

## SHORT COMMUNICATION

### Rare production of brachypterous queens in a social parasitic ant, *Vollenhovia nipponica* (Hymenoptera: Formicidae)

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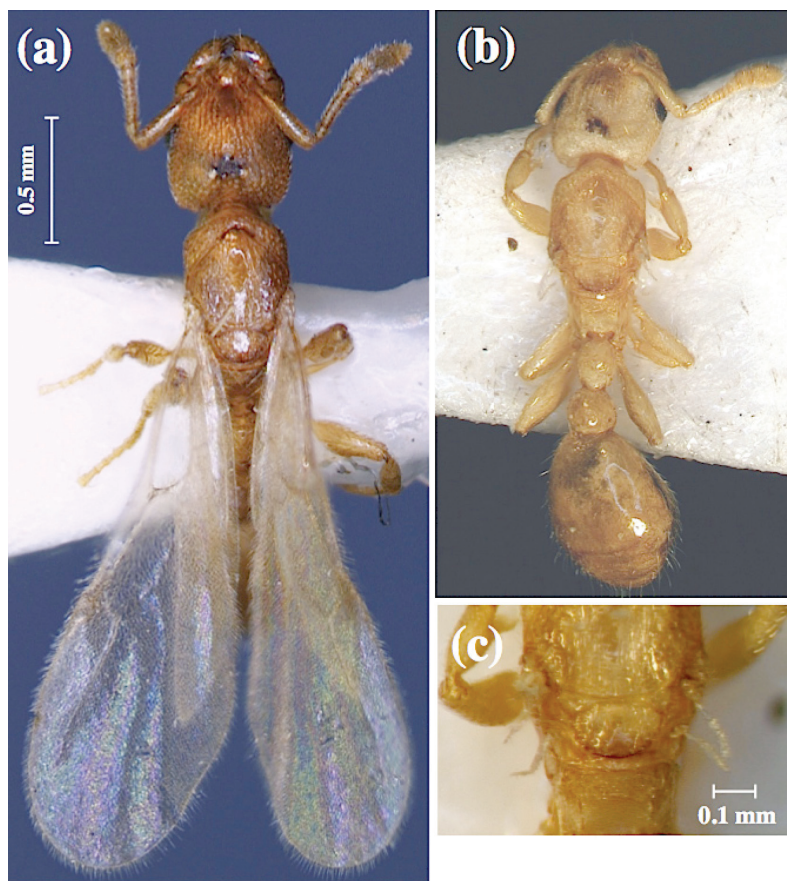
In most species of ants, the queen caste is easily distinguished from the worker caste by its morphology. Generally, the queen has two pairs of wings, which are shed after mating, a fully developed thoracic skeleton, and large ovaries with a spermatheca for the storage of sperm. In contrast, workers are wingless, possess greatly fused thoracic sclerites, have reduced ovaries, and in most species lack a spermatheca (Wilson 1971; Hölldobler & Wilson 1990). However, these morphological differences are not always clear. In some species, the queens are worker-like, can be wingless and have a reduction of thorax sclerites. In these cases, it is difficult to distinguish queens and workers by their morphology. In many cases, these queens are regularly produced as a reproductive caste, which can mate and is the ordinary egg-layer of the colony (Peeters 1991, 2012). In such ‘queens’, the length of wings and the reduction of thoracic sclerites varies within and among species (Heinze & Buschinger 1987; Heinze 1998). Based on morphological characteristics, they have been classified into ergatoid (wingless, worker-like queens) and brachypterous queens (short-winged queens) (Peeters 2012).

Winglessness in the queen caste may be associated with certain life history strategies including colony founding and mating (Peeters & Molet 2010; Cronin *et al.* 2013). In isolated habitat patches where resource are limited temporally and spatially, wingless queens are

likely to occur, because it is difficult for queens to mate with males from other nests and found new colonies independently (Heinze & Buschinger 1987; Buschinger and Heinze, 1992; Heinze and Tsuji 1995; Cronin *et al.* 2013). Under such environmental conditions, founding by colony budding with intranest mating (Dependent Colony Foundation; Peeters & Molet 2010) may be more advantageous, and promote the loss of flight ability, with associated reduction of wings and thorax sclerites.

*Vollenhovia nipponica* Kinomura and Yamauchi, 1992, is a workerless socially parasitic ant of the congeneric species *Vollenhovia emeryi* Wheeler, 1906, (Kinomura & Yamauchi 1992). Queens of *V. nipponica* live in colonies of *V. emeryi* and produce only reproductives by using the host worker force. The queen has two mating tactics; mating in the host nest and by nuptial flights (Satoh & Ohkawara 2008). About 27% of new queens mated with their brother males in the natal nest soon after eclosion in autumn, whereas others undertook nuptial flights in spring after over-wintering (Okamoto & Ohkawara 2009). Normally, the queen is alate with a pair of long wings and developed thoracic sclerites, (Fig. 1a, Fig. 2a). However, based on the high frequency of intranest mating, it is possible that *V. nipponica* also has wingless queens.

