A RECORD OF THE BEHAVIOUR AND DISTRIBUTION OF NEW ZEALAND LAND NEMERTINES

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ABSTRACT

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Terrestrial habitats have been colonised by nemertine worms many times in parallel. Three species have been described from New Zealand as constituting the endemic genus *Antiponemertes* Moore & Gibson 1981; also endemic is the upper littoral nemertine *Acteonemertes bathamae* Pantin 1961 which shows transition to terrestrial habitats. In the present paper observations of living worms provide a brief description of their locomotory behaviour, a previously unknown feature which can be useful to taxonomy. Their behaviour is significantly different from that of the four Australian species (genus *Argonemertes* Moore & Gibson 1981) notably in the minimal use of the proboscis for quick escape, which supports the (disputed) placement of these species in two different genera. The distribution of land nemertines in New Zealand is recorded and the need for conservation emphasized, especially for the species known only from Banks Peninsula.

KEY WORDS: New Zealand land nemertines - *Antiponemertes*.

INTRODUCTION

Nemertine worms are primitively and predominantly marine. On certain oceanic islands however, a few species of terrestrial nemertines occur in damp cool habitats, usually in or under rotting logs. Originally all land nemertines were combined in the genus *Geonemertes*, but it has now become clear that evolution of the land-living habit has independently occurred several times; different marine ancestors colonised islands on separate occasions in many parts of the world (Pantin 1969, Moore & Gibson 1985, 1988). The different species of land nemertines have been identified from preserved material, by histological examination of serial sections. On the basis of internal morphology the species have not only been separated from each other but also combined into genera, a combination which accords closely with geographical distribution in the Indopacific islands, Australia, New Zealand and on certain Atlantic islands (Moore & Gibson 1981). Very little information exists on the behaviour of the living animals, mainly because these nemertines are very hard to find and have seldom been observed.

New Zealand is a particularly rich source of land nemertines. Using preserved specimens which had been collected by or sent to Dr Pantin, the present author (Moore 1973) described and compared the three fully terrestrial species known: *Geonemertes novaezealandiae* Dendy 1894, *G. pantini* Southgate 1954 and *G. allisonae* Moore 1973. When the artificial conglomerate "*Geonemertes*" was divided (Moore & Gibson 1981) these three species were separated to form the new genus *Antiponemertes* Moore & Gibson 1981, which now joins the Australian land nemertines and others in the family Plectonemertidae (Moore & Gibson 1988). The appearance of *A. novaezealandiae* and *A. pantini* is illustrated by Dr Batham's colour photograph in Pantin (1969). Both species are strikingly striped in brown and yellow or pinkish white; the patterns are characteristically different and analysis has shown that the brown pigment is a porphyrin in *A. novaezeal-*

andiae and a melanin in *A. pantini* (Pantin 1969). They are larger than most land nemertines, being up to 80 mm long when fully extended. There are two pairs of eyes, the larger and more posterior pair being particularly prominent. *A. allisonae* is small (up to 10 mm in length), speckled with brown, instead of being striped, and has only one pair of eyes.

Also endemic to New Zealand is an upper littoral nemertine, *Acteonemertes bathamae* Pantin 1961, which is essentially marine but has some characters in common with New Zealand land nemertines. On Auckland Island it has become fully terrestrial: this observation is of particular interest as it may be a pointer to the course of evolution of land nemertines in general (Moore 1973).

The present paper arises from a visit made to New Zealand from January to April 1988, in order to study these nemertines alive. It has two aims: 1. to publish for the first time a brief description of the behaviour of New Zealand land nemertines; as well as its intrinsic interest this is one possible source of taxonomic information which has been neglected; 2. to record the known distribution of the New Zealand species and to emphasize the need for conservation: since they depend upon damp cool conditions in or at the edge of forest, these animals are threatened by the widespread and rapid removal of forests.

THE BEHAVIOUR OF NEW ZEALAND LAND NEMERTINES

No description of these animals in life has ever been published, apart from Dendy's (1895) description of colouration and two sentences: "The animal crawls very slowly, and leaves behind it a slimy track. As it progresses the head is moved from side to side". An account is needed not only to fill this gap, but because observation of animals in life may provide information of taxonomic importance. For example, New Zealand land nemertines resemble the four Australian species (the genus *Argonemertes*) in several aspects of their internal anatomy, and it has been suggested (Sundberg 1989) that all these species should be combined in a single genus. Observation of behavioural similarities or differences may be useful in this context.

