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# CONSERVATION OF NATIVE EARTHWORMS AND THE ROLE OF THE GIANT GIPPSLAND EARTHWORM AS A FLAGSHIP TAXON.

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**Abstract**

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Very little is known of the Australian native earthworm fauna, which has been largely replaced by introduced species in most disturbed areas. The Giant Gippsland Earthworm, *Megascolides australis*, is one of the better known earthworm species and has aroused public curiosity and sympathy due to its gigantism and restricted distribution. The role of *M. australis* as a flagship taxon is discussed in terms of its wider value in the conservation of other earthworm species.

## Introduction

Australia has a very diverse indigenous earthworm fauna arising from its long geographical isolation (Lee, 1985), but little detailed information exists on the ecology, distribution or conservation status of any native species (reviewed by Lee, 1985, Kingston and Dyne, 1996). The only species of native earthworm studied in any detail to date is the Giant Gippsland Earthworm, *Megascolides australis* McCoy (Van Praagh, 1992, 1994), the first Australian native earthworm to be described. Most available information regarding native earthworms lies in the taxonomic and biogeographic literature (e.g., McCoy, 1878; Spencer, 1888; Jamieson, 1981; Dyne, 1984; Abbott, 1994). Museum collections are also a valuable source of ecological information on species through the provision of details of habitat or locality data.

Much information on the ecology of earthworms deals primarily with species belonging to the European family Lumbricidae which includes the introduced earthworm species commonly encountered in Australian gardens. The introduced lumbricid *Lumbricus terrestris* Linnaeus, is still commonly used to illustrate a 'typical earthworm' in Australian biology classes and most biology textbooks. Ironically, the existence of this species in Australian soils has yet to be confirmed (R. Blakemore pers. comm. 1995). The assumption that information obtained for lumbricids can be transferred directly to megascolecids is unjustified when the major differences in soils, vegetation types and geological history between Australia and the Northern Hemisphere are considered (Abbott, 1985b). Wood (1974) stated that 'it is surprising that more is known about the abundance of introduced Lumbricidae in New Zealand and Australia than that of the native Megascolecidae' and more than 20 years later this observation still applies. This paper discusses the conservation status of Australian earthworms and the role of the famous Giant Gippsland Earthworm as a flagship taxon in promoting the conservation of native earthworm fauna.

## Australia's earthworm fauna

All Australian native earthworms belong to the family Megascolecidae (Kingston and Dyne, 1996) a mainly southern hemisphere group which occurs over South and Central America, Africa and south-east Asia. Approximately 325 native earthworm species, belonging to 28 genera, have been described from Australia (Kingston and Dyne, 1996). However, knowledge of the indigenous earthworms in different States varies, with the earthworm fauna of Western Australia and the Northern Territory particularly poorly known (Abbott, 1994). For example, only 12 species of earthworms have been described from the Northern Territory (R. Blakemore, pers. comm. 1996). Extrapolation of the number of new species found from recent surveys by Kingston and Dyne (1996) indicate that the number of native earthworm species in Australia is probably well over 1000.

In a recent examination of nearly 2000 museum and literature records, Abbott (1994) mapped the distribution of the native earthworm fauna of Australia and found the major factor limiting earthworm distribution was rainfall. Earthworms were generally absent in regions where rainfall was less than 400 mm. However, 30 records of earthworm distribution occurred in areas receiving less than 400 mm. At least 16 of these were found to be surviving under favourable situations such as waterholes, moist caves, permanent rivers and farm dams (Abbott, 1994).

Changes in soil and vegetation resulting from European settlement have led to destruction of some of our indigenous earthworm fauna and to major changes in the distribution and composition of earthworms in Australian soils. In general, native earthworm species do not survive the change from native bush to pasture (Lee, 1961, Wood, 1974) and the predominant family in cultivated soil in southern temperate Australia is the introduced Lumbricidae (Baker et al., 1992a). In disturbed areas of tropical Australia, the native earthworm fauna is largely replaced by a small group of earthworms from the families Glossoscolecidae and Megascolecidae, originally from South and Central America, Africa and south-east Asia (Lee, 1991).

