

## DIVERSITY AND BIOGEOGRAPHY OF AUSTRALIAN MILLIPEDES (DIPLOPODA)

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### Abstract

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Twenty families of millipedes, representing nine orders, have been recorded from Australia. Three of these families and one of the orders are introduced. The greatest diversity is found east of the Great Dividing Range and in the south-east, including Tasmania. Approximately 250 native species have been described, probably representing only 10-20% of the actual number. Large areas of Australia, such as the north-west and west central coast, have yet to be adequately surveyed. Lack of detailed taxonomic and biological information precludes use of Australia's diverse millipede fauna for environmental management purposes.

### Introduction

The millipede fauna of Australia is rich but largely unknown. As detailed below, nine of the 15 orders recognised in the world fauna (Hoffman, 1979) and 20 of the approximately 100 families (Hoffman, 1982) have been recorded from Australia. Three of the 20 families and one of the nine orders have been introduced since European settlement. P.M. Johns (pers. comm.) estimates that there are at least 2000 native species, about eight times the present known fauna. The majority of the undescribed species are small, inconspicuous soil and litter dwellers.

The aims of the present work were fourfold:

1. to briefly summarise the history of Australian millipede studies;
2. to give an overview of the taxonomic and morphological diversity of Australian millipedes at the order and family levels;
3. to document the geographical distributions of millipede orders and families regionally within Australia; and
4. to identify the major gaps in our present knowledge of the Australian millipede fauna.

Distributional records are based on data gleaned from specimen material lodged in all of the major museums in Australia, supplemented with records from collections made by the author and the personal research collections of R. Mesibov in Tasmania and J. Majer in Western Australia.

### Millipede studies in Australia

Prior to about 1990 there were no millipede

taxonomists working within Australia. All taxonomic descriptions of Australian millipedes published before the 1990s had been prepared by European and North American specialists. Many of the specimens on which these works were based were collected during major expeditions to Australia early this century (Attems, 1911; Verhoeff, 1924). No attempt had been made, however, to characterise the nature of the fauna as a whole. Modern millipede studies began after the visit in 1980 of C.A.W. Jeekel, an eminent European systematist. In reporting this visit, Jeekel (1981) summarised the state of taxonomic knowledge of eastern Australian millipedes and documented zoogeographic distributions of higher taxa. His summary is, and will continue to be an invaluable reference for all subsequent millipede studies in this country.

In the 1980s, most published accounts dealing with Australian Diplopoda by local researchers concerned the ecology and control of the introduced *Ommatoiulus moreletii* Lucas, 1860 (the Black Portuguese Millipede). The research was concentrated in South Australia, where localised outbreaks of this nuisance pest were considered serious enough to have warranted considerable efforts in a search for a biological control agent. The search was carried out both in the area of origin of the species (Iberia) and in south-eastern Australia, and resulted in the importation of a parasitic fly from Portugal and the identification of a nematode parasitic in Australian millipedes (Baker, 1985a, b; Bailey, 1989; Shulte, 1989). Possible interactions between *O. moreletii* and native millipede species were investigated as an honours project at Flinders University in Adelaide (Griffin and Bull, 1995).

Other applied work on millipedes in Australia has dealt with the ecology of the pineushion millipede *Unixenus mjobergi* (Verhoeff, 1924) in the Pilbara region of Western Australia. Like *O. moreletii* this species also becomes a nuisance when it invades townships in the hundreds of thousands after rain (Burt, 1984; Koch, 1985).

Australian species of the order Chordeumatida (Craspedosomatida) have received recent attention (Golovatch, 1986; Mauriès, 1987; Shear and Mesibov, 1994, 1995), after first having been mentioned as being present in Australia by Jeekel (1981). This order is well represented in Australia, but all species are cryptic litter dwellers. The fact that it is only now being well documented illustrates the embryonic state of our knowledge of Australian millipedes generally.

