Leafhoppers in Ant Nests: Some Aspects of the Behaviour of Pogonoscopini (Hemiptera: Eurymelidae)

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Abstract
Field and laboratory observations on a species of the leafhopper tribe Pogonoscopini have shown that it lives in nests of ants of the genus *Camponotus* during the day. At dusk it emerges, attended by the ants, to feed on mallee during the night. (*The Victorian Naturalist* 116 (1), 1999, 12-15).

Introduction

In the 1920s the north-western Mallee district was still a remote part of Victoria when Charles Oke, at that time an amateur entomologist with a particular interest in beetles, visited the railway siding of Gypsum and Hattah Lakes with J.E. Dixon. He described their excursion in a delightful essay published in *The Victorian Naturalist* (Oke 1926). About this time, a fascinating Australian fauna of insects and other invertebrates living as inquilines (guests) in ant and termite nests was being brought to light, and Oke had become an avid collector of the often bizarre inquiline beetles, discovering a diversity of new species. On this trip Oke found many beetles, but at Hattah Lakes he was also intrigued by 'a kind of froghopper (Cercopidae)' which he encountered in ant nests under the ground. The ant host was apparently the 'sugar ant', *Camponotus nigriceps* (Smith). Oke states the froghoppers 'were found in all stages, except the eggs. Little larvae from slightly more than 1 mm up to fully matured imagines (adults) were seen in the same nest....On rolling over the covering log from one of the nests sometimes a dozen or 20 of these guests will be revealed'. Several froghoppers were found at a depth of 'over 3 feet' (915 mm) in a large *Camponotus* nest 'covered by a log and a sheet of bark' that Oke excavated. Speculating on the habits of these inquilines, Oke said 'it would appear that they spent their lives in these nests - unless they are taken out at night to feed on the trees'. However, his brief observations at night did not reveal any froghoppers outside the nests. Oke did not identify his inquiline froghoppers, but we recognised them as one of the Pogonoscopini, a remarkable tribe of eurymelid leafhoppers.

The Pogonoscopini are poorly studied, distinctive and unusual insects confined, as far as is known, to the southern and interior parts of Australia. The history of the discovery and description of the species and their association with ants is worth recording. In 1909 Jacobi described two leafhoppers from the nests of sugar ants of the genus *Camponotus* from Western Australia; he accommodated the two in the existing eurymelid genus *Eurymeloides*, as *E. acmaeops* and *E. levis* (Jacobi 1909). In 1924 China described the new genus *Pogonoscopus* for a new species *P. myrmex*, and suggested that Jacobi's two species probably belonged to the same genus. China (1926) subsequently revised the group, describing several new genera and species to comprise a new subfamily, the Pogonoscopinae. Evans (1966) later referred to the group as the Tribe Pogonoscopini. Representatives of this unusual group were subsequently collected mainly by myrmecologists and almost always in the nests of *Camponotus*.

Yet the most basic aspects of pogonoscopine biology remained a mystery. They must have sucked sap like all leafhoppers, but where did they feed, and where were the eggs laid? Oke's observations shed no light on these questions. Evans (1931), apparently unaware of Oke's observations, was of the opinion that the pogonoscopines 'sucked up sap from below ground level', basing his comments on the advice of D.C. Swan, then in South Australia. Later, he stated unequivocally that the Pogonoscopini 'feed on the roots of eucalypts' (Evans 1946). In a subsequent revision of the Australian leafhopper fauna,

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Fig. 1. Mallee at Calperum. Characteristic of the habitat of *Pogonoscopus*.

Evans (1966) recognised five species of Pogonoscopini in four genera, placing several of China's species into synonymy. On the behaviour of these leafhopers, he quoted Mr Peter McMillan of Perth, who had frequently collected them with ants in Western Australia. McMillan wrote that the ants 'build their nests under logs and stones and have tunnels with large entrance holes which are smooth and vertical'. The leafhoppers 'walk around with a peculiar rolling motion and when escaping just fold their legs and tumble down the shaft'.

