
13..11..9.MeC29	ace_chc - queen_chc	1.642	0.930	229.0	1.766	0.079	1.000
13..11..9.MeC29	ace_chc - queen_dg	1.295	0.701	229.0	1.846	0.066	1.000
13..11..9.MeC29	ace_chc - queen_egg	0.593	0.479	229.0	1.237	0.217	1.000
13..11..9.MeC29	ace_dg - ace_egg	-2.523	0.518	229.0	-4.871	0.000	0.006
13..11..9.MeC29	ace_dg - met_chc	-2.549	0.511	229.0	-4.987	0.000	0.004
13..11..9.MeC29	ace_dg - met_dg	0.076	0.564	229.0	0.135	0.893	1.000
13..11..9.MeC29	ace_dg - met_egg	-2.983	0.499	229.0	-5.979	0.000	0.000
13..11..9.MeC29	ace_dg - pre_chc	-2.753	0.488	229.0	-5.638	0.000	0.000
13..11..9.MeC29	ace_dg - pre_dg	1.367	0.493	229.0	2.771	0.006	1.000
13..11..9.MeC29	ace_dg - pre_egg	-2.933	0.493	229.0	-5.945	0.000	0.000
13..11..9.MeC29	ace_dg - queen_chc	-1.118	0.930	229.0	-1.202	0.231	1.000
13..11..9.MeC29	ace_dg - queen_dg	-1.464	0.701	229.0	-2.088	0.038	1.000
13..11..9.MeC29	ace_dg - queen_egg	-2.167	0.479	229.0	-4.521	0.000	0.029
13..11..9.MeC29	ace_egg - met_chc	-0.026	0.539	229.0	-0.048	0.962	1.000
13..11..9.MeC29	ace_egg - met_dg	2.599	0.590	229.0	4.407	0.000	0.047
13..11..9.MeC29	ace_egg - met_egg	-0.460	0.528	229.0	-0.871	0.385	1.000
13..11..9.MeC29	ace_egg - pre_chc	-0.230	0.518	229.0	-0.444	0.657	1.000
13..11..9.MeC29	ace_egg - pre_dg	3.891	0.523	229.0	7.442	0.000	0.000
13..11..9.MeC29	ace_egg - pre_egg	-0.410	0.523	229.0	-0.785	0.433	1.000
13..11..9.MeC29	ace_egg - queen_chc	1.406	0.946	229.0	1.486	0.139	1.000
13..11..9.MeC29	ace_egg - queen_dg	1.059	0.722	229.0	1.466	0.144	1.000
13..11..9.MeC29	ace_egg - queen_egg	0.357	0.509	229.0	0.700	0.485	1.000
13..11..9.MeC29	met_chc - met_dg	2.625	0.584	229.0	4.497	0.000	0.032
13..11..9.MeC29	met_chc - met_egg	-0.434	0.521	229.0	-0.833	0.406	1.000
13..11..9.MeC29	met_chc - pre_chc	-0.204	0.511	229.0	-0.400	0.690	1.000
13..11..9.MeC29	met_chc - pre_dg	3.916	0.516	229.0	7.591	0.000	0.000
13..11..9.MeC29	met_chc - pre_egg	-0.385	0.516	229.0	-0.745	0.457	1.000
13..11..9.MeC29	met_chc - queen_chc	1.431	0.942	229.0	1.520	0.130	1.000
13..11..9.MeC29	met_chc - queen_dg	1.085	0.717	229.0	1.512	0.132	1.000
13..11..9.MeC29	met_chc - queen_egg	0.382	0.502	229.0	0.761	0.447	1.000
13..11..9.MeC29	met_dg - met_egg	-3.059	0.573	229.0	-5.338	0.000	0.001
13..11..9.MeC29	met_dg - pre_chc	-2.829	0.564	229.0	-5.017	0.000	0.003
13..11..9.MeC29	met_dg - pre_dg	1.292	0.568	229.0	2.273	0.024	1.000
13..11..9.MeC29	met_dg - pre_egg	-3.009	0.568	229.0	-5.295	0.000	0.001
13..11..9.MeC29	met_dg - queen_chc	-1.194	0.972	229.0	-1.228	0.221	1.000
13..11..9.MeC29	met_dg - queen_dg	-1.540	0.756	229.0	-2.038	0.043	1.000
13..11..9.MeC29	met_dg - queen_egg	-2.243	0.556	229.0	-4.033	0.000	0.218
13..11..9.MeC29	met_egg - pre_chc	0.229	0.499	229.0	0.460	0.646	1.000
13..11..9.MeC29	met_egg - pre_dg	4.350	0.504	229.0	8.635	0.000	0.000
13..11..9.MeC29	met_egg - pre_egg	0.049	0.504	229.0	0.098	0.922	1.000
13..11..9.MeC29	met_egg - queen_chc	1.865	0.935	229.0	1.994	0.047	1.000
13..11..9.MeC29	met_egg - queen_dg	1.518	0.709	229.0	2.143	0.033	1.000
13..11..9.MeC29	met_egg - queen_egg	0.816	0.490	229.0	1.666	0.097	1.000
13..11..9.MeC29	pre_chc - pre_dg	4.121	0.493	229.0	8.351	0.000	0.000
13..11..9.MeC29	pre_chc - pre_egg	-0.180	0.493	229.0	-0.365	0.715	1.000
13..11..9.MeC29	pre_chc - queen_chc	1.636	0.930	229.0	1.759	0.080	1.000
13..11..9.MeC29	pre_chc - queen_dg	1.289	0.701	229.0	1.838	0.067	1.000
13..11..9.MeC29	pre_chc - queen_egg	0.587	0.479	229.0	1.224	0.222	1.000
13..11..9.MeC29	pre_dg - pre_egg	-4.301	0.498	229.0	-8.629	0.000	0.000
13..11..9.MeC29	pre_dg - queen_chc	-2.485	0.932	229.0	-2.665	0.008	1.000
13..11..9.MeC29	pre_dg - queen_dg	-2.832	0.705	229.0	-4.017	0.000	0.232
13..11..9.MeC29	pre_dg - queen_egg	-3.534	0.484	229.0	-7.296	0.000	0.000
13..11..9.MeC29	pre_egg - queen_chc	1.816	0.932	229.0	1.947	0.053	1.000
13..11..9.MeC29	pre_egg - queen_dg	1.469	0.705	229.0	2.084	0.038	1.000
13..11..9.MeC29	pre_egg - queen_egg	0.767	0.484	229.0	1.583	0.115	1.000
13..11..9.MeC29	queen_chc - queen_dg	-0.347	1.057	229.0	-0.328	0.743	1.000
13..11..9.MeC29	queen_chc - queen_egg	-1.049	0.925	229.0	-1.134	0.258	1.000
13..11..9.MeC29	queen_dg - queen_egg	-0.702	0.695	229.0	-1.010	0.313	1.000
13.17.diMeC33	ace_chc - ace_dg	-4.636	0.713	229.0	-6.505	0.000	0.000
13.17.diMeC33	ace_chc - ace_egg	0.001	0.756	229.0	0.001	0.999	1.000
13.17.diMeC33	ace_chc - met_chc	0.000	0.746	229.0	0.000	1.000	1.000

13.17.diMeC33	ace_chc - met_dg	-1.989	0.823	229.0	-2.417	0.016	1.000
13.17.diMeC33	ace_chc - met_egg	0.000	0.728	229.0	0.001	0.999	1.000
13.17.diMeC33	ace_chc - pre_chc	0.000	0.713	229.0	0.000	1.000	1.000
13.17.diMeC33	ace_chc - pre_dg	-2.729	0.720	229.0	-3.789	0.000	0.561
13.17.diMeC33	ace_chc - pre_egg	0.000	0.720	229.0	0.001	1.000	1.000
13.17.diMeC33	ace_chc - queen_chc	0.000	1.357	229.0	0.000	1.000	1.000
13.17.diMeC33	ace_chc - queen_dg	-4.814	1.024	229.0	-4.703	0.000	0.013
13.17.diMeC33	ace_chc - queen_egg	0.001	0.699	229.0	0.001	0.999	1.000
13.17.diMeC33	ace_dg - ace_egg	4.637	0.756	229.0	6.134	0.000	0.000
13.17.diMeC33	ace_dg - met_chc	4.636	0.746	229.0	6.216	0.000	0.000
13.17.diMeC33	ace_dg - met_dg	2.647	0.823	229.0	3.216	0.001	1.000
13.17.diMeC33	ace_dg - met_egg	4.637	0.728	229.0	6.369	0.000	0.000
13.17.diMeC33	ace_dg - pre_chc	4.636	0.713	229.0	6.505	0.000	0.000
13.17.diMeC33	ace_dg - pre_dg	1.908	0.720	229.0	2.649	0.009	1.000
13.17.diMeC33	ace_dg - pre_egg	4.637	0.720	229.0	6.439	0.000	0.000
13.17.diMeC33	ace_dg - queen_chc	4.636	1.357	229.0	3.417	0.001	1.000
13.17.diMeC33	ace_dg - queen_dg	-0.177	1.024	229.0	-0.173	0.863	1.000
13.17.diMeC33	ace_dg - queen_egg	4.637	0.699	229.0	6.630	0.000	0.000
13.17.diMeC33	ace_egg - met_chc	-0.001	0.787	229.0	-0.001	0.999	1.000
13.17.diMeC33	ace_egg - met_dg	-1.990	0.861	229.0	-2.312	0.022	1.000
13.17.diMeC33	ace_egg - met_egg	0.000	0.770	229.0	0.000	1.000	1.000
13.17.diMeC33	ace_egg - pre_chc	-0.001	0.756	229.0	-0.001	0.999	1.000
13.17.diMeC33	ace_egg - pre_dg	-2.729	0.763	229.0	-3.577	0.000	1.000
13.17.diMeC33	ace_egg - pre_egg	0.000	0.763	229.0	0.000	1.000	1.000
13.17.diMeC33	ace_egg - queen_chc	-0.001	1.380	229.0	0.000	1.000	1.000
13.17.diMeC33	ace_egg - queen_dg	-4.814	1.054	229.0	-4.567	0.000	0.023
13.17.diMeC33	ace_egg - queen_egg	0.000	0.743	229.0	0.000	1.000	1.000
13.17.diMeC33	met_chc - met_dg	-1.989	0.852	229.0	-2.335	0.020	1.000
13.17.diMeC33	met_chc - met_egg	0.000	0.761	229.0	0.001	1.000	1.000
13.17.diMeC33	met_chc - pre_chc	0.000	0.746	229.0	0.000	1.000	1.000
13.17.diMeC33	met_chc - pre_dg	-2.729	0.753	229.0	-3.624	0.000	1.000
13.17.diMeC33	met_chc - pre_egg	0.000	0.753	229.0	0.001	1.000	1.000
13.17.diMeC33	met_chc - queen_chc	0.000	1.375	229.0	0.000	1.000	1.000
13.17.diMeC33	met_chc - queen_dg	-4.814	1.047	229.0	-4.598	0.000	0.021
13.17.diMeC33	met_chc - queen_egg	0.001	0.733	229.0	0.001	0.999	1.000
13.17.diMeC33	met_dg - met_egg	1.990	0.836	229.0	2.379	0.018	1.000
13.17.diMeC33	met_dg - pre_chc	1.989	0.823	229.0	2.417	0.016	1.000
13.17.diMeC33	met_dg - pre_dg	-0.739	0.829	229.0	-0.891	0.374	1.000
13.17.diMeC33	met_dg - pre_egg	1.990	0.829	229.0	2.399	0.017	1.000
13.17.diMeC33	met_dg - queen_chc	1.989	1.418	229.0	1.403	0.162	1.000
13.17.diMeC33	met_dg - queen_dg	-2.824	1.103	229.0	-2.560	0.011	1.000
13.17.diMeC33	met_dg - queen_egg	1.990	0.811	229.0	2.452	0.015	1.000
13.17.diMeC33	met_egg - pre_chc	-0.001	0.728	229.0	-0.001	0.999	1.000
13.17.diMeC33	met_egg - pre_dg	-2.729	0.735	229.0	-3.712	0.000	0.751
13.17.diMeC33	met_egg - pre_egg	0.000	0.735	229.0	0.000	1.000	1.000
13.17.diMeC33	met_egg - queen_chc	-0.001	1.365	229.0	0.000	1.000	1.000
13.17.diMeC33	met_egg - queen_dg	-4.814	1.034	229.0	-4.654	0.000	0.016
13.17.diMeC33	met_egg - queen_egg	0.000	0.715	229.0	0.000	1.000	1.000
13.17.diMeC33	pre_chc - pre_dg	-2.729	0.720	229.0	-3.789	0.000	0.561
13.17.diMeC33	pre_chc - pre_egg	0.000	0.720	229.0	0.001	0.999	1.000
13.17.diMeC33	pre_chc - queen_chc	0.000	1.357	229.0	0.000	1.000	1.000
13.17.diMeC33	pre_chc - queen_dg	-4.814	1.024	229.0	-4.703	0.000	0.013
13.17.diMeC33	pre_chc - queen_egg	0.001	0.699	229.0	0.001	0.999	1.000
13.17.diMeC33	pre_dg - pre_egg	2.729	0.727	229.0	3.752	0.000	0.646
13.17.diMeC33	pre_dg - queen_chc	2.729	1.361	229.0	2.005	0.046	1.000
13.17.diMeC33	pre_dg - queen_dg	-2.085	1.029	229.0	-2.027	0.044	1.000
13.17.diMeC33	pre_dg - queen_egg	2.729	0.707	229.0	3.861	0.000	0.427
13.17.diMeC33	pre_egg - queen_chc	-0.001	1.361	229.0	0.000	1.000	1.000
13.17.diMeC33	pre_egg - queen_dg	-4.814	1.029	229.0	-4.680	0.000	0.014
13.17.diMeC33	pre_egg - queen_egg	0.000	0.707	229.0	0.000	1.000	1.000
13.17.diMeC33	queen_chc - queen_dg	-4.813	1.543	229.0	-3.119	0.002	1.000
13.17.diMeC33	queen_chc - queen_egg	0.001	1.350	229.0	0.000	1.000	1.000
13.17.diMeC33	queen_dg - queen_egg	4.814	1.014	229.0	4.746	0.000	0.011
15..13.MeC31	ace_chc - ace_dg	3.880	0.641	229.0	6.053	0.000	0.000
15..13.MeC31	ace_chc - ace_egg	7.816	0.680	229.0	11.495	0.000	0.000
15..13.MeC31	ace_chc - met_chc	-1.113	0.671	229.0	-1.659	0.099	1.000
15..13.MeC31	ace_chc - met_dg	7.148	0.740	229.0	9.657	0.000	0.000
15..13.MeC31	ace_chc - met_egg	7.816	0.655	229.0	11.936	0.000	0.000

15..13.MeC31	ace_chc - pre_chc	0.071	0.641	229.0	0.111	0.912	1.000
15..13.MeC31	ace_chc - pre_dg	6.586	0.648	229.0	10.168	0.000	0.000
15..13.MeC31	ace_chc - pre_egg	7.816	0.648	229.0	12.067	0.000	0.000
15..13.MeC31	ace_chc - queen_chc	1.171	1.221	229.0	0.960	0.338	1.000
15..13.MeC31	ace_chc - queen_dg	1.882	0.921	229.0	2.045	0.042	1.000
15..13.MeC31	ace_chc - queen_egg	7.816	0.629	229.0	12.425	0.000	0.000
15..13.MeC31	ace_dg - ace_egg	3.936	0.680	229.0	5.789	0.000	0.000
15..13.MeC31	ace_dg - met_chc	-4.993	0.671	229.0	-7.443	0.000	0.000
15..13.MeC31	ace_dg - met_dg	3.268	0.740	229.0	4.415	0.000	0.045
15..13.MeC31	ace_dg - met_egg	3.936	0.655	229.0	6.010	0.000	0.000
15..13.MeC31	ace_dg - pre_chc	-3.809	0.641	229.0	-5.942	0.000	0.000
15..13.MeC31	ace_dg - pre_dg	2.706	0.648	229.0	4.177	0.000	0.122
15..13.MeC31	ace_dg - pre_egg	3.936	0.648	229.0	6.076	0.000	0.000
15..13.MeC31	ace_dg - queen_chc	-2.709	1.221	229.0	-2.219	0.027	1.000
15..13.MeC31	ace_dg - queen_dg	-1.998	0.921	229.0	-2.170	0.031	1.000
15..13.MeC31	ace_dg - queen_egg	3.936	0.629	229.0	6.257	0.000	0.000
15..13.MeC31	ace_egg - met_chc	-8.929	0.708	229.0	-12.609	0.000	0.000
15..13.MeC31	ace_egg - met_dg	-0.668	0.774	229.0	-0.862	0.389	1.000
15..13.MeC31	ace_egg - met_egg	0.000	0.693	229.0	0.000	1.000	1.000
15..13.MeC31	ace_egg - pre_chc	-7.745	0.680	229.0	-11.390	0.000	0.000
15..13.MeC31	ace_egg - pre_dg	-1.230	0.686	229.0	-1.793	0.074	1.000
15..13.MeC31	ace_egg - pre_egg	0.000	0.686	229.0	0.000	1.000	1.000
15..13.MeC31	ace_egg - queen_chc	-6.645	1.241	229.0	-5.353	0.000	0.001
15..13.MeC31	ace_egg - queen_dg	-5.934	0.948	229.0	-6.258	0.000	0.000
15..13.MeC31	ace_egg - queen_egg	0.000	0.669	229.0	0.000	1.000	1.000
15..13.MeC31	met_chc - met_dg	8.261	0.766	229.0	10.782	0.000	0.000
15..13.MeC31	met_chc - met_egg	8.929	0.684	229.0	13.053	0.000	0.000
15..13.MeC31	met_chc - pre_chc	1.184	0.671	229.0	1.765	0.079	1.000
15..13.MeC31	met_chc - pre_dg	7.699	0.677	229.0	11.368	0.000	0.000
15..13.MeC31	met_chc - pre_egg	8.929	0.677	229.0	13.184	0.000	0.000
15..13.MeC31	met_chc - queen_chc	2.284	1.236	229.0	1.847	0.066	1.000
15..13.MeC31	met_chc - queen_dg	2.995	0.942	229.0	3.181	0.002	1.000
15..13.MeC31	met_chc - queen_egg	8.929	0.659	229.0	13.540	0.000	0.000
15..13.MeC31	met_dg - met_egg	0.668	0.752	229.0	0.887	0.376	1.000
15..13.MeC31	met_dg - pre_chc	-7.077	0.740	229.0	-9.561	0.000	0.000
15..13.MeC31	met_dg - pre_dg	-0.563	0.746	229.0	-0.754	0.452	1.000
15..13.MeC31	met_dg - pre_egg	0.667	0.746	229.0	0.895	0.372	1.000
15..13.MeC31	met_dg - queen_chc	-5.977	1.275	229.0	-4.686	0.000	0.014
15..13.MeC31	met_dg - queen_dg	-5.266	0.992	229.0	-5.307	0.000	0.001
15..13.MeC31	met_dg - queen_egg	0.668	0.730	229.0	0.915	0.361	1.000
15..13.MeC31	met_egg - pre_chc	-7.745	0.655	229.0	-11.827	0.000	0.000
15..13.MeC31	met_egg - pre_dg	-1.230	0.661	229.0	-1.860	0.064	1.000
15..13.MeC31	met_egg - pre_egg	0.000	0.661	229.0	0.000	1.000	1.000
15..13.MeC31	met_egg - queen_chc	-6.644	1.228	229.0	-5.412	0.000	0.000
15..13.MeC31	met_egg - queen_dg	-5.934	0.930	229.0	-6.378	0.000	0.000
15..13.MeC31	met_egg - queen_egg	0.000	0.643	229.0	0.000	1.000	1.000
15..13.MeC31	pre_chc - pre_dg	6.514	0.648	229.0	10.058	0.000	0.000
15..13.MeC31	pre_chc - pre_egg	7.745	0.648	229.0	11.957	0.000	0.000
15..13.MeC31	pre_chc - queen_chc	1.100	1.221	229.0	0.901	0.368	1.000
15..13.MeC31	pre_chc - queen_dg	1.811	0.921	229.0	1.967	0.050	1.000
15..13.MeC31	pre_chc - queen_egg	7.745	0.629	229.0	12.312	0.000	0.000
15..13.MeC31	pre_dg - pre_egg	1.230	0.654	229.0	1.880	0.061	1.000
15..13.MeC31	pre_dg - queen_chc	-5.414	1.224	229.0	-4.423	0.000	0.044
15..13.MeC31	pre_dg - queen_dg	-4.704	0.925	229.0	-5.083	0.000	0.002
15..13.MeC31	pre_dg - queen_egg	1.230	0.636	229.0	1.935	0.054	1.000
15..13.MeC31	pre_egg - queen_chc	-6.644	1.224	229.0	-5.428	0.000	0.000
15..13.MeC31	pre_egg - queen_dg	-5.934	0.925	229.0	-6.413	0.000	0.000
15..13.MeC31	pre_egg - queen_egg	0.000	0.636	229.0	0.000	1.000	1.000
15..13.MeC31	queen_chc - queen_dg	0.711	1.388	229.0	0.512	0.609	1.000
15..13.MeC31	queen_chc - queen_egg	6.644	1.214	229.0	5.472	0.000	0.000
15..13.MeC31	queen_dg - queen_egg	5.934	0.912	229.0	6.504	0.000	0.000
3.MeC23	ace_chc - ace_dg	-8.471	0.731	229.0	-11.585	0.000	0.000
3.MeC23	ace_chc - ace_egg	4.390	0.776	229.0	5.660	0.000	0.000
3.MeC23	ace_chc - met_chc	-0.804	0.765	229.0	-1.050	0.295	1.000
3.MeC23	ace_chc - met_dg	-7.047	0.844	229.0	-8.346	0.000	0.000
3.MeC23	ace_chc - met_egg	4.687	0.747	229.0	6.276	0.000	0.000
3.MeC23	ace_chc - pre_chc	0.346	0.731	229.0	0.473	0.637	1.000
3.MeC23	ace_chc - pre_dg	-8.114	0.739	229.0	-10.984	0.000	0.000