In this study, we report on a brachypterous type of queen in *V. nipponica*. From May to June of 2004 – 2007, we collected total 81 *V. emeryi*



**Fig. 1.** Alate queen (a), brachypterous queen (b), and vestigial wings (c) in *Vollenhovia nipponica*.

nests in the deciduous forest of the Fushohji Park in Kanazawa city, central Japan. In the collected nests, 26 (32.1%) included *V. nipponica* queens and males and 20 nests of the parasited nests were kept in the laboratory. A total of 432 new queens emerged from July to October, and five brachypterous queens were discovered in five nests. These latter queens did not have developed wings, though a pair of tiny alate alitrunk was observed on the thorax (Fig. 1b, Fig. 2b). Normal wings were already visibly lacking at the pupal stage. Appendages attached to the thorax sclerites seemed to be vestigial wings (Fig. 1c). However, body size, ocelli number, and body colour were not different from those of normal alate queens. Three individuals were dissected to examine reproductive physiology. These brachypterous queens had a spermatheca and eight ovarioles; equivalent to alate queens (Ohkawara unpublished

data), suggesting that brachypterous queens have the same reproductive potential as alate queens. Additionally, the behaviour of brachypterous queens in the host nests, specifically the frequency of mating with males or grooming by host workers, was not different from that of alate queens.

In general, wings in brachypterous queens range from two-thirds the normal length to very small. The thorax tends to be less simplified than that of ergatoid queens, and is thus conspicuously distinct from workers (Peeters 2012). Brachypterous queens are currently known in 14 genera. Particularly, in some ants, the wings are extremely small and short, like vestigial wings: *Nothomyrmecia macrops* (Hölldobler & Taylor 1983), *Leptogenys ergatogyna* (Wheeler 1923), *Monomorium rufum* (Bolton 1986) and *Pogonomyrmex laticeps* (Peeters 2012). Winglessness is considered rare in ants. It may

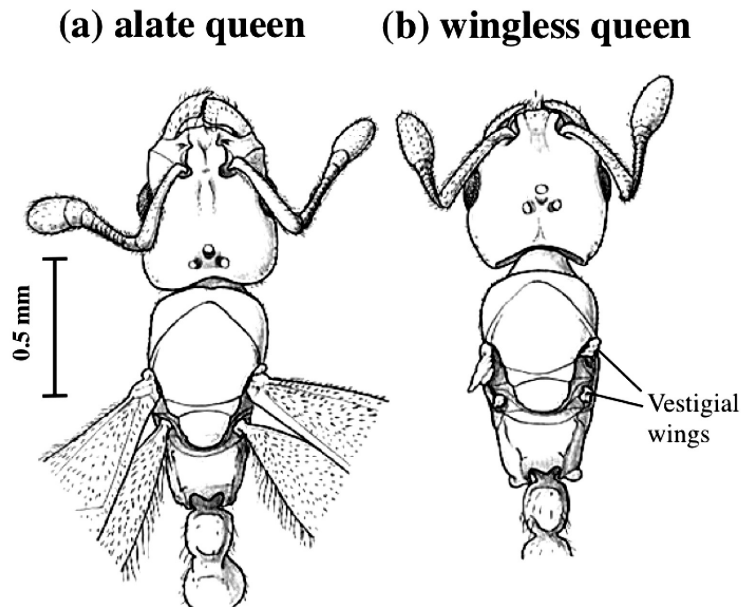


Fig. 2. Illustration of thorax structure of (a) alate, and (b) brachypterous queen.

be possible that brachypterous queens are more widespread, but are often mistaken for normal winged queens after dealation (Peeters 2012). In our observation of *V. nipponica*, the number of brachypterous queens was only five, probably because it is difficult to observe them even in laboratory. However, it is possible that brachypterous queens are more frequently produced, and hold reproductive roles like alate queens.

Wingless queens have been reported in other social parasitic ants, including *Aporomyrmex ampeloni* (Faber 1969), *Harpagoxenus sublaevis* (Buschinger 1978), *Formicoxenus quebecensis* (Francoeur *et al.* 1985), *F. provancheri* (Heinze *et al.* 1993), and *Epimyrma* spp. (Buschinger 1989). As mentioned above, winglessness may be adaptation to isolated habitats where resources are limited. For social parasitic ants, if the host colonies are patchily distributed and limited in local area, it encourages parasites not to disperse widely and to mate in the host nest. Colonies of *V. emeryi* as hosts of *V. nipponica* tend to be patchily distributed in the field, since they reproduce via colony budding within local area in early spring (Sato & Ohkawara 2008). This distribution of host colonies might promote variation in the mating mode in *V. nipponica* queens, leading to

wing reduction. In the future, the relationship between the frequency of wingless queen production and the distribution of host colonies should be examined in the field.

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