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SPECIES RICHNESS AND ENDEMISM OF BAEINE WASPS (HYMENOPTERA: SCELIONIDAE) IN AUSTRALIA

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Abstract

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The species richness and level of endemicity of baeine scelionid wasps, which are endoparasitic on spider eggs, were determined for four sites of urban bushland in the Perth area and among four more distant localities across the Australian continent. Among the Perth sites the number of baeine species varied from 14 to 20, with a total number of 27 for the sites combined. The proportion of species shared among sites was high, 55–71%, but 22% of species were only recorded at one site. The four distant locations which had different vegetation types, viz. Western Australia (Perth), South Australia (Mt Barker), and north and south-east Queensland (Split Rock and Mt Glorious), varied in number of species from 20 to 31 (total of 97 species) but with virtually no species in common among them. These results are discussed in relation to differences in habitat preference, collecting techniques, the size of the Australian baeine fauna, and a possible trophic level relationship between spider and baeine species richness (i.e. host and parasitoid).

Introduction

In recent years comprehensive surveys of invertebrates using multiple trapping techniques have shown that the insect order Hymenoptera to be one of, if not the most, species rich ordinal taxa of animals (LaSalle and Gauld, 1992, 1993). This is particularly obvious from surveys in tropical forests (Askew, 1990; Naumann et al., 1991; Noyes, 1989a, 1989b) but generally it applies across most terrestrial habitats (LaSalle and Gauld, 1993). Like the other huge orders of insects, the Hymenoptera comprise a large number of functional groups, including herbivores (exposed leaf-feeders, leaf miners, gall formers, seed feeders, pollen and nectar feeders, and xylophagous species), predators, parasitoids (both ecto- and endoparasitoids), and hyperparasitoids (see Gauld and Bolton, 1988). However, it is one functional group, the parasitoids, that is responsible for the species richness of the order. Parasitoids exploit arthropods as a food source for their developing larvae and they have radiated into this almost unlimited resource, producing a phenomenal number of species, probably several hundred thousand world-wide. It is this biology, associated with their high degree of host specificity, that has lent them to being utilised as biological control agents of insects.

One group of small scelionid parasitoids, the Baeini (< 2 mm in length), endoparasitically attack the eggs of spiders (Austin, 1985), and they are postulated to be important regulating agents of spider populations (Austin, 1984a). Given that spiders are becoming one of the preferred groups as ecological indicators, to assess such aspects as general species richness, habitat disturbance, faunal community structure and biogeographic relationships (see Churchill, 1997; Harvey et al., 1997; Main, 1997; York, 1997), a comparable knowledge of the distribution patterns, richness and levels of endemism of baeine wasps may allow such ecological questions to be examined and compared between trophic levels, i.e. between spiders and their parasitoids. In this respect, the current study documents distribution patterns and composition among baeine wasps for a number of sites within the Perth urban area, and among four distant localities across the Australian continent which vary substantially in habitat type.

Methods

Four sites around the Perth urban area were selected to assess baeine species richness, and they represented areas of remnant native vegetation which were used in a more extensive study by Harvey et al. (1997). These were located at Bold Park, Perth Airport, Tuart Hill and the Talbot Road Reserve, and they generally comprise open *Eucalyptus-Banksia* woodland. The collecting method at these sites was three or four grids, each of 10 2-l plastic ice-cream containers charged with concentrated (95%) ethylene glycol and run for 12 months. It was not possible to use other collecting techniques around Perth, such as Malaise traps, because of the high risk of vandalism (see Harvey et al., 1997 for more detailed description of the sites and collecting method). Specimens were removed from traps about every six weeks; they were then washed, transferred to 70% ethanol and sorted under a stereomicroscope, point-mounted and labelled.

Taxonomically, baeine scelionids are well-known at the generic level (Galloway and Austin, 1984). Further, sufficient information is available at the species level to accurately separate morphospecies (e.g. Austin, 1981, 1984b, 1986, 1995), even though the majority are undescribed. Characters found to be particularly important in separating species include the relative size and shape of body segments and tergites, surface sculpturing, length and shape of antennal segments, presence and size of a metasomal horn, development of wings, length of veins, wing pilosity, and colour pattern.