3.MeC23	ace_chc - pre_egg	4.248	0.739	229.0	5.750	0.000	0.000
3.MeC23	ace_chc - queen_chc	-0.979	1.392	229.0	-0.704	0.482	1.000
3.MeC23	ace_chc - queen_dg	-4.366	1.050	229.0	-4.158	0.000	0.132
3.MeC23	ace_chc - queen_egg	4.934	0.718	229.0	6.877	0.000	0.000
3.MeC23	ace_dg - ace_egg	12.861	0.776	229.0	16.583	0.000	0.000
3.MeC23	ace_dg - met_chc	7.667	0.765	229.0	10.020	0.000	0.000
3.MeC23	ace_dg - met_dg	1.424	0.844	229.0	1.687	0.093	1.000
3.MeC23	ace_dg - met_egg	13.158	0.747	229.0	17.617	0.000	0.000
3.MeC23	ace_dg - pre_chc	8.817	0.731	229.0	12.058	0.000	0.000
3.MeC23	ace_dg - pre_dg	0.356	0.739	229.0	0.482	0.630	1.000
3.MeC23	ace_dg - pre_egg	12.719	0.739	229.0	17.216	0.000	0.000
3.MeC23	ace_dg - queen_chc	7.491	1.392	229.0	5.381	0.000	0.001
3.MeC23	ace_dg - queen_dg	4.105	1.050	229.0	3.909	0.000	0.354
3.MeC23	ace_dg - queen_egg	13.405	0.718	229.0	18.683	0.000	0.000
3.MeC23	ace_egg - met_chc	-5.194	0.808	229.0	-6.430	0.000	0.000
3.MeC23	ace_egg - met_dg	-11.437	0.883	229.0	-12.952	0.000	0.000
3.MeC23	ace_egg - met_egg	0.298	0.790	229.0	0.376	0.707	1.000
3.MeC23	ace_egg - pre_chc	-4.044	0.776	229.0	-5.215	0.000	0.001
3.MeC23	ace_egg - pre_dg	-12.504	0.783	229.0	-15.976	0.000	0.000
3.MeC23	ace_egg - pre_egg	-0.142	0.783	229.0	-0.182	0.856	1.000
3.MeC23	ace_egg - queen_chc	-5.369	1.416	229.0	-3.792	0.000	0.555
3.MeC23	ace_egg - queen_dg	-8.756	1.081	229.0	-8.097	0.000	0.000
3.MeC23	ace_egg - queen_egg	0.544	0.763	229.0	0.714	0.476	1.000
3.MeC23	met_chc - met_dg	-6.243	0.874	229.0	-7.144	0.000	0.000
3.MeC23	met_chc - met_egg	5.491	0.780	229.0	7.038	0.000	0.000
3.MeC23	met_chc - pre_chc	1.149	0.765	229.0	1.502	0.134	1.000
3.MeC23	met_chc - pre_dg	-7.311	0.772	229.0	-9.464	0.000	0.000
3.MeC23	met_chc - pre_egg	5.051	0.772	229.0	6.539	0.000	0.000
3.MeC23	met_chc - queen_chc	-0.176	1.410	229.0	-0.125	0.901	1.000
3.MeC23	met_chc - queen_dg	-3.562	1.074	229.0	-3.317	0.001	1.000
3.MeC23	met_chc - queen_egg	5.738	0.752	229.0	7.629	0.000	0.000
3.MeC23	met_dg - met_egg	11.734	0.858	229.0	13.677	0.000	0.000
3.MeC23	met_dg - pre_chc	7.393	0.844	229.0	8.756	0.000	0.000
3.MeC23	met_dg - pre_dg	-1.068	0.851	229.0	-1.255	0.211	1.000
3.MeC23	met_dg - pre_egg	11.294	0.851	229.0	13.274	0.000	0.000
3.MeC23	met_dg - queen_chc	6.067	1.455	229.0	4.171	0.000	0.125
3.MeC23	met_dg - queen_dg	2.681	1.132	229.0	2.369	0.019	1.000
3.MeC23	met_dg - queen_egg	11.981	0.832	229.0	14.392	0.000	0.000
3.MeC23	met_egg - pre_chc	-4.342	0.747	229.0	-5.813	0.000	0.000
3.MeC23	met_egg - pre_dg	-12.802	0.754	229.0	-16.971	0.000	0.000
3.MeC23	met_egg - pre_egg	-0.440	0.754	229.0	-0.583	0.560	1.000
3.MeC23	met_egg - queen_chc	-5.667	1.400	229.0	-4.046	0.000	0.207
3.MeC23	met_egg - queen_dg	-9.053	1.061	229.0	-8.532	0.000	0.000
3.MeC23	met_egg - queen_egg	0.247	0.734	229.0	0.336	0.737	1.000
3.MeC23	pre_chc - pre_dg	-8.460	0.739	229.0	-11.452	0.000	0.000
3.MeC23	pre_chc - pre_egg	3.902	0.739	229.0	5.282	0.000	0.001
3.MeC23	pre_chc - queen_chc	-1.325	1.392	229.0	-0.952	0.342	1.000
3.MeC23	pre_chc - queen_dg	-4.712	1.050	229.0	-4.487	0.000	0.033
3.MeC23	pre_chc - queen_egg	4.588	0.718	229.0	6.395	0.000	0.000
3.MeC23	pre_dg - pre_egg	12.362	0.746	229.0	16.565	0.000	0.000
3.MeC23	pre_dg - queen_chc	7.135	1.396	229.0	5.111	0.000	0.002
3.MeC23	pre_dg - queen_dg	3.748	1.055	229.0	3.552	0.000	1.000
3.MeC23	pre_dg - queen_egg	13.049	0.725	229.0	17.992	0.000	0.000
3.MeC23	pre_egg - queen_chc	-5.227	1.396	229.0	-3.744	0.000	0.665
3.MeC23	pre_egg - queen_dg	-8.614	1.055	229.0	-8.162	0.000	0.000
3.MeC23	pre_egg - queen_egg	0.687	0.725	229.0	0.947	0.345	1.000
3.MeC23	queen_chc - queen_dg	-3.387	1.583	229.0	-2.139	0.033	1.000
3.MeC23	queen_chc - queen_egg	5.914	1.385	229.0	4.270	0.000	0.083
3.MeC23	queen_dg - queen_egg	9.300	1.041	229.0	8.937	0.000	0.000
3.MeC25	ace_chc - ace_dg	0.056	0.167	229.0	0.332	0.740	1.000
3.MeC25	ace_chc - ace_egg	0.484	0.177	229.0	2.728	0.007	1.000
3.MeC25	ace_chc - met_chc	-0.075	0.175	229.0	-0.426	0.671	1.000
3.MeC25	ace_chc - met_dg	-0.384	0.193	229.0	-1.988	0.048	1.000
3.MeC25	ace_chc - met_egg	0.470	0.171	229.0	2.750	0.006	1.000
3.MeC25	ace_chc - pre_chc	0.038	0.167	229.0	0.228	0.820	1.000
3.MeC25	ace_chc - pre_dg	-0.182	0.169	229.0	-1.078	0.282	1.000
3.MeC25	ace_chc - pre_egg	0.423	0.169	229.0	2.504	0.013	1.000
3.MeC25	ace_chc - queen_chc	-0.217	0.319	229.0	-0.681	0.496	1.000

3.MeC25	ace_chc - queen_dg	0.970	0.240	229.0	4.036	0.000	0.215
3.MeC25	ace_chc - queen_egg	-0.275	0.164	229.0	-1.673	0.096	1.000
3.MeC25	ace_dg - ace_egg	0.429	0.177	229.0	2.415	0.017	1.000
3.MeC25	ace_dg - met_chc	-0.130	0.175	229.0	-0.743	0.458	1.000
3.MeC25	ace_dg - met_dg	-0.440	0.193	229.0	-2.275	0.024	1.000
3.MeC25	ace_dg - met_egg	0.414	0.171	229.0	2.425	0.016	1.000
3.MeC25	ace_dg - pre_chc	-0.018	0.167	229.0	-0.105	0.917	1.000
3.MeC25	ace_dg - pre_dg	-0.238	0.169	229.0	-1.407	0.161	1.000
3.MeC25	ace_dg - pre_egg	0.368	0.169	229.0	2.175	0.031	1.000
3.MeC25	ace_dg - queen_chc	-0.273	0.319	229.0	-0.856	0.393	1.000
3.MeC25	ace_dg - queen_dg	0.914	0.240	229.0	3.804	0.000	0.530
3.MeC25	ace_dg - queen_egg	-0.330	0.164	229.0	-2.012	0.045	1.000
3.MeC25	ace_egg - met_chc	-0.559	0.185	229.0	-3.023	0.003	1.000
3.MeC25	ace_egg - met_dg	-0.868	0.202	229.0	-4.296	0.000	0.075
3.MeC25	ace_egg - met_egg	-0.014	0.181	229.0	-0.078	0.938	1.000
3.MeC25	ace_egg - pre_chc	-0.446	0.177	229.0	-2.513	0.013	1.000
3.MeC25	ace_egg - pre_dg	-0.666	0.179	229.0	-3.720	0.000	0.728
3.MeC25	ace_egg - pre_egg	-0.061	0.179	229.0	-0.340	0.735	1.000
3.MeC25	ace_egg - queen_chc	-0.701	0.324	229.0	-2.164	0.032	1.000
3.MeC25	ace_egg - queen_dg	0.486	0.247	229.0	1.963	0.051	1.000
3.MeC25	ace_egg - queen_egg	-0.759	0.175	229.0	-4.348	0.000	0.060
3.MeC25	met_chc - met_dg	-0.309	0.200	229.0	-1.547	0.123	1.000
3.MeC25	met_chc - met_egg	0.545	0.179	229.0	3.050	0.003	1.000
3.MeC25	met_chc - pre_chc	0.113	0.175	229.0	0.643	0.521	1.000
3.MeC25	met_chc - pre_dg	-0.108	0.177	229.0	-0.609	0.543	1.000
3.MeC25	met_chc - pre_egg	0.498	0.177	229.0	2.817	0.005	1.000
3.MeC25	met_chc - queen_chc	-0.142	0.323	229.0	-0.441	0.659	1.000
3.MeC25	met_chc - queen_dg	1.044	0.246	229.0	4.249	0.000	0.091
3.MeC25	met_chc - queen_egg	-0.200	0.172	229.0	-1.163	0.246	1.000
3.MeC25	met_dg - met_egg	0.854	0.196	229.0	4.350	0.000	0.060
3.MeC25	met_dg - pre_chc	0.422	0.193	229.0	2.185	0.030	1.000
3.MeC25	met_dg - pre_dg	0.202	0.195	229.0	1.037	0.301	1.000
3.MeC25	met_dg - pre_egg	0.807	0.195	229.0	4.146	0.000	0.138
3.MeC25	met_dg - queen_chc	0.167	0.333	229.0	0.502	0.616	1.000
3.MeC25	met_dg - queen_dg	1.354	0.259	229.0	5.227	0.000	0.001
3.MeC25	met_dg - queen_egg	0.109	0.191	229.0	0.574	0.567	1.000
3.MeC25	met_egg - pre_chc	-0.432	0.171	229.0	-2.527	0.012	1.000
3.MeC25	met_egg - pre_dg	-0.652	0.173	229.0	-3.779	0.000	0.584
3.MeC25	met_egg - pre_egg	-0.047	0.173	229.0	-0.271	0.787	1.000
3.MeC25	met_egg - queen_chc	-0.687	0.320	229.0	-2.144	0.033	1.000
3.MeC25	met_egg - queen_dg	0.500	0.243	229.0	2.058	0.041	1.000
3.MeC25	met_egg - queen_egg	-0.745	0.168	229.0	-4.437	0.000	0.041
3.MeC25	pre_chc - pre_dg	-0.220	0.169	229.0	-1.303	0.194	1.000
3.MeC25	pre_chc - pre_egg	0.385	0.169	229.0	2.279	0.024	1.000
3.MeC25	pre_chc - queen_chc	-0.255	0.319	229.0	-0.801	0.424	1.000
3.MeC25	pre_chc - queen_dg	0.932	0.240	229.0	3.877	0.000	0.401
3.MeC25	pre_chc - queen_egg	-0.313	0.164	229.0	-1.905	0.058	1.000
3.MeC25	pre_dg - pre_egg	0.606	0.171	229.0	3.546	0.000	1.000
3.MeC25	pre_dg - queen_chc	-0.035	0.320	229.0	-0.109	0.913	1.000
3.MeC25	pre_dg - queen_dg	1.152	0.242	229.0	4.770	0.000	0.010
3.MeC25	pre_dg - queen_egg	-0.093	0.166	229.0	-0.558	0.578	1.000
3.MeC25	pre_egg - queen_chc	-0.640	0.320	229.0	-2.004	0.046	1.000
3.MeC25	pre_egg - queen_dg	0.547	0.242	229.0	2.263	0.025	1.000
3.MeC25	pre_egg - queen_egg	-0.698	0.166	229.0	-4.206	0.000	0.108
3.MeC25	queen_chc - queen_dg	1.187	0.362	229.0	3.276	0.001	1.000
3.MeC25	queen_chc - queen_egg	-0.058	0.317	229.0	-0.182	0.856	1.000
3.MeC25	queen_dg - queen_egg	-1.245	0.238	229.0	-5.226	0.000	0.001
3.MeC27	ace_chc - ace_dg	-13.494	0.158	229.0	-85.562	0.000	0.000
3.MeC27	ace_chc - ace_egg	-12.955	0.167	229.0	-77.446	0.000	0.000
3.MeC27	ace_chc - met_chc	0.000	0.165	229.0	0.000	1.000	1.000
3.MeC27	ace_chc - met_dg	-13.691	0.182	229.0	-75.181	0.000	0.000
3.MeC27	ace_chc - met_egg	-13.203	0.161	229.0	-81.954	0.000	0.000
3.MeC27	ace_chc - pre_chc	0.000	0.158	229.0	0.000	1.000	1.000
3.MeC27	ace_chc - pre_dg	-13.594	0.159	229.0	-85.317	0.000	0.000
3.MeC27	ace_chc - pre_egg	-13.032	0.159	229.0	-81.784	0.000	0.000
3.MeC27	ace_chc - queen_chc	0.000	0.300	229.0	0.000	1.000	1.000
3.MeC27	ace_chc - queen_dg	-13.313	0.226	229.0	-58.781	0.000	0.000
3.MeC27	ace_chc - queen_egg	-13.588	0.155	229.0	-87.803	0.000	0.000

