**Supplementary material**

**Methods used to synthesise queen-characteristic esters and alkenes**

*Synthesis of myristyl palmitoleate and palmityl palmitoleate*

A solution of tetradecanol (2.14 g, 10 mmol), palmitoleic acid (2.54 g, 10 mmol), and dimethylaminopyridine (50 mg) in 50 ml dry methylene chloride was cooled in an ice bath, and 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride coupling reagent (2.4 g, 12.5 mmol) was added in one portion. The resulting mixture was warmed to room temperature and stirred overnight. The methylene chloride was then removed by rotary evaporation, and the residue was partitioned between water and hexane. The hexane layer was washed with dilute aqueous NaHCO3 and brine, then dried over anhydrous Na2SO4. The residue was purified by vacuum flash chromatography on silica gel, eluting with 5% EtOAc in hexane. The purified product was then dissolved in 40 ml warm EtOH and recrystallised overnight at -20°C. The product was filtered in a cold room, and on warming to room temperature, the solid white product melted to a viscous oil (3.33 g, 74%). 1H NMR (CDCl3, 400 MHz): 5.37 (m, 2H), 4.08 (t, 2H, J = 6.7 Hz), 2.31 (t, 2H, J = 7.5 Hz), 2.03 (m, 4H), 1.63 (m, 4H), 1.2ooo5-1.42 (m, 38H), 0.90 (t, 6H, J = 6.6 Hz) ppm. 13C NMR (CDCl3, 101 MHz): 174.00, 129.99, 129.76, 64.41, 34.31, 31.93, 31.79, 29.69, 29.59, 29.54, 29.37, 29.27, 29.18, 29.14, 29.00, 28.66, 27.23, 27.17, 25.95, 25.02, 22.70, 22.67, 14.11 ppm.

Hexadecyl palmitoleate was made in analogous fashion, substituting hexadecanol for tetradecanol. After initial purification by flash chromatography, the product was further purified by dissolution in 50 ml warm EtOH and recrystallisation at 4°C. After filtering cold, the resulting white crystals melted on warming to room temperature, to a colourless oil (3.45 g, 72%). 1H NMR (CDCl3, 400 MHz): 5.37 (m, 2H), 4.08 (t, 2H, J = 6.7 Hz), 2.31 (t, 2H, J = 7.5 Hz), 2.03 (m, 4H), 1.63 (m, 4H), 1.25-1.42 (m, 42H), 0.90 (t, 6H, J = 6.6 Hz) ppm. 13C NMR (CDCl3, 101 MHz): 174.00, 130.00, 129.77, 64.42, 34.41, 31.94, 31.79, 29.70, 29.59, 29.54, 29.37, 29.27, 29.18, 29.14, 29.00, 28.67, 27.23, 27.17, 25.954, 25.03, 22.70, 22.67, 14.11 ppm.

*Synthesis of mixture of (Z)-15-tritriacontene, (Z)-15-pentatriacontene, (Z)-15-heptatriacontene and (Z)-15-nonatriacontene*

Pyridinium dichromate (1.88 g, 7 mmol) and powdered 4 Ångstrom molecular sieve were ground together with a mortar and pestle, then added in one portion to a methylene chloride solution of a mixture of octadecanol (0.280 g, 1 mmol), eicosanol (0.290 g, 0.97 mmol), docosanol (0.295 g, 0.91 mmol), and tetracosanol (0.225 g, 0.63 mmol). The mixture was stirred two hours, then diluted with 150 ml hexane, and filtered through a plug of activated charcoal layered over celite filtering aid, rinsing with 50 ml 3:1 hexane in methylene chloride. The solution was concentrated, and the residue was purified by flash chromatography on silica gel, eluting with 5% ethyl acetate in hexane. The resulting white solid was taken up in ~ 10 ml dry tetrahydrofuran and used immediately in the next step.

A solution of pentadecyltriphenylphosphonium bromide (3.87 g, 7 mmol) in 50 ml dry THF under argon was cooled to -15°C in an ice-salt bath, and sodium hexamethyldilazide (2.5 M in THF) was added dropwise until the solution maintained a pale orange-yellow colour, followed by the dropwise addition of a further 3.5 ml (7 mmol) of the sodium hexamethyldilazide solution. The resulting solution was stirred for one hour at -15°C, then the tetrahydrofuran solution of octadecanal, eicosanal, docosanal, and tetracosanal in 10 ml THF was added by syringe pump over 30 min. The resulting mixture was allowed to warm slowly to room temperature overnight, then quenched with dilute aqueous NH4Cl and extracted with hexane. The organic layer was washed with water and brine, dried over Na2SO4 and concentrated. The residue was triturated with hexane, and the soluble portion was purified by flash chromatography on silica gel, eluting with hexane. The fractions containing alkenes were combined, yielding the alkenes as a viscous oil, in proportions equal to those found in the extracts.