LOCOMOTION

Locomotion as in many nemertines is a characteristic form of gliding, depending more on cilia (beating in secreted mucus) than on muscular contraction. If interrupted, the worms can glide backward. Two of the New Zealand species (*A. novaezealandiae* and *A. pantini*) have been observed to have a very pronounced side to side movement of the anterior end during forward gliding. At the same time the head appears to rotate slightly about the longitudinal axis, thereby regularly altering the distance from the substrate of any lateral structures such as the eyes. All four Australian species have been observed by the present author (Moore 1975); they too may show some movement of the head from side to side as they glide, but this is distinctively different from the movement seen in the two New Zealand species. Presumably these movements serve for sensing the environment.

Locomotion always appears to be negatively phototactic. In a dish with log fragments or damp white paper tissue, the worms invariably move until their heads are tucked underneath some cover. The animals appear to react positively to contact: they crawl along the protruding vein on the underside of a leaf, and wherever possible two specimens of the same species crawl over each other. This had also been recorded in 1961 by Dr Batham in a letter to Dr Pantin, of two *A. pantini* which both turned out to be female. Whether they actively sought each other could not be established with certainty. Mr Southgate reported (pers. comm.) that when a specimen of *A. novaezealandiae* was put in a dish with one of *A. pantini*, they very clearly avoided each other. Locomotion ceases in the day-time when the animals have reached some form of head cover. Two specimens of the same species in the same dish always curl up together, or a single worm folds over itself, thus reducing the surface area. Mucus is then secreted and the worms remain quiescent (unless disturbed) at least until nightfall. The animals can move actively in the dark. Two *A. novaezealandiae* were kept overnight insufficiently secured, and wormed their way out under the cover of their dish and through the folds of a polythene bag. By the morning one of them, 80 mm long, had covered at least 240 mm of floor. When picked up with a paintbrush it irregularly fragmented and then everted its proboscis. Mr Southgate (pers. comm.) observed similar fragmentation in a specimen of *A. pantini* kept for several days in captivity. Such fragmentation is well known in aquatic nemertines but has not previously been recorded in terrestrial species (the only known specimen of *Argonemertes stocki* from Australia cast regular millimetre cubes from the posterior end, but this is a very different phenomenon from the irregular fragmentation of *Antiponemertes*).

PROBOSCIS EVERSION

Proboscis eversion as a means of rapid escape provides a striking behavioural difference between New Zealand *Antiponemertes* and *Argonemertes*. All four species of *Argonemertes* respond instantly to touch by rapid eversion of their proboscides; the tip is attached to the substrate and the rest of the worm is drawn after it, the process being successively repeated to effect rapid movement. Dendy's (1889) description for *Argonemertes australiensis* is vivid: "Suddenly, to my utmost consternation, the little beast with lightening-like rapidity shot out a great long slimy white thing from its front end larger than itself, and at the same time its body became much slenderer." This response is very much rarer in *Antiponemertes*, and can only be elicited in the smaller specimens. Mr Southgate (pers. comm.) had never seen it in the many specimens of *A. pantini* which he had observed, but one of my smallest *A. pantini* twice everted the proboscis when climbing out of its dish.

There is a similar contrast within the other family of land nemertines; the terrestrial and semi-terrestrial species of *Pantinonemertes* very readily evert the proboscis, while *Geonemertes pelaensis* behaves like *Antiponemertes*.

FEEDING

Feeding in these New Zealand species has not been recorded by anyone. This is particularly unfortunate because histological examination shows considerable variation in stomach position in this genus only, suggesting that the functioning of the stomach during feeding may be different from that in other terrestrial species. Worms were supplied with likely food (collembolans, small amphipods, insect larvae) but despite considerable nocturnal activity, nothing was eaten. Land nemertines have been described as ambush predators (Hickman 1963) but active nocturnal search for prey may well be more important than this description suggests.

In conclusion, observation of living animals clearly reveals marked differences between New Zealand *Antiponemertes* and Australian *Argonemertes*. The differences in head movements, and in readiness to evert the proboscis, should be included as taxonomic characters. They do not support the combination of these two species groups into one genus.