## Conservation of earthworms

*Vulnerability*

Apart from a recent discussion of the conservation of the earthworm fauna of the wet tropics of Queensland by Dyne and Wallace (1994), the conservation status of Australian earthworms is poorly known. Many have extremely limited geographical distributions and may be highly specialised suggesting tolerance to only a narrow range of soil conditions. For example, Dyne (1991a) found *Digaster nothofagi* Jamieson only from a look out in Warrie National Park, Queensland, in apparently uniform and continuous rainforest cover. More recently, Dyne and Wallace (1994) found 45% of new species found in the wet tropics of Queensland's world heritage area from only single sites. The Lake Pedder earthworm, *Diporochaeta pedderensis* Jamieson, was described from a single specimen collected in 1971 from the beach psammon of Lake Pedder in Tasmania. Subsequent searches for the species following the flooding of Lake Pedder in 1972 failed to find any specimens (Dyne, 1991b). Earthworms appear to be highly susceptible to environmental disturbance. In Victoria, The Giant Gippsland Earthworm, *Megascolides australis* is restricted to approximately 40 000 ha of the Bass River Valley and is extremely patchy within this area, being mainly confined to creek banks, gullies and some south facing slopes. Anecdotal information regarding historical distribution patterns suggests that numbers have declined and the range of the species has contracted through vegetation clearance and farming practices, particularly ploughing (Smith and Peterson, 1981; Van Praagh, 1994). Protection of native earthworms may be particularly important for species that have a restricted distribution or are naturally rare.

*Listing of threatened earthworms*

Worldwide, three species of giant worms, four genera of South African Acanthodrilinae and two genera of South African microchaetids are listed by the International Union for the Conservation of Nature (IUCN) Invertebrate Red Data Book (Wells et al., 1983). The endemic Acanthodrilinae of South Africa comprise some 90 species, most of which are regarded as threatened (Ljungström, 1972) since they are predominantly litter species restricted to indigenous forests which have been reduced to about 0.3% of their original range for agriculture or exotic plantations (Ljungström, 1972, Wells et al., 1983). *Microchaetus* spp. and *Triogenia* spp. (Microchaetidae) are characteristic of sandy and clayey soils of primary grasslands and savannahs. Agricultural practices have reduced the available areas of suitable habitat by overgrazing, lowering of the water table and desertification of the savannas (Reinecke, 1983, Wells et al., 1983). The microchaetids includes the giant *Microchaetus michrocaetus* Rapp which is thought to be one of the largest earthworms in the world. In Australia, two oligochaetes are documented on threatened species lists. *M. australis* is listed as vulnerable under the Department of Conservation and Natural Resources threatened species list (CNR, 1995) and as threatened under Victoria's *Flora and Fauna Guarantee Act* (1988) (Flora and Fauna Guarantee Scientific Advisory Committee, 1991) and the Lake Pedder earthworm is listed as endangered under the Tasmanian rare or threatened species list (Invertebrate Advisory Committee, 1994), but is thought to be extinct.

*Threats to earthworms*

Vegetation Clearance. Since European settlement, there has been complete conversion of whole land systems to the growing of wheat and improved pastures (Frood and Calder, 1987). Native earthworms are rarely found in cultivated soils (Wood, 1974; Abbott and Parker; 1980, Baker et. al, 1992a, b, 1995; Kingston and Temple-Smith, 1988; Tisdall, 1985; Mele, 1991). The conversion of land systems to cane farming in Queensland is thought to have resulted in the extinction of some earthworm species (Wells et al., 1983).

Reasons for the disappearance of native earthworms after cultivation are unknown but may be linked to the shift in the microclimate with clearing of native vegetation and establishment of pasture (Baker et al., 1992b; Kingston and Dyne, 1996). This includes changes in sunlight, soil temperature and moisture, removal of food sources (particularly important for surface feeders), disruption of burrow systems, altered soil pH and fertility and the use of chemicals such as pesticides. Changes in soil microflora, with which some native species have a symbiotic relationship, may also be important (Kingston and Dyne, 1996). Most native earthworms do not survive the initial cultivation process such as conversion of native vegetation to pasture and the direct effects of cultivation on earthworms are mainly from studies on introduced earthworms.

*Survival of species in Agricultural Land*

Some species of native earthworms can persist in cultivated soils. In a study of the earthworm fauna of the northern jarrah forest of Western Australia, Abbott (1985b) found indigenous species both in little disturbed and grossly disturbed sites. Baker (1996) and Mele (1991) found native species of *Spenceriella* Michaelsen and *Heteroporodrilus* Jamieson to predominate in many pastures in western Victoria. A native megascolecid, *Gemascolex walkeri* Jamieson, was found occasionally to constitute a substantial proportion of the total earthworm population in pasture soils of the Mt Lofty Ranges with densities reaching up to 108 per $m^2$ (Baker et al., 1993). Cultivation has actually appeared to create a favourable environment for the indigenous megascolecid *Megascolex imparicystis* Michaelsen which is more abundant under cultivated areas and clovered pastures than in its natural habitat of undisturbed bush (Abbott et al., 1985).