**SUPPLEMENTAL FIGURES**



**Fig. S1.** Relative peak areas observed in workers (W), egg-laying queens (Q) and virgin queens (VQ) for the putative queen pheromones that we shortlisted from the GC-MS analysis of total cuticular extracts (*cf*. Fig. 1 & Table 1). Columns and whiskers show the expected marginal means and 95% confidence intervals of robust linear models fit on log10 transformed relative peak areas. Asterisks indicate significance following *FDR* correction for multiple testing across the tests performed for all compounds (Y axis is shown on a square root scale). All compounds were significantly (*p* < 0.001) more abundant on the cuticle of egg-laying queens compared to that of workers or virgin, non-egg-laying queens.

**SUPPLEMENTAL TABLES**

**Table S1.** Cuticular compounds present on workers, virgin queens and egg-laying queens. The compounds are clustered per reproductive class (see also heatmap Fig. 1). Identifications were done based on chemical profiles obtained from 20 workers, 18 virgin queens and eleven egg-laying queens. The Cohen’s *d* effect size of each comparison between classes is given for every compound. Additionally, the relative peak areas of each compound were compared between reproductive classes using a robust linear model with *p*-values *FDR* corrected for multiple testing. Significances are indicated by asterisks.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Compound name** | **Compound  cluster** | **Compound class** | **Retention index** | **Cohens *d* Q vs. W** | **Cohens *d* Q vs. VQ** | **Cohens *d* VQ vs. W** | **Rel. peak area Q** | ***SD*** | **Rel. peak area VQ** | ***SD*** | **Rel. peak area W** | ***SD*** | ***PFDR* Q vs. W** | ***PFDR* Q vs. VQ** | ***PFDR* VQ vs. W** | |
| 1-dodecene | worker characteristic | alkenes | 1191 | -1.53 | -0.02 | -1.51 | 0.04% | 0.04% | 0.04% | 0.01% | 0.07% | 0.02% | \*\*\* |  | \*\*\* | |
| decanal | worker characteristic | aldehydes | 1202 | -0.75 | 0.01 | -0.76 | 0.02% | 0.02% | 0.02% | 0.02% | 0.04% | 0.04% |  |  |  | |
| geraniol | worker characteristic | terpenoids | 1254 | -2.72 | -0.08 | -2.64 | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.01% | \*\*\* |  | \*\*\* | |
| 3-methyldodecane | worker characteristic | methylalkanes | 1273 | -4.51 | -0.66 | -3.85 | 0.04% | 0.03% | 0.10% | 0.03% | 0.47% | 0.14% | \*\*\* | \*\*\* | \*\*\* | |
| 5,7-dimethyldodecane | worker characteristic | dimethylalkanes | 1283 | -4.12 | -0.68 | -3.44 | 0.02% | 0.02% | 0.05% | 0.02% | 0.19% | 0.06% | \*\*\* | \*\*\* | \*\*\* | |
| tridecane | worker characteristic | alkanes | 1300 | -2.64 | -1.90 | -0.74 | 0.03% | 0.04% | 0.11% | 0.03% | 0.14% | 0.04% | \*\*\* | \*\*\* |  | |
| 3,5-dimethyldodecane | worker characteristic | dimethylalkanes | 1322 | -4.04 | -0.51 | -3.53 | 0.06% | 0.06% | 0.10% | 0.03% | 0.38% | 0.11% | \*\*\* | \*\*\* | \*\*\* | |
| 7-+5-methyltridecane | worker characteristic | methylalkanes | 1350 | -3.05 | -0.05 | -3.01 | 0.00% | 0.01% | 0.00% | 0.01% | 0.03% | 0.01% | \*\*\* |  | \*\*\* | |
| 3-methyltridecane | virgin queen characteristic | methylalkanes | 1360 | 0.33 | -0.36 | 0.69 | 0.00% | 0.00% | 0.01% | 0.01% | 0.00% | 0.00% | \*\*\* |  | \*\*\* | |
