New Zealand Journal of Zoology, 1994, Vol. 21: 249–252
0301–4223/2103–0249 $2.50/0

Fustiserphus (Hymenoptera: Proctotrupidae) parasitises Lepidoptera in leaf litter in New Zealand

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Abstract The New Zealand proctotrupid *Fustiserphus intrudens* (Smith) was reared from two species of *Tingena* (Lepidoptera: Oecophoridae) feeding on leaf litter in *Nothofagus* forest. Host relationships in the Proctotrupidae are discussed.

Keywords *Fustiserphus intrudens*; *Fustiserphus reticulatus*; Proctotrupidae; Hymenoptera; *Tingena*; Oecophoridae; Lepidoptera; New Zealand; leaf litter; host relationships

INTRODUCTION

Townes & Townes (1981) summarised the biology and host associations of Proctotrupidae. Most are solitary or gregarious internal parasitoids of the larvae of various families of Coleoptera, but there are a few exceptions. Members of *Cryptoserphus* Kieffer, and perhaps also related genera, are restricted to fungus gnat larvae (Diptera: Mycetophilidae) (Masner 1968; Huggert 1979; Townes & Townes 1981). *Phaneroserphus calcar* (Haliday) was reared from a lithobiid centipede (Chilopoda) (Newman 1867) as well as two genera of Staphylinidae.

We present evidence that Lepidoptera larvae are parasitised by proctotrupids. This is an unusual host association for the family, and was discovered by JSD during investigations into the Lepidoptera fauna of leaf litter in New Zealand forests.

Received 19 July 1993; accepted 2 March 1994

METHOD

About 40 larvae of *Tingena* species and a smaller number of *Gymnobathra* species (Oecophoridae: Oecophorinae) from leaf litter in *Nothofagus* forests from a variety of localities in the North Island were reared in the laboratory until pupation or mortality. All reared proctotrupids and their host remains are in the New Zealand Arthropod Collection, Mt Albert Research Centre, Auckland.

RESULTS

A single *Fustiserphus intrudens* female emerged from each of three *Tingena armigerella* (Walker) and one *T. nycteris* (Meyrick) larvae. Data for the four specimens, using the locality codes of Crosby et al. (1976), are as follows:

1. TO, Waipakihi River, The Narrows, 16.iv.1990, JSD, *Nothofagus* litter, emerged from *Tingena nycteris* larva 20.xi.1990.
2. WN, Orongorongo Valley, Station Ridge, 150 m, as larva 2.xii.1991, B. M. Fitzgerald, reared ex *Tingena armigerella* ex *Nothofagus truncata* litter, emerged 3.i.1992.
3. WN, Orongorongo Valley, Station Ridge, 150 m, 24.ix.1991, JSD, hard beech litter, reared ex *Tingena armigerella*, parasitised 20.xi.1991, emerged .xii.1991.
4. WN, Orongorongo Valley, Station Ridge, 250 m, 24.ix.1991, JSD, ex litter in fine grass, reared ex *Tingena armigerella*, emerged .i.1992.

With all four specimens, the parasitoid larva emerged from the ventral surface near the posterior end of the host larva, to pupate facing anteriorly as shown in Fig. 1. This seems to be the usual pattern for Proctotrupidae.

Gymnobathra larvae proved difficult to rear. No

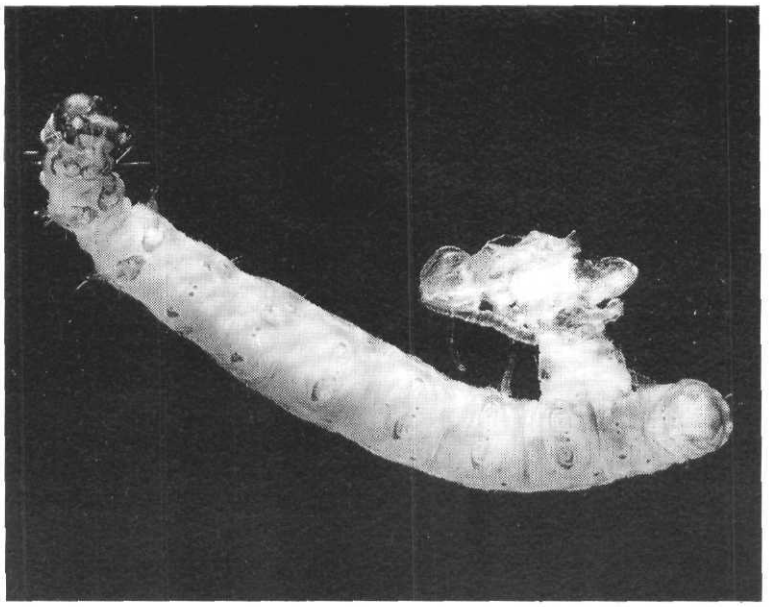

Fig. 1 Ventral view of final instar larva of *Tingena nycteris* with pupal skin of *F. intrudens* at posterior end. Larva is 12 mm long. *(Photo: J. W. M. Marris, Lincoln University.)*

parasitoids and only a few adult moths were produced.