3.MeC27	ace_dg - ace_egg	0.539	0.167	229.0	3.222	0.001	1.000
3.MeC27	ace_dg - met_chc	13.494	0.165	229.0	81.757	0.000	0.000
3.MeC27	ace_dg - met_dg	-0.197	0.182	229.0	-1.083	0.280	1.000
3.MeC27	ace_dg - met_egg	0.291	0.161	229.0	1.806	0.072	1.000
3.MeC27	ace_dg - pre_chc	13.494	0.158	229.0	85.561	0.000	0.000
3.MeC27	ace_dg - pre_dg	-0.101	0.159	229.0	-0.632	0.528	1.000
3.MeC27	ace_dg - pre_egg	0.462	0.159	229.0	2.900	0.004	1.000
3.MeC27	ace_dg - queen_chc	13.494	0.300	229.0	44.939	0.000	0.000
3.MeC27	ace_dg - queen_dg	0.180	0.226	229.0	0.797	0.426	1.000
3.MeC27	ace_dg - queen_egg	-0.095	0.155	229.0	-0.611	0.542	1.000
3.MeC27	ace_egg - met_chc	12.955	0.174	229.0	74.363	0.000	0.000
3.MeC27	ace_egg - met_dg	-0.736	0.190	229.0	-3.865	0.000	0.420
3.MeC27	ace_egg - met_egg	-0.248	0.170	229.0	-1.455	0.147	1.000
3.MeC27	ace_egg - pre_chc	12.955	0.167	229.0	77.446	0.000	0.000
3.MeC27	ace_egg - pre_dg	-0.640	0.169	229.0	-3.790	0.000	0.560
3.MeC27	ace_egg - pre_egg	-0.077	0.169	229.0	-0.455	0.649	1.000
3.MeC27	ace_egg - queen_chc	12.955	0.305	229.0	42.419	0.000	0.000
3.MeC27	ace_egg - queen_dg	-0.359	0.233	229.0	-1.537	0.126	1.000
3.MeC27	ace_egg - queen_egg	-0.634	0.164	229.0	-3.852	0.000	0.442
3.MeC27	met_chc - met_dg	-13.691	0.188	229.0	-72.632	0.000	0.000
3.MeC27	met_chc - met_egg	-13.203	0.168	229.0	-78.452	0.000	0.000
3.MeC27	met_chc - pre_chc	0.000	0.165	229.0	0.000	1.000	1.000
3.MeC27	met_chc - pre_dg	-13.594	0.167	229.0	-81.595	0.000	0.000
3.MeC27	met_chc - pre_egg	-13.032	0.167	229.0	-78.217	0.000	0.000
3.MeC27	met_chc - queen_chc	0.000	0.304	229.0	0.000	1.000	1.000
3.MeC27	met_chc - queen_dg	-13.313	0.232	229.0	-57.469	0.000	0.000
3.MeC27	met_chc - queen_egg	-13.588	0.162	229.0	-83.759	0.000	0.000
3.MeC27	met_dg - met_egg	0.488	0.185	229.0	2.638	0.009	1.000
3.MeC27	met_dg - pre_chc	13.691	0.182	229.0	75.181	0.000	0.000
3.MeC27	met_dg - pre_dg	0.096	0.184	229.0	0.525	0.600	1.000
3.MeC27	met_dg - pre_egg	0.659	0.184	229.0	3.593	0.000	1.000
3.MeC27	met_dg - queen_chc	13.691	0.314	229.0	43.633	0.000	0.000
3.MeC27	met_dg - queen_dg	0.378	0.244	229.0	1.547	0.123	1.000
3.MeC27	met_dg - queen_egg	0.103	0.180	229.0	0.571	0.568	1.000
3.MeC27	met_egg - pre_chc	13.203	0.161	229.0	81.954	0.000	0.000
3.MeC27	met_egg - pre_dg	-0.392	0.163	229.0	-2.408	0.017	1.000
3.MeC27	met_egg - pre_egg	0.171	0.163	229.0	1.052	0.294	1.000
3.MeC27	met_egg - queen_chc	13.203	0.302	229.0	43.709	0.000	0.000
3.MeC27	met_egg - queen_dg	-0.111	0.229	229.0	-0.483	0.630	1.000
3.MeC27	met_egg - queen_egg	-0.386	0.158	229.0	-2.437	0.016	1.000
3.MeC27	pre_chc - pre_dg	-13.594	0.159	229.0	-85.316	0.000	0.000
3.MeC27	pre_chc - pre_egg	-13.031	0.159	229.0	-81.783	0.000	0.000
3.MeC27	pre_chc - queen_chc	0.000	0.300	229.0	0.000	1.000	1.000
3.MeC27	pre_chc - queen_dg	-13.313	0.226	229.0	-58.781	0.000	0.000
3.MeC27	pre_chc - queen_egg	-13.588	0.155	229.0	-87.803	0.000	0.000
3.MeC27	pre_dg - pre_egg	0.563	0.161	229.0	3.497	0.001	1.000
3.MeC27	pre_dg - queen_chc	13.594	0.301	229.0	45.145	0.000	0.000
3.MeC27	pre_dg - queen_dg	0.281	0.228	229.0	1.235	0.218	1.000
3.MeC27	pre_dg - queen_egg	0.006	0.156	229.0	0.039	0.969	1.000
3.MeC27	pre_egg - queen_chc	13.031	0.301	229.0	43.275	0.000	0.000
3.MeC27	pre_egg - queen_dg	-0.282	0.228	229.0	-1.238	0.217	1.000
3.MeC27	pre_egg - queen_egg	-0.557	0.156	229.0	-3.559	0.000	1.000
3.MeC27	queen_chc - queen_dg	-13.313	0.341	229.0	-38.990	0.000	0.000
3.MeC27	queen_chc - queen_egg	-13.588	0.299	229.0	-45.487	0.000	0.000
3.MeC27	queen_dg - queen_egg	-0.275	0.224	229.0	-1.225	0.222	1.000
3.MeC29	ace_chc - ace_dg	-0.948	0.917	229.0	-1.034	0.302	1.000
3.MeC29	ace_chc - ace_egg	-6.772	0.973	229.0	-6.959	0.000	0.000
3.MeC29	ace_chc - met_chc	0.583	0.960	229.0	0.607	0.545	1.000
3.MeC29	ace_chc - met_dg	-1.198	1.059	229.0	-1.131	0.259	1.000
3.MeC29	ace_chc - met_egg	-6.951	0.937	229.0	-7.417	0.000	0.000
3.MeC29	ace_chc - pre_chc	0.000	0.917	229.0	0.000	1.000	1.000
3.MeC29	ace_chc - pre_dg	-0.016	0.927	229.0	-0.017	0.987	1.000
3.MeC29	ace_chc - pre_egg	-7.015	0.927	229.0	-7.568	0.000	0.000
3.MeC29	ace_chc - queen_chc	0.072	1.747	229.0	0.041	0.967	1.000
3.MeC29	ace_chc - queen_dg	-2.307	1.318	229.0	-1.751	0.081	1.000
3.MeC29	ace_chc - queen_egg	-6.648	0.900	229.0	-7.384	0.000	0.000
3.MeC29	ace_dg - ace_egg	-5.824	0.973	229.0	-5.985	0.000	0.000
3.MeC29	ace_dg - met_chc	1.531	0.960	229.0	1.594	0.112	1.000

3.MeC29	ace_dg - met_dg	-0.249	1.059	229.0	-0.235	0.814	1.000
3.MeC29	ace_dg - met_egg	-6.002	0.937	229.0	-6.405	0.000	0.000
3.MeC29	ace_dg - pre_chc	0.948	0.917	229.0	1.034	0.302	1.000
3.MeC29	ace_dg - pre_dg	0.933	0.927	229.0	1.006	0.315	1.000
3.MeC29	ace_dg - pre_egg	-6.066	0.927	229.0	-6.545	0.000	0.000
3.MeC29	ace_dg - queen_chc	1.020	1.747	229.0	0.584	0.560	1.000
3.MeC29	ace_dg - queen_dg	-1.358	1.318	229.0	-1.031	0.304	1.000
3.MeC29	ace_dg - queen_egg	-5.700	0.900	229.0	-6.331	0.000	0.000
3.MeC29	ace_egg - met_chc	7.354	1.013	229.0	7.257	0.000	0.000
3.MeC29	ace_egg - met_dg	5.574	1.108	229.0	5.031	0.000	0.003
3.MeC29	ace_egg - met_egg	-0.179	0.992	229.0	-0.180	0.857	1.000
3.MeC29	ace_egg - pre_chc	6.772	0.973	229.0	6.959	0.000	0.000
3.MeC29	ace_egg - pre_dg	6.756	0.982	229.0	6.880	0.000	0.000
3.MeC29	ace_egg - pre_egg	-0.243	0.982	229.0	-0.247	0.805	1.000
3.MeC29	ace_egg - queen_chc	6.844	1.777	229.0	3.852	0.000	0.441
3.MeC29	ace_egg - queen_dg	4.465	1.357	229.0	3.291	0.001	1.000
3.MeC29	ace_egg - queen_egg	0.124	0.957	229.0	0.130	0.897	1.000
3.MeC29	met_chc - met_dg	-1.780	1.097	229.0	-1.624	0.106	1.000
3.MeC29	met_chc - met_egg	-7.533	0.979	229.0	-7.695	0.000	0.000
3.MeC29	met_chc - pre_chc	-0.583	0.960	229.0	-0.607	0.545	1.000
3.MeC29	met_chc - pre_dg	-0.598	0.969	229.0	-0.617	0.538	1.000
3.MeC29	met_chc - pre_egg	-7.597	0.969	229.0	-7.839	0.000	0.000
3.MeC29	met_chc - queen_chc	-0.511	1.769	229.0	-0.289	0.773	1.000
3.MeC29	met_chc - queen_dg	-2.889	1.348	229.0	-2.144	0.033	1.000
3.MeC29	met_chc - queen_egg	-7.230	0.944	229.0	-7.662	0.000	0.000
3.MeC29	met_dg - met_egg	-5.753	1.076	229.0	-5.344	0.000	0.001
3.MeC29	met_dg - pre_chc	1.198	1.059	229.0	1.131	0.259	1.000
3.MeC29	met_dg - pre_dg	1.182	1.068	229.0	1.107	0.269	1.000
3.MeC29	met_dg - pre_egg	-5.817	1.068	229.0	-5.449	0.000	0.000
3.MeC29	met_dg - queen_chc	1.269	1.825	229.0	0.696	0.487	1.000
3.MeC29	met_dg - queen_dg	-1.109	1.420	229.0	-0.781	0.436	1.000
3.MeC29	met_dg - queen_egg	-5.450	1.045	229.0	-5.218	0.000	0.001
3.MeC29	met_egg - pre_chc	6.951	0.937	229.0	7.417	0.000	0.000
3.MeC29	met_egg - pre_dg	6.935	0.946	229.0	7.327	0.000	0.000
3.MeC29	met_egg - pre_egg	-0.064	0.946	229.0	-0.068	0.946	1.000
3.MeC29	met_egg - queen_chc	7.022	1.757	229.0	3.997	0.000	0.252
3.MeC29	met_egg - queen_dg	4.644	1.331	229.0	3.488	0.001	1.000
3.MeC29	met_egg - queen_egg	0.303	0.920	229.0	0.329	0.742	1.000
3.MeC29	pre_chc - pre_dg	-0.016	0.927	229.0	-0.017	0.987	1.000
3.MeC29	pre_chc - pre_egg	-7.014	0.927	229.0	-7.568	0.000	0.000
3.MeC29	pre_chc - queen_chc	0.072	1.747	229.0	0.041	0.967	1.000
3.MeC29	pre_chc - queen_dg	-2.307	1.318	229.0	-1.751	0.081	1.000
3.MeC29	pre_chc - queen_egg	-6.648	0.900	229.0	-7.384	0.000	0.000
3.MeC29	pre_dg - pre_egg	-6.999	0.936	229.0	-7.475	0.000	0.000
3.MeC29	pre_dg - queen_chc	0.087	1.752	229.0	0.050	0.960	1.000
3.MeC29	pre_dg - queen_dg	-2.291	1.324	229.0	-1.730	0.085	1.000
3.MeC29	pre_dg - queen_egg	-6.632	0.910	229.0	-7.288	0.000	0.000
3.MeC29	pre_egg - queen_chc	7.086	1.752	229.0	4.045	0.000	0.207
3.MeC29	pre_egg - queen_dg	4.708	1.324	229.0	3.555	0.000	1.000
3.MeC29	pre_egg - queen_egg	0.367	0.910	229.0	0.403	0.687	1.000
3.MeC29	queen_chc - queen_dg	-2.378	1.986	229.0	-1.197	0.232	1.000
3.MeC29	queen_chc - queen_egg	-6.720	1.738	229.0	-3.867	0.000	0.417
3.MeC29	queen_dg - queen_egg	-4.341	1.306	229.0	-3.325	0.001	1.000
3.MeC31	ace_chc - ace_dg	-12.537	0.343	229.0	-36.518	0.000	0.000
3.MeC31	ace_chc - ace_egg	0.001	0.364	229.0	0.001	0.999	1.000
3.MeC31	ace_chc - met_chc	0.000	0.359	229.0	0.000	1.000	1.000
3.MeC31	ace_chc - met_dg	-12.352	0.396	229.0	-31.160	0.000	0.000
3.MeC31	ace_chc - met_egg	0.000	0.351	229.0	0.001	0.999	1.000
3.MeC31	ace_chc - pre_chc	0.000	0.343	229.0	0.000	1.000	1.000
3.MeC31	ace_chc - pre_dg	-11.308	0.347	229.0	-32.599	0.000	0.000
3.MeC31	ace_chc - pre_egg	0.000	0.347	229.0	0.001	0.999	1.000
3.MeC31	ace_chc - queen_chc	0.000	0.654	229.0	0.000	1.000	1.000
3.MeC31	ace_chc - queen_dg	-13.250	0.493	229.0	-26.874	0.000	0.000
3.MeC31	ace_chc - queen_egg	0.001	0.337	229.0	0.002	0.999	1.000
3.MeC31	ace_dg - ace_egg	12.538	0.364	229.0	34.431	0.000	0.000
3.MeC31	ace_dg - met_chc	12.537	0.359	229.0	34.895	0.000	0.000
3.MeC31	ace_dg - met_dg	0.185	0.396	229.0	0.466	0.642	1.000
3.MeC31	ace_dg - met_egg	12.538	0.351	229.0	35.751	0.000	0.000

3.MeC31	ace_dg - pre_chc	12.537	0.343	229.0	36.518	0.000	0.000
3.MeC31	ace_dg - pre_dg	1.229	0.347	229.0	3.544	0.000	1.000
3.MeC31	ace_dg - pre_egg	12.538	0.347	229.0	36.145	0.000	0.000
3.MeC31	ace_dg - queen_chc	12.537	0.654	229.0	19.180	0.000	0.000
3.MeC31	ace_dg - queen_dg	-0.713	0.493	229.0	-1.446	0.150	1.000
3.MeC31	ace_dg - queen_egg	12.538	0.337	229.0	37.216	0.000	0.000
3.MeC31	ace_egg - met_chc	-0.001	0.379	229.0	-0.001	0.999	1.000
3.MeC31	ace_egg - met_dg	-12.353	0.415	229.0	-29.796	0.000	0.000
3.MeC31	ace_egg - met_egg	0.000	0.371	229.0	0.000	1.000	1.000
3.MeC31	ace_egg - pre_chc	-0.001	0.364	229.0	-0.002	0.999	1.000
3.MeC31	ace_egg - pre_dg	-11.308	0.367	229.0	-30.771	0.000	0.000
3.MeC31	ace_egg - pre_egg	0.000	0.367	229.0	0.000	1.000	1.000
3.MeC31	ace_egg - queen_chc	-0.001	0.665	229.0	-0.001	0.999	1.000
3.MeC31	ace_egg - queen_dg	-13.251	0.508	229.0	-26.096	0.000	0.000
3.MeC31	ace_egg - queen_egg	0.000	0.358	229.0	0.000	1.000	1.000
3.MeC31	met_chc - met_dg	-12.352	0.410	229.0	-30.103	0.000	0.000
3.MeC31	met_chc - met_egg	0.000	0.366	229.0	0.001	0.999	1.000
3.MeC31	met_chc - pre_chc	0.000	0.359	229.0	0.000	1.000	1.000
3.MeC31	met_chc - pre_dg	-11.308	0.363	229.0	-31.178	0.000	0.000
3.MeC31	met_chc - pre_egg	0.000	0.363	229.0	0.001	0.999	1.000
3.MeC31	met_chc - queen_chc	0.000	0.662	229.0	0.000	1.000	1.000
3.MeC31	met_chc - queen_dg	-13.250	0.504	229.0	-26.274	0.000	0.000
3.MeC31	met_chc - queen_egg	0.001	0.353	229.0	0.001	0.999	1.000
3.MeC31	met_dg - met_egg	12.353	0.403	229.0	30.665	0.000	0.000
3.MeC31	met_dg - pre_chc	12.352	0.396	229.0	31.160	0.000	0.000
3.MeC31	met_dg - pre_dg	1.045	0.400	229.0	2.615	0.010	1.000
3.MeC31	met_dg - pre_egg	12.353	0.400	229.0	30.920	0.000	0.000
3.MeC31	met_dg - queen_chc	12.352	0.683	229.0	18.084	0.000	0.000
3.MeC31	met_dg - queen_dg	-0.898	0.531	229.0	-1.689	0.093	1.000
3.MeC31	met_dg - queen_egg	12.353	0.391	229.0	31.603	0.000	0.000
3.MeC31	met_egg - pre_chc	-0.001	0.351	229.0	-0.001	0.999	1.000
3.MeC31	met_egg - pre_dg	-11.308	0.354	229.0	-31.928	0.000	0.000
3.MeC31	met_egg - pre_egg	0.000	0.354	229.0	0.000	1.000	1.000
3.MeC31	met_egg - queen_chc	-0.001	0.658	229.0	-0.001	0.999	1.000
3.MeC31	met_egg - queen_dg	-13.250	0.498	229.0	-26.596	0.000	0.000
3.MeC31	met_egg - queen_egg	0.000	0.344	229.0	0.000	1.000	1.000
3.MeC31	pre_chc - pre_dg	-11.308	0.347	229.0	-32.599	0.000	0.000
3.MeC31	pre_chc - pre_egg	0.000	0.347	229.0	0.001	0.999	1.000
3.MeC31	pre_chc - queen_chc	0.000	0.654	229.0	0.000	1.000	1.000
3.MeC31	pre_chc - queen_dg	-13.250	0.493	229.0	-26.874	0.000	0.000
3.MeC31	pre_chc - queen_egg	0.001	0.337	229.0	0.002	0.999	1.000
3.MeC31	pre_dg - pre_egg	11.308	0.350	229.0	32.273	0.000	0.000
3.MeC31	pre_dg - queen_chc	11.308	0.656	229.0	17.250	0.000	0.000
3.MeC31	pre_dg - queen_dg	-1.942	0.496	229.0	-3.920	0.000	0.340
3.MeC31	pre_dg - queen_egg	11.308	0.341	229.0	33.209	0.000	0.000
3.MeC31	pre_egg - queen_chc	-0.001	0.656	229.0	-0.001	0.999	1.000
3.MeC31	pre_egg - queen_dg	-13.250	0.496	229.0	-26.740	0.000	0.000
3.MeC31	pre_egg - queen_egg	0.000	0.341	229.0	0.000	1.000	1.000
3.MeC31	queen_chc - queen_dg	-13.250	0.743	229.0	-17.826	0.000	0.000
3.MeC31	queen_chc - queen_egg	0.001	0.650	229.0	0.001	0.999	1.000
3.MeC31	queen_dg - queen_egg	13.251	0.489	229.0	27.120	0.000	0.000
4.MeC24	ace_chc - ace_dg	6.504	0.191	229.0	34.122	0.000	0.000
4.MeC24	ace_chc - ace_egg	6.504	0.202	229.0	32.171	0.000	0.000
4.MeC24	ace_chc - met_chc	-0.334	0.199	229.0	-1.676	0.095	1.000
4.MeC24	ace_chc - met_dg	6.504	0.220	229.0	29.549	0.000	0.000
4.MeC24	ace_chc - met_egg	6.504	0.195	229.0	33.403	0.000	0.000
4.MeC24	ace_chc - pre_chc	-0.226	0.191	229.0	-1.185	0.237	1.000
4.MeC24	ace_chc - pre_dg	6.504	0.193	229.0	33.771	0.000	0.000
4.MeC24	ace_chc - pre_egg	6.504	0.193	229.0	33.772	0.000	0.000
4.MeC24	ace_chc - queen_chc	-0.140	0.363	229.0	-0.387	0.699	1.000
4.MeC24	ace_chc - queen_dg	6.504	0.274	229.0	23.758	0.000	0.000
4.MeC24	ace_chc - queen_egg	6.504	0.187	229.0	34.772	0.000	0.000
4.MeC24	ace_dg - ace_egg	0.000	0.202	229.0	0.001	1.000	1.000
4.MeC24	ace_dg - met_chc	-6.838	0.199	229.0	-34.280	0.000	0.000
4.MeC24	ace_dg - met_dg	0.000	0.220	229.0	-0.001	0.999	1.000
4.MeC24	ace_dg - met_egg	0.000	0.195	229.0	0.000	1.000	1.000
4.MeC24	ace_dg - pre_chc	-6.730	0.191	229.0	-35.306	0.000	0.000
4.MeC24	ace_dg - pre_dg	0.000	0.193	229.0	0.000	1.000	1.000