Studies by resident Australian taxonomists have only begun in the last five years. R. Mesibov (Queen Victoria Museum and Art Gallery) has contributed to works on the Tasmanian Chordeumatida (Shear and Mesibov, 1994, 1995) and is investigating the systematics of the Tasmanian Dalodesmidae (Polydesmida) and the zoogeography of all Tasmanian millipedes. The author has undertaken revisions of genera in two Australian families, Siphonotidae (Polyzoniida) and Siphonophoridae (Siphonophorida), and is conducting a family level review and producing a key to the millipede families occurring in Australia.

Recent investigations of cave millipedes at Cape Range and Barrow Island, Western Australia, were initiated by W. Humphreys at the Western Australian Museum (Humphreys and Shear, 1993; Hoffman, 1994). Allozyme electrophoresis carried out on cave populations of the polydesmidan *Stygiochiropus* spp. from Cape Range (Humphreys and Shear, 1993) is one of the few examples of a molecular approach to millipede systematics in the literature.

#### Taxonomic and morphological diversity

Orders and families of Australian millipedes are listed in Table 1. Omitted from this table are the introduced taxa including the order Julida (families Julidae and Blaniulidae) and the Polydesmidae of the order Polydesmida, leaving eight orders and 17 families. Only one family, Peterjohnsiidae, is known to be endemic (Mauriès, 1987). The family list in Table 1 is based primarily on Jeekel (1981), Hoffman (1982) and the unpublished work of P.M. Johns. Harvey and Yen (1989) provide a very useful illustrated

key for identification of millipede material to order level.

The pineushion millipedes (Polyxenida) are atypical, being very small (generally less than 5 mm in length), extremely setose and able to withstand much drier conditions than most other Diplopoda.

Pill Millipedes (Sphaerotheriida) are inhabitants of wet eucalypt forest and rainforest. Since rainforest invertebrates have been much better collected in Australia than those from many other habitat types, the systematics of the Australian pill millipedes is probably better known than that of any other order.

The orders Polyzoniida and Siphonophorida are known as 'sucking millipedes' and show a reduction in mouthparts which is much more pronounced in the latter. Both groups are primarily wet forest millipedes. They are obviously not typical macrodetritivores, given the structure of their mouthparts, but what they do eat is unknown.

The Chordeumatida are small litter dwellers found in wet forest. Members of the two families found in Australia can be distinguished from other millipedes by the occurrence on each body segment of six dorsal macrosetae.

The most taxonomically diverse of the millipede orders in Australia is Polydesmida. The Paradoxosomatidae is the most species of all the native millipede families and paradoxosomatids are common in most forest and woodland habitats. Dalodesmidae are common in the east and south-west, and are particularly well represented in Tasmania. Members of the families Haplodesmidae and Pyrgodesmidae are difficult to distinguish from one another. They are small, highly sculptured and rigid-bodied animals, widespread in soil and litter. Very little is known about them in Australia, and there may be many undescribed species. At least one species of the family Polydesmidae, *Brachydesmus superus* Latzel, 1884 has been introduced to Tasmania (R. Mesibov, pers. comm.). The occurrence of this or other introduced Polydesmida elsewhere in Australia has not been reported.

Along with the introduced Julida, the last two orders in Table 1 are collectively known as 'juliform', which refers to the general body shape. Australian species of Julida are introduced. Most are restricted to metropolitan areas in southern Australia, but *Ommatoiulus moreletii* has made substantial inroads into dry native bush around the cities. The three families of Spirobolida in Australia are typically found in

Table 1. Regional distributions of Australian millipede families, excluding those introduced. P = present (recorded from that region); Qld = Queensland, NSW/Vic. = New South Wales and Victoria, Tas = Tasmania, NT = Northern Territory, SA = South Australia, Upper WA = upper Western Australia, Lower WA = lower Western Australia. Boundaries are approximate, based on divisions shown in Figure 2.