DISCUSSION

New Zealand Proctotrupidae, *Fustiserphus* and its hosts

New Zealand's fauna of Proctotrupidae is virtually unstudied. It is composed mainly of the two endemic genera *Oxyserphus* Masner (shared with Australia and New Guinea) and *Fustiserphus* Townes (shared with South America and the southern part of North America). Several species appear to belong to two or three undescribed genera, but on closer study some may prove to be highly apomorphic members of *Oxyserphus* and *Fustiserphus*. There is also at least one cosmopolitan tramp species, *Exallonyx trifoveatus* Kieffer (Townes & Townes 1981). *Oxyserphus* dominates the fauna in terms of number of species. Those for whom hosts are known all attack larval Curculionidae and Anthribidae (Townes & Townes 1981; reared specimens in the New Zealand Arthropod Collection). *Fustiserphus* is represented by only two named and two or three unnamed species, but it is the ubiquitous *Fustiserphus intrudens* which is the most commonly collected proctotrupid in New Zealand.

Fustiserphus intrudens is found in a variety of habitats including native forest of most types, forest margin, shrubland, and semi-woodland suburban gardens. Adults are most commonly collected from December to mid March. The abundance of *F. intrudens* is closely linked to the abundance and distribution of its hosts. The host genus *Tingena* contains 80 named species so far (Dugdale 1988). All feed on leaf litter during the larval stage, and in any one locality there may be up to 12 species within the same habitat, all living and feeding in the same way (J. S. Dugdale pers. obs.). There seems little adaptive reason for *F. intrudens* to show host specificity and, although we have reared it from only two species to date, we expect that it will prove to parasitise other *Tingena* species. Indeed, proctotrupids whose biology is better known are oligophagous, each attacking several species (often in several genera) within a family (Townes & Townes 1981).

Tingena larvae are found in the leaf litter at the boundary between the upper layer of loose and dryish leaves and the lower, more compacted and permanently moist zone. They loosely tie two dead leaves together with silk and live in a gallery within. The silken gallery soon extends beyond these leaves as larvae grow, with tunnels spreading out to new feeding sites. Larval densities may reach up to 20/m^2, and each larva produces a large amount of frass. *F. intrudens* possibly locates its hosts largely by frass odour; indeed frass is the most commonly reported source of kairomonal cues for parasitoid host location (Vinson 1988).

The life cycle of *F. intrudens* seems to be well

synchronised with that of its hosts. Proctotrupidae generally attack hosts in their early instars (Eastham 1929; Askew 1971). If this is true for *F. intrudens*, then its peak adult abundance coincides with the presence of young *Tingena* larvae in the litter from mid to late summer. *Tingena* larvae develop slowly through the autumn and winter, pupating in spring and early summer. Emergence dates for the four *F. intrudens* we reared (see above) indicate that they are well timed to coincide with the next *Tingena* generation.

Proctotrupid host associations

Ours is not the first published record of a proctotrupid parasitising a lepidopteran. Townes & Townes (1981) provided label data for two paratypes of *Fustiserphus reticulatus reticulatus* Townes from Colorado, U.S.A., which indicate that they were reared from the pine tip moth *Rhyaciona buoliana* (Lepidoptera: Tortricidae). On the face of it, this was an unlikely association since it did not accord with the weight of available evidence pointing to Coleoptera as principal hosts. Many host records for Hymenoptera are unreliable because of misidentifications. For whatever reason, Townes & Townes (1981) omitted this record from their discussion of proctotrupid host relationships.