| 1-tetradecene | virgin queen characteristic | alkenes | 1391 | 1.35 | -3.33 | 4.68 | 0.05% | 0.05% | 0.16% | 0.04% | 0.00% | 0.00% | \*\*\* | \*\*\* | \*\*\* | |
| tetradecane | worker characteristic | alkanes | 1400 | -3.85 | 0.12 | -3.97 | 0.05% | 0.05% | 0.05% | 0.02% | 0.28% | 0.08% | \*\*\* |  | \*\*\* | |
| 5,7-dimethyltetradecane | worker characteristic | dimethylalkanes | 1492 | -4.83 | -0.25 | -4.59 | 0.02% | 0.01% | 0.05% | 0.02% | 0.56% | 0.17% | \*\*\* | \*\*\* | \*\*\* | |
| pentadecane | worker characteristic | alkanes | 1500 | -4.68 | -0.29 | -4.40 | 0.00% | 0.00% | 0.00% | 0.00% | 0.04% | 0.01% | \*\*\* | \*\*\* | \*\*\* | |
| 7-methylpentadecane | worker characteristic | methylalkanes | 1546 | -4.35 | -0.31 | -4.04 | 0.01% | 0.01% | 0.02% | 0.01% | 0.13% | 0.04% | \*\*\* |  | \*\*\* | |
| 3-methylpentadecane | worker characteristic | methylalkanes | 1567 | -4.83 | -0.21 | -4.62 | 0.00% | 0.00% | 0.01% | 0.01% | 0.11% | 0.04% | \*\*\* | \*\* | \*\*\* | |
| 5,x-dimethylpentadecane | worker characteristic | dimethylalkanes | 1575 | -4.62 | -0.16 | -4.45 | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.02% | \*\*\* |  | \*\*\* | |
| 5,y-dimethylpentadecane | worker characteristic | dimethylalkanes | 1583 | -3.30 | -0.83 | -2.47 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | \*\*\* | \*\*\* | \*\*\* | |
| 1-hexadecene | virgin queen characteristic | alkenes | 1592 | 1.38 | -3.53 | 4.90 | 0.04% | 0.03% | 0.13% | 0.03% | 0.01% | 0.00% | \*\*\* | \*\*\* | \*\*\* | |
| hexadecane | worker characteristic | alkanes | 1600 | -3.65 | -0.55 | -3.10 | 0.11% | 0.08% | 0.17% | 0.05% | 0.53% | 0.16% | \*\*\* |  | \*\*\* | |
| heptadecane | worker characteristic | alkanes | 1700 | -4.50 | -0.38 | -4.13 | 0.04% | 0.01% | 0.09% | 0.07% | 0.62% | 0.19% | \*\*\* |  | \*\*\* | |
| 3,x-dimethylhexadecane | worker characteristic | dimethylalkanes | 1709 | -4.29 | 0.16 | -4.45 | 0.01% | 0.01% | 0.01% | 0.01% | 0.10% | 0.03% | \*\*\* |  | \*\*\* | |
| 3,11-dimethylhexadecane | worker characteristic | dimethylalkanes | 1715 | -4.65 | -0.16 | -4.50 | 0.00% | 0.00% | 0.00% | 0.00% | 0.04% | 0.01% | \*\*\* |  | \*\*\* | |
| 7-methylheptadecane | worker characteristic | methylalkanes | 1744 | -4.62 | -0.21 | -4.41 | 0.05% | 0.03% | 0.08% | 0.04% | 0.67% | 0.20% | \*\*\* |  | \*\*\* | |
| 5,x-dimethylheptadecane | worker characteristic | dimethylalkanes | 1778 | -2.62 | -0.70 | -1.91 | 0.01% | 0.00% | 0.02% | 0.02% | 0.05% | 0.02% | \*\*\* |  | \*\*\* | |
| 5,y-dimethylheptadecane | worker characteristic | dimethylalkanes | 1785 | -3.91 | -0.45 | -3.46 | 0.01% | 0.01% | 0.02% | 0.01% | 0.07% | 0.02% | \*\*\* | \*\*\* | \*\*\* | |
| 1-octadecene | virgin queen characteristic | alkenes | 1793 | 0.17 | -3.26 | 3.44 | 0.06% | 0.02% | 0.21% | 0.07% | 0.06% | 0.02% |  | \*\*\* | \*\*\* | |
| octadecane | worker characteristic | alkanes | 1800 | -4.82 | -0.32 | -4.50 | 0.04% | 0.01% | 0.08% | 0.03% | 0.76% | 0.23% | \*\*\* | \*\*\* | \*\*\* | |
| 3,x-dimethylheptadecane | virgin queen characteristic | dimethylalkanes | 1818 | 0.52 | -1.19 | 1.71 | 0.04% | 0.02% | 0.07% | 0.03% | 0.03% | 0.01% |  |  | \*\*\* | |