Field observations on *Pogonoscopus myrmex*

An opportunity to study a pogonoscopine species under field conditions arose when three leafhoppers identified as *Pogonoscopus myrmex* China were caught in traps set in mallee as part of a survey of the invertebrates of the Calperum sector of Bookmark Biosphere Reserve, South Australia (Pullen 1997). The collection site (Fig. 1), situated in the old Amalia paddock of the former Calperum sheep station, is dominated by Red Mallee, *Eucalyptus socialis* F.Muell. ex Miq. Calperum is located north of Renmark and has a semi-arid climate. The manner of collection of the specimens - two nymphs in pitfall traps and an adult female in a combination pitfall/flight intercept trap - dispelled the view that they passed their lives confined to ant nests.

We returned to the Amalia site on 12 October 1995 with the aim of observing *Pogonoscopus* and collecting additional material. Since previous ant collectors had found pogonoscopines most commonly in the nests of *Camponotus* at the base of eucalypts, the Amalia search was begun by excavating nests of *C. gouldianus* Forel located at the base of mallees. The nest tunnels invariably penetrated between the mallee roots, allowing only partial excavation, but after several hours five adults and one nymph of *P. myrmex* had been found, confirming *C. gouldianus* as a host ant. This work was carried out during daylight hours and no leafhoppers were seen outside the *Camponotus* nests.

Appreciating that *Camponotus* are night foragers, we returned to the site at dusk. We found many ants milling around the entrances to their nests and soon one or two pogonoscopines were observed. As darkness fell, more appeared, and eventually both nymphs and adults were seen to be climbing the mallee stems. The temperature was approximately 12-15°C. The pogonoscopines were noticeably more

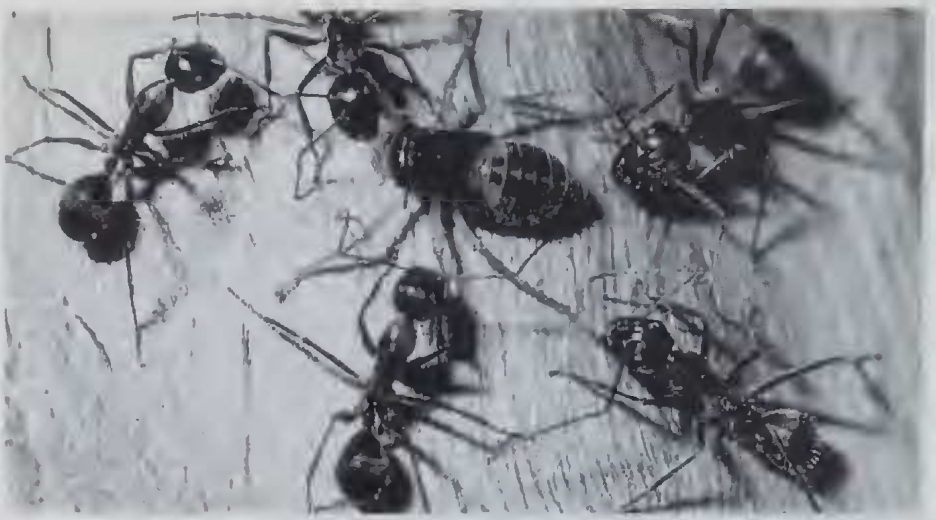

Fig. 2. A nymph of *Pogonoscopus myrmex* feeding at night on *Eucalyptus socialis* and attended by *Camponotus gouldianus*.

affected by the torch beams and moved faster than the ants, either to the far side of the trunk or more frequently under adhering bark. They were not 'herded', but moved independently of the ants, although ants attempted to follow any leafhoppers they encountered. Finally, at about 1930 hrs, some leafhoppers were seen to begin to feed, and then they were always attended by several ants (Fig. 2). During feeding, it was observed that the hind legs were often elevated and waved; the significance of this behaviour is not known. Most of the trees were above 3 m in height, so that, without ladders, it was not possible to see whether the leafhoppers ascended to the smaller branchlets. All nymphal stages and adults were present. Although they were more readily collected at night than during the day, they were not easy to capture because of their rapid movements and their aversion to light. The same behaviour was observed on the following night when the insects were photographed.

