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NESTING HABITS OF *CARDIOCONDYLA WROUGHTONI* FOREL (1890) (HYMENOPTERA: FORMICIDAE)

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ABSTRACT

The behaviour of the small tree ant *Cardiocondyla wroughtoni* Forel (1890) has been studied in its natural habitat as well as in artificial nests in the laboratory. The characteristics of the ant and its community were surveyed in connection with the specific living conditions in the small nests.
***KEY WORDS: Cardiocondyla wroughtoni,* Ants, Tandem running, Ergatoid males.**

INTRODUCTION

In November 1966, in the course of studies carried out in the Tel-Aviv district on the symbiotic relationships between the figs of *Ficus sycomorus* L. and the small torymid wasp *Sycophaga sycomori* L. (Galil and Eisikowitch, 1968) the authors of the present article came across an unusual find. On the ground, beneath the tree canopy, numerous ripening sycomore figs were scattered. These were soft pink-coloured fruit, about 25-30 mm in diameter, that had at their ostiolar pole 1-2 small apertures through which small ants (1.5-2 mm long) could be seen emerging or entering freely. When such figs were cut across, they were found to contain a complete ant colony, composed of several ant workers, queens and their progeny (Fig. 1). The nest was very small, considering the miniature cavity of the fig, which attained only 5-8 mm in diameter. Apart from the ant nest,the fig cavity contained also numerous *S. sycomori* males and a few females, apparently serving as food for the carnivorous ants. On the sycomore branches above, similar ant-occupied figs were encountered which would also drop to the ground within a few days.

Such ant nests inside sycomore figs were first observed by Carmin and Scheinkin in 1931. The ant in question was described by Donisthorpe (1930) as a new species, *Cardiocondyla bicolor,* but subsequently Kugler (1983) synonymized it with the much earlier name, *C. wroughtoni* Forel (1890).

The cavity inside the sycomore fig is a natural one, produced spontaneously within the ripening fruit; however, the small tunnels which enable the entrance and exit of ants are the labour of the busy males of the *S. sycomori* wasps which develop in the ovules of the fig (Galil and Eisikowitch, 1968). Since, in the Tel Aviv area, *S. sycomori* wasps inhabit *F. sycomorus* only at the end of the summer, figs suitable for

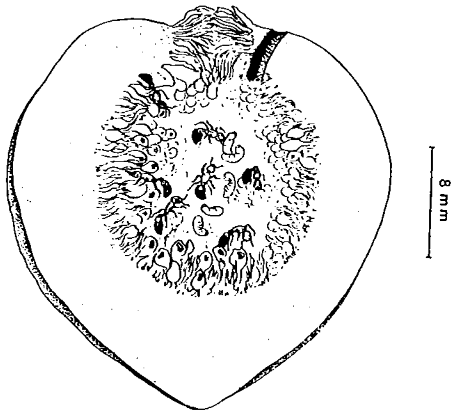

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Fig. 1. Cross section through a sycomore fig, inhabited by a nest of *Cardiocondyla wroughtoni.*

Fig. 2. Longitudinal section through a spindle of the moth *Amblypalpis olivierella* gall, containing a nest of *Cardiocondyla wroughtoni.*

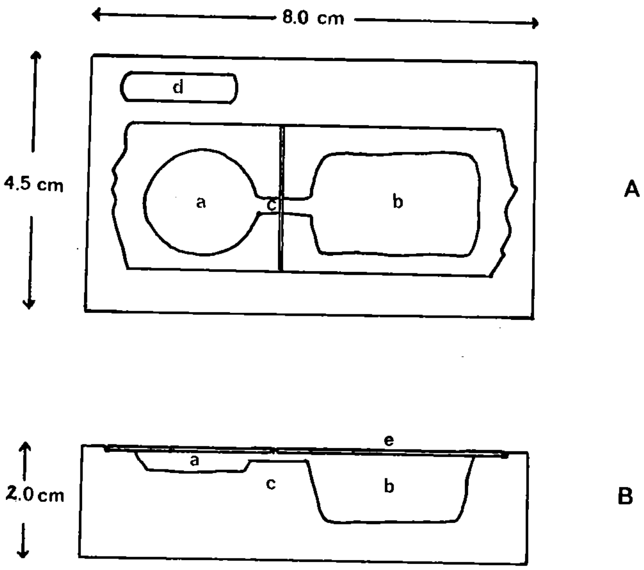

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Fig. 3. Artificial plaster nest: A – viewed from above; B – longitudinal section. (a) nesting chamber; (b) yard chamber; (c) tunnel connecting the nest with the yard; (d) water trough; (e) glass cover.

occupation by the ants are encountered in November-December, after the entry canals are bored through the peel of the fig by the males of the wasps. Throughout the rest of the year the figs are not suitable for colonization by the ants, who must seek other suitable cavities.