| 5-nonadecene | virgin queen characteristic | alkenes | 1877 | -0.64 | -3.85 | 3.21 | 0.00% | 0.00% | 0.11% | 0.04% | 0.02% | 0.03% | \*\*\* | \*\*\* | \*\*\* | |
| nonadecane | virgin queen characteristic | alkanes | 1900 | 0.83 | -3.21 | 4.04 | 0.05% | 0.02% | 0.21% | 0.08% | 0.01% | 0.03% | \*\*\* | \*\*\* | \*\*\* | |
| 3,x-dimethyloctadecane | worker characteristic | dimethylalkanes | 1913 | -4.47 | -0.51 | -3.95 | 0.06% | 0.03% | 0.12% | 0.05% | 0.61% | 0.18% | \*\*\* | \*\*\* | \*\*\* | |
| 5-methylnonadecane | worker characteristic | methylalkanes | 1949 | -4.02 | -0.10 | -3.91 | 0.01% | 0.01% | 0.01% | 0.01% | 0.07% | 0.02% | \*\*\* | \* | \*\*\* | |
| 9,x-dimethylnonadecane | worker characteristic | dimethylalkanes | 1962 | -1.72 | 0.59 | -2.30 | 0.08% | 0.12% | 0.04% | 0.03% | 0.20% | 0.06% | \*\*\* |  | \*\*\* | |
| 7,x-dimethylnonadecane | worker characteristic | dimethylalkanes | 1972 | -2.84 | 0.07 | -2.92 | 0.04% | 0.06% | 0.04% | 0.02% | 0.16% | 0.05% | \*\*\* |  | \*\*\* | |
| 5,x-dimethylnonadecane | worker characteristic | dimethylalkanes | 1994 | -1.88 | -0.37 | -1.51 | 0.07% | 0.04% | 0.08% | 0.03% | 0.14% | 0.04% | \*\*\* |  |  | |
| eicosane | worker characteristic | alkanes | 2000 | -4.81 | -0.08 | -4.73 | 0.06% | 0.04% | 0.08% | 0.03% | 0.97% | 0.29% | \*\*\* |  | \*\*\* | |
| 5-methyleicosane | virgin queen characteristic | methylalkanes | 2050 | 0.37 | -0.67 | 1.04 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | \*\*\* |  | \*\*\* | |
| 7-heneicosene | virgin queen characteristic | alkenes | 2075 | 0.45 | -2.83 | 3.28 | 0.01% | 0.01% | 0.04% | 0.02% | 0.00% | 0.00% | \*\*\* | \*\*\* | \*\*\* | |
| 1-octadecanol | worker characteristic | alcohols | 2086 | -3.27 | -0.43 | -2.84 | 0.11% | 0.05% | 0.16% | 0.06% | 0.48% | 0.16% | \*\*\* |  | \*\*\* | |
| heneicosane | virgin queen characteristic | alkanes | 2100 | -0.04 | -5.60 | 5.56 | 0.15% | 0.04% | 2.07% | 0.55% | 0.16% | 0.12% |  | \*\*\* | \*\*\* | |
| 5,11-dimethylheneicosane | worker characteristic | dimethylalkanes | 2166 | -2.77 | 0.24 | -3.01 | 0.04% | 0.04% | 0.01% | 0.01% | 0.38% | 0.19% | \*\*\* | \*\*\* | \*\*\* | |
| docosane | worker characteristic | alkanes | 2200 | -4.65 | -1.00 | -3.65 | 0.08% | 0.03% | 0.31% | 0.10% | 1.12% | 0.34% | \*\*\* | \*\*\* | \*\*\* | |
| 3,x-dimethylheneicosane | worker characteristic | dimethylalkanes | 2208 | -0.47 | 0.18 | -0.65 | 0.02% | 0.02% | 0.02% | 0.02% | 0.03% | 0.01% |  |  | \*\*\* | |
| 9-eicosen-1-ol | queen characteristic | alcohols | 2263 | -0.52 | 0.01 | -0.53 | 0.00% | 0.00% | 0.00% | 0.00% | 0.15% | 0.44% | \*\*\* | \*\*\* | \*\*\* | |
| 9-tricosene | virgin queen characteristic | alkenes | 2274 | -0.80 | -3.16 | 2.36 | 0.05% | 0.02% | 0.49% | 0.15% | 0.17% | 0.16% | \*\* | \*\*\* | \*\*\* | |
| 7-tricosene | worker characteristic | alkenes | 2281 | -1.15 | -0.24 | -0.90 | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | \*\*\* |  | \* | |
| 1-tricosene | worker characteristic | alkenes | 2295 | -3.59 | 0.27 | -3.86 | 0.08% | 0.05% | 0.04% | 0.04% | 0.59% | 0.22% | \*\*\* | \*\*\* | \*\*\* | |