4.MeC24	ace_dg - pre_egg	0.000	0.193	229.0	0.000	1.000	1.000
4.MeC24	ace_dg - queen_chc	-6.644	0.363	229.0	-18.308	0.000	0.000
4.MeC24	ace_dg - queen_dg	0.000	0.274	229.0	-0.001	0.999	1.000
4.MeC24	ace_dg - queen_egg	0.000	0.187	229.0	0.000	1.000	1.000
4.MeC24	ace_egg - met_chc	-6.838	0.211	229.0	-32.477	0.000	0.000
4.MeC24	ace_egg - met_dg	0.000	0.230	229.0	-0.001	0.999	1.000
4.MeC24	ace_egg - met_egg	0.000	0.206	229.0	0.000	1.000	1.000
4.MeC24	ace_egg - pre_chc	-6.730	0.202	229.0	-33.288	0.000	0.000
4.MeC24	ace_egg - pre_dg	0.000	0.204	229.0	-0.001	0.999	1.000
4.MeC24	ace_egg - pre_egg	0.000	0.204	229.0	-0.001	1.000	1.000
4.MeC24	ace_egg - queen_chc	-6.645	0.369	229.0	-18.001	0.000	0.000
4.MeC24	ace_egg - queen_dg	0.000	0.282	229.0	-0.001	0.999	1.000
4.MeC24	ace_egg - queen_egg	0.000	0.199	229.0	0.000	1.000	1.000
4.MeC24	met_chc - met_dg	6.838	0.228	229.0	30.014	0.000	0.000
4.MeC24	met_chc - met_egg	6.838	0.203	229.0	33.619	0.000	0.000
4.MeC24	met_chc - pre_chc	0.108	0.199	229.0	0.544	0.587	1.000
4.MeC24	met_chc - pre_dg	6.838	0.201	229.0	33.958	0.000	0.000
4.MeC24	met_chc - pre_egg	6.838	0.201	229.0	33.959	0.000	0.000
4.MeC24	met_chc - queen_chc	0.194	0.368	229.0	0.527	0.598	1.000
4.MeC24	met_chc - queen_dg	6.838	0.280	229.0	24.422	0.000	0.000
4.MeC24	met_chc - queen_egg	6.838	0.196	229.0	34.875	0.000	0.000
4.MeC24	met_dg - met_egg	0.000	0.224	229.0	0.001	0.999	1.000
4.MeC24	met_dg - pre_chc	-6.730	0.220	229.0	-30.575	0.000	0.000
4.MeC24	met_dg - pre_dg	0.000	0.222	229.0	0.001	0.999	1.000
4.MeC24	met_dg - pre_egg	0.000	0.222	229.0	0.001	0.999	1.000
4.MeC24	met_dg - queen_chc	-6.644	0.379	229.0	-17.520	0.000	0.000
4.MeC24	met_dg - queen_dg	0.000	0.295	229.0	0.000	1.000	1.000
4.MeC24	met_dg - queen_egg	0.000	0.217	229.0	0.002	0.999	1.000
4.MeC24	met_egg - pre_chc	-6.730	0.195	229.0	-34.563	0.000	0.000
4.MeC24	met_egg - pre_dg	0.000	0.197	229.0	-0.001	1.000	1.000
4.MeC24	met_egg - pre_egg	0.000	0.197	229.0	0.000	1.000	1.000
4.MeC24	met_egg - queen_chc	-6.644	0.365	229.0	-18.200	0.000	0.000
4.MeC24	met_egg - queen_dg	0.000	0.277	229.0	-0.001	0.999	1.000
4.MeC24	met_egg - queen_egg	0.000	0.191	229.0	0.000	1.000	1.000
4.MeC24	pre_chc - pre_dg	6.730	0.193	229.0	34.944	0.000	0.000
4.MeC24	pre_chc - pre_egg	6.730	0.193	229.0	34.944	0.000	0.000
4.MeC24	pre_chc - queen_chc	0.085	0.363	229.0	0.235	0.814	1.000
4.MeC24	pre_chc - queen_dg	6.730	0.274	229.0	24.583	0.000	0.000
4.MeC24	pre_chc - queen_egg	6.730	0.187	229.0	35.979	0.000	0.000
4.MeC24	pre_dg - pre_egg	0.000	0.195	229.0	0.000	1.000	1.000
4.MeC24	pre_dg - queen_chc	-6.644	0.364	229.0	-18.256	0.000	0.000
4.MeC24	pre_dg - queen_dg	0.000	0.275	229.0	-0.001	1.000	1.000
4.MeC24	pre_dg - queen_egg	0.000	0.189	229.0	0.001	0.999	1.000
4.MeC24	pre_egg - queen_chc	-6.644	0.364	229.0	-18.256	0.000	0.000
4.MeC24	pre_egg - queen_dg	0.000	0.275	229.0	-0.001	0.999	1.000
4.MeC24	pre_egg - queen_egg	0.000	0.189	229.0	0.001	1.000	1.000
4.MeC24	queen_chc - queen_dg	6.644	0.413	229.0	16.100	0.000	0.000
4.MeC24	queen_chc - queen_egg	6.644	0.361	229.0	18.403	0.000	0.000
4.MeC24	queen_dg - queen_egg	0.000	0.271	229.0	0.001	0.999	1.000
4.MeC26	ace_chc - ace_dg	9.971	0.134	229.0	74.515	0.000	0.000
4.MeC26	ace_chc - ace_egg	-0.453	0.142	229.0	-3.194	0.002	1.000
4.MeC26	ace_chc - met_chc	0.101	0.140	229.0	0.724	0.470	1.000
4.MeC26	ace_chc - met_dg	9.970	0.155	229.0	64.531	0.000	0.000
4.MeC26	ace_chc - met_egg	-0.218	0.137	229.0	-1.596	0.112	1.000
4.MeC26	ace_chc - pre_chc	0.141	0.134	229.0	1.055	0.292	1.000
4.MeC26	ace_chc - pre_dg	9.971	0.135	229.0	73.750	0.000	0.000
4.MeC26	ace_chc - pre_egg	-0.242	0.135	229.0	-1.790	0.075	1.000
4.MeC26	ace_chc - queen_chc	0.668	0.255	229.0	2.622	0.009	1.000
4.MeC26	ace_chc - queen_dg	9.970	0.192	229.0	51.884	0.000	0.000
4.MeC26	ace_chc - queen_egg	-0.163	0.131	229.0	-1.245	0.215	1.000
4.MeC26	ace_dg - ace_egg	-10.424	0.142	229.0	-73.447	0.000	0.000
4.MeC26	ace_dg - met_chc	-9.869	0.140	229.0	-70.477	0.000	0.000
4.MeC26	ace_dg - met_dg	0.000	0.155	229.0	-0.002	0.999	1.000
4.MeC26	ace_dg - met_egg	-10.189	0.137	229.0	-74.542	0.000	0.000
4.MeC26	ace_dg - pre_chc	-9.829	0.134	229.0	-73.460	0.000	0.000
4.MeC26	ace_dg - pre_dg	0.000	0.135	229.0	-0.001	1.000	1.000
4.MeC26	ace_dg - pre_egg	-10.213	0.135	229.0	-75.541	0.000	0.000
4.MeC26	ace_dg - queen_chc	-9.303	0.255	229.0	-36.515	0.000	0.000

4.MeC26	ace_dg - queen_dg	0.000	0.192	229.0	-0.001	0.999	1.000
4.MeC26	ace_dg - queen_egg	-10.134	0.131	229.0	-77.179	0.000	0.000
4.MeC26	ace_egg - met_chc	0.555	0.148	229.0	3.753	0.000	0.644
4.MeC26	ace_egg - met_dg	10.424	0.162	229.0	64.508	0.000	0.000
4.MeC26	ace_egg - met_egg	0.235	0.145	229.0	1.625	0.105	1.000
4.MeC26	ace_egg - pre_chc	0.594	0.142	229.0	4.189	0.000	0.116
4.MeC26	ace_egg - pre_dg	10.424	0.143	229.0	72.776	0.000	0.000
4.MeC26	ace_egg - pre_egg	0.211	0.143	229.0	1.475	0.142	1.000
4.MeC26	ace_egg - queen_chc	1.121	0.259	229.0	4.328	0.000	0.065
4.MeC26	ace_egg - queen_dg	10.424	0.198	229.0	52.671	0.000	0.000
4.MeC26	ace_egg - queen_egg	0.290	0.140	229.0	2.077	0.039	1.000
4.MeC26	met_chc - met_dg	9.869	0.160	229.0	61.708	0.000	0.000
4.MeC26	met_chc - met_egg	-0.320	0.143	229.0	-2.238	0.026	1.000
4.MeC26	met_chc - pre_chc	0.040	0.140	229.0	0.284	0.777	1.000
4.MeC26	met_chc - pre_dg	9.869	0.141	229.0	69.816	0.000	0.000
4.MeC26	met_chc - pre_egg	-0.343	0.141	229.0	-2.430	0.016	1.000
4.MeC26	met_chc - queen_chc	0.567	0.258	229.0	2.196	0.029	1.000
4.MeC26	met_chc - queen_dg	9.869	0.197	229.0	50.211	0.000	0.000
4.MeC26	met_chc - queen_egg	-0.265	0.138	229.0	-1.924	0.056	1.000
4.MeC26	met_dg - met_egg	-10.189	0.157	229.0	-64.893	0.000	0.000
4.MeC26	met_dg - pre_chc	-9.829	0.155	229.0	-63.617	0.000	0.000
4.MeC26	met_dg - pre_dg	0.000	0.156	229.0	0.001	0.999	1.000
4.MeC26	met_dg - pre_egg	-10.212	0.156	229.0	-65.587	0.000	0.000
4.MeC26	met_dg - queen_chc	-9.302	0.266	229.0	-34.943	0.000	0.000
4.MeC26	met_dg - queen_dg	0.000	0.207	229.0	0.000	1.000	1.000
4.MeC26	met_dg - queen_egg	-10.134	0.152	229.0	-66.519	0.000	0.000
4.MeC26	met_egg - pre_chc	0.359	0.137	229.0	2.629	0.009	1.000
4.MeC26	met_egg - pre_dg	10.189	0.138	229.0	73.809	0.000	0.000
4.MeC26	met_egg - pre_egg	-0.024	0.138	229.0	-0.173	0.863	1.000
4.MeC26	met_egg - queen_chc	0.886	0.256	229.0	3.458	0.001	1.000
4.MeC26	met_egg - queen_dg	10.189	0.194	229.0	52.470	0.000	0.000
4.MeC26	met_egg - queen_egg	0.055	0.134	229.0	0.408	0.684	1.000
4.MeC26	pre_chc - pre_dg	9.829	0.135	229.0	72.706	0.000	0.000
4.MeC26	pre_chc - pre_egg	-0.383	0.135	229.0	-2.835	0.005	1.000
4.MeC26	pre_chc - queen_chc	0.527	0.255	229.0	2.068	0.040	1.000
4.MeC26	pre_chc - queen_dg	9.829	0.192	229.0	51.150	0.000	0.000
4.MeC26	pre_chc - queen_egg	-0.305	0.131	229.0	-2.320	0.021	1.000
4.MeC26	pre_dg - pre_egg	-10.213	0.137	229.0	-74.781	0.000	0.000
4.MeC26	pre_dg - queen_chc	-9.302	0.255	229.0	-36.410	0.000	0.000
4.MeC26	pre_dg - queen_dg	0.000	0.193	229.0	-0.001	0.999	1.000
4.MeC26	pre_dg - queen_egg	-10.134	0.133	229.0	-76.357	0.000	0.000
4.MeC26	pre_egg - queen_chc	0.910	0.255	229.0	3.562	0.000	1.000
4.MeC26	pre_egg - queen_dg	10.212	0.193	229.0	52.878	0.000	0.000
4.MeC26	pre_egg - queen_egg	0.079	0.133	229.0	0.592	0.554	1.000
4.MeC26	queen_chc - queen_dg	9.302	0.290	229.0	32.110	0.000	0.000
4.MeC26	queen_chc - queen_egg	-0.831	0.253	229.0	-3.281	0.001	1.000
4.MeC26	queen_dg - queen_egg	-10.134	0.190	229.0	-53.215	0.000	0.000
5.MeC23	ace_chc - ace_dg	0.000	0.175	229.0	0.002	0.998	1.000
5.MeC23	ace_chc - ace_egg	0.001	0.186	229.0	0.003	0.998	1.000
5.MeC23	ace_chc - met_chc	-0.323	0.183	229.0	-1.760	0.080	1.000
5.MeC23	ace_chc - met_dg	0.000	0.202	229.0	0.001	0.999	1.000
5.MeC23	ace_chc - met_egg	0.000	0.179	229.0	0.003	0.998	1.000
5.MeC23	ace_chc - pre_chc	-0.271	0.175	229.0	-1.548	0.123	1.000
5.MeC23	ace_chc - pre_dg	0.000	0.177	229.0	0.002	0.998	1.000
5.MeC23	ace_chc - pre_egg	0.000	0.177	229.0	0.002	0.998	1.000
5.MeC23	ace_chc - queen_chc	0.000	0.334	229.0	0.000	1.000	1.000
5.MeC23	ace_chc - queen_dg	0.000	0.252	229.0	0.001	0.999	1.000
5.MeC23	ace_chc - queen_egg	0.001	0.172	229.0	0.003	0.998	1.000
5.MeC23	ace_dg - ace_egg	0.000	0.186	229.0	0.001	1.000	1.000
5.MeC23	ace_dg - met_chc	-0.323	0.183	229.0	-1.763	0.079	1.000
5.MeC23	ace_dg - met_dg	0.000	0.202	229.0	-0.001	0.999	1.000
5.MeC23	ace_dg - met_egg	0.000	0.179	229.0	0.000	1.000	1.000
5.MeC23	ace_dg - pre_chc	-0.272	0.175	229.0	-1.550	0.122	1.000
5.MeC23	ace_dg - pre_dg	0.000	0.177	229.0	0.000	1.000	1.000
5.MeC23	ace_dg - pre_egg	0.000	0.177	229.0	0.000	1.000	1.000
5.MeC23	ace_dg - queen_chc	-0.001	0.334	229.0	-0.002	0.999	1.000
5.MeC23	ace_dg - queen_dg	0.000	0.252	229.0	-0.001	0.999	1.000
5.MeC23	ace_dg - queen_egg	0.000	0.172	229.0	0.001	1.000	1.000

5.MeC23	ace_egg - met_chc	-0.323	0.194	229.0	-1.670	0.096	1.000
5.MeC23	ace_egg - met_dg	0.000	0.212	229.0	-0.002	0.999	1.000
5.MeC23	ace_egg - met_egg	0.000	0.189	229.0	0.000	1.000	1.000
5.MeC23	ace_egg - pre_chc	-0.272	0.186	229.0	-1.462	0.145	1.000
5.MeC23	ace_egg - pre_dg	0.000	0.188	229.0	-0.001	0.999	1.000
5.MeC23	ace_egg - pre_egg	0.000	0.188	229.0	-0.001	1.000	1.000
5.MeC23	ace_egg - queen_chc	-0.001	0.339	229.0	-0.002	0.998	1.000
5.MeC23	ace_egg - queen_dg	0.000	0.259	229.0	-0.001	0.999	1.000
5.MeC23	ace_egg - queen_egg	0.000	0.183	229.0	0.000	1.000	1.000
5.MeC23	met_chc - met_dg	0.323	0.210	229.0	1.542	0.124	1.000
5.MeC23	met_chc - met_egg	0.323	0.187	229.0	1.729	0.085	1.000
5.MeC23	met_chc - pre_chc	0.052	0.183	229.0	0.281	0.779	1.000
5.MeC23	met_chc - pre_dg	0.323	0.185	229.0	1.746	0.082	1.000
5.MeC23	met_chc - pre_egg	0.323	0.185	229.0	1.746	0.082	1.000
5.MeC23	met_chc - queen_chc	0.323	0.338	229.0	0.955	0.341	1.000
5.MeC23	met_chc - queen_dg	0.323	0.257	229.0	1.255	0.211	1.000
5.MeC23	met_chc - queen_egg	0.323	0.180	229.0	1.794	0.074	1.000
5.MeC23	met_dg - met_egg	0.000	0.206	229.0	0.001	0.999	1.000
5.MeC23	met_dg - pre_chc	-0.271	0.202	229.0	-1.341	0.181	1.000
5.MeC23	met_dg - pre_dg	0.000	0.204	229.0	0.001	0.999	1.000
5.MeC23	met_dg - pre_egg	0.000	0.204	229.0	0.001	0.999	1.000
5.MeC23	met_dg - queen_chc	0.000	0.349	229.0	-0.001	0.999	1.000
5.MeC23	met_dg - queen_dg	0.000	0.271	229.0	0.000	1.000	1.000
5.MeC23	met_dg - queen_egg	0.000	0.200	229.0	0.002	0.999	1.000
5.MeC23	met_egg - pre_chc	-0.272	0.179	229.0	-1.518	0.130	1.000
5.MeC23	met_egg - pre_dg	0.000	0.181	229.0	-0.001	1.000	1.000
5.MeC23	met_egg - pre_egg	0.000	0.181	229.0	0.000	1.000	1.000
5.MeC23	met_egg - queen_chc	-0.001	0.336	229.0	-0.002	0.999	1.000
5.MeC23	met_egg - queen_dg	0.000	0.254	229.0	-0.001	0.999	1.000
5.MeC23	met_egg - queen_egg	0.000	0.176	229.0	0.000	1.000	1.000
5.MeC23	pre_chc - pre_dg	0.272	0.177	229.0	1.534	0.126	1.000
5.MeC23	pre_chc - pre_egg	0.272	0.177	229.0	1.534	0.126	1.000
5.MeC23	pre_chc - queen_chc	0.271	0.334	229.0	0.813	0.417	1.000
5.MeC23	pre_chc - queen_dg	0.271	0.252	229.0	1.079	0.282	1.000
5.MeC23	pre_chc - queen_egg	0.272	0.172	229.0	1.580	0.115	1.000
5.MeC23	pre_dg - pre_egg	0.000	0.179	229.0	0.000	1.000	1.000
5.MeC23	pre_dg - queen_chc	0.000	0.335	229.0	-0.001	0.999	1.000
5.MeC23	pre_dg - queen_dg	0.000	0.253	229.0	-0.001	1.000	1.000
5.MeC23	pre_dg - queen_egg	0.000	0.174	229.0	0.001	0.999	1.000
5.MeC23	pre_egg - queen_chc	-0.001	0.335	229.0	-0.002	0.999	1.000
5.MeC23	pre_egg - queen_dg	0.000	0.253	229.0	-0.001	0.999	1.000
5.MeC23	pre_egg - queen_egg	0.000	0.174	229.0	0.001	1.000	1.000
5.MeC23	queen_chc - queen_dg	0.000	0.379	229.0	0.001	0.999	1.000
5.MeC23	queen_chc - queen_egg	0.001	0.332	229.0	0.002	0.998	1.000
5.MeC23	queen_dg - queen_egg	0.000	0.249	229.0	0.001	0.999	1.000
5.MeC25	ace_chc - ace_dg	9.174	0.268	229.0	34.205	0.000	0.000
5.MeC25	ace_chc - ace_egg	1.550	0.284	229.0	5.448	0.000	0.000
5.MeC25	ace_chc - met_chc	0.153	0.281	229.0	0.546	0.586	1.000
5.MeC25	ace_chc - met_dg	9.173	0.310	229.0	29.622	0.000	0.000
5.MeC25	ace_chc - met_egg	0.834	0.274	229.0	3.043	0.003	1.000
5.MeC25	ace_chc - pre_chc	-0.054	0.268	229.0	-0.201	0.841	1.000
5.MeC25	ace_chc - pre_dg	9.173	0.271	229.0	33.854	0.000	0.000
5.MeC25	ace_chc - pre_egg	0.909	0.271	229.0	3.354	0.001	1.000
5.MeC25	ace_chc - queen_chc	1.195	0.511	229.0	2.341	0.020	1.000
5.MeC25	ace_chc - queen_dg	9.173	0.385	229.0	23.817	0.000	0.000
5.MeC25	ace_chc - queen_egg	1.160	0.263	229.0	4.407	0.000	0.047
5.MeC25	ace_dg - ace_egg	-7.624	0.284	229.0	-26.801	0.000	0.000
5.MeC25	ace_dg - met_chc	-9.020	0.281	229.0	-32.138	0.000	0.000
5.MeC25	ace_dg - met_dg	0.000	0.310	229.0	-0.001	0.999	1.000
5.MeC25	ace_dg - met_egg	-8.340	0.274	229.0	-30.442	0.000	0.000
5.MeC25	ace_dg - pre_chc	-9.227	0.268	229.0	-34.406	0.000	0.000
5.MeC25	ace_dg - pre_dg	0.000	0.271	229.0	0.000	1.000	1.000
5.MeC25	ace_dg - pre_egg	-8.265	0.271	229.0	-30.501	0.000	0.000
5.MeC25	ace_dg - queen_chc	-7.978	0.511	229.0	-15.624	0.000	0.000
5.MeC25	ace_dg - queen_dg	0.000	0.385	229.0	-0.001	1.000	1.000
5.MeC25	ace_dg - queen_egg	-8.014	0.263	229.0	-30.450	0.000	0.000
5.MeC25	ace_egg - met_chc	-1.396	0.296	229.0	-4.714	0.000	0.012
5.MeC25	ace_egg - met_dg	7.624	0.324	229.0	23.539	0.000	0.000