While there have been no detailed studies examining why some indigenous species can survive disturbance such as vegetation clearance, one reason may be a consequence of the specific ecological niche occupied by the species. Several studies have shown that subsoil species generally have the best chance of survival in comparison to litter and top soil species when native vegetation is converted to pasture (Lee, 1961; Wood, 1974; Miller et al., 1955 in Lee, 1985; Dyne, 1991a). For example, the giant rainforest species *Digaster longmani* Boardman, found at depths of 0.8–1.5 m, is occasionally reported from areas where its original rainforest vegetation has been completely removed and is now used for cultivation or housing (Dyne, 1991a). Non selectivity usually associated with the geophagous diet of subsoil species has been implicated as a factor in allowing this species to survive habitat alteration (Dyne, 1991a). Geophagous species feed in the deeper soil horizons and ingest large quantities of soil, in contrast to detritivores which feed mainly on plant litter, dead roots and other plant debris at or near the soil surface. Therefore, when the natural vegetation is cleared, there is a major change in the nature and quantity of the major food source available to detritivores. Similarly, Ljungström and Reinecke (1969) and Reinecke (1983) found that only a few of the large endemic subsoil microchaetids survived the cultivation of South African soils, though their range has contracted. In contrast the litter dwelling Acanthodrilinae under the same conditions have almost totally disappeared.

Clearly small amounts of remnant vegetation will be important for the survival of some native species in agricultural land. For example, clearing of native vegetation on areas occupied by *M. australis* took place between the 1870s and the 1930s. Even though the extent of suitable habitat for *M. australis* has been reduced, the worm has been able to survive in highly altered circumstances in refuge areas such as stream banks, roadsides and gullies where the effects of cultivation have been less severe. In several cases where the species was found along roadsides, its distribution did not extend into the adjacent paddocks (Van Praagh, 1994). Survival of species along stream banks and road sides may be partly encouraged as a result of remnant native vegetation still found in these areas. Buckerfield (1992) found native earthworms persisting under native vegetation on roadsides but not in fields under crops and attributed this partly to the availability of food. Baker et al. (1993) suggested the existence of some remnant *Eucalyptus* in one corner of a pasture site in the Mount Lofty Ranges, South Australia, may be responsible for local survival of the native *Gemascolex lateralis* Spencer. Buckerfield (1993) has shown that even if some indigenous earthworms survive cultivation or clearing, other factors such as the addition of fungicides may contribute to their decline. In South Australian pastures, the native species *Gemascolex* *walkeri* Jamieson survived clearing of its original habitat until a single application of the fungicide Benomyl was made. This resulted in a marked reduction of *G. walkeri* numbers with introduced species becoming more abundant (Buckerfield, 1993).

*Threats from introduced species?*

Approximately 50 species of exotic earthworms have been recorded from Australia (R. Blakemore, pers. comm. 1995). Most exotic species are from accidental introductions, primarily from soil in potted plants (Lee, 1985). Distribution of introduced earthworms in Australia is patchy, reflecting chance introductions and different species predominate in different regions (Baker et al., 1992b; Baker and Mele, 1996). Much earthworm research in Australia is focused on trying to establish appropriate exotic species in cultivated land to improve productivity. This has led to the suggestion of translocation of exotic earthworm species from a) other regions of Australia and b) overseas (Lee, 1985; Rovira et al., 1987; Baker et al., 1992b, 1996). The two most popular earthworms used in worm farming include the Tiger worm *Eisenia fetida* (Savigny) and the Red worm *Lumbricus rubellus* Hoffmeister both introduced species, which are primarily used in composting.

Little is known about the invasion of native habitats by introduced species already in Australia. Although most introduced species are confined to disturbed areas, some have invaded native vegetated areas. Dyne and Wallace (1994) expressed concern at the presence of the exotic *Pontoscolex corethrurus* (Müller) in primary forest in Queensland. This species is a vigorous coloniser which may pose a threat to the indigenous species since native species rarely coexist with *P. corethrurus*. Dyne and Wallace (1994) suggested that the colonising species may inhibit reinvasion by native species through chemical interference or changes in soil structure.