To assess regional (continent wide) levels of baeine richness and endemism, the data from the four Perth sites was pooled and compared with that from three additional localities. These data were collected in an *a posteriori* fashion, i.e. they were accessed from existing material in museum collections (primarily the Australian National Insect Collection, Canberra and Department of Primary Industries, Brisbane). These sites were selected because they have been extensively collected, they are very distant from each other, and they represent very different habitat types. They are Mt Barker summit, 30 km ESE of Adelaide, SA, comprising disturbed open mallee woodland; Mt Glorious summit, a well-known rainforest site in SE Queensland; and Split Rock, north Queensland, comprising tropical savannah. The collecting methods and duration of trapping varied among the four locations as indicated in Table 2. However, the techniques employed were chosen to optimise the wasp catch at each location. A Malaise trap was used at Mt Barker, Mt Glorious and Split Rock, a flight-intercept trap (FIT) was deployed at the latter two locations, while sweep-netting was only undertaken at Mt Glorious (N.B. the latter technique did not yield any additional species). Further, the six month duration of trapping at Mt Barker is probably equivalent to the 12 months at the other locations, given that previous experience has shown that baeine wasps are hardly ever collected there during the winter months and, when specimens have been taken, they have represented common summer-active species. As for the pitfall traps at Perth, the FIT at Split Rock used ethylene glycol as a preservative, while the Malaise traps used 70% ethanol.

Results and discussion

The genera and number of baeine species for the four sites around Perth are given in Table 1. The number of genera varied little, from five to six, but the composition was different among sites, with no site having all seven genera. The number of species varied from 14 at Tuart Hill to 20 at Bold Park, with a total of 27 species recorded across all sites. Of these, 14 species (52%) are either wingless or micropterous, including all females of *Baeus* Haliday, *Mirobaeoides* Dodd and *Mirobaeus* Dodd, and three species of *Idris* Foerster (data not shown), while the majority of *Idris* and *Ceratobaeus* Ashmead, and all *Odontacolus* Kieffer and *Hickmanella* Austin are fully winged. The overlap in species composition among sites is shown in Figure 1. It varied from 55% (Bold Park versus Tuart Hill) to 71% (Tuart Hill versus Talbot Road and Perth Airport), although six species (22%) were restricted to just one site. However, more extensive collecting at the four sites is likely to increase the number of shared species.

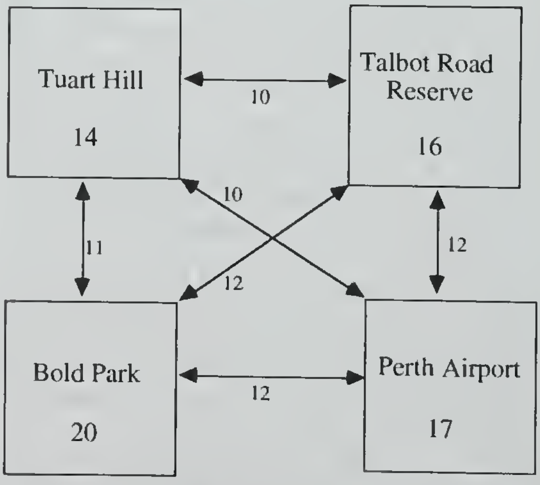

Figure 1. Number of baeine scelionid species shared between the four sites of remnant vegetation in the Perth area.

Table 1: Number of species of baeine scelionid wasps at four sites in the Perth urban area.

	Sites			
Genus	Tuart Hill	Talbot Rd Reserve	Bold Park	Perth Airport
Baeus	2	2	2	2
Ceratobaeus	—	2	3	3
Hickmanella	1	1	1	—
Idris	4	5	7	4
Mirobaeoides	6	6	6	5
Mirobaeus	1	—	—	1
Odontacolus	—	—	1	2
Total	14	16	20	17

Table 2: Number of species of baeine scelionid wasps at four localities in Australia

Locality	Perth, WA	Mt Barker, SA	Mt Glorious, SE Qld	Split Rock, N Qld
Trap type	Pitfall	Maliase	Maliase, FIT, Sweeping	Maliase, FIT
Duration	12 months	6 months	Sporadic, long term	12 months
Baeus	2	1	2	—
Ceratobaeus	4	11	15	10
Hickmanella	2	—	—	—
Idris	8	8	12	11
Mirobaeoides	8	—	1	1
Mirobaeus	1	—	—	—
Odontacolus	2	—	1	1
Total	27	20	31	23

Data for the four Perth sites was pooled and is presented along with the three distant localities, Mt Barker, Mt Glorious and Split Rock in Table 2. Because of differences in collecting techniques, number of traps, and duration of sampling the data are only generally comparable. However, they are most similar for the three eastern localities, all of which approximate 12 months collecting and used similar traps.