Unfortunately, the specimens have no associated host remains for verification, but original notes held in the United States National Museum of Natural History pertaining to them refer to an unknown lepidopteran larva feeding on mistletoe on *Pinus ponderosa*; presumably this was identified later as *R. buoliana* (P. Marsh, *in litt.*). Powell & Miller (1978) indicate that *R. buoliana* does not live in Colorado, so the host record is clearly a misidentification, perhaps for one of the seven endemic *Rhyaciona* species that are found in Colorado (Powell & Miller 1978), several of them pests of *Pinus* spp. Extensive rearing of *Rhyaciona* species by many researchers throughout North America searching for biocontrol agents has not produced any more proctotrupid specimens (Yates III 1967; Harman & Kulman 1973). If *F. r. reticulatus* parasitises *Rhyaciona* at all, it is likely to target one of the less economically important and less well known species. Whatever the usual host species is, there is no reason to dispute its ordinal position.

The host records summarised by Townes & Townes (1981) show that each proctotrupid genus is restricted to one or a few families within an order. There are now records of two *Fustiserphus* species parasitising Lepidoptera, indicating that this might be the norm for the genus. Although it represents a major taxonomic jump in hosts from the usual Coleoptera, at least the hosts of *F. intrudens* are found in "typical" procotrupid habitat. Proctotrupid hosts are usually hidden in some way, in soil and leaf litter (Coleoptera: Carabidae, Elateridae, Staphylinidae; Chilopoda: Lithobiidae) or in habitats close to the ground like decaying wood and the fruiting bodies of fungi (Coleoptera: Anthribidae, Curculionidae, Erotylidae, Melandryidae, Phalacridae; Diptera: Mycetophilidae). The parasitoid/host relationship is an intricate one involving complex behavioural, morphological, biochemical, and phenological components. The first step in initiating successful parasitism is selection of the habitat in which to search (Doutt 1959; Vinson 1976) and this narrows down the choice of potential hosts. Indeed, it is easy to rear some parasitoids on "unnatural" hosts (i.e. species usually closely taxonomically related, which would not be encountered because they live outside of the habitat searched) (Simmonds 1944; J. W. Early pers. obs.). But "unnatural" hosts in different orders have been used: Salt (1938) showed that *Trichogramma evanescens* (Trichogrammatidae), normally parasitic on Lepidoptera eggs, attacked eggs of Diptera, Neuroptera, and Coleoptera when presented with them. It may prove easier (or at least no more difficult) for some parasitoids to switch to taxonomically unrelated hosts within the same habitat than to overcome a behavioural barrier which would allow them to search for related hosts but in a different habitat.

The question remains, which insect group (Coleoptera, Diptera, or Lepidoptera) were the original hosts of ancestral Proctotrupidae, and in which directions have host changes occurred? The simplest explanation postulates Coleoptera as the ancestral hosts from which two groups have independently adapted to different hosts: *Cryptoserphus* from fungus-dwelling Coleoptera to mycetophagous Diptera, and *Fustiserphus* from soil/litter-dwelling Coleoptera to detritivorous Lepidoptera, the latter habit being unusual in an order where most members are feeders on fresh plant tissue. Arguments could be made for either Diptera or Lepidoptera as ancestral hosts but, without going into detail here, these explanations pose problems. A thorough phylogenetic analysis of the family is likely to reveal more of the evolutionary relationships of proctotrupid genera and their host associations.

Biogeographic considerations

Fustiserphus is basically a southern genus known only from New Zealand and South America; one species is known from the U.S.A. It has only six named species plus an estimated six still undescribed (Townes & Townes 1981). Similarly, the host family Oecophoridae is well developed in the Southern Hemisphere, at least in Australia and New Zealand (not enough is known of South America), where it has many detritivorous species. Oecophoridae are comparatively less well represented in the Northern Hemisphere (Common 1990) where dead-tissue feeders do not appear to be a feature of the Lepidoptera (Dugdale 1975). If parasitism of litter-dwelling Lepidoptera is widespread within *Fustiserphus*, its absence from Australia and New Caledonia, whose litter faunas also have a rich oecophorine component, is perplexing. Common (1990) states that there are about 2300 described species of Oecophorinae in Australia, of which a substantial proportion feed on *Eucalyptus* leaf litter. He also notes that, in general, Australia's oecophorine fauna is distinct from that of New Zealand and South America. If host-parasitoid associations prove to be biogeographically significant, the shared presence of *Fustiserphus* may indicate that the affinities of some New Zealand Oecophorinae lie more closely with South America than Australia.

ACKNOWLEDGMENTS

We thank Paul Marsh, Systematic Entomology Laboratory, Washington D.C., for checking the paratypes of *Fustiserphus reticulatus reticulatus* and providing additional information, and John Marris, Lincoln University, for Fig. 1. Jo Berry and an anonymous reviewer provided valuable comments on the manuscript.

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