THE DISTRIBUTION OF LAND NEMERTINES IN NEW ZEALAND

Two over-riding factors govern this record of distribution: one is that the habitat in which any land nemertine can live is narrowly restricted and the other is that the worms are very hard to find. Habitat is restricted because land nemertines can only survive in damp, cool conditions away from direct sunlight: they cannot withstand desiccation, sustained flooding or contact with sea water. They are found under or within rotting logs or tree ferns (rarely under stones). Logs must not be too wet (sodden with fungi) nor too dry (running with ants) and they must be sited on leaf litter on fairly level ground, not too close to a water course. Such conditions supply a rich associated fauna, including suitable potential prey (collembolans, insect larvae, millipedes).

However, the search for land nemertines in suitable habitat is very often unrewarded. This is not necessarily because the worms are rare; but may be because they are not under logs to be caught. V.V. Hickman over a period of thirty years recorded over 200 specimens of *Geonemertes* (=*Argonemertes*) *australiensis* in Tasmania. I can with feeling echo his comment, "It is a common experience to search areas, where it is known to occur, and yet not find a single specimen" (Hickman 1963). Accordingly, negative evidence can mean very little.

A further difficulty is that land nemertines are very readily confused with more commonly occurring land planarians, which also may be elongated, cylindrical in cross section and coloured by dark brown stripes on a paler background. In living specimens, eversion of a proboscis is the only certain diagnosis of a nemertine. Land planarians may flatten, lift and extend the anterior end, but this is quite distinct from the sudden "shooting" of a proboscis from inside the animal which (as has been described) characterises a land nemertine. That it can be difficult to elicit this response from *Antiponemertes* makes confusion more likely.

Table 1 and Fig.1 record the sites where land nemertines have been found, mostly by Mr P.M. Johns of the Zoology Department, University of Canterbury, and by Dr Pantin on his 1954 and 1961 visits, with a few contributions from the present author in 1988. Occurrences are confined to native bush, either mixed podocarp and broadleaf or *Nothofagus* forest, and range in altitude from sea level to 1600 m. Every specimen included in this record has been proved to be a nemertine, by proboscis eversion and/or histological examination by the present author.

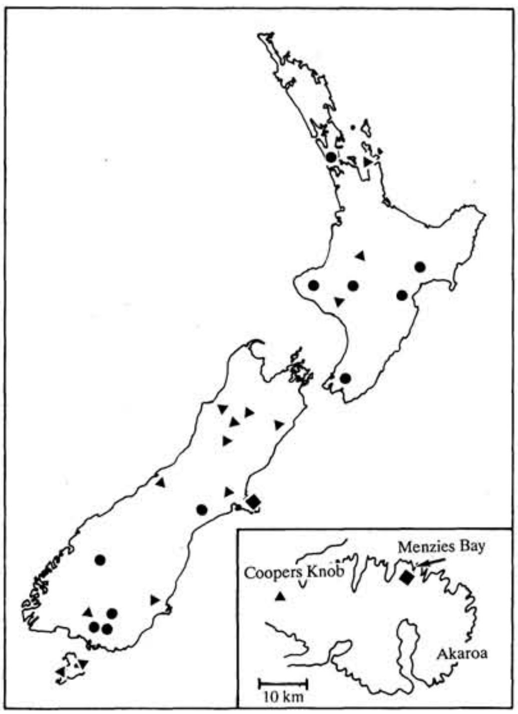

Figure 1. The distribution of land nemertines in New Zealand. Based on verified records of occurrence of the 3 species, 1954-1988. (● *A. novaezealandiae*, ▲ *A. pantini*, ▪ *A. allisonae*).

(i) *Antiponemertes novaezealandiae* and *A. pantini* are widely distributed in both North and South Islands (see Fig.1) and *A. pantini* also occurs on Stewart Island. Since failure to find land nemertines is not necessarily significant, the many sites searched in vain by the present author in 1988 have not been listed (they include sites such as Cass and Bob's Cove where the species have previously been found). 1988 was a long dry summer, and in such conditions it is never easy to find land nemertines. While the very dry soil under Kauri trees in Waipoua Forest, Northland and the very wet Westland forests in the South Island may prove to be unsuitable habitat at any time, no conclusion can be drawn from (for example) a fruitless search on Little Barrier Island after an unusually prolonged drought.