5.MeC25	ace_egg - met_egg	-0.716	0.290	229.0	-2.469	0.014	1.000
5.MeC25	ace_egg - pre_chc	-1.604	0.284	229.0	-5.637	0.000	0.000
5.MeC25	ace_egg - pre_dg	7.624	0.287	229.0	26.556	0.000	0.000
5.MeC25	ace_egg - pre_egg	-0.641	0.287	229.0	-2.233	0.027	1.000
5.MeC25	ace_egg - queen_chc	-0.354	0.519	229.0	-0.682	0.496	1.000
5.MeC25	ace_egg - queen_dg	7.624	0.397	229.0	19.220	0.000	0.000
5.MeC25	ace_egg - queen_egg	-0.390	0.280	229.0	-1.393	0.165	1.000
5.MeC25	met_chc - met_dg	9.020	0.321	229.0	28.140	0.000	0.000
5.MeC25	met_chc - met_egg	0.681	0.286	229.0	2.378	0.018	1.000
5.MeC25	met_chc - pre_chc	-0.207	0.281	229.0	-0.738	0.461	1.000
5.MeC25	met_chc - pre_dg	9.020	0.283	229.0	31.837	0.000	0.000
5.MeC25	met_chc - pre_egg	0.756	0.283	229.0	2.667	0.008	1.000
5.MeC25	met_chc - queen_chc	1.042	0.517	229.0	2.015	0.045	1.000
5.MeC25	met_chc - queen_dg	9.020	0.394	229.0	22.896	0.000	0.000
5.MeC25	met_chc - queen_egg	1.007	0.276	229.0	3.649	0.000	0.947
5.MeC25	met_dg - met_egg	-8.340	0.315	229.0	-26.501	0.000	0.000
5.MeC25	met_dg - pre_chc	-9.227	0.310	229.0	-29.796	0.000	0.000
5.MeC25	met_dg - pre_dg	0.000	0.312	229.0	0.001	1.000	1.000
5.MeC25	met_dg - pre_egg	-8.265	0.312	229.0	-26.481	0.000	0.000
5.MeC25	met_dg - queen_chc	-7.978	0.534	229.0	-14.952	0.000	0.000
5.MeC25	met_dg - queen_dg	0.000	0.415	229.0	0.000	1.000	1.000
5.MeC25	met_dg - queen_egg	-8.013	0.305	229.0	-26.244	0.000	0.000
5.MeC25	met_egg - pre_chc	-0.888	0.274	229.0	-3.240	0.001	1.000
5.MeC25	met_egg - pre_dg	8.340	0.277	229.0	30.142	0.000	0.000
5.MeC25	met_egg - pre_egg	0.075	0.277	229.0	0.271	0.787	1.000
5.MeC25	met_egg - queen_chc	0.362	0.514	229.0	0.704	0.482	1.000
5.MeC25	met_egg - queen_dg	8.340	0.389	229.0	21.427	0.000	0.000
5.MeC25	met_egg - queen_egg	0.326	0.269	229.0	1.212	0.227	1.000
5.MeC25	pre_chc - pre_dg	9.227	0.271	229.0	34.053	0.000	0.000
5.MeC25	pre_chc - pre_egg	0.963	0.271	229.0	3.553	0.000	1.000
5.MeC25	pre_chc - queen_chc	1.249	0.511	229.0	2.447	0.015	1.000
5.MeC25	pre_chc - queen_dg	9.227	0.385	229.0	23.957	0.000	0.000
5.MeC25	pre_chc - queen_egg	1.214	0.263	229.0	4.612	0.000	0.019
5.MeC25	pre_dg - pre_egg	-8.265	0.274	229.0	-30.194	0.000	0.000
5.MeC25	pre_dg - queen_chc	-7.978	0.512	229.0	-15.580	0.000	0.000
5.MeC25	pre_dg - queen_dg	0.000	0.387	229.0	0.000	1.000	1.000
5.MeC25	pre_dg - queen_egg	-8.014	0.266	229.0	-30.125	0.000	0.000
5.MeC25	pre_egg - queen_chc	0.287	0.512	229.0	0.560	0.576	1.000
5.MeC25	pre_egg - queen_dg	8.265	0.387	229.0	21.350	0.000	0.000
5.MeC25	pre_egg - queen_egg	0.251	0.266	229.0	0.944	0.346	1.000
5.MeC25	queen_chc - queen_dg	7.978	0.581	229.0	13.740	0.000	0.000
5.MeC25	queen_chc - queen_egg	-0.036	0.508	229.0	-0.070	0.944	1.000
5.MeC25	queen_dg - queen_egg	-8.013	0.382	229.0	-20.995	0.000	0.000
7..5.MeC27	ace_chc - ace_dg	-11.892	0.132	229.0	-90.027	0.000	0.000
7..5.MeC27	ace_chc - ace_egg	0.001	0.140	229.0	0.004	0.997	1.000
7..5.MeC27	ace_chc - met_chc	0.000	0.138	229.0	0.000	1.000	1.000
7..5.MeC27	ace_chc - met_dg	-12.557	0.153	229.0	-82.324	0.000	0.000
7..5.MeC27	ace_chc - met_egg	0.000	0.135	229.0	0.003	0.997	1.000
7..5.MeC27	ace_chc - pre_chc	0.000	0.132	229.0	0.000	1.000	1.000
7..5.MeC27	ace_chc - pre_dg	-11.559	0.133	229.0	-86.607	0.000	0.000
7..5.MeC27	ace_chc - pre_egg	0.000	0.133	229.0	0.003	0.997	1.000
7..5.MeC27	ace_chc - queen_chc	0.000	0.251	229.0	0.000	1.000	1.000
7..5.MeC27	ace_chc - queen_dg	-12.375	0.190	229.0	-65.233	0.000	0.000
7..5.MeC27	ace_chc - queen_egg	0.001	0.130	229.0	0.004	0.997	1.000
7..5.MeC27	ace_dg - ace_egg	11.892	0.140	229.0	84.882	0.000	0.000
7..5.MeC27	ace_dg - met_chc	11.892	0.138	229.0	86.024	0.000	0.000
7..5.MeC27	ace_dg - met_dg	-0.665	0.153	229.0	-4.359	0.000	0.057
7..5.MeC27	ace_dg - met_egg	11.892	0.135	229.0	88.135	0.000	0.000
7..5.MeC27	ace_dg - pre_chc	11.892	0.132	229.0	90.027	0.000	0.000
7..5.MeC27	ace_dg - pre_dg	0.333	0.133	229.0	2.497	0.013	1.000
7..5.MeC27	ace_dg - pre_egg	11.892	0.133	229.0	89.107	0.000	0.000
7..5.MeC27	ace_dg - queen_chc	11.892	0.251	229.0	47.284	0.000	0.000
7..5.MeC27	ace_dg - queen_dg	-0.483	0.190	229.0	-2.546	0.012	1.000
7..5.MeC27	ace_dg - queen_egg	11.892	0.130	229.0	91.746	0.000	0.000
7..5.MeC27	ace_egg - met_chc	-0.001	0.146	229.0	-0.004	0.997	1.000
7..5.MeC27	ace_egg - met_dg	-12.557	0.160	229.0	-78.721	0.000	0.000
7..5.MeC27	ace_egg - met_egg	0.000	0.143	229.0	0.000	1.000	1.000
7..5.MeC27	ace_egg - pre_chc	-0.001	0.140	229.0	-0.004	0.997	1.000

7..5.MeC27	ace_egg - pre_dg	-11.559	0.141	229.0	-81.751	0.000	0.000
7..5.MeC27	ace_egg - pre_egg	0.000	0.141	229.0	-0.001	0.999	1.000
7..5.MeC27	ace_egg - queen_chc	-0.001	0.256	229.0	-0.003	0.998	1.000
7..5.MeC27	ace_egg - queen_dg	-12.375	0.195	229.0	-63.344	0.000	0.000
7..5.MeC27	ace_egg - queen_egg	0.000	0.138	229.0	0.000	1.000	1.000
7..5.MeC27	met_chc - met_dg	-12.557	0.158	229.0	-79.533	0.000	0.000
7..5.MeC27	met_chc - met_egg	0.000	0.141	229.0	0.003	0.997	1.000
7..5.MeC27	met_chc - pre_chc	0.000	0.138	229.0	0.000	1.000	1.000
7..5.MeC27	met_chc - pre_dg	-11.559	0.140	229.0	-82.830	0.000	0.000
7..5.MeC27	met_chc - pre_egg	0.000	0.140	229.0	0.003	0.998	1.000
7..5.MeC27	met_chc - queen_chc	0.000	0.255	229.0	-0.001	1.000	1.000
7..5.MeC27	met_chc - queen_dg	-12.375	0.194	229.0	-63.777	0.000	0.000
7..5.MeC27	met_chc - queen_egg	0.001	0.136	229.0	0.004	0.997	1.000
7..5.MeC27	met_dg - met_egg	12.557	0.155	229.0	81.017	0.000	0.000
7..5.MeC27	met_dg - pre_chc	12.557	0.153	229.0	82.324	0.000	0.000
7..5.MeC27	met_dg - pre_dg	0.998	0.154	229.0	6.493	0.000	0.000
7..5.MeC27	met_dg - pre_egg	12.557	0.154	229.0	81.692	0.000	0.000
7..5.MeC27	met_dg - queen_chc	12.557	0.263	229.0	47.779	0.000	0.000
7..5.MeC27	met_dg - queen_dg	0.182	0.204	229.0	0.890	0.375	1.000
7..5.MeC27	met_dg - queen_egg	12.557	0.150	229.0	83.496	0.000	0.000
7..5.MeC27	met_egg - pre_chc	-0.001	0.135	229.0	-0.004	0.997	1.000
7..5.MeC27	met_egg - pre_dg	-11.559	0.136	229.0	-84.823	0.000	0.000
7..5.MeC27	met_egg - pre_egg	0.000	0.136	229.0	0.000	1.000	1.000
7..5.MeC27	met_egg - queen_chc	-0.001	0.253	229.0	-0.002	0.998	1.000
7..5.MeC27	met_egg - queen_dg	-12.375	0.192	229.0	-64.558	0.000	0.000
7..5.MeC27	met_egg - queen_egg	0.000	0.133	229.0	0.000	1.000	1.000
7..5.MeC27	pre_chc - pre_dg	-11.559	0.133	229.0	-86.607	0.000	0.000
7..5.MeC27	pre_chc - pre_egg	0.000	0.133	229.0	0.003	0.997	1.000
7..5.MeC27	pre_chc - queen_chc	0.000	0.251	229.0	0.000	1.000	1.000
7..5.MeC27	pre_chc - queen_dg	-12.375	0.190	229.0	-65.232	0.000	0.000
7..5.MeC27	pre_chc - queen_egg	0.001	0.130	229.0	0.004	0.997	1.000
7..5.MeC27	pre_dg - pre_egg	11.559	0.135	229.0	85.740	0.000	0.000
7..5.MeC27	pre_dg - queen_chc	11.559	0.252	229.0	45.828	0.000	0.000
7..5.MeC27	pre_dg - queen_dg	-0.816	0.191	229.0	-4.281	0.000	0.080
7..5.MeC27	pre_dg - queen_egg	11.559	0.131	229.0	88.226	0.000	0.000
7..5.MeC27	pre_egg - queen_chc	-0.001	0.252	229.0	-0.002	0.998	1.000
7..5.MeC27	pre_egg - queen_dg	-12.375	0.191	229.0	-64.908	0.000	0.000
7..5.MeC27	pre_egg - queen_egg	0.000	0.131	229.0	0.001	0.999	1.000
7..5.MeC27	queen_chc - queen_dg	-12.375	0.286	229.0	-43.270	0.000	0.000
7..5.MeC27	queen_chc - queen_egg	0.001	0.250	229.0	0.003	0.998	1.000
7..5.MeC27	queen_dg - queen_egg	12.375	0.188	229.0	65.829	0.000	0.000
7.MeC29	ace_chc - ace_dg	-5.925	0.709	229.0	-8.360	0.000	0.000
7.MeC29	ace_chc - ace_egg	0.001	0.752	229.0	0.001	0.999	1.000
7.MeC29	ace_chc - met_chc	0.000	0.742	229.0	0.000	1.000	1.000
7.MeC29	ace_chc - met_dg	-5.791	0.818	229.0	-7.076	0.000	0.000
7.MeC29	ace_chc - met_egg	0.000	0.724	229.0	0.001	0.999	1.000
7.MeC29	ace_chc - pre_chc	0.000	0.709	229.0	0.000	1.000	1.000
7.MeC29	ace_chc - pre_dg	-5.245	0.716	229.0	-7.325	0.000	0.000
7.MeC29	ace_chc - pre_egg	0.000	0.716	229.0	0.001	1.000	1.000
7.MeC29	ace_chc - queen_chc	0.000	1.349	229.0	0.000	1.000	1.000
7.MeC29	ace_chc - queen_dg	-9.055	1.018	229.0	-8.896	0.000	0.000
7.MeC29	ace_chc - queen_egg	0.001	0.695	229.0	0.001	0.999	1.000
7.MeC29	ace_dg - ace_egg	5.926	0.752	229.0	7.883	0.000	0.000
7.MeC29	ace_dg - met_chc	5.925	0.742	229.0	7.989	0.000	0.000
7.MeC29	ace_dg - met_dg	0.135	0.818	229.0	0.164	0.869	1.000
7.MeC29	ace_dg - met_egg	5.926	0.724	229.0	8.185	0.000	0.000
7.MeC29	ace_dg - pre_chc	5.925	0.709	229.0	8.360	0.000	0.000
7.MeC29	ace_dg - pre_dg	0.680	0.716	229.0	0.950	0.343	1.000
7.MeC29	ace_dg - pre_egg	5.926	0.716	229.0	8.275	0.000	0.000
7.MeC29	ace_dg - queen_chc	5.925	1.349	229.0	4.391	0.000	0.050
7.MeC29	ace_dg - queen_dg	-3.129	1.018	229.0	-3.075	0.002	1.000
7.MeC29	ace_dg - queen_egg	5.926	0.695	229.0	8.520	0.000	0.000
7.MeC29	ace_egg - met_chc	-0.001	0.783	229.0	-0.001	0.999	1.000
7.MeC29	ace_egg - met_dg	-5.791	0.856	229.0	-6.766	0.000	0.000
7.MeC29	ace_egg - met_egg	0.000	0.766	229.0	0.000	1.000	1.000
7.MeC29	ace_egg - pre_chc	-0.001	0.752	229.0	-0.001	0.999	1.000
7.MeC29	ace_egg - pre_dg	-5.245	0.759	229.0	-6.914	0.000	0.000
7.MeC29	ace_egg - pre_egg	0.000	0.759	229.0	0.000	1.000	1.000

7.MeC29	ace_egg - queen_chc	-0.001	1.372	229.0	0.000	1.000	1.000
7.MeC29	ace_egg - queen_dg	-9.055	1.048	229.0	-8.639	0.000	0.000
7.MeC29	ace_egg - queen_egg	0.000	0.739	229.0	0.000	1.000	1.000
7.MeC29	met_chc - met_dg	-5.791	0.847	229.0	-6.836	0.000	0.000
7.MeC29	met_chc - met_egg	0.000	0.756	229.0	0.001	1.000	1.000
7.MeC29	met_chc - pre_chc	0.000	0.742	229.0	0.000	1.000	1.000
7.MeC29	met_chc - pre_dg	-5.245	0.749	229.0	-7.005	0.000	0.000
7.MeC29	met_chc - pre_egg	0.000	0.749	229.0	0.001	1.000	1.000
7.MeC29	met_chc - queen_chc	0.000	1.367	229.0	0.000	1.000	1.000
7.MeC29	met_chc - queen_dg	-9.055	1.041	229.0	-8.698	0.000	0.000
7.MeC29	met_chc - queen_egg	0.001	0.729	229.0	0.001	0.999	1.000
7.MeC29	met_dg - met_egg	5.791	0.832	229.0	6.964	0.000	0.000
7.MeC29	met_dg - pre_chc	5.791	0.818	229.0	7.076	0.000	0.000
7.MeC29	met_dg - pre_dg	0.546	0.825	229.0	0.662	0.509	1.000
7.MeC29	met_dg - pre_egg	5.791	0.825	229.0	7.022	0.000	0.000
7.MeC29	met_dg - queen_chc	5.791	1.410	229.0	4.107	0.000	0.162
7.MeC29	met_dg - queen_dg	-3.264	1.097	229.0	-2.975	0.003	1.000
7.MeC29	met_dg - queen_egg	5.791	0.807	229.0	7.177	0.000	0.000
7.MeC29	met_egg - pre_chc	-0.001	0.724	229.0	-0.001	0.999	1.000
7.MeC29	met_egg - pre_dg	-5.245	0.731	229.0	-7.174	0.000	0.000
7.MeC29	met_egg - pre_egg	0.000	0.731	229.0	0.000	1.000	1.000
7.MeC29	met_egg - queen_chc	-0.001	1.357	229.0	0.000	1.000	1.000
7.MeC29	met_egg - queen_dg	-9.055	1.029	229.0	-8.804	0.000	0.000
7.MeC29	met_egg - queen_egg	0.000	0.711	229.0	0.000	1.000	1.000
7.MeC29	pre_chc - pre_dg	-5.245	0.716	229.0	-7.325	0.000	0.000
7.MeC29	pre_chc - pre_egg	0.000	0.716	229.0	0.001	0.999	1.000
7.MeC29	pre_chc - queen_chc	0.000	1.349	229.0	0.000	1.000	1.000
7.MeC29	pre_chc - queen_dg	-9.055	1.018	229.0	-8.896	0.000	0.000
7.MeC29	pre_chc - queen_egg	0.001	0.695	229.0	0.001	0.999	1.000
7.MeC29	pre_dg - pre_egg	5.245	0.723	229.0	7.252	0.000	0.000
7.MeC29	pre_dg - queen_chc	5.245	1.353	229.0	3.876	0.000	0.403
7.MeC29	pre_dg - queen_dg	-3.810	1.023	229.0	-3.724	0.000	0.716
7.MeC29	pre_dg - queen_egg	5.245	0.703	229.0	7.462	0.000	0.000
7.MeC29	pre_egg - queen_chc	-0.001	1.353	229.0	0.000	1.000	1.000
7.MeC29	pre_egg - queen_dg	-9.055	1.023	229.0	-8.852	0.000	0.000
7.MeC29	pre_egg - queen_egg	0.000	0.703	229.0	0.000	1.000	1.000
7.MeC29	queen_chc - queen_dg	-9.055	1.534	229.0	-5.901	0.000	0.000
7.MeC29	queen_chc - queen_egg	0.001	1.342	229.0	0.000	1.000	1.000
7.MeC29	queen_dg - queen_egg	9.055	1.009	229.0	8.978	0.000	0.000
7.MeC31	ace_chc - ace_dg	8.527	0.059	229.0	144.383	0.000	0.000
7.MeC31	ace_chc - ace_egg	8.527	0.063	229.0	136.127	0.000	0.000
7.MeC31	ace_chc - met_chc	-0.334	0.062	229.0	-5.396	0.000	0.000
7.MeC31	ace_chc - met_dg	8.527	0.068	229.0	125.036	0.000	0.000
7.MeC31	ace_chc - met_egg	8.527	0.060	229.0	141.343	0.000	0.000
7.MeC31	ace_chc - pre_chc	0.117	0.059	229.0	1.975	0.050	1.000
7.MeC31	ace_chc - pre_dg	8.527	0.060	229.0	142.901	0.000	0.000
7.MeC31	ace_chc - pre_egg	8.527	0.060	229.0	142.902	0.000	0.000
7.MeC31	ace_chc - queen_chc	-0.061	0.112	229.0	-0.540	0.590	1.000
7.MeC31	ace_chc - queen_dg	8.527	0.085	229.0	100.533	0.000	0.000
7.MeC31	ace_chc - queen_egg	8.527	0.058	229.0	147.135	0.000	0.000
7.MeC31	ace_dg - ace_egg	0.000	0.063	229.0	0.002	0.999	1.000
7.MeC31	ace_dg - met_chc	-8.861	0.062	229.0	-143.359	0.000	0.000
7.MeC31	ace_dg - met_dg	0.000	0.068	229.0	-0.003	0.997	1.000
7.MeC31	ace_dg - met_egg	0.000	0.060	229.0	0.001	0.999	1.000
7.MeC31	ace_dg - pre_chc	-8.411	0.059	229.0	-142.408	0.000	0.000
7.MeC31	ace_dg - pre_dg	0.000	0.060	229.0	-0.001	0.999	1.000
7.MeC31	ace_dg - pre_egg	0.000	0.060	229.0	0.000	1.000	1.000
7.MeC31	ace_dg - queen_chc	-8.588	0.112	229.0	-76.373	0.000	0.000
7.MeC31	ace_dg - queen_dg	0.000	0.085	229.0	-0.003	0.998	1.000
7.MeC31	ace_dg - queen_egg	0.000	0.058	229.0	0.002	0.999	1.000
7.MeC31	ace_egg - met_chc	-8.861	0.065	229.0	-135.819	0.000	0.000
7.MeC31	ace_egg - met_dg	0.000	0.071	229.0	-0.005	0.996	1.000
7.MeC31	ace_egg - met_egg	0.000	0.064	229.0	-0.001	0.999	1.000
7.MeC31	ace_egg - pre_chc	-8.411	0.063	229.0	-134.265	0.000	0.000
7.MeC31	ace_egg - pre_dg	0.000	0.063	229.0	-0.003	0.998	1.000
7.MeC31	ace_egg - pre_egg	0.000	0.063	229.0	-0.002	0.999	1.000
7.MeC31	ace_egg - queen_chc	-8.588	0.114	229.0	-75.090	0.000	0.000
7.MeC31	ace_egg - queen_dg	0.000	0.087	229.0	-0.004	0.997	1.000