A more abundant localization for nests of *C. wroughtoni* was found by Lupo (1973) in the spindle galls of the moth *Amblypalpis olivierella* Ragonot (Gelechiidae) developing on the branches of *Tamarix* spp. (e.g. *T. nilotica* (Ehrenb.) Bga. and *T. jordanis* Boiss.) in various parts of Israel. While the structure, origin and phenology of these galls differ from those of the figs of *F. sycomorus*, there are, nevertheless, some features in common, which enable the ants to colonize them. The chief requisite, of course, is that the wall of the gall be punctured by the original dweller, so as to enable entry by the ants.

The female moth oviposits in small crevices on the woody branches of *Tamarix* in November and December. The moth larvae, which hatch during March-April, crawl onto the newly developing young branches, pierce them and enter the tissues (Gerling et al., 1976; Lupo, 1979; Lupo and Gerling, 1984). They feed on parenchyma cells inside the central vascular cylinder, thereby inducing the development of the typical spindle-shaped galls. In addition to the nutritive parenchyma inside the gall, a lignified, greatly indurated wall develops on the outside. The fully formed gall contains an elongated, narrow cavity which remains closed and shelters the larva throughout its development. At the end of the summer, with the approach of pupation, the advanced larva bores through the wall of the gall but then plugs up, with its accumulated excreta, the tunnel thus formed. This penetration in advance of the gall ensures the eventual unhampered exit of the mature moth. However, this also enables ants to enter the gall via the same opening (Fig. 2). So far as the invading ant is concerned, the gall thus provides both shelter and food – the latter in the form of prepupal or pupal moth. Ant-wise, the *Tamarix* galls have an advantage over the fruit of *Ficus*. For one thing, they do not deteriorate rapidly, as figs do. Admittedly, here too the food supply is soon depleted, but the ants can then gather additional food from neighbouring galls or from other sources. The food problem becomes especially acute in the months when moth pupae and prepupae are not available (January-August).

The afore-described nesting of *C. wroughtoni* in minute tree cavities, sometimes in close association with other organisms, entails various specific adjustments which enable these ants to carry out the complicated behavioural patterns which their social organization demands. The purpose of the present investigation was to study the behaviour of the ants in the field as well as under controlled laboratory conditions.

This work is dedicated to our friend, Prof. J. Kugler, on the occasion of his 70th birthday, and in appreciation of his scientific work on ants and other insects.

MATERIALS AND METHODS

In the Tel Aviv area *C. wroughtoni* colonies are readily obtained from spindle moth galls. For following the behaviour of the ants, they were reared in plaster nests, each comprised of a small and flat chamber functioning as "living room" (Fig. 3,a) and a much larger feeding "yard" (Fig. 3,b). Humidity was maintained with the aid of an elongated water trough, situated alongside the "living room". Such artificial nests were covered from above by a glass plate on which a sheet of black paper was placed. Here the behaviour of the ants could be observed both under constant and changing conditions. Food, such as larvae and pupae of the moth or of *Musca domestica* and small drops of honey, was given to the ants in the "yard".

RESULTS

The nest of *C. wroughtoni*

As already mentioned, *C. wroughtoni* nests in small hollows on trees rather than in the soil, as do several other species of *Cardiocondyla* (Creighton and Snelling, 1974). It does not build its living chambers, but simply make suse of various types of hollows, in addition to galls and figs, and these are usually found on various parts of trees. Nesting hollows may result also from normal growth processes of various trees and their organs, such as the small hollows between perianth leaves of some growing fruits.

Throughout the year active colonies of this ant on *Tamarix* spp. are found only on living branches, for the dry galls on dead branches do not suit them. Even so, before August, the new verdant galls which have not yet been tunnelled through by the large pre-pupal larvae are impenetrable to the ants. In fact, the most suitable time for ant colonization, when both food and shelter are available, is in the autumn (September-December), after the galls have been tunnelled through and yet contain the prepupal or pupal moths. The percentage of galls occupied by ant colonies sometimes reached 30%.

In numerous counts made thoughout the year, the adult ant population in natural spindle galls of *Tamarix* seldom exceeded 3-4 scores and in most galls it was even smaller. We obtained also experimental evidence that the size of the nest cavity affects the size of the ant population. Thus, in artificial plaster nests where the "living rooms" were considerably larger than in the natural nest, the ant population increased, especially when food was in abundance. When the ants were provided with more than one nesting "room" the number of occupied "rooms" changed in accordance with the changing number of adult ants. Generally, in artificial nests with somewhat larger "rooms", the population was proportionately greater, but when the dwelling "rooms" were made too large the ants sought to diminish them by constructing partitions made of sand and debris (Fig. 4).

