

Phoridae are particularly important ant parasitoids (Borgmeier 1963; Feener 1981; Feener and Moss 1990; Brown 1993); most phorid larvae are internal parasites of their ant hosts, but larvae of at least one species are free-living in nests of the European *Plagiolepis pygmaea*, receiving regurgitated liquid from worker ants (LeMasne 1941).

Predatory velvet worms (Phylum Onychophora) have been discovered in rainforest *Pheidole* nests, but it is unknown whether they feed upon the ants (McGlynn and Kelley 1999). In what may be a mutualistic association, the earthworm *Dendrodrilus rubidus* (Phylum Annelida) is found in nests of the European red wood ant *Formica aquilonia* (Laakso and Setälä 1997). Adult snakes in the families Colubridae, Elapidae, and Leptotyphlopidae, and lizards in the families Amphisbaenidae and Teiidae, live in nests of species of the leaf-cutting ant genera *Acromyrmex* and *Atta* and/or use the nests as oviposition sites. In some cases these associations are obligate. Some of these snakes are capable of following ant pheromone trails and may utilize the ants or brood as food (Goeldi 1897; Autuori 1942; Gallardo 1951; Vaz-Ferreira et al. 1970, 1973; Weber 1972b; Brandão and Vanzolini 1985).

Internal metazoan parasites of ants are known to include nematodes, trematodes, and cestodes. Protozoan ant parasites include (class) Microsporidea (phylum Cnidospora), known from *Leptothorax*, *Myrmecia*, *Pheidole*, and *Solenopsis* species, and (class) Neogregarinida (phylum Apicomplexa), known from *Leptothorax* and *Solenopsis* species (Hölldobler 1929, 1933; Gösswald 1932; Allen and Buren 1974; Allen and Silveira-Guido 1974; Jouvenaz and Anthony 1979; Espadaler 1982; Buschinger and Winter 1983; Jouvenaz 1986; Crosland 1988; Buschinger et al. 1995).

SYMBIOSES BETWEEN ANTS. Finally, ant species may enter into varying degrees of symbiosis

with each other. For instance, "thief ants" of *Solenopsis* subgenus *Diplorhoptum* live in the walls of the nests of larger ant species and steal their food and larvae. In a more derived case, *Megalomyrmex symmetochus* is found within the nests of the fungus-growing ant *Sericomyrmex amabilis* (Wheeler 1925) and has also been reported from the nest of an unidentified *Trachymyrmex* species. The queen and brood occupy the fungus gardens, ignored by their hosts and apparently feeding on the fungus. The closely related *M. silvestrii* and an undescribed *Megalomyrmex* species parasitize other fungus-growing ants (Brandão 1990; J. Wetterer, pers. comm.).

In cases of social parasitism, ants of one species utilize the work force of another colony in order to raise their own brood. Workers of "slavemaking" species raid colonies, steal brood, and raise them as slaves. In other cases, parasitic foundress queens enter established colonies and take over, by either killing or dominating the host colony queen. Thereafter, the host workers aid in raising the interloping queen's offspring, which ultimately supplant the former inhabitants. In the most extreme cases, the parasite queen produces only sexual brood, having lost the ability to produce a worker caste. For example, the attine ant *Pseudoatta argentina* parasitizes nests of *Acromyrmex lundii*. Its exclusively sexual brood is reared by the *Acromyrmex* workers, and upon maturity they depart and mate, and the queens find new *A. lundii* nests to parasitize (Gallardo 1929).

## Associations with Fungi

In general, ants avoid associations with fungi. Indeed ants have evolved at least two important characteristics for discouraging the presence of fungi (as well as bacteria) in their nests: elaborate grooming behaviors (Wilson 1962a) and the antiseptic-secreting metapleural gland (Maschwitz et al. 1970; Maschwitz 1974; Beattie