7.MeC31	ace_egg - queen_egg	0.000	0.062	229.0	0.000	1.000	1.000
7.MeC31	met_chc - met_dg	8.860	0.071	229.0	125.521	0.000	0.000
7.MeC31	met_chc - met_egg	8.861	0.063	229.0	140.596	0.000	0.000
7.MeC31	met_chc - pre_chc	0.450	0.062	229.0	7.283	0.000	0.000
7.MeC31	met_chc - pre_dg	8.861	0.062	229.0	142.013	0.000	0.000
7.MeC31	met_chc - pre_egg	8.861	0.062	229.0	142.014	0.000	0.000
7.MeC31	met_chc - queen_chc	0.273	0.114	229.0	2.395	0.017	1.000
7.MeC31	met_chc - queen_dg	8.860	0.087	229.0	102.133	0.000	0.000
7.MeC31	met_chc - queen_egg	8.861	0.061	229.0	145.847	0.000	0.000
7.MeC31	met_dg - met_egg	0.000	0.069	229.0	0.004	0.997	1.000
7.MeC31	met_dg - pre_chc	-8.410	0.068	229.0	-123.326	0.000	0.000
7.MeC31	met_dg - pre_dg	0.000	0.069	229.0	0.002	0.998	1.000
7.MeC31	met_dg - pre_egg	0.000	0.069	229.0	0.003	0.997	1.000
7.MeC31	met_dg - queen_chc	-8.588	0.118	229.0	-73.085	0.000	0.000
7.MeC31	met_dg - queen_dg	0.000	0.091	229.0	0.000	1.000	1.000
7.MeC31	met_dg - queen_egg	0.000	0.067	229.0	0.005	0.996	1.000
7.MeC31	met_egg - pre_chc	-8.411	0.060	229.0	-139.410	0.000	0.000
7.MeC31	met_egg - pre_dg	0.000	0.061	229.0	-0.002	0.999	1.000
7.MeC31	met_egg - pre_egg	0.000	0.061	229.0	-0.001	0.999	1.000
7.MeC31	met_egg - queen_chc	-8.588	0.113	229.0	-75.920	0.000	0.000
7.MeC31	met_egg - queen_dg	0.000	0.086	229.0	-0.003	0.997	1.000
7.MeC31	met_egg - queen_egg	0.000	0.059	229.0	0.001	0.999	1.000
7.MeC31	pre_chc - pre_dg	8.411	0.060	229.0	140.946	0.000	0.000
7.MeC31	pre_chc - pre_egg	8.411	0.060	229.0	140.947	0.000	0.000
7.MeC31	pre_chc - queen_chc	-0.177	0.112	229.0	-1.577	0.116	1.000
7.MeC31	pre_chc - queen_dg	8.410	0.085	229.0	99.158	0.000	0.000
7.MeC31	pre_chc - queen_egg	8.411	0.058	229.0	145.123	0.000	0.000
7.MeC31	pre_dg - pre_egg	0.000	0.060	229.0	0.001	0.999	1.000
7.MeC31	pre_dg - queen_chc	-8.588	0.113	229.0	-76.154	0.000	0.000
7.MeC31	pre_dg - queen_dg	0.000	0.085	229.0	-0.002	0.999	1.000
7.MeC31	pre_dg - queen_egg	0.000	0.059	229.0	0.003	0.998	1.000
7.MeC31	pre_egg - queen_chc	-8.588	0.113	229.0	-76.155	0.000	0.000
7.MeC31	pre_egg - queen_dg	0.000	0.085	229.0	-0.003	0.998	1.000
7.MeC31	pre_egg - queen_egg	0.000	0.059	229.0	0.002	0.999	1.000
7.MeC31	queen_chc - queen_dg	8.588	0.128	229.0	67.160	0.000	0.000
7.MeC31	queen_chc - queen_egg	8.588	0.112	229.0	76.767	0.000	0.000
7.MeC31	queen_dg - queen_egg	0.000	0.084	229.0	0.004	0.997	1.000
7..diMeC33	ace_chc - ace_dg	6.690	0.225	229.0	29.728	0.000	0.000
7..diMeC33	ace_chc - ace_egg	6.690	0.239	229.0	28.028	0.000	0.000
7..diMeC33	ace_chc - met_chc	-0.258	0.236	229.0	-1.096	0.274	1.000
7..diMeC33	ace_chc - met_dg	6.690	0.260	229.0	25.744	0.000	0.000
7..diMeC33	ace_chc - met_egg	6.690	0.230	229.0	29.102	0.000	0.000
7..diMeC33	ace_chc - pre_chc	0.531	0.225	229.0	2.362	0.019	1.000
7..diMeC33	ace_chc - pre_dg	6.690	0.227	229.0	29.423	0.000	0.000
7..diMeC33	ace_chc - pre_egg	6.690	0.227	229.0	29.423	0.000	0.000
7..diMeC33	ace_chc - queen_chc	0.045	0.428	229.0	0.106	0.916	1.000
7..diMeC33	ace_chc - queen_dg	6.690	0.323	229.0	20.699	0.000	0.000
7..diMeC33	ace_chc - queen_egg	6.690	0.221	229.0	30.294	0.000	0.000
7..diMeC33	ace_dg - ace_egg	0.000	0.239	229.0	0.000	1.000	1.000
7..diMeC33	ace_dg - met_chc	-6.948	0.236	229.0	-29.502	0.000	0.000
7..diMeC33	ace_dg - met_dg	0.000	0.260	229.0	-0.001	0.999	1.000
7..diMeC33	ace_dg - met_egg	0.000	0.230	229.0	0.000	1.000	1.000
7..diMeC33	ace_dg - pre_chc	-6.158	0.225	229.0	-27.366	0.000	0.000
7..diMeC33	ace_dg - pre_dg	0.000	0.227	229.0	0.000	1.000	1.000
7..diMeC33	ace_dg - pre_egg	0.000	0.227	229.0	0.000	1.000	1.000
7..diMeC33	ace_dg - queen_chc	-6.644	0.428	229.0	-15.508	0.000	0.000
7..diMeC33	ace_dg - queen_dg	0.000	0.323	229.0	-0.001	0.999	1.000
7..diMeC33	ace_dg - queen_egg	0.000	0.221	229.0	0.000	1.000	1.000
7..diMeC33	ace_egg - met_chc	-6.948	0.249	229.0	-27.950	0.000	0.000
7..diMeC33	ace_egg - met_dg	0.000	0.272	229.0	-0.001	0.999	1.000
7..diMeC33	ace_egg - met_egg	0.000	0.243	229.0	0.000	1.000	1.000
7..diMeC33	ace_egg - pre_chc	-6.158	0.239	229.0	-25.801	0.000	0.000
7..diMeC33	ace_egg - pre_dg	0.000	0.241	229.0	-0.001	0.999	1.000
7..diMeC33	ace_egg - pre_egg	0.000	0.241	229.0	0.000	1.000	1.000
7..diMeC33	ace_egg - queen_chc	-6.645	0.436	229.0	-15.247	0.000	0.000
7..diMeC33	ace_egg - queen_dg	0.000	0.333	229.0	-0.001	0.999	1.000
7..diMeC33	ace_egg - queen_egg	0.000	0.235	229.0	0.000	1.000	1.000
7..diMeC33	met_chc - met_dg	6.948	0.269	229.0	25.830	0.000	0.000

7..diMeC33	met_chc - met_egg	6.948	0.240	229.0	28.933	0.000	0.000
7..diMeC33	met_chc - pre_chc	0.789	0.236	229.0	3.352	0.001	1.000
7..diMeC33	met_chc - pre_dg	6.948	0.238	229.0	29.225	0.000	0.000
7..diMeC33	met_chc - pre_egg	6.948	0.238	229.0	29.225	0.000	0.000
7..diMeC33	met_chc - queen_chc	0.303	0.434	229.0	0.699	0.485	1.000
7..diMeC33	met_chc - queen_dg	6.948	0.331	229.0	21.018	0.000	0.000
7..diMeC33	met_chc - queen_egg	6.948	0.231	229.0	30.014	0.000	0.000
7..diMeC33	met_dg - met_egg	0.000	0.264	229.0	0.001	0.999	1.000
7..diMeC33	met_dg - pre_chc	-6.158	0.260	229.0	-23.699	0.000	0.000
7..diMeC33	met_dg - pre_dg	0.000	0.262	229.0	0.001	1.000	1.000
7..diMeC33	met_dg - pre_egg	0.000	0.262	229.0	0.001	0.999	1.000
7..diMeC33	met_dg - queen_chc	-6.644	0.448	229.0	-14.840	0.000	0.000
7..diMeC33	met_dg - queen_dg	0.000	0.348	229.0	0.000	1.000	1.000
7..diMeC33	met_dg - queen_egg	0.000	0.256	229.0	0.001	0.999	1.000
7..diMeC33	met_egg - pre_chc	-6.158	0.230	229.0	-26.790	0.000	0.000
7..diMeC33	met_egg - pre_dg	0.000	0.232	229.0	0.000	1.000	1.000
7..diMeC33	met_egg - pre_egg	0.000	0.232	229.0	0.000	1.000	1.000
7..diMeC33	met_egg - queen_chc	-6.644	0.431	229.0	-15.416	0.000	0.000
7..diMeC33	met_egg - queen_dg	0.000	0.327	229.0	-0.001	0.999	1.000
7..diMeC33	met_egg - queen_egg	0.000	0.226	229.0	0.000	1.000	1.000
7..diMeC33	pre_chc - pre_dg	6.158	0.227	229.0	27.085	0.000	0.000
7..diMeC33	pre_chc - pre_egg	6.158	0.227	229.0	27.085	0.000	0.000
7..diMeC33	pre_chc - queen_chc	-0.486	0.428	229.0	-1.134	0.258	1.000
7..diMeC33	pre_chc - queen_dg	6.158	0.323	229.0	19.055	0.000	0.000
7..diMeC33	pre_chc - queen_egg	6.158	0.221	229.0	27.888	0.000	0.000
7..diMeC33	pre_dg - pre_egg	0.000	0.230	229.0	0.000	1.000	1.000
7..diMeC33	pre_dg - queen_chc	-6.644	0.430	229.0	-15.463	0.000	0.000
7..diMeC33	pre_dg - queen_dg	0.000	0.325	229.0	0.000	1.000	1.000
7..diMeC33	pre_dg - queen_egg	0.000	0.223	229.0	0.001	0.999	1.000
7..diMeC33	pre_egg - queen_chc	-6.644	0.430	229.0	-15.463	0.000	0.000
7..diMeC33	pre_egg - queen_dg	0.000	0.325	229.0	-0.001	0.999	1.000
7..diMeC33	pre_egg - queen_egg	0.000	0.223	229.0	0.000	1.000	1.000
7..diMeC33	queen_chc - queen_dg	6.644	0.487	229.0	13.637	0.000	0.000
7..diMeC33	queen_chc - queen_egg	6.644	0.426	229.0	15.588	0.000	0.000
7..diMeC33	queen_dg - queen_egg	0.000	0.320	229.0	0.001	0.999	1.000
9.13...11.15.diMeC27	ace_chc - ace_dg	14.032	0.112	229.0	125.732	0.000	0.000
9.13...11.15.diMeC27	ace_chc - ace_egg	2.271	0.118	229.0	19.185	0.000	0.000
9.13...11.15.diMeC27	ace_chc - met_chc	0.088	0.117	229.0	0.754	0.452	1.000
9.13...11.15.diMeC27	ace_chc - met_dg	14.031	0.129	229.0	108.886	0.000	0.000
9.13...11.15.diMeC27	ace_chc - met_egg	1.938	0.114	229.0	17.001	0.000	0.000
9.13...11.15.diMeC27	ace_chc - pre_chc	0.049	0.112	229.0	0.442	0.659	1.000
9.13...11.15.diMeC27	ace_chc - pre_dg	14.032	0.113	229.0	124.442	0.000	0.000
9.13...11.15.diMeC27	ace_chc - pre_egg	2.115	0.113	229.0	18.753	0.000	0.000
9.13...11.15.diMeC27	ace_chc - queen_chc	-0.027	0.212	229.0	-0.125	0.901	1.000
9.13...11.15.diMeC27	ace_chc - queen_dg	14.031	0.160	229.0	87.547	0.000	0.000
9.13...11.15.diMeC27	ace_chc - queen_egg	2.340	0.110	229.0	21.370	0.000	0.000
9.13...11.15.diMeC27	ace_dg - ace_egg	-11.761	0.118	229.0	-99.357	0.000	0.000
9.13...11.15.diMeC27	ace_dg - met_chc	-13.944	0.117	229.0	-119.387	0.000	0.000
9.13...11.15.diMeC27	ace_dg - met_dg	0.000	0.129	229.0	-0.002	0.999	1.000
9.13...11.15.diMeC27	ace_dg - met_egg	-12.094	0.114	229.0	-106.085	0.000	0.000
9.13...11.15.diMeC27	ace_dg - pre_chc	-13.982	0.112	229.0	-125.290	0.000	0.000
9.13...11.15.diMeC27	ace_dg - pre_dg	0.000	0.113	229.0	-0.001	0.999	1.000
9.13...11.15.diMeC27	ace_dg - pre_egg	-11.917	0.113	229.0	-105.690	0.000	0.000
9.13...11.15.diMeC27	ace_dg - queen_chc	-14.058	0.212	229.0	-66.163	0.000	0.000
9.13...11.15.diMeC27	ace_dg - queen_dg	0.000	0.160	229.0	-0.001	0.999	1.000
9.13...11.15.diMeC27	ace_dg - queen_egg	-11.691	0.110	229.0	-106.757	0.000	0.000
9.13...11.15.diMeC27	ace_egg - met_chc	-2.183	0.123	229.0	-17.707	0.000	0.000
9.13...11.15.diMeC27	ace_egg - met_dg	11.761	0.135	229.0	87.264	0.000	0.000
9.13...11.15.diMeC27	ace_egg - met_egg	-0.333	0.121	229.0	-2.759	0.006	1.000
9.13...11.15.diMeC27	ace_egg - pre_chc	-2.222	0.118	229.0	-18.768	0.000	0.000
9.13...11.15.diMeC27	ace_egg - pre_dg	11.761	0.119	229.0	98.449	0.000	0.000
9.13...11.15.diMeC27	ace_egg - pre_egg	-0.156	0.119	229.0	-1.309	0.192	1.000
9.13...11.15.diMeC27	ace_egg - queen_chc	-2.297	0.216	229.0	-10.631	0.000	0.000
9.13...11.15.diMeC27	ace_egg - queen_dg	11.761	0.165	229.0	71.251	0.000	0.000
9.13...11.15.diMeC27	ace_egg - queen_egg	0.069	0.116	229.0	0.596	0.551	1.000
9.13...11.15.diMeC27	met_chc - met_dg	13.943	0.133	229.0	104.533	0.000	0.000
9.13...11.15.diMeC27	met_chc - met_egg	1.850	0.119	229.0	15.535	0.000	0.000
9.13...11.15.diMeC27	met_chc - pre_chc	-0.039	0.117	229.0	-0.331	0.741	1.000