(ii) *A. allisonae* has only been recorded from Banks Peninsula, the distinct region of the South Island which appeared in the late Miocene as a volcanic island, separate from the South Island. Erosion and further eruption produced two main craters, Lyttelton and Akaroa harbours, with rock outcrops formed by molten magma radiating to give the series of steep hillsides seen today. In the Pliocene, some 5.2 million years ago, the island became joined to the Canterbury Plains as a peninsula of the South Island. This history may explain the presence of many endemic invertebrates (Johns 1969). *A. allisonae* was discovered at Menzies Bay on the north of the peninsula in the 1950s by Mrs F.R. Allison, of the Zoology Department, University of Canterbury, and collected from there by herself and Dr Pantin in 1961. Failure to find the species again in 1988 may be sadly significant because the habitat has largely been destroyed; the Menzies Bay valley has been intensively grazed by sheep and deer. The exact site was identified in the company of Mrs F.R. Allison, with the aid of a 1961 photograph, and every one of the few remaining logs was searched in vain. Further searches were then made of 12 of the patches of remaining bush on Banks Peninsula, 7 of which are on Scenic Reserves, without finding *A. allisonae*. This species has already been recorded as endangered in the I.U.C.N. Invertebrate Red Data book (Wells, Pyle & Collins 1983). It is feared that it may be extinct; news to the contrary would be very

NORTH ISLAND: *A. novaezealandiae*

Date	Reference	Finder	Site notes
11.1.64	36°57′ x 174°28′	P.M. Johns	Piha Gorge, Auckland
29.12.64	?	P.M. Johns	near Mount Egmont
1961	38°45′ x 177°10′	P.M. Johns	near Lake Waikaremoana
1961	?	P.M. Johns	Napier area, near coast
?	39 °15′ x 175°21′	P.M. Johns	Erua, near Mount Ruapehu, by Cuffs Road; exceptionally wet, rotten log
17.8.52	41°10′ x 174°59′	B. Holloway	Stokes Valley near Wellington.

NORTH ISLAND: *A. pantini*

Date	Reference	Finder	Site notes
13.1.64	36°55′ x 175°41′	P.M.Johns	Coroglen, Coromandel
Aug 61	38°47′ x 175°35′	P.M.Johns	Mount Kaku, Hauhangaroa Range, near L. Taupo; in deep leaf mould; no ground water, porous rock
4.1.58	39°47′ x 174°44′	P.M.Johns	Margawhoio, near Waitotara, near Wanganui

D'URVILLE ISLAND: *Antiponemertes* sp.

Date	Reference	Finder	Site notes
22.8.60	40°49′ x 174°49′	V.Stout	Greville Harbour. Grid ref.137.855, under burnt log in gully of main stream. 4 other specimens in nearby bush.

SOUTH ISLAND: *A. novaezealandiae*

Date	Reference	Finder	Site notes
(Before 1894)	46°32′ x 168°49′	(Sent to Dendy)	TYPE LOCALITY: Toi Toi, Fortrose, near Invercargill, Southland.
21.11.54	46°32′ x 168°49′	C.F.A. Pantin	Deserted farmhouse 3 miles south of Waimahaka on road to Fortrose (3 specimens)
1.8.61	46°34′ x 168°57′	CFAP & H. Pantin E. J. Batham A. J. Southgate	Tokanui: 1.5 miles SE of township, small patch of bush on slope of hill (10 specimens) in hollows in rotten tree fern trunks
12.2.88	46°34′ x 168°57′	N.W. & J Moore	Tokanui: 1.5 miles SE of township, small patch of bush on slope of hill (2 specimens) under logs.
1894	43°42′ x 171°29′	Dendy	TYPE LOCALITY: Mount Somers, near Ashburton, Canterbury. At edge of Alford Forest, near Springburn (2 specimens)
12.8.61	43°42′ x 171°29′	C.F.A. Pantin & P.M. Johns	TYPE LOCALITY: Mount Somers, near Ashburton, Canterbury. At edge of Alford Forest, near Springburn (3 specimens)
27.8.75	45°03′ x 168°34′	P.M. Johns	Bob's Cove, 15km west of Queenstown. *Nothofagus* forest.
1.8.64	46°19′ x 168°52′	P.M. Johns	Edendale Scenic Reserve, Southland. Mixed broadleaf forest.

