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Nonflying Reproductives in Ants

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Synonyms

Brachypterous queen; Dichthadiiform queen; Dichthadiigyne; Ergatoid queen; Gamergate

Insect flight allows better defense, foraging, and especially dispersal. However wing muscles are large and expensive both to manufacture and to maintain. In a substantial number of solitary insects, wing loss evolved as a trade-off for higher fecundity. In ants however, queens become permanently flightless not to increase egg-laying rates but as a consequence of alternative strategies of colonial reproduction. In most species, young queens disperse during a brief solo flight, after which they found a new colony alone (independent colony foundation, ICF). In other species, existing colonies divide in half as young queens walk together with nestmate workers to a new nesting site (colony fission, also called dependent colony foundation, DCF). This dichotomy between ICF and DCF is often reflected by the loss of winged queens. Flightless reproductives are known in at least 75 genera belonging to most subfamilies [2].

"Ergatoid queen" broadly describes any permanently wingless reproductives that are morphologically distinct from workers: while the loss of wing muscles results in a reduced (hence, worker-like) thorax, the gaster is usually larger than workers', and a functional spermatheca is always present. The ergatoid queens of species showing the army ant syndrome are termed "dichthadiiform" when their gaster is huge, e.g., *Eciton and Simopelta.* Short-winged "brachypterous" queens exist also: their thorax retains flight sclerites despite the lack of wing muscles, and once dealate these are often mistaken for flying queens [3, 5]. In contrast to nonflying queens, "gamergates" are ordinary workers that are both inseminated and egg-laying. Gamergate species are restricted to subfamilies Amblyoponinae, Ponerinae, and Ectatomminae (e.g., *Dinoponera*). Except for *Diacamma,* aggressive interactions lead to a dominance hierarchy that regulates which individuals mate and reproduce. Across all ants, wingless queens and future gamergates mate with foreign males inside or just outside their natal nests [3]. The great morphological heterogeneity among flightless reproductives, especially the extent of dimorphism relative to conspecific workers (or the winged queens of related species) (Fig. 1), is the consequence of convergent evolution. Ergatoid queens in various species can be interpreted as mosaics of queen and worker traits [1].

C. Starr (ed.), *Encyclopedia of Social Insects*,
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Nonflying Reproductives in Ants, Fig. 1 Large variation in the degree of dimorphism in body size between flightless queen (left) and conspecific worker (right) in *Mystrium oberthueri, Odontomachus coquereli, Lioponera* sp., and *Dorylus sp.* (Credits Mathieu Molet and Antweb)

Some species have both winged and wingless reproductives, but these have different functions: flying queens start new colonies by ICF and ergatoid queens reproduce later. Indeed, these cheaper secondary reproductives are adaptive after colonies are established, and dispersal is no longer needed. In contrast, flying females have been eliminated in a number of genera, e.g., *Megaponera*. The complete replacement of winged queens by ergatoid queens leads to a highly reduced reproductive investment at colony level. When DCF is obligate, fewer ergatoid

queens need to be produced annually because they have much lower mortality rates compared to winged queens that disperse and found colonies alone. Importantly, there is a shift to greater colonial investment in workers, because these must be sufficiently numerous to allow successful DCF (i.e., an existing colony divides in two parts that must be autonomous from the start). In just a few genera, ergatoid or brachypterous queens do ICF, e.g., seed-eating *Pogonomyrmex* where founding queens forage for a resource that is abundant and reliable at one time of the year [5]. Individual fecundity is not affected by flightlessness and can vary as much as among species with winged queens. Colonies are monogynous in many species with ergatoid queens, but colony size varies tremendously [2]. In *Monomorium algiricum*, ergatoid queens are produced at the end of summer and mate promptly. These can coexist with the previous cohort of queens, and both monogynous and polygynous colonies are found throughout the year although individual fecundity is affected by queen number [4].

Ant males lose flying ability in only few species (e.g., *Cardiocondyla, Metapone, Platythyrea*) although the adaptive pressures are incompletely understood. In most species with flightless female reproductives, aerial dispersal by males is essential to achieve an adequate gene flow. Species with flightless reproductives have an increased probability of local extinction if environmental conditions become unsuitable, and they cannot colonize disjunct patches since queens disperse on foot.

Cross-References

- ▶ *Cardiocondyla*
- ▶ Colony Foundation
- ▶ *Dinoponera*
- ▶ *Platythyrea*

References

1. Molet, M., Wheeler, D., & Peeters, C. (2012). Evolution of novel mosaic castes in ants: Modularity, phenotypic plasticity, and colonial buffering. *The American Naturalist, 180*, 328–341.
2. Peeters, C. (2012). Convergent evolution of wingless reproductives across all subfamilies of ants, and sporadic loss of winged queens. *Myrmecological News, 16*, 75–91.
3. Peeters, C., & Aron, S. (2017). Evolutionary reduction of female dispersal in *Cataglyphis* desert ants. *Biological Journal of the Linnean Society, 122*, 58–70.
4. Peeters, C., & Tinaut, A. (2014). Reconstructing life history in ants: Ergatoid queens, facultative monogyny and dependent colony foundation in *Monomorium algiricum*. *Myrmecological News, 20*, 77–85.
5. Peeters, C., Keller, R. A., & Johnson, R. A. (2012). Selection against aerial dispersal in ants: Two non-flying queen phenotypes in *Pogonomyrmex laticeps*. *PLoS One, 7*(10), e47727.