The number of genera varied more significantly than among the four Perth sites, from seven at Perth (combined) to three at Mt Barker, while the number of species varied from 20 at Mt Barker to 31 at Mt Glorious (Table 2), with a total of 97 species. Further, the species composition varied substantially among Perth and the other three localities in the number of apterous/micropterous forms, from 4–5% (one species) at Mt Barker and Split Rock to 26% (eight species) at Mt Glorious and 52% at Perth (see above). These differences are primarily reflected in the numbers of *Mirobaeoides* spp., all of which have apterous females. Whereas the four sites at Perth had eight species, the other three locations had one or none. The richness of this genus around Perth is particularly surprising, given that a recent revision of *Mirobaeoides* for the whole continent (Austin 1986) recorded only 12 species, most of which are apparently restricted to the eastern seaboard. Like Perth, the other three localities were dominated by *Ceratobaeus* and *Idris* spp. but even more so, i.e. 87% or more of the total species. The reasons for the above differences among locations are not clear. They could be arifactual and the result of different collecting techniques, or they could reflect real differences in habitat preferences and levels of endemicity among genera and species. Quite probably, both factors are involved. As might be expected, the locality with the highest proportion of apterous/micropterous species (Perth) was the one where only pitfall traps were used, a technique that is likely to optimise the catch of ground-inhabiting, reduced-winged forms. However, flight interception traps also catch ground-living species (Austin pers. observ.) and in the two locations, Mt Glorious and Split Rock, where these traps were employed, the proportion of apterous/micropterous forms was surprisingly much lower.

Where the number of species shared among the Perth sites exceeded 50%, that among the four distant locations was very low. Only two species were shared between Perth and Mt Barker, and a further two between Perth and Mt Glorious (i.e. 7%), while no species were shared among Mt Barker, Mt Glorious and Split Rock.

Although the species recorded at the four localities undoubtedly occur more widely, the fact that there is very little overlap in the fauna among localities indicates that many baeines have restricted distributions, e.g. no species in common between the eastern sites (Mt Glorious and Split Rock). These data raise the question — what is the true size of the Australian baeine fauna? Recent surveys by us, based on examination of Australian and overseas collections, and extensive field work over the last 15 years by one of us (ADA) show that the number of described species conservatively represents only about one-sixth of the estimated total number (Table 3). Already, about 150 species each of *Idris* and *Ceratobaeus* have been recognised. This estimate is based on the number of species identified in collections, increased by a factor of approximately 20–25% to account for as yet unrecorded new species. Indeed, new species have been collected within the last 12 months from relatively well-collected habitats close to major Australian cities. Further, the level of endemism indicated in this study among geographically close and distant localities strongly suggest that areas of the continent that have not been collected or only poorly surveyed (for which there are many) are likely to yield many new species. Therefore, our estimated increase of 20–25% over and above the currently known species, may be far too conservative.

Table 3. Recorded and estimated number of Australian baeine species

Genus	Described species	Estimated species
Baeus	3	20
Ceratobaeus	31	200
Hickmanella	4	10
Idris	27	200
Mirobaeoides	15	35
Mirobaeus	2	15
Odontacolus	3	20
Total	85	500

Whether or not the species richness of baeine wasps is related to that of their host spiders is yet to be determined. However, the present study provides the background and means for this to be undertaken, at least at the four urban bushland sites around Perth (see Harvey et al., 1996). If baeine richness is so related, then these small wasps may prove an important adjunct to studies on the diversity of spiders, and to examining species richness between trophically linked groups, viz. invertebrate hosts and their insect parasitoids. One aspect of the biology of baeine wasps that is yet to be investigated and which is likely to impinge on both of these questions (the size of the continent's fauna and whether baeine and host species richness are linked) is their level of host specificity. Preliminary studies on four species of baeines indicate that they are specific to at least a single spider genus, and possibly more narrowly to a species-group (Austin, 1984a). If this is the case, then the total number of baeine species will be dictated, to a large degree, by the number of genera/species-groups they have evolved to exploit. Clearly, not all spiders are attacked by baeine wasps. For instance, they are not recorded from mygalomorph eggs, whereas they are known from many araneomorph species (Austin, 1985). However, for the great majority of araneomorphs such information is just not available.

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