Taxon (Orders in caps)	Qld	NSW/ Vic.	Tas.	NT	SA	Upper WA	Lower WA
<b>POLYXENIDA</b>							
Synxenidae	P	P			P	P	P
Polyxenidae	P	P	P	P	P	P	P
Lophoproctidae	P					P	
<b>SPHAEROTHERIIDA</b>							
Sphaerotheriidae	P	P	P				P
<b>SIPHONOPHORIDA</b>							
Siphonophoridae	P	P		P			
<b>POLYZONIIDA</b>							
Siphonotidae	P	P	P		P	P	P
<b>CHORDEUMATIDA</b>							
Peterjohnsiidae	P	P	P				
Metopidiotrichidae	P	P	P				P
<b>POLYDESMIDA</b>							
Paradoxosomatidae	P	P	P	P	P	P	P
Dalodesmidae	P	P	P				P
Haplodesmidae and Pyrgodesmidae	P	P	P	P		P	P
<b>SPIROSTREPTIDA</b>							
Cambalidae	P	P	P				
Iulomorphidae	P	P	P	P	P	P	P
<b>SPIROBOLIDA</b>							
Rhinoericidae	P	P					
Paehybolidae	P	P		P	P	P	
Spirobolellidae	P	P					

rotten logs or litter of wet forest in the north of the continent. The two families of Spirostreptida are widespread, with many species adapted to drier conditions than are suitable for other millipedes. They are conspicuous components of the forest floor fauna, being found commonly in litter, rotten wood and under bark at the bases of trees.

#### Distributions of orders and families

Table 1 lists the distributions of the orders and families of millipedes found in Australia within six arbitrary divisions of the continent (Tasmania constituting a seventh region). The three introduced families have been omitted from the compilation. The table provides an overview of the diversity of Diplopoda at higher taxonomic levels in different areas of the country. Pyrgodesmidae and Haplodesmidae have been lumped

for this analysis because of difficulties in assigning species to one family or the other, giving maximum possible numbers of eight orders and 16 families.

As more collecting and survey work is carried out in more remote areas of Australia, the numbers in Table 1 are likely to increase considerably for the central and north-western divisions. However, our present knowledge of distributions suggests that the greatest millipede diversity occurs in eastern Australia. This dominance is almost certainly associated with the widespread occurrence of wet forest types east of the Great Dividing Range.

#### Gaps in knowledge

There is still a great deal of taxonomic work to be done on Australian millipedes. Polyxenida are common and widespread, but seldom collected

or recognised as millipedes. Large collections of material do exist, however, and the handful of species now known will no doubt increase to many times that number when Polyxenida eventually receive some attention. Sphaerotheriida are reasonably well known, and revisions of the Polyzoniida and Siphonophorida are being completed. Chordeumatida are currently receiving attention, but there are still many species to be described. Within the Polydesmida, the Dalodesmidae are currently being looked at, but the Paradoxosomatidae, the largest of all Australian families, are not being studied. The two families of tiny Polydesmida, Pyrgodesmidae and Haplodesmidae, are essentially unknown, although they are clearly well represented in Australia. Both orders of native juliforms, Spirobolida and Spirostreptida, are badly in need of work, with no resident expertise available.

As limited as our taxonomic knowledge is, our knowledge of the general biology of millipedes in Australia is even more sparse. Most of what little we do know was collected in the course of applied research into millipede control. Even basic topics have not been addressed, such as the relative importance of millipedes in nutrient turnover in forest ecosystems.

### Conclusions

The taxonomic framework of millipede orders and families in Australia is fairly well known, but there is still much work needed below family level. The distributions of most species-level taxa are very poorly known, with the exception of those in the Tasmanian fauna. Basic information of this kind is required in order to make informed decisions about the conservation status of Australian millipedes, and at this point in time such assessment is quite impossible. Nevertheless, millipedes have the potential to be quite useful indicator taxa. In many forest and woodland habitats they are common and conspicuous, diverse, easily collected and sensitive to environmental perturbations. Given the taxonomic impediments involved, however, and the almost complete lack of knowledge of their general biology, millipedes cannot at this stage be recommended as 'environmental indicators' in Australia.

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