| tricosane | virgin queen characteristic | alkanes | 2300 | 0.30 | -3.60 | 3.90 | 2.75% | 1.73% | 11.47% | 3.69% | 2.01% | 0.69% |  | \*\*\* | \*\*\* | |
| 9-methyltricosane | worker characteristic | methylalkanes | 2336 | -2.48 | -2.86 | 0.38 | 0.01% | 0.01% | 0.11% | 0.04% | 0.10% | 0.04% | \*\*\* | \*\*\* |  | |
| 7-methyltricosane | virgin queen characteristic | methylalkanes | 2345 | 0.97 | -0.66 | 1.63 | 0.01% | 0.02% | 0.02% | 0.01% | 0.00% | 0.00% | \*\*\* | \*\*\* | \*\*\* | |
| 5-methyltricosane | worker characteristic | methylalkanes | 2349 | -0.01 | -0.23 | 0.22 | 0.00% | 0.01% | 0.01% | 0.01% | 0.00% | 0.00% | \*\*\* | \*\* |  | |
| 3-methyltricosane | worker characteristic | methylalkanes | 2371 | -2.71 | -0.80 | -1.90 | 0.04% | 0.02% | 0.13% | 0.16% | 0.36% | 0.11% | \*\*\* | \*\*\* | \*\*\* | |
| 5,11-dimethyltricosane | worker characteristic | dimethylalkanes | 2378 | -3.86 | -0.81 | -3.05 | 0.01% | 0.01% | 0.03% | 0.02% | 0.11% | 0.03% | \*\*\* | \*\*\* | \*\*\* | |
| 5,9-dimethyltricosane | worker characteristic | dimethylalkanes | 2394 | -0.81 | -0.92 | 0.10 | 0.02% | 0.01% | 0.04% | 0.04% | 0.04% | 0.01% | \*\*\* |  |  | |
| tetracosane | worker characteristic | alkanes | 2400 | -5.39 | -0.21 | -5.19 | 0.11% | 0.07% | 0.16% | 0.05% | 1.23% | 0.31% | \*\*\* |  | \*\*\* | |
| 3,13-dimethyltricosane | worker characteristic | dimethylalkanes | 2405 | -2.63 | -0.66 | -1.97 | 0.01% | 0.02% | 0.03% | 0.02% | 0.07% | 0.02% | \*\*\* | \*\*\* | \*\*\* | |
| 3,11-dimethyltricosane | worker characteristic | dimethylalkanes | 2413 | -0.54 | -0.61 | 0.07 | 0.03% | 0.01% | 0.04% | 0.02% | 0.04% | 0.01% |  |  |  | |
| 9-pentacosene | worker characteristic | alkenes | 2473 | -2.37 | -1.93 | -0.45 | 0.16% | 0.07% | 0.37% | 0.09% | 0.42% | 0.14% | \*\*\* | \*\*\* |  | |
| 7-pentacosene | worker characteristic | alkenes | 2481 | -1.99 | 0.36 | -2.35 | 0.02% | 0.01% | 0.01% | 0.01% | 0.04% | 0.02% | \*\*\* |  | \*\*\* | |
| pentacosane | virgin queen characteristic | alkanes | 2500 | 0.43 | 0.35 | 0.08 | 5.41% | 5.67% | 4.35% | 1.91% | 4.12% | 1.28% |  |  |  | |
| 13-+11-methylpentacosane | virgin queen characteristic | methylalkanes | 2532 | -1.16 | -2.75 | 1.59 | 0.11% | 0.10% | 0.61% | 0.19% | 0.32% | 0.21% | \*\*\* | \*\*\* | \*\*\* | |
| 9-methylpentacosane | worker characteristic | methylalkanes | 2537 | -3.84 | -0.90 | -2.94 | 0.01% | 0.01% | 0.04% | 0.02% | 0.14% | 0.05% | \*\*\* | \*\*\* | \*\*\* | |
| 7-methylpentacosane | worker characteristic | methylalkanes | 2545 | -3.71 | -0.07 | -3.64 | 0.01% | 0.01% | 0.01% | 0.01% | 0.05% | 0.02% | \*\*\* |  | \*\*\* | |
| 5-methylpentacosane | worker characteristic | methylalkanes | 2549 | -1.64 | -2.01 | 0.37 | 0.01% | 0.01% | 0.04% | 0.01% | 0.03% | 0.01% | \*\*\* | \*\*\* |  | |
| 9,13-dimethylpentacosane | worker characteristic | dimethylalkanes | 2579 | -3.93 | -2.32 | -1.61 | 0.02% | 0.01% | 0.14% | 0.04% | 0.22% | 0.07% | \*\*\* | \*\*\* |  | |
| 5,x-dimethylpentacosane | worker characteristic | dimethylalkanes | 2586 | -3.87 | -0.86 | -3.02 | 0.01% | 0.01% | 0.03% | 0.01% | 0.08% | 0.03% | \*\*\* | \*\*\* | \*\*\* |
