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**Scientific note**

# A scientific note on the mating frequency of *Apis dorsata*

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*Apis dorsata* Fabricius has the highest level of polyandry recorded for any social insect (Tab. I, Moritz et al., 1995; Oldroyd et al., 1996). To improve the precision of current estimates, we re-examined paternity frequency using larger sample sizes and 4 microsatellite loci, including a new highly variable locus cloned from *A. dorsata* by Paar et al., unpublished data. We also compared mating frequency between colonies found in aggregations and colonies found singly.

Combs of *A. dorsata* were obtained from the wild during 1998–1999. Eight of these (colonies 1–8) were collected from a group of 14 aggregated colonies in the Pua district of Nan province. Another five solitary colonies (colonies 9–13) were collected from various parts of Thailand (Tab. I).

Workers were genetically analyzed using the microsatellite loci A14 (Estoup et al., 1993), A24 and A88 (Estoup et al., 1995) and Ad3 (Paar et al., 2003) as described in Oldroyd et al. (2000). Effective mating frequency ($m_e$) corrected for finite sample size (Pamilo, 1993; Boomsma and Ratnieks, 1996), average coefficient of relatedness ($g$) weighted according to the relative proportions of each subfamily (Boomsma and Ratnieks, 1996) and the expected frequency of non-detected patrilines due to two or males in the mating having the same genotype ($d_p$) (Boomsma and Ratnieks, 1996) were calculated as described in Palmer et al. (2001).

The number of subfamilies found per colony in this investigation ranged from 47–102 and the effective mating frequency ranged between 26.9 and 88.5 (Tab. I). As a consequence of increased sample size and the use of highly variable genetic markers, the number of subfamilies observed per colony are much higher in this study than those reported by Moritz et al. (1995) and Oldroyd et al. (1996). However, they are within the range estimated by Moritz et al. (1995) after they fitted the distribution of patrilines to a binomial distribution. Our results confirm the widespread incidence of extreme mating frequencies in *A. dorsata*.

The mean number of patrilines ($\bar{x} \pm$ s.e.) per colony did not differ ($P$ = 0.2 2-tailed $t$-test) between colonies sampled from the aggregation (76.1 ± 4.4) and the single colonies (86.6 ± 5.6). The mean effective number of matings in the aggregated colonies (64.1 ± 7.6) was the same ($P$ = 0.82) as the mean effective number of matings in the single colonies (61.2 ± 9.6). On the assumption that there are more drones present at drone congregation areas near colony aggregations, this may indicate that the availability of drones is not a factor in determining mating frequency.

The probability of non-detected patrilines due to genetically identical inseminating drones ($d_p$) (Boomsma and Ratnieks, 1996) was 0.0003 for colonies from the aggregation, and 0.002 for the solitary colonies. This means that fewer than 3 fathering males were expected to be undetected in all 13 colonies.

Extreme multiple mating has now been demonstrated in at least 7 species of *Apis* (Palmer et al., 2001), and may be regarded as plesiomorphic for the genus (Palmer and Oldroyd, 2000). The

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**Table I.** Sample size, *N*, per colony, number of patrilines , *k*, detected, effective mating frequency, $m_e$, and average coefficient of relatedness, *g*, in *A. dorsata* colonies from several provinces of Thailand (this study), Malaysia (Moritz et al., 1995) and central Thailand (Oldroyd et al., 1996).

| Colony | *N* | *k* | $m_e$ | *g* | Province |
|---|---|---|---|---|---|
| A1 | 144 | 72 | 88.0 | 0.26 | Nan [a] |
| A2 | 189 | 74 | 80.0 | 0.26 | Nan |
| A3 | 111 | 47 | 37.7 | 0.26 | Nan |
| A4 | 248 | 78 | 28.8 | 0.27 | Nan |
| A5 | 204 | 92 | 77.6 | 0.26 | Nan |
| A6 | 206 | 88 | 64.6 | 0.26 | Nan |
| A7 | 235 | 87 | 62.1 | 0.26 | Nan |
| A8 | 156 | 71 | 74.2 | 0.26 | Nan |
| S9 | 176 | 83 | 88.5 | 0.26 | Nakornratchsima [b] |
| S10 | 271 | 102 | 67.6 | 0.26 | Lopburi [c] |
| S11 | 288 | 80 | 55.6 | 0.26 | Nakornratchsima [b] |
| S12 | 276 | 83 | 26.9 | 0.27 | Supanburi [d] |
| S13 | 192 | 85 | 67.7 | 0.26 | Tak [e] |
| Mean ± SE, this study | 207.4 ± 15.2 | 80.1 ± 3.6 | 63.0 ± 5.7 | 0.259 ± 0.001 | |
| Mean Moritz et al. (1995) | 28.3 ± 4.4 | 18.2 ± 2.4 | 25.6 ± 11.6 | – | |
| Mean Oldroyd et al. (1996) | 86 ± 33.4 | 26.7 ± 5.4 | 20.0 ± 6.6 | 0.29 ± 0.009 | |

[a] Nan Province, northern Thailand.
[b] Nakornratchsima Province, north-eastern Thailand.
[c] Lopburi Province, central Thailand.
[d] Supanburi Province, western Thailand.
[e] Tak Province, north-western Thailand.

adaptive significance of the extraordinarily high mating frequency in this genus in general, and this species in particular, remains a mystery.

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**Note scientifique sur la fréquence des accouplements chez *Apis dorsata*.**

**Eine wissenschaftliche Notiz über die Paarungshäufigkeit von *Apis dorsata*.**

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