The ant community

C. wroughtoni forms polygamous colonies comprised of several workers and females and sometimes a single wingless male. In addition to mature, inseminated, wingless females, many nests contain also several young females before their nuptial flight, which have not yet shed their wings. As for the male ants, two types are encountered in the nests. The winged males, which resemble ordinary aculeate males. The body of such a male is darkly pigmented and the sense organs are well developed, including large antennae, compound eyes and three ocelli. They are distinctly "outdoor" insects, adjusted to nuptial flight, as is usual in many other ants. In several instances the pupae of such males were detected in our artificial nests, chiefly in the summer, but, before they could eclose, almost all of them were devoured by the adult ants. Oddly enough, not even a single winged male was ever detected within the very

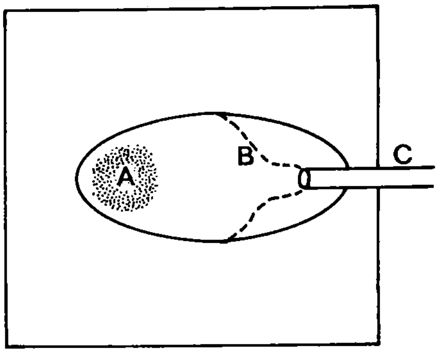

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Fig. 4. Artificial nest of *Cardiocondyla wroughtoni* restricted by sand and debris partitions. (a) ants and their brood; (b) partition; (c) entrance.

Fig. 5. Wingless male of *Cardiocondyla wroughtoni.*

numerous field nests explored by us throughout the year. One winged male was caught in the field outside a nest. The chances of observing winged males in copula during the outdoor nuptial flight are thus close to nil, considering the small size of the colonies and the paucity of winged males. There is reason to believe, therefore, that in the case of *C. wroughtoni* the process of outdoor copulation of winged males and females must be very rare.

The second type of male is ergatoid (Fig. 5), devoid of wings and differs considerably from its winged counterpart also in many other respects (Borgmeler, 1937; Kugler, 1983). The pale yellowish colour of the body is typical and so also is the weak development of the sense organs. That is, the short club-shaped antennae, the small compound eyes and the lack of ocelli. An outstanding feature of the wingless males is the very long, sickle-shaped, pointed mandibles which differentiate them immediately from their winged counterparts, as well as from the female workers (Fig. 6,w) These mandibles were observed to be used for embracing females during courtship, but never observed to have been used for fighting.

The wingless males were often encountered by us within field nests. Almost invariably there was, at most, one male per nest, but in one instance two such males were found in the same field nest. The wingless males are active to a very small extent. Although they were often present in the field nests, we were not able to observe the process of copulation within the nest in its entirety. We did observe, on numerous occasions, males distinctly courting females (and even workers), mounting them and making efforts to copulate. Evidently, copulation must take place on such occasions. The females thus treated lost their wings within 2-3 weeks and sometimes commenced ovipositing. They shortly joined the mature wingless females in the nest.

The development in the *C. wroughtoni* nest of "indoor" males capable of inseminating the virgin winged females contributes to the enhancement of the nest

Fig. 6. Adult ants and brood of *Cardiocondyla wroughtoni.* Worker – W; Wingless female – WF; Wingless male – WM; Larva – L; Pupa – P.

population and the consequent splitting up of the original colony into a number of daughter colonies.

Translocation of a colony of *C. wroughtoni* may evolve from two opposing situations, namely, deterioration of conditions or amelioration of conditions. In the first case, the need to move arises from a worsening of the conditions in the immediate environment of the nest, especially from depletion of the food supply. In the second case, conditions become too favourable, which leads to population increase and overcrowding – again demanding a splitting up of the community, followed by migration and translocation of part of its members.

The flexibility of *C. wroughtoni* manifests itself not only in the task of locating a nesting place, but also in communicating the information on the whereabouts of the new place to the other members of the family. In large ant communities, the usual procedure is to form long "live" trails from the old nest to the new one, but this is not feasible in the case of *C. wroughtoni*, where both the nest and the population are small sized.

To get from the old nest to the new site, *C. wroughtoni* ants exercise two methods of conveyance, namely, "tandem running' and physical transportation. By the first method, when one of the colony members finds a new, suitable nesting site, it then leads another ant to the right place. The second ant closely follows the leader, from time to time touching its abdomen. In a few instances we saw three ants following one another in such "tandem running". For other examples of such behaviour, see Creighton and Snelling, 1974; Wilson, 1959; Wilson, 1980.

The second method of conveying information chiefly involves nest mates which do not usually leave the nest and are not acquainted with the surroundings. Such are the fertile females, and the homely workers, which care for the brood and the progeny of the nest, namely the eggs, larvae and pupae. All of them are lifted by their leading mates and carried to the new site, where a new nest is initiated.

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