| 5,9-dimethylpentacosane | worker characteristic | dimethylalkanes | 2595 | -0.45 | -0.71 | 0.26 | 0.02% | 0.02% | 0.04% | 0.04% | 0.03% | 0.01% |  |  |  | |
| hexacosane | worker characteristic | alkanes | 2600 | -5.15 | -0.18 | -4.98 | 0.31% | 0.17% | 0.35% | 0.10% | 1.48% | 0.32% | \*\*\* |  | \*\*\* | |
| 9-heptacosene | worker characteristic | alkenes | 2674 | -5.95 | -0.50 | -5.45 | 0.08% | 0.04% | 0.10% | 0.03% | 0.37% | 0.06% | \*\*\* |  | \*\*\* | |
| 7-heptacosene | worker characteristic | alkenes | 2682 | -2.96 | -0.12 | -2.84 | 0.02% | 0.01% | 0.02% | 0.01% | 0.11% | 0.05% | \*\*\* |  | \*\*\* | |
| heptacosane | virgin queen characteristic | alkanes | 2700 | 0.85 | -0.22 | 1.06 | 11.57% | 4.42% | 12.33% | 3.32% | 8.59% | 3.14% |  |  |  | |
| 13-+11-+9-methylheptacosane | virgin queen characteristic | methylalkanes | 2731 | -0.18 | -3.31 | 3.14 | 0.18% | 0.10% | 4.23% | 1.93% | 0.40% | 0.54% |  | \*\*\* | \*\*\* | |
| 7-methylheptacosane | virgin queen characteristic | methylalkanes | 2739 | 1.00 | -1.27 | 2.27 | 0.04% | 0.03% | 0.08% | 0.05% | 0.00% | 0.00% | \*\*\* | \*\*\* | \*\*\* | |
| 5,x-dimethylheptacosane | worker characteristic | dimethylalkanes | 2787 | -3.35 | 0.75 | -4.10 | 0.02% | 0.02% | 0.01% | 0.00% | 0.09% | 0.03% | \*\*\* | \*\*\* | \*\*\* | |
| 5,15-dimethylheptacosane | worker characteristic | dimethylalkanes | 2795 | -3.77 | 0.77 | -4.53 | 0.02% | 0.02% | 0.00% | 0.00% | 0.08% | 0.02% | \*\*\* | \*\*\* | \*\*\* | |
| octacosane | worker characteristic | alkanes | 2800 | -5.39 | 0.39 | -5.78 | 0.48% | 0.14% | 0.39% | 0.06% | 1.61% | 0.31% | \*\*\* |  | \*\*\* | |
| 3,15-+3,13-dimethylheptacosane | worker characteristic | dimethylalkanes | 2818 | -2.98 | 0.61 | -3.60 | 0.01% | 0.01% | 0.00% | 0.00% | 0.04% | 0.02% | \*\*\* | \*\*\* | \*\*\* | |
| 14-nonacosene | queen characteristic | alkenes | 2866 | 3.24 | 3.33 | -0.09 | 0.15% | 0.07% | 0.01% | 0.02% | 0.01% | 0.03% | \*\*\* | \*\*\* | \*\* | |
| 9-+10-nonacosene | worker characteristic | alkenes | 2876 | -4.15 | -1.06 | -3.09 | 0.08% | 0.04% | 0.19% | 0.08% | 0.50% | 0.13% | \*\*\* | \*\*\* | \*\*\* | |
| 8-nonacosene | worker characteristic | alkenes | 2879 | -3.30 | -0.15 | -3.14 | 0.19% | 0.11% | 0.21% | 0.10% | 0.67% | 0.19% | \*\*\* |  | \*\*\* | |
| nonacosane | queen characteristic | alkanes | 2900 | 0.71 | 1.16 | -0.44 | 12.03% | 4.10% | 8.86% | 1.70% | 10.08% | 2.60% |  |  |  | |
| 15-+13-+11-methylnonacosane | virgin queen characteristic | methylalkanes | 2929 | -0.18 | -2.90 | 2.72 | 0.14% | 0.12% | 4.13% | 2.08% | 0.39% | 0.82% |  | \*\*\* | \*\*\* | |
| tetradecanoic acid, tetradecyl ester | queen characteristic | esters | 2965 | 4.12 | 3.43 | 0.69 | 1.56% | 0.65% | 0.28% | 0.36% | 0.02% | 0.04% | \*\*\* | \*\*\* | \*\*\* | |
| 13,17-+11,15-dimethylnonacosane | worker characteristic | dimethylalkanes | 2995 | -0.47 | 0.22 | -0.69 | 0.01% | 0.01% | 0.01% | 0.01% | 0.02% | 0.01% | \*\* |  | \*\*\* | |
| triacontane | worker characteristic | alkanes | 3000 | -4.09 | 1.22 | -5.31 | 0.50% | 0.24% | 0.23% | 0.06% | 1.39% | 0.28% | \*\*\* | \*\*\* | \*\*\* | |
| 9,23-hentriacontadiene | worker characteristic | alkadienes | 3058 | -1.62 | -0.16 | -1.46 | 0.42% | 0.38% | 0.55% | 0.85% | 1.66% | 0.84% | \*\*\* |  | \*\*\* | |