9.13...11.15.diMeC27	met_chc - pre_dg	13.944	0.118	229.0	118.267	0.000	0.000
9.13...11.15.diMeC27	met_chc - pre_egg	2.026	0.118	229.0	17.188	0.000	0.000
9.13...11.15.diMeC27	met_chc - queen_chc	-0.115	0.215	229.0	-0.532	0.595	1.000
9.13...11.15.diMeC27	met_chc - queen_dg	13.943	0.164	229.0	85.056	0.000	0.000
9.13...11.15.diMeC27	met_chc - queen_egg	2.252	0.115	229.0	19.619	0.000	0.000
9.13...11.15.diMeC27	met_dg - met_egg	-12.093	0.131	229.0	-92.352	0.000	0.000
9.13...11.15.diMeC27	met_dg - pre_chc	-13.982	0.129	229.0	-108.502	0.000	0.000
9.13...11.15.diMeC27	met_dg - pre_dg	0.000	0.130	229.0	0.001	0.999	1.000
9.13...11.15.diMeC27	met_dg - pre_egg	-11.917	0.130	229.0	-91.763	0.000	0.000
9.13...11.15.diMeC27	met_dg - queen_chc	-14.058	0.222	229.0	-63.315	0.000	0.000
9.13...11.15.diMeC27	met_dg - queen_dg	0.000	0.173	229.0	0.000	1.000	1.000
9.13...11.15.diMeC27	met_dg - queen_egg	-11.691	0.127	229.0	-92.011	0.000	0.000
9.13...11.15.diMeC27	met_egg - pre_chc	-1.889	0.114	229.0	-16.567	0.000	0.000
9.13...11.15.diMeC27	met_egg - pre_dg	12.094	0.115	229.0	105.040	0.000	0.000
9.13...11.15.diMeC27	met_egg - pre_egg	0.176	0.115	229.0	1.532	0.127	1.000
9.13...11.15.diMeC27	met_egg - queen_chc	-1.965	0.214	229.0	-9.191	0.000	0.000
9.13...11.15.diMeC27	met_egg - queen_dg	12.093	0.162	229.0	74.672	0.000	0.000
9.13...11.15.diMeC27	met_egg - queen_egg	0.402	0.112	229.0	3.593	0.000	1.000
9.13...11.15.diMeC27	pre_chc - pre_dg	13.982	0.113	229.0	124.004	0.000	0.000
9.13...11.15.diMeC27	pre_chc - pre_egg	2.065	0.113	229.0	18.315	0.000	0.000
9.13...11.15.diMeC27	pre_chc - queen_chc	-0.076	0.212	229.0	-0.357	0.721	1.000
9.13...11.15.diMeC27	pre_chc - queen_dg	13.982	0.160	229.0	87.239	0.000	0.000
9.13...11.15.diMeC27	pre_chc - queen_egg	2.291	0.110	229.0	20.920	0.000	0.000
9.13...11.15.diMeC27	pre_dg - pre_egg	-11.917	0.114	229.0	-104.627	0.000	0.000
9.13...11.15.diMeC27	pre_dg - queen_chc	-14.058	0.213	229.0	-65.973	0.000	0.000
9.13...11.15.diMeC27	pre_dg - queen_dg	0.000	0.161	229.0	-0.001	0.999	1.000
9.13...11.15.diMeC27	pre_dg - queen_egg	-11.691	0.111	229.0	-105.620	0.000	0.000
9.13...11.15.diMeC27	pre_egg - queen_chc	-2.141	0.213	229.0	-10.048	0.000	0.000
9.13...11.15.diMeC27	pre_egg - queen_dg	11.917	0.161	229.0	73.982	0.000	0.000
9.13...11.15.diMeC27	pre_egg - queen_egg	0.226	0.111	229.0	2.040	0.042	1.000
9.13...11.15.diMeC27	queen_chc - queen_dg	14.058	0.242	229.0	58.182	0.000	0.000
9.13...11.15.diMeC27	queen_chc - queen_egg	2.367	0.211	229.0	11.197	0.000	0.000
9.13...11.15.diMeC27	queen_dg - queen_egg	-11.691	0.159	229.0	-73.609	0.000	0.000
9.13.diMeC29	ace_chc - ace_dg	11.508	0.037	229.0	313.576	0.000	0.000
9.13.diMeC29	ace_chc - ace_egg	11.508	0.039	229.0	295.644	0.000	0.000
9.13.diMeC29	ace_chc - met_chc	0.032	0.038	229.0	0.833	0.406	1.000
9.13.diMeC29	ace_chc - met_dg	11.508	0.042	229.0	271.559	0.000	0.000
9.13.diMeC29	ace_chc - met_egg	11.508	0.037	229.0	306.974	0.000	0.000
9.13.diMeC29	ace_chc - pre_chc	0.102	0.037	229.0	2.770	0.006	1.000
9.13.diMeC29	ace_chc - pre_dg	11.508	0.037	229.0	310.357	0.000	0.000
9.13.diMeC29	ace_chc - pre_egg	11.508	0.037	229.0	310.359	0.000	0.000
9.13.diMeC29	ace_chc - queen_chc	-0.076	0.070	229.0	-1.082	0.280	1.000
9.13.diMeC29	ace_chc - queen_dg	11.508	0.053	229.0	218.342	0.000	0.000
9.13.diMeC29	ace_chc - queen_egg	11.508	0.036	229.0	319.552	0.000	0.000
9.13.diMeC29	ace_dg - ace_egg	0.000	0.039	229.0	0.003	0.998	1.000
9.13.diMeC29	ace_dg - met_chc	-11.476	0.038	229.0	-298.799	0.000	0.000
9.13.diMeC29	ace_dg - met_dg	0.000	0.042	229.0	-0.006	0.996	1.000
9.13.diMeC29	ace_dg - met_egg	0.000	0.037	229.0	0.001	0.999	1.000
9.13.diMeC29	ace_dg - pre_chc	-11.407	0.037	229.0	-310.805	0.000	0.000
9.13.diMeC29	ace_dg - pre_dg	0.000	0.037	229.0	-0.002	0.998	1.000
9.13.diMeC29	ace_dg - pre_egg	0.000	0.037	229.0	0.000	1.000	1.000
9.13.diMeC29	ace_dg - queen_chc	-11.584	0.070	229.0	-165.780	0.000	0.000
9.13.diMeC29	ace_dg - queen_dg	0.000	0.053	229.0	-0.004	0.997	1.000
9.13.diMeC29	ace_dg - queen_egg	0.000	0.036	229.0	0.003	0.998	1.000
9.13.diMeC29	ace_egg - met_chc	-11.476	0.041	229.0	-283.084	0.000	0.000
9.13.diMeC29	ace_egg - met_dg	0.000	0.044	229.0	-0.008	0.994	1.000
9.13.diMeC29	ace_egg - met_egg	0.000	0.040	229.0	-0.002	0.999	1.000
9.13.diMeC29	ace_egg - pre_chc	-11.407	0.039	229.0	-293.033	0.000	0.000
9.13.diMeC29	ace_egg - pre_dg	0.000	0.039	229.0	-0.004	0.996	1.000
9.13.diMeC29	ace_egg - pre_egg	0.000	0.039	229.0	-0.003	0.998	1.000
9.13.diMeC29	ace_egg - queen_chc	-11.584	0.071	229.0	-162.995	0.000	0.000
9.13.diMeC29	ace_egg - queen_dg	0.000	0.054	229.0	-0.006	0.995	1.000
9.13.diMeC29	ace_egg - queen_egg	0.000	0.038	229.0	0.000	1.000	1.000
9.13.diMeC29	met_chc - met_dg	11.476	0.044	229.0	261.621	0.000	0.000
9.13.diMeC29	met_chc - met_egg	11.476	0.039	229.0	293.040	0.000	0.000
9.13.diMeC29	met_chc - pre_chc	0.070	0.038	229.0	1.814	0.071	1.000
9.13.diMeC29	met_chc - pre_dg	11.476	0.039	229.0	295.995	0.000	0.000
9.13.diMeC29	met_chc - pre_egg	11.476	0.039	229.0	295.997	0.000	0.000

9.13.diMeC29	met_chc - queen_chc	-0.108	0.071	229.0	-1.520	0.130	1.000
9.13.diMeC29	met_chc - queen_dg	11.476	0.054	229.0	212.875	0.000	0.000
9.13.diMeC29	met_chc - queen_egg	11.476	0.038	229.0	303.985	0.000	0.000
9.13.diMeC29	met_dg - met_egg	0.000	0.043	229.0	0.006	0.995	1.000
9.13.diMeC29	met_dg - pre_chc	-11.406	0.042	229.0	-269.160	0.000	0.000
9.13.diMeC29	met_dg - pre_dg	0.000	0.043	229.0	0.004	0.997	1.000
9.13.diMeC29	met_dg - pre_egg	0.000	0.043	229.0	0.005	0.996	1.000
9.13.diMeC29	met_dg - queen_chc	-11.584	0.073	229.0	-158.643	0.000	0.000
9.13.diMeC29	met_dg - queen_dg	0.000	0.057	229.0	0.000	1.000	1.000
9.13.diMeC29	met_dg - queen_egg	0.000	0.042	229.0	0.008	0.994	1.000
9.13.diMeC29	met_egg - pre_chc	-11.407	0.037	229.0	-304.262	0.000	0.000
9.13.diMeC29	met_egg - pre_dg	0.000	0.038	229.0	-0.003	0.998	1.000
9.13.diMeC29	met_egg - pre_egg	0.000	0.038	229.0	-0.001	0.999	1.000
9.13.diMeC29	met_egg - queen_chc	-11.584	0.070	229.0	-164.796	0.000	0.000
9.13.diMeC29	met_egg - queen_dg	0.000	0.053	229.0	-0.005	0.996	1.000
9.13.diMeC29	met_egg - queen_egg	0.000	0.037	229.0	0.001	0.999	1.000
9.13.diMeC29	pre_chc - pre_dg	11.406	0.037	229.0	307.616	0.000	0.000
9.13.diMeC29	pre_chc - pre_egg	11.407	0.037	229.0	307.617	0.000	0.000
9.13.diMeC29	pre_chc - queen_chc	-0.177	0.070	229.0	-2.537	0.012	1.000
9.13.diMeC29	pre_chc - queen_dg	11.406	0.053	229.0	216.413	0.000	0.000
9.13.diMeC29	pre_chc - queen_egg	11.407	0.036	229.0	316.729	0.000	0.000
9.13.diMeC29	pre_dg - pre_egg	0.000	0.037	229.0	0.002	0.999	1.000
9.13.diMeC29	pre_dg - queen_chc	-11.584	0.070	229.0	-165.305	0.000	0.000
9.13.diMeC29	pre_dg - queen_dg	0.000	0.053	229.0	-0.003	0.998	1.000
9.13.diMeC29	pre_dg - queen_egg	0.000	0.036	229.0	0.005	0.996	1.000
9.13.diMeC29	pre_egg - queen_chc	-11.584	0.070	229.0	-165.306	0.000	0.000
9.13.diMeC29	pre_egg - queen_dg	0.000	0.053	229.0	-0.004	0.997	1.000
9.13.diMeC29	pre_egg - queen_egg	0.000	0.036	229.0	0.003	0.998	1.000
9.13.diMeC29	queen_chc - queen_dg	11.584	0.079	229.0	145.783	0.000	0.000
9.13.diMeC29	queen_chc - queen_egg	11.584	0.070	229.0	166.635	0.000	0.000
9.13.diMeC29	queen_dg - queen_egg	0.000	0.052	229.0	0.006	0.995	1.000

Table S6: Permutation analysis (PERMANOVA) representing the CHC samples (including non-treated workers).

	<i>F</i> value	R ²	<i>p</i> value	Significance level
All groups (CHC)	23.095	0.490	< 0.001	***
pairs	<i>F</i> value	R ²	<i>p</i> value	Significance level
queen vs workers no treatment	62.342	0.690	0.020	*
queen vs workers acetone	74.692	0.734	0.010	**
queen vs workers methoprene	33.897	0.596	0.010	**
queen vs workers precocene	111.027	0.804	0.020	*
workers no treatment vs workers acetone	5.864	0.107	0.040	*
workers no treatment vs workers methoprene	14.918	0.249	0.010	**
workers no treatment vs workers precocene	6.974	0.125	0.010	**
workers acetone vs workers methoprene	8.663	0.165	0.010	**
workers acetone vs workers precocene	0.921	0.019	1.000	n.s.
workers methoprene vs workers precocene	8.218	0.157	0.010	**

Table S7: Relative abundances for each chemical compound identified in samples of CHCs, eggs and *Dufour's* gland of *Vespula germanica*. Mean and standard deviation (%).

Compounds	CHCs								Eggs								Dufour's gland							
	queen		methoprene		precocene		acetone		queen		methoprene		precocene		acetone		queen		methoprene		precocene		acetone	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
n-C21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.87	0.76	0.70	0.77	1.38	0.74	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
n-C22	0.10	0.00	0.24	0.32	0.05	0.11	0.05	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
n-C23	0.21	0.01	0.76	1.00	0.21	0.24	0.19	0.10	0.75	1.04	1.30	0.95	1.16	1.15	0.88	0.91	1.37	1.99	1.05	1.00	0.86	1.19	1.29	1.62
11-;9-MeC23	0.00	0.00	0.08	0.08	0.01	0.03	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-MeC23	0.00	0.00	0.01	0.02	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-MeC23	0.13	0.06	0.14	0.07	0.08	0.04	0.10	0.05	0.08	0.28	0.12	0.36	0.20	0.50	0.20	0.49	2.12	2.51	11.12	9.33	26.46	18.29	26.45	15.44
n-C24	0.36	0.06	0.26	0.14	0.20	0.14	0.18	0.08	0.42	0.64	0.40	0.71	0.60	1.07	0.78	1.51	0.24	0.30	0.12	0.20	0.24	0.37	0.37	0.41
12-;11-;10-MeC24	0.10	0.00	0.14	0.10	0.13	0.09	0.14	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-;10-MeC24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.48	0.26	0.48	0.38	0.78	0.37	0.55	2.37	1.71	0.63	0.48	0.70	0.78	1.23	1.18
4-MeC24	0.10	0.00	0.15	0.07	0.11	0.03	0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C25:1	0.10	0.00	0.21	0.16	0.09	0.05	0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C25:1-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.38	0.29	0.35	0.36	0.65	0.42	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
n-C25	13.57	2.26	8.16	1.38	7.72	1.23	7.04	1.76	8.48	2.49	6.13	1.93	5.68	1.89	6.64	3.51	2.28	2.15	1.44	0.90	1.96	2.05	2.57	1.71
13-;11-;9-;7-MeC25	1.63	0.09	7.05	2.11	7.51	1.36	7.38	1.94	5.44	2.20	4.51	1.62	4.49	1.30	4.38	1.27	8.25	2.80	9.33	5.02	6.37	5.37	6.44	2.51
5-MeC25	0.26	0.06	0.55	0.17	0.60	0.08	0.59	0.11	0.36	0.33	0.38	0.29	0.44	0.46	0.32	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-MeC25	7.38	1.53	7.03	2.47	6.24	1.46	6.45	1.71	8.38	4.08	5.05	2.51	4.84	1.50	4.85	2.20	3.32	1.01	8.48	2.59	8.28	4.59	6.74	3.19
n-C26	5.03	0.45	2.36	0.32	2.31	0.32	2.24	0.38	2.49	0.50	2.20	0.73	2.69	1.53	2.63	1.43	11.01	4.96	9.93	2.81	7.37	4.47	6.53	3.07
12-;10-MeC26	0.78	0.10	2.78	0.54	3.26	0.23	3.23	0.24	2.13	0.70	1.86	0.63	2.19	1.23	2.01	0.97	4.90	2.69	3.55	0.94	2.31	1.13	2.80	1.31
4-MeC26	0.65	0.15	0.96	0.23	0.93	0.21	1.02	0.21	1.15	0.28	1.25	0.52	1.30	0.68	2.74	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C27:1and 3-MeC26	0.83	0.31	1.69	0.78	1.40	0.27	1.12	0.25	1.11	0.34	1.14	0.45	1.09	0.60	1.02	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C27:1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.69	1.07	0.14	0.36	0.17	0.38	0.41	0.63
n-C27	31.58	3.44	15.46	3.59	13.75	1.60	13.53	1.46	15.53	5.58	16.27	6.27	17.11	6.59	18.56	7.39	1.20	0.63	0.57	0.52	0.80	1.60	0.88	0.61
13-;11-;9-MeC27	9.45	1.05	22.85	1.86	26.91	2.23	27.03	3.17	18.99	6.29	16.23	3.61	15.99	5.53	15.49	5.01	2.66	1.16	1.35	0.48	1.89	2.62	1.48	0.98
7-;5-MeC27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.84	3.07	7.02	4.77	3.86	3.16	4.02	1.39
9,13-; 11,15-diMeC27	17.13	1.93	15.83	1.59	16.21	0.98	16.78	1.19	3.57	1.32	4.72	2.28	4.24	1.54	3.74	1.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3-MeC27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.14	3.72	9.78	2.60	8.88	2.55	8.72	3.32	10.88	4.39	14.29	6.26	14.96	8.55	12.67	5.28
n-C28 + 3,9-; 3,11-diMeC27	2.40	0.26	1.80	0.32	1.72	0.20	1.78	0.30	2.10	0.72	2.72	1.13	3.33	2.17	3.22	2.08	21.65	6.52	16.23	3.22	13.67	5.83	13.11	3.43
12-;10-MeC28	0.39	0.05	1.25	0.32	1.44	0.25	1.45	0.33	1.45	0.98	1.57	0.77	1.63	1.24	1.38	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12,16-diMeC28	0.26	0.06	0.37	0.13	0.35	0.11	0.39	0.12	0.55	0.64	1.07	0.60	1.05	0.53	1.18	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C29:1	0.34	0.13	0.58	0.30	0.48	0.10	0.42	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C29:1-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.42	0.95	0.70	0.92	0.87	1.25	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C29:1-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	1.71	1.42	0.89	1.15	0.98	1.83	1.46
n-C29	2.32	0.20	1.61	0.71	1.04	0.24	1.14	0.33	3.63	3.86	10.50	5.39	10.25	5.32	8.54	5.99	0.30	0.43	0.32	0.38	0.20	0.26	0.37	0.44
13-;11-;9-MeC29	1.19	0.24	3.23	0.80	3.70	0.78	3.77	0.99	3.02	2.27	4.59	1.87	4.28	0.97	3.75	2.22	1.70	1.01	1.04	0.96	0.65	0.63	1.07	0.86
7-MeC29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.29	0.64	0.82	0.41	0.53	0.64	0.69
9,13-diMeC29	3.07	0.11	2.90	0.60	2.74	0.38	2.95	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-MeC29	0.08	0.05	0.07	0.05	0.08	0.04	0.08	0.04	3.99	3.76	4.64	3.08	4.53	1.49	4.51	3.06	0.79	0.69	1.33	2.10	0.51	0.83	0.74	0.83
n-C30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	4.03	0.96	1.61	1.10	1.36	1.13	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
n-C31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	1.70	0.39	0.65	0.52	0.93	0.57	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-;13-MeC31	0.10	0.00	0.80	0.92	0.26	0.20	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.84	0.07	0.27	0.12	0.33	0.42	0.63
7-MeC31	0.39	0.05	0.51	0.24	0.35	0.06	0.37	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-MeC31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.84	12.92	9.74	8.08	6.86	8.42	7.49	5.26
13,17-diMeC33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.75	0.20	0.42	0.21	0.36	0.46	0.62
7,x-diMeC33	0.10	0.00	0.17	0.09	0.10	0.04	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CHAPTER 6: Supplementary information

Table S1: Raw descriptive data that include all the collected information for each of the nests during the experiment I and II. Day set up = day when the experiment was set up (in the *Mischocyttarus cerberus* focal nest), n = number, status = codes used during the construction of the survival curves (1 = present / 2 = removed), policed = represents whether the eggs were present or not in the nest when the experiment was ended (0 = present / 1 = not present).

day set up	nest	group	experiment number	n females	n eggs	n larvae	n pupae	n cells
23/02/2021	Mc14	Mischocyttarus_cerberus	experiment_1	3	6	16	4	29
23/02/2021	Mc39	Mischocyttarus_cerberus	experiment_1	3	9	13	2	39
23/02/2021	Mc22	Mischocyttarus_cerberus	experiment_1	3	7	9	6	39
23/02/2021	Mc23	Mischocyttarus_cerberus	experiment_1	9	35	31	12	106
01/03/2021	Mc40	Mischocyttarus_cerberus	experiment_1	5	16	20	7	61
01/03/2021	Mc43	Mischocyttarus_cerberus	experiment_1	4	9	12	16	65
01/03/2021	Mc44	Mischocyttarus_cerberus	experiment_1	4	20	25	11	56
01/03/2021	Mc19	Mischocyttarus_cerberus	experiment_1	4	5	9	13	50
02/03/2021	Mc31	Mischocyttarus_cerberus	experiment_1	3	3	13	8	74
04/03/2021	Mc13	Mischocyttarus_cerberus	experiment_1	2	13	20	16	72
04/03/2021	Mc47	Mischocyttarus_cerberus	experiment_1	4	23	20	9	70
09/03/2021	Mc18	Mischocyttarus_cerberus	experiment_1	3	6	6	2	28
09/03/2021	Mc24	Mischocyttarus_cerberus	experiment_1	4	11	13	8	62
09/03/2021	Mc48	Mischocyttarus_cerberus	experiment_1	4	21	14	3	47
11/03/2021	Mc57	Mischocyttarus_cerberus	experiment_1	3	8	16	4	42
11/03/2021	Mc59	Mischocyttarus_cerberus	experiment_1	3	7	12	8	40
11/03/2021	Mc55	Mischocyttarus_cerberus	experiment_1	3	6	6	2	32
15/03/2021	Mc56	Mischocyttarus_cerberus	experiment_1	4	12	15	24	63
15/03/2021	Mc54	Mischocyttarus_cerberus	experiment_1	5	3	11	5	35
16/03/2021	Mc20	Mischocyttarus_cerberus	experiment_1	7	8	7	8	50
18/03/2021	Mc60	Mischocyttarus_cerberus	experiment_1	5	6	7	20	60
18/03/2021	Mc61	Mischocyttarus_cerberus	experiment_1	3	6	8	11	38
18/03/2021	Mc63	Mischocyttarus_cerberus	experiment_1	3	4	9	7	30

