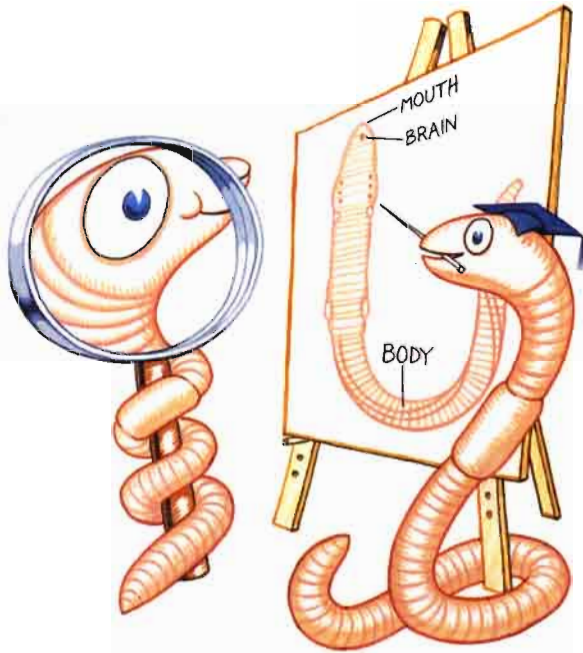


# Worm Wise II



*A pictorial guide to the paddock  
earthworms of south eastern Australia.*



by P. Mele and C. Hollier  
Photographs by J. Schneider



*This booklet was produced as part of the earthworm research programs funded by Agriculture Victoria (Rutherglen Research Institute), the Grains Research and Development Corporation and the Rural Industries Research and Development Corporation. It acknowledges the input of many of the staff at Rutherglen Research Institute, and particularly the editorial comment of J. Hirth.*

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*June 1995.*

# Why Do We Need to Know the Types of Earthworms We have in Our Agricultural Soils?

Because “WORMS AIN’T WORMS”  
... some do better than others to improve soil fertility.

This booklet is designed to help you easily recognise the earthworms that you are most likely to encounter in your paddocks and gardens. It will also help you estimate the numbers of earthworms living in your paddocks and provide a picture of the general “health” of your soil and the potential to improve it.

## Life Cycle and Biology

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The life cycle of most earthworms that live in our agricultural soils is dictated by the seasons. All paddock earthworms are active in the surface layer of soil in the wetter, cooler months of May to September.



They feed on soil which contains plant fragments and micro-organisms such as bacteria and fungi. As they feed, they excrete, as casts, the soil they have eaten. These are deposited either at the soil surface or in their burrows.

## Life Cycle and Biology ... continued

Earthworms contain both male and female sexual structures but they usually mate with another earthworm to exchange sperm, rather than fertilise themselves. This occurs during autumn and winter and results in the production of eggs, or cocoons.



*Earthworm Cocoons (x2).*

The size of these cocoons varies between the different types of earthworms although they are generally between 2 and 4mm in length. The quantity of cocoons produced in a season depends on the type of earthworm and where they are active.

For example, paddock earthworms that are generally active below the soil surface produce fewer cocoons (about eight per individual) because the risk of mortality is lower than for other types, such as compost or dung feeders, that live at, or just below the soil surface, where they are more prone to predation. These types produce about twenty cocoons per individual.

Cocoon production can also be related to soil moisture and temperature and the quality and abundance of the soil food supply.

Up to four hatchlings are produced from each cocoon, although in paddock conditions, one to two hatchlings is more common.



*Earthworm Hatchling with Cocoons (x1).*

As the soil starts to dry out in late spring, earthworms burrow deeper into the soil and excavate a small chamber. They seal the chamber and keep themselves moist by rolling up into a ball, and slowly leaking their gut contents. By doing this they can survive the hot, dry conditions of summer. Not all earthworms, however, survive in this way, and rely instead on cocoons to provide the next generation in the following winter.

# Benefits to Soil Fertility and Plant Growth

Earthworms improve soil fertility by their burrowing, casting and feeding. Water and plant roots penetrate deeper into soil in which earthworms have burrowed. Compared to the bulk soil, casts contain greater levels of available plant nutrients, such as phosphorus and nitrogen, as well as more bacteria and fungi. The quantity of nutrients contained in casts depends on the quality of the food the earthworm eats and the age of the casts. Fresh casts tend to



*A common sight, the surface casts of paddock earthworms.*

have a higher nutrient content compared to old casts. Earthworms also create burrows through which rainfall can drain freely away from the soil surface. Increases in water infiltration of up to 40% means a greatly reduced risk of surface soil erosion and ensures that the plant roots