| 15-hentriacontene | queen characteristic | alkenes | 3066 | 0.27 | 1.11 | -0.84 | 1.02% | 0.41% | 0.28% | 0.30% | 0.84% | 0.94% |  | \*\* |  | |
| 10-hentriacontene | worker characteristic | alkenes | 3074 | -2.17 | -0.02 | -2.15 | 3.60% | 1.34% | 3.64% | 1.10% | 6.63% | 1.64% |  |  |  | |
| 8-hentriacontene | worker characteristic | alkenes | 3081 | -1.57 | -0.17 | -1.40 | 2.75% | 0.85% | 2.97% | 0.92% | 4.84% | 1.78% |  |  |  | |
| hentriacontane | queen characteristic | alkanes | 3100 | 1.19 | 1.15 | 0.04 | 10.76% | 5.06% | 7.15% | 2.26% | 7.03% | 2.42% |  |  |  | |
| 15-+13-+9-methylhentriacontane | virgin queen characteristic | methylalkanes | 3128 | -0.17 | -2.81 | 2.64 | 0.03% | 0.05% | 2.14% | 1.15% | 0.16% | 0.44% | \*\*\* | \*\*\* | \*\*\* | |
| 9-hexadecenoic acid, tetradecyl ester | queen characteristic | esters | 3149 | 2.97 | 2.09 | 0.88 | 2.49% | 1.21% | 0.89% | 0.76% | 0.22% | 0.34% | \*\*\* | \*\*\* | \*\*\* | |
| tetradecanoic acid, hexadecyl ester | queen characteristic | esters | 3164 | 5.87 | 5.70 | 0.17 | 3.26% | 1.06% | 0.13% | 0.37% | 0.04% | 0.11% | \*\*\* | \*\*\* | \*\*\* | |
| 10-dotriacontene | worker characteristic | alkenes | 3176 | -1.08 | -0.95 | -0.13 | 0.32% | 0.07% | 0.56% | 0.37% | 0.59% | 0.16% |  |  |  | |
| dotriacontane | worker characteristic | alkanes | 3200 | -4.03 | -0.34 | -3.69 | 0.22% | 0.13% | 0.30% | 0.13% | 1.14% | 0.32% | \*\*\* |  | \*\*\* | |
| 9,23-tritriacontadiene | worker characteristic | alkadienes | 3254 | -3.33 | 1.08 | -4.41 | 1.06% | 0.40% | 0.39% | 0.18% | 3.10% | 0.89% | \*\*\* | \*\*\* | \*\*\* | |
| 15-tritriacontene | queen characteristic | alkenes | 3266 | 6.82 | 7.49 | -0.68 | 2.22% | 0.60% | 0.06% | 0.06% | 0.25% | 0.09% | \*\*\* | \*\*\* | \*\*\* | |
| 12-tritriacontene | queen characteristic | alkenes | 3270 | 0.05 | 1.10 | -1.05 | 1.35% | 0.32% | 1.04% | 0.28% | 1.34% | 0.26% |  |  |  | |
| 10-tritriacontene | queen characteristic | alkenes | 3277 | -0.14 | -1.05 | 0.91 | 10.17% | 1.67% | 13.04% | 4.05% | 10.56% | 1.41% |  |  |  | |
| 8-tritriacontene | queen characteristic | alkenes | 3283 | -0.18 | -0.52 | 0.35 | 0.57% | 0.10% | 0.70% | 0.30% | 0.61% | 0.25% |  |  |  | |
| tritriacontane | queen characteristic | alkanes | 3300 | 1.35 | 1.56 | -0.21 | 2.38% | 1.49% | 1.00% | 0.59% | 1.18% | 0.63% |  | \*\*\* |  | |
| 13-+11-+9-methyltritriacontane | virgin queen characteristic | methylalkanes | 3327 | -0.12 | -3.05 | 2.93 | 0.03% | 0.06% | 0.75% | 0.34% | 0.06% | 0.17% | \*\*\* | \*\*\* | \*\*\* | |
| 9-octadecenoic acid, tetradecyl ester | queen characteristic | esters | 3343 | 3.72 | 3.66 | 0.06 | 2.09% | 1.17% | 0.06% | 0.14% | 0.03% | 0.09% | \*\*\* | \*\*\* |  | |
| 9-hexadecenoic acid, hexadecyl ester | queen characteristic | esters | 3350 | 4.43 | 4.48 | -0.06 | 2.45% | 1.00% | 0.11% | 0.12% | 0.14% | 0.35% | \*\*\* | \*\*\* |  | |
| hexadecanoic acid, hexadecyl ester | queen characteristic | esters | 3364 | 4.72 | 4.64 | 0.08 | 1.01% | 0.43% | 0.05% | 0.06% | 0.03% | 0.04% | \*\*\* | \*\*\* |  | |