Laboratory observations on *Pogonoscopus myrmex*

Some nymphs and adult *P. myrmex* and their attendant ants were brought alive to Canberra where they survived for a week without food. Others were offered *Eucalyptus leucoxylon* F.Muell., on which they appeared to feed, even when the branchlets were considerably desiccated. To test the reaction of a local non-host *Camponotus* to their presence, several *P. myrmex* were placed in a previously prepared colony of *C.consobrinus* Erichson. The leafhoppers were vigorously attacked, with no evidence of any symbiotic relationship, inherent or otherwise.

Observations on *Australoscopus* sp.

During our stay at Calperum, a colleague Mr Michael Moore of Adelaide, returned from a day trip to Waikerie, South Australia, with live specimens of a second pogonoscopine, identified as a species of *Australoscopus*. The species is smaller than *Pogonoscopus myrmex* and was attended by *Camponotus terebrans* (Lowne) in a nest under cover on the ground. In culture, the ants on being disturbed were observed to pick up and carry the leafhoppers, behaviour noted by Oke (1926). On uncovering an ant nest, Oke observed that his froghoppers 'seem to be greatly agitated', and that 'any ant meeting one of the guests will immediately seize it by the thorax and carry it down one of the holes.... The ants invariably carry the leafhoppers off head foremost, and generally turn them over with their feet uppermost as soon as they take hold of them...' . To Oke it was evident 'that these froghoppers are used to being carried by the ants'.

It seems likely that the insect Oke was describing was a species of *Australoscopus*. We never observed *Camponotus gouldianus* carry *P. myrmex*.

Discussion

Our observations demonstrated that *Pogonoscopus myrmex* is not confined to ant nests and that, while feeding, its behavioural interaction with its ant host is comparable to that of other eurymelids (Evans 1931; Buckley 1987), except that *P. myrmex* feeds at night. Diurnal ant inquilinism and nocturnal foraging may be a strategy that allows *Pogonoscopus* to avoid both predation and the hot, desiccating diurnal conditions where it lives.

In most characters, such as their mouthparts, antennae, leg structure and fully developed wings, the Pogonoscopini are typically eurymeline. However, neither the nymphs nor adults are capable of jumping, so that 'leafhopper' is an inappropriate name for these insects. The unusually long legs of all stages, even 1st instar nymphs, have been mentioned in all previous reports, several authors referring to their 'spider-like' appearance. The long legs could be an adaptation to allow an easier daily trip from the host ants' nest up to the mallee branches and return. It would be of interest to learn whether the young nymphs travel long distances walking, both after hatching from the egg and to feed; such travel would represent a substantial feat.

Pogonoscopus myrmex does not appear to exhibit special myrmecophile adaptations for permanent life in ant nests. Myrmecophiles typically have the eyes reduced or absent, and the epidermis is often unpigmented. To avoid injury by their ant hosts they are often rapid runners (e.g. Thysanura, Staphylinidae) or are able to retract the antennae and legs into grooves in the body integument (e.g. many inquiline beetles).

The fat body of both adults and immature stages of pogonoscopines is very well developed, possibly an adaptation necessary to hold them over on occasions when, perhaps due to weather conditions, the insects are unable to leave the host ant nest to feed.

The observations noted above show that significant differences exist between pogonoscopine genera in their behavioural relationships with their host ants. Much of the life history of these inquiline leafhoppers remains completely unknown. We do not know where or at what time of the year the eggs are laid, or where the early instars live. If the eggs are inserted into the twigs or stems of the host plant, as in other eurymelids, how do the nymphs reach the nest of a host ant? We know nothing of the behaviour of the other three described pogonoscopine species. An interesting study awaits a future student.

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