22/03/2021	Mc49	Mischocyttarus_cerberus	experiment_1	3	5	6	7	39
24/03/2021	Mc64	Mischocyttarus_cerberus	experiment_1	4	6	15	5	33
24/03/2021	Mc11	Mischocyttarus_cerberus	experiment_1	2	12	12	7	52
24/03/2021	Mc62	Mischocyttarus_cerberus	experiment_1	4	6	15	13	51
24/03/2021	Mc51	Mischocyttarus_cerberus	experiment_1	4	4	6	7	28
25/03/2021	Mc70	Mischocyttarus_cerberus	experiment_1	4	8	7	8	31
30/03/2021	Mc71	Mischocyttarus_cerberus	experiment_1	3	7	8	13	42
31/03/2021	Mc53	Mischocyttarus_cerberus	experiment_1	4	11	6	7	32
01/04/2021	Mc26	Mischocyttarus_cerberus	experiment_1	4	10	16	8	57
01/04/2021	Mc72	Mischocyttarus_cerberus	experiment_1	4	3	7	6	38
07/04/2021	Mc73	Mischocyttarus_cerberus	experiment_1	5	6	7	8	39
23/02/2021	Mmon3	Mischocyttarus_montei	experiment_1	3	6	16	4	29
23/02/2021	Mmon3	Mischocyttarus_montei	experiment_1	3	9	13	2	39
23/02/2021	Mmon5	Mischocyttarus_montei	experiment_1	3	7	9	6	39
23/02/2021	Mmon5	Mischocyttarus_montei	experiment_1	9	35	31	12	106
01/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	5	16	20	7	61
01/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	4	9	12	16	65
01/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	4	20	25	11	56
01/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	4	5	9	13	50
02/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	3	3	13	8	74
04/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	2	13	20	16	72
04/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	4	23	20	9	70
09/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	3	6	6	2	28
09/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	4	11	13	8	62
09/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	4	21	14	3	47
11/03/2021	Mmon3	Mischocyttarus_montei	experiment_1	3	8	16	4	42
11/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	3	7	12	8	40
11/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	3	6	6	2	32
15/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	4	12	15	24	63
15/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	5	3	11	5	35
16/03/2021	Mmon3	Mischocyttarus_montei	experiment_1	7	8	7	8	50
18/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	5	6	7	20	60

18/03/2021	Mmon3	Mischocyttarus_montei	experiment_1	3	6	8	11	38
18/03/2021	Mmon1	Mischocyttarus_montei	experiment_1	3	4	9	7	30
22/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	3	5	6	7	39
24/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	4	6	15	5	33
24/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	2	12	12	7	52
24/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	4	6	15	13	51
24/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	4	4	6	7	28
25/03/2021	Mmon2	Mischocyttarus_montei	experiment_1	4	8	7	8	31
30/03/2021	Mmon3	Mischocyttarus_montei	experiment_1	3	7	8	13	42
31/03/2021	Mmon5	Mischocyttarus_montei	experiment_1	4	11	6	7	32
01/04/2021	Mmon3	Mischocyttarus_montei	experiment_1	4	10	16	8	57
01/04/2021	Mmon5	Mischocyttarus_montei	experiment_1	4	3	7	6	38
07/04/2021	Mmon6	Mischocyttarus_montei	experiment_1	5	6	7	8	39
14/04/2021	Mc59	Mischocyttarus_cerberus	experiment_2	4	6	9	10	50
14/04/2021	Mc64	Mischocyttarus_cerberus	experiment_2	3	24	15	13	52
16/04/2021	Mc66	Mischocyttarus_cerberus	experiment_2	6	6	7	5	32
19/04/2021	Mc24	Mischocyttarus_cerberus	experiment_2	5	11	20	8	72
19/04/2021	Mc18	Mischocyttarus_cerberus	experiment_2	3	11	6	0	33
19/04/2021	Mc19	Mischocyttarus_cerberus	experiment_2	4	2	12	13	60
19/04/2021	Mc20	Mischocyttarus_cerberus	experiment_2	4	12	10	3	59
20/04/2021	Mc49b	Mischocyttarus_cerberus	experiment_2	6	4	17	5	48
20/04/2021	Mc76	Mischocyttarus_cerberus	experiment_2	5	3	3	4	43
20/04/2021	Mc74	Mischocyttarus_cerberus	experiment_2	6	21	8	9	54
26/04/2021	Mc73	Mischocyttarus_cerberus	experiment_2	4	5	7	10	47
29/04/2021	Mc81	Mischocyttarus_cerberus	experiment_2	4	5	9	8	37
04/05/2021	Mc16	Mischocyttarus_cerberus	experiment_2	3	4	11	7	26
05/05/2021	Mc82	Mischocyttarus_cerberus	experiment_2	5	5	4	9	50
13/05/2021	Mc84	Mischocyttarus_cerberus	experiment_2	4	5	13	4	58
17/05/2021	Mc62	Mischocyttarus_cerberus	experiment_2	5	5	25	8	51
14/04/2021	Mc14	Mischocyttarus_experimental	experiment_2	4	6	9	10	50
14/04/2021	Mc14	Mischocyttarus_experimental	experiment_2	3	24	15	13	52
16/04/2021	Mc14	Mischocyttarus_experimental	experiment_2	6	6	7	5	32

19/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	5	11	20	8	72
19/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	3	11	6	0	33
19/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	4	2	12	13	60
19/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	4	12	10	3	59
20/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	6	4	17	5	48
20/04/2021	Mc14	Mischocyttarus_experimental	experiment_2	5	3	3	4	43
20/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	6	21	8	9	54
26/04/2021	Mc48	Mischocyttarus_experimental	experiment_2	4	5	7	10	47
29/04/2021	Mc47	Mischocyttarus_experimental	experiment_2	4	5	9	8	37
04/05/2021	Mc53	Mischocyttarus_experimental	experiment_2	3	4	11	7	26
05/05/2021	Mc22	Mischocyttarus_experimental	experiment_2	5	5	4	9	50
13/05/2021	Mc53	Mischocyttarus_experimental	experiment_2	4	5	13	4	58
17/05/2021	Mc14	Mischocyttarus_experimental	experiment_2	5	5	25	8	51

present after one hour	present after 24 hours	present after one week	days as eggs	time	species	status	policed
1	1	1	7	168	1	1	0
1	1	1	13	312	1	1	0
1	1	1	10	240	1	1	0
1	1	1	8	192	1	1	0
1	1	1	8	192	1	1	0
1	1	1	11	264	1	1	0
1	1	1	10	240	1	1	0
1	1	1	8	192	1	1	0
1	1	1	13	312	1	1	0
1	1	0	2	48	1	2	1
1	1	1	11	264	1	1	0
1	1	1	9	216	1	1	0
1	1	1	10	240	1	1	0
1	1	0	3	72	1	2	1
0	0	0	0	0	1	2	1
1	1	1	11	264	1	1	0

1	0	0	0	1	1	2	1
1	1	1	14	336	1	1	0
1	1	1	9	216	1	1	0
1	1	1	7	168	1	1	0
1	1	1	11	264	1	1	0
1	1	1	11	264	1	1	0
1	1	0	2	48	1	2	1
1	1	1	9	216	1	1	0
1	1	1	12	288	1	1	0
1	1	1	12	288	1	1	0
1	1	1	7	168	1	1	0
1	0	0	1	24	1	2	1
1	1	1	11	264	1	1	0
1	1	1	8	192	1	1	0
1	1	1	7	168	1	1	0
1	1	1	11	264	1	1	0
1	1	1	13	312	1	1	0
1	1	1	8	192	1	1	0
1	1	1	13	312	2	1	0
1	0	0	1	24	2	2	1
1	0	0	1	24	2	2	1
1	0	0	1	24	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
1	1	0	2	48	2	2	1
0	0	0	0	0	2	2	1
1	1	0	4	96	2	2	1
0	0	0	0	0	2	2	1
1	1	1	13	312	2	1	0
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1

1	1	1	11	264	2	1	0
0	0	0	0	0	2	2	1
1	0	0	0	24	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
1	0	0	1	24	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
1	1	1	12	288	2	1	0
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
1	1	1	7	168	2	1	0
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
0	0	0	0	0	2	2	1
1	0	0	1	24	2	2	1
0	0	0	0	0	2	2	1
1	1	1	14	336	3	1	0
1	1	1	12	288	3	1	0
1	1	1	10	240	3	1	0
1	1	1	16	384	3	1	0
1	1	1	15	360	3	1	0
1	1	0	2	24	3	2	1
1	1	1	10	240	3	1	0
1	1	1	9	216	3	1	0
1	1	1	13	312	3	1	0
1	1	0	3	72	3	2	1
1	1	1	7	168	3	1	0
1	1	1	13	312	3	1	0

1	1	1	15	360	3	1	0
1	1	1	13	312	3	1	0
1	1	1	11	264	3	1	0
0	1	1	11	264	3	1	0
0	0	0	0	1	4	2	1
1	1	1	12	288	4	1	0
1	0	0	1	24	4	2	1
0	0	0	0	1	4	2	1
1	1	1	16	384	4	1	0
0	0	0	0	1	4	2	1
0	0	0	0	1	4	2	1
0	0	0	0	1	4	2	1
0	0	0	0	1	4	2	1
1	1	1	20	480	4	1	0
0	0	0	0	1	4	2	1
1	1	0	2	48	4	2	1
1	1	1	14	336	4	1	0
1	0	0	1	24	4	2	1
1	1	0	4	96	4	2	1
0	0	0	0	1	4	2	1

Table S2: List of hydrocarbons identified in the egg samples. Group 1 = *Mischocyttarus cerberus*, Group 2 = *Mischocyttarus montei*, Group 3 = *Mischocyttarus cerberus* control and Group 4 = *Mischocyttarus cerberus* experimental. RT = retention time. RI = retention index. Sd = standard deviation.

Compounds	RT	RI	Ions	Experiment 1				Experiment 2			
				Group 1		Group 2		Group 3		Group 4	
				mean	sd	mean	sd	mean	sd	mean	sd
n-C16	12.12	1600	226	0.358	0.191	0.38	0.209	0.358	0.255	0.456	0.243
n-C17	13.18	1700	240	0.769	0.438	0.815	0.442	0.704	0.47	0.909	0.427
n-C18	14.23	1800	254	0.875	0.433	0.896	0.451	0.835	0.46	1.054	0.47
n-C19	15.29	1900	268	0.695	0.356	0.73	0.381	0.671	0.398	0.859	0.397
n-C20	16.37	2000	282	0.698	0.437	0.76	0.508	0.617	0.331	0.819	0.409
n-C21	17.46	2100	296	0.481	0.233	0.457	0.259	0.502	0.282	0.599	0.269
n-C22	18.55	2200	310	1.051	0.731	1.01	0.582	0.957	0.557	1.169	0.572
n-C23	19.64	2300	324	0.488	0.183	0.376	0.193	0.496	0.325	0.555	0.2
C25:1	21.57	2475	350	0.369	0.291	0.397	0.247	0.301	0.18	0.416	0.201
n-C25	21.8	2500	352	1.056	0.546	1.241	0.701	0.988	0.471	1.162	0.688
n-C26	22.88	2600	366	0.364	0.189	0.455	0.234	0.339	0.195	0.42	0.235
C27:1	23.71	2669	378	0.422	0.27	0.487	0.245	0.401	0.253	0.497	0.274
n-C27	24	2700	380	0.873	0.299	5.707	2.223	0.715	0.273	0.883	0.289
13-;11-;9-;7-MeC27	24.39	2730	169/253/197/225/141/281/113/309	0.519	0.298	0.754	0.227	0.472	0.274	0.563	0.283
5-MeC27	24.55	2744	85/337	0.419	0.254	0.531	0.27	0.375	0.212	0.508	0.282
3-MeC27	24.85	2770	57/365	0.71	0.438	6.362	1.147	0.599	0.345	0.936	0.426
n-C28	25.13	2800	394	1.06	0.372	1.636	0.597	0.911	0.26	1.029	0.343
14-;13-;12-;11-MeC28	25.51	2828	211 / 225 / 197 / 239 / 183 / 253 / 169 / 267 / 393	0.919	0.476	1.093	0.442	0.808	0.486	1.012	0.502
4-MeC28	25.81	2855	71 / 365 / 393	0.386	0.179	0.517	0.144	0.399	0.178	0.45	0.199
3-MeC28	25.98	2869	57/379/393	0.843	0.403	1.155	0.365	0.782	0.353	0.991	0.45
n-C29	26.28	2900	408	7.076	1.944	9.266	2.838	5.446	1.328	7.678	1.503
15-;13-;11-;9-;7-MeC29	26.66	2928	225/197/253/169/281/141/309/113/337/407	2.172	0.635	5.357	1.97	2.595	0.907	2.7	0.698

5-MeC29	26.87	2947	85/365/407	0.324	0.103	0.424	0.113	0.347	0.211	0.409	0.133
11,15-; 9,15-diMeC29	27.02	2960	169 / 239 / 225 / 295 / 141 / 323 / 421	0.726	0.114	1.743	0.895	0.762	0.233	0.841	0.192
3-MeC29	27.15	2971	57/393/407	13.252	2.535	7.072	1.066	12.981	2.748	13.56	2.53
x,y-diMeC29	27.43	2996	-	1.992	0.345	0.913	0.16	1.772	0.357	1.641	0.296
n-C30	27.51	3000	422	0.939	0.248	0.994	0.242	0.916	0.309	0.98	0.291
14-;12-MeC30	27.79	3027	211/253/183/281/421	1.353	0.197	1.743	0.351	1.586	0.297	1.611	0.226
4-MeC30	28.11	3056	71/393/421	3.345	0.601	0.898	0.195	3.575	1.376	2.092	1.203
3-MeC30	28.27	3070	57/407/421	1.15	0.365	0.84	0.315	1.137	0.449	1.465	0.463
4,16-diMeC30	28.45	3085	71/225/253/407/421	0.346	0.12	0.28	0.114	0.349	0.134	0.367	0.132
n-C31	28.57	3100	436	3.922	0.69	2.213	0.686	3.072	0.51	4.472	0.924
15-;13-;11-MeC31	28.94	3128	225/197/281/169/309/435	10.452	3.175	15.333	4.899	13.305	4.106	13.319	3.808
11,15-; 11,17-diMeC31	29.26	3157	169/267/225/323/239/253/435	12.772	3.425	4.493	2.212	13.36	4.802	8.671	4.833
3-MeC31	29.42	3171	57/421/435	5.054	0.738	1.679	0.265	4.604	0.918	4.194	1.029
16-;14-MeC32	30.05	3227	239/253/211/281/449	2.256	0.243	1.691	0.182	2.395	0.447	2.108	0.289
4,14-diMeC32	30.35	3254	71/225/281/435/449	2.362	0.513	1.472	0.406	2.151	0.353	2.045	0.443
n-C33	30.82	3300	464	1.025	0.279	0.781	0.285	0.837	0.323	1.055	0.351
17-;15-MeC33	31.16	3328	253/225/281/463	5.828	1.295	6.554	2.072	5.993	1.477	4.835	1.266
15,19-; 13,17-; 13,19-diMeC33	31.44	3353	225/295/197/267/253/323/295/477	5.245	0.763	3.911	0.92	5.438	1.133	4.342	0.769
17-;15-;13-;11-MeC35	33.32	3528	281/253/225/309/197/337/169/365/491	1.492	0.546	2.016	0.365	1.493	0.708	1.845	0.712
17,21-diMeC35	33.58	3552	253/323/225/295/505	1.133	0.33	1.477	0.256	1.13	0.391	1.279	0.452
x,y-diMeC37	35.7	3755	-	2.429	1.104	3.089	0.729	2.527	1.578	3.203	1.577

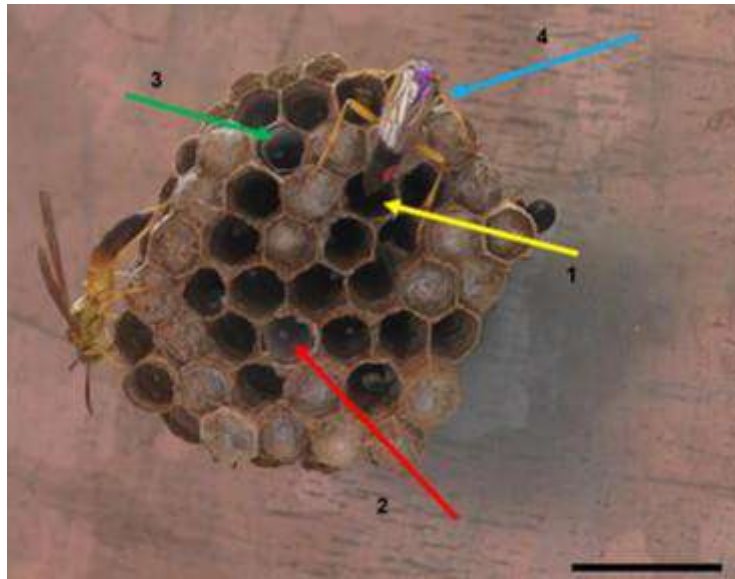


Figure S1: Experimental nest of *Mischocyttarus Cerberus* used during the execution of the present work. (1) Represents the spot where an artificial cell was placed at first to collect a natal egg. (2) Spot where an artificial cell containing a natal egg was placed when the experiment was settled. (3) Spot where an artificial cell containing an alien egg was placed (*Mischocyttarus monteii* egg). (4) *M. cerberus* female checking cells.

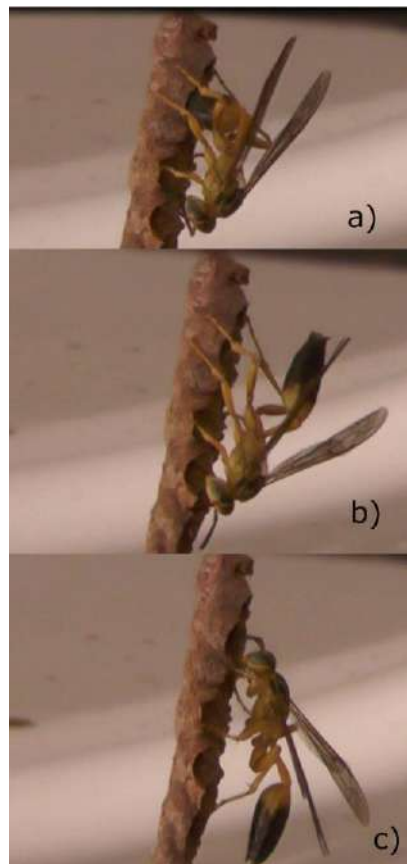


Figure S2: Oviposition process of a *Mischocyttarus cerberus* female in a pre-worker emergent nest. a) Abdomen insertion in a nest cell; b) Abdomen removal from the nest cell; c) Egg scanning after oviposition