| tetratriacontane | worker characteristic | alkanes | 3400 | -4.44 | -0.30 | -4.14 | 0.05% | 0.08% | 0.11% | 0.08% | 0.96% | 0.30% | \*\*\* | \*\*\* | \*\*\* | |
| 9,23-pentatriacontadiene | worker characteristic | alkadienes | 3451 | -1.85 | 0.99 | -2.84 | 0.41% | 0.20% | 0.19% | 0.11% | 0.82% | 0.30% | \*\*\* | \*\*\* | \*\*\* | |
| 15-pentatriacontene | queen characteristic | alkenes | 3466 | 5.99 | 6.14 | -0.15 | 2.28% | 0.78% | 0.03% | 0.03% | 0.09% | 0.06% | \*\*\* | \*\*\* | \*\*\* | |
| 12-+14-pentatriacontene | queen characteristic | alkenes | 3471 | 1.65 | 1.14 | 0.51 | 0.39% | 0.15% | 0.26% | 0.12% | 0.20% | 0.08% |  |  |  | |
| 10-pentatriacontene | queen characteristic | alkenes | 3477 | 1.30 | 0.25 | 1.05 | 0.24% | 0.13% | 0.21% | 0.13% | 0.11% | 0.06% | \*\* |  | \*\* | |
| pentatriacontane | worker characteristic | alkanes | 3500 | -0.95 | -0.14 | -0.81 | 0.16% | 0.10% | 0.21% | 0.41% | 0.47% | 0.32% | \*\* | \* | \*\*\* | |
| 9-octadecenoic acid, hexadecyl ester | queen characteristic | esters | 3544 | 3.34 | 3.33 | 0.01 | 2.68% | 1.14% | 0.43% | 0.61% | 0.42% | 0.31% | \*\*\* | \*\*\* |  | |
| 9-hexadecenoic acid, octadecyl ester | queen characteristic | esters | 3553 | 0.28 | 0.10 | 0.18 | 0.61% | 0.32% | 0.56% | 0.89% | 0.45% | 0.28% |  | \* |  | |
| hexatriacontane | worker characteristic | alkanes | 3600 | -3.95 | -0.25 | -3.71 | 0.02% | 0.01% | 0.05% | 0.04% | 0.50% | 0.19% | \*\*\* | \*\*\* | \*\*\* | |
| 15-heptatriacontene | queen characteristic | alkenes | 3669 | 5.63 | 5.70 | -0.07 | 2.00% | 0.69% | 0.09% | 0.15% | 0.11% | 0.05% | \*\*\* | \*\*\* | \*\*\* | |
| 9-octadecenoic acid, octadecyl ester | virgin queen characteristic | esters | 3747 | 1.36 | -1.23 | 2.59 | 0.66% | 0.38% | 1.10% | 0.49% | 0.17% | 0.15% | \*\*\* |  | \*\*\* | |
| octatriacontane | worker characteristic | alkanes | 3800 | -2.95 | 0.05 | -3.00 | 0.02% | 0.02% | 0.01% | 0.02% | 0.41% | 0.20% | \*\*\* |  | \*\*\* | |
| hexadecanoic acid, eicosyl ester | worker characteristic | esters | 3826 | -1.19 | -0.55 | -0.64 | 2.60% | 1.80% | 5.29% | 7.11% | 8.38% | 3.15% | \*\*\* |  | \*\*\* | |
| 15-nonatriacontene | queen characteristic | alkenes | 3869 | 4.12 | 4.06 | 0.06 | 1.37% | 0.70% | 0.04% | 0.03% | 0.02% | 0.04% | \*\*\* | \*\*\* | \*\*\* | |

**Table S2.** The effect of the treatments on the proportion of workers with developed ovaries. Odds ratio, lower and upper 95% confidence bounds, z-ratio, and one-sided FDR corrected p-values of the binomial generalised linear mixed model are shown.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Odds ratio** | **Lower 95% CB** | **Upper 95% CB** | **z-ratio** | **p-value** |  |
| QMP | 5.39 | 2.84 | 52.8 | -3.68 | 0.00027 | \*\*\* |
| 9-ODA | 6.52 | 3.41 | 74.7 | -4.03 | 0.00008 | \*\*\* |
| 9-HDA | 8.17 | 4.22 | 135 | -4.38 | 0.00005 | \*\*\* |
| HOB | 2.33 | 1.22 | 27.1 | -1.82 | 0.0346 | \* |
| HVA | 3.21 | 1.72 | 24.3 | -2.63 | 0.00769 | \*\* |
| Cuticular esters | 2.27 | 1.25 | 11.9 | -1.98 | 0.0281 | \* |
| Cuticular alkenes | 2.25 | 1.24 | 12.0 | -1.96 | 0.0281 | \* |
| Tergal gland esters | 6.97 | 3.61 | 98.6 | -4.10 | 0.00008 | \*\*\* |
| Tergal gland acids | 2.51 | 1.37 | 14.2 | -2.19 | 0.0215 | \* |