It is not always clear whether native or introduced species are involved in introductions or translocations for soil improvement. For example, one earthworm commonly used by worm breeders is known as 'the Blue' or 'Indian Blue'. This species is usually sold as the exotic species *Perionyx excavatus* (Perrier) but it has recently been identified (Murphy, 1993) as a native species of *Spenceriella*. The introduced *Aporrectodea caliginosa* (Savigny), recommended for use in increased pasture productivity, is described as an indigenous earthworm by Windust (1994). The vigorous *Pontoscolex corethrurus*, already shown to invade undisturbed areas, is also promoted by worm breeders as a pasture species for tropical pastures and croplands (Windust, 1994). Exotic species and possibly some native species are being moved around Australia through worm farming and breeding. At present, there are no controls in place and little monitoring of what species are being released and where.

While studies suggest that exotic species are mainly confined to disturbed areas and there is little evidence of competition between introduced and native species, very little detailed data exist on the indigenous species that do survive clearing or the effects on native earthworms of those exotics that can invade undisturbed areas. Some of these issues are currently being addressed (G. Baker, pers. comm. 1995). However, until more information is available on these issues, caution should be taken in the redistribution of introduced earthworm species and priority given toward the formulation of guidelines and monitoring procedures regulating the industry.

## Flagship taxa

Not all invertebrates are equal in their ability to elicit public sympathy or concern for their welfare. Flagship taxa, also termed 'attention grabbers' by Towns and Williams (1993), are recognised as those taxa that are either charismatic or popular and are used to initiate awareness and draw attention to the wider role of invertebrates as serious components of the ecosystem. *M. australis* is one of the most famous members of Australia's endemic fauna due to its gigantic size. The species is restricted to a small area of the Bass River Valley in South Gippsland, Victoria. Even though *M. australis* has been known for over one hundred years and was recognised as vulnerable by the IUCN in 1983, recent studies (Yen et al., 1990; Van Praagh , 1992, 1994) represent the first efforts to address the conservation and management issues of an earthworm.

*M. australis* is an excellent example of a flagship taxon and fulfils most of the desirable features of flagship taxa outlined by New (1991). Those relevant to *M. australis* include:

1. taxonomy well known and easily identifiable;
2. ability to elicit public sympathy and appeal;

3. occurrence in areas where other aspects of conservation are a concern (e.g., conserving the unknown biodiversity of the soil fauna by aiming to conserve what is already a diminishing habitat);
4. the actual or potential threatening processes can be identified and response of taxon monitored; and
5. facility to influence conservation policy.

*M. australis* is a charismatic species that has aroused public curiosity and sympathy primarily due to its novelty value as a giant and its localised distribution. Adult worms obtain lengths of over 1 m and weigh up to 400 g (Van Praagh, 1994). This has aroused pride in the local community in which the worm occurs, to the extent that a festival is held each year in its honour. The local shire has sponsored a static exhibit of the species in its underground habitat at the Coal Creek Historical Park, a major tourism focus in the area. The interest generated by this species has raised the awareness of invertebrates to local Department of Conservation and Natural Resource officers who help to record sightings of the species and have helped influence government policy to protect the worm. The Land for Wildlife scheme was developed to encourage private land owners to conserve wildlife on their properties and several local farmers are involved in conserving stream banks, the primary habitat of *M. australis*, by fencing off stock and replanting steam banks with indigenous vegetation. A pamphlet with management guidelines for *M. australis* (Van Praagh, 1991), is distributed through local land care groups and extension programs. The interest generated in this study both nationally and internationally through various television shows, radio interviews and newspaper and magazine articles served to raise the awareness of the role of earthworms in the environment and the importance of their conservation.

Species such as *M. australis* can be used to highlight the role of earthworms in the environment and increase the interest in the conservation of Australia's native earthworm fauna. With probably only one quarter of Australia's indigenous earthworm fauna described and the conservation status of only two earthworms known, it is clear that much greater attention should be given to native earthworm research to gain a clearer understanding of the conservation needs of earthworms. *M. australis* could be used to generate awareness of the conservation issues facing native earthworms, including the unresolved issues of unregulated worm farming and earthworm translocation within Australia. Indeed worm farming may present an excellent opportunity for promoting earthworm conservation.

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