Table 1. *(Continued on following page)* Sites where land nemertines of the genus *Antiponemertes* have been found in New Zealand. Single specimens unless otherwise stated.

SOUTH ISLAND: *A. pantini*			
July 1951 onwards	45°49′ x 170°30′	A.J. Southgate	TYPE LOCALITY: Signal Hill Dunedin. Many specimens.
12.11.54	45°49′ x 170°30′	E.J. Batham	TYPE LOCALITY: Signal Hill, Dunedin. (2 specimens).
19.10.57	45°49′ x 170°30′	E.J. Batham	TYPE LOCALITY: Signal Hill, Dunedin.
6,7,8.8.61	45°49′ x 170°30′	C.F.A.Pantin	TYPE LOCALITY: Signal Hill, Dunedin. (7 specimens).
11.8.61	45°49′ x 170°30′	E.J. Batham	TYPE LOCALITY: Signal Hill, Dunedin. (2 specimens).
27.2.88	45°49′ x 170°30′	N.W. & J. Moore & A.J. Southgate	TYPE LOCALITY: Signal Hill, Dunedin.
5.10.54	45°50′ x 170°30′	C.F.A. Pantin	Leith Valley, Dunedin
29.7.61	46°13′ x 168°52′	C.F.A. Pantin	Thornhill Farm, 7 miles SE of Mataura.
October 61	43°02′ x 171°46′	R Pilgrim	Cass; *Nothofagus* bush by stream near University Field Station.
1961	42°19′ x 173°44′	P.M. Johns	Hapuku near Kaikoura. Coastal *Ngaio* forest.
1961	42°24′ x 172°24′	P.M. Johns	Lewis Pass: subalpine.
1961	42°06′ x 171°36′	P.M. Johns	Minchin Pass, Arthurs Pass National Park: subalpine.
1961	42°08′ x 171°24′	P.M. Johns	Paparoa Range near Westport.
1961	43°41′ x 169°14′	P.M. Johns	Trotter's Creek, Moeraki, S. Westland. Mixed broadleaf.
17.2.74	43°40′ x 172°40′	P.M. Johns	Banks Peninsula: Cooper's Knob. Podocarp and broadleaf dry in summer. (2 specimens)
24.1.88	43°40′x 172°40′	N.W. & J. Moore, F.R. Allison & L. Whitten	Banks Peninsula: Cooper's Knob. Podocarp and broadleaf, very dry in summer. (3 specimens).
SOUTH ISLAND: *A. allisonae*			
1950s	43°39′ x 172°57′	F.R. Allison	Banks Peninsula, Menzies Bay. TYPE LOCALITY. Under fallen logs in valley at edge of bush.
13.8.61	43°39′ x 172°57′	F.R. Allison, Allison & C.F.A.Pantin	Banks Peninsula, Menzies Bay. TYPE LOCALITY. Under fallen logs in valley at edge of bush.(3 specimens).
STEWART ISLAND: *A. pantini*			
26.1.55	47°09′ x 167°34′	B. Holloway & L R. Dell	Easy Cove (= Easy Harbour).
19.2.88	46°56′ x 168°08′	N.W. & J. Moore	Ulva Island in Paterson Inlet of main Stewart Island. In primary forest, under very wet log beside track at west end.

Table 1. *(continued)*

warmly welcomed.

No other land nemertine has ever been found at any site on the peninsula except at Cooper's Knob on the western edge (Fig. 1) Here two specimens of *A. pantini* were found by Mr Johns in February 1974, and during our search in January 1988 we found three more specimens of the same species (heavily parasitised by gregarines in the blood vessels).

(iii) *Acteonemertes bathamae.* The type locality, where Dr Pantin found the species in 1954, is Crib Beach beside the Portobello Marine Laboratory on the Portobello peninsula. The animals were formerly very common under stones at the top of the shore (Dr Batham, pers. comm.) but have never been found since the rebuilding of the Laboratory on that site. Occurring between High Water Neaps and High Water Springs, it has been recorded from elsewhere in New Zealand. Dr Pantin received specimens from Stewart Island (site unspecified) and it has been recorded from the "Rhino Horns" near Kaikoura Marine Laboratory as recently as 1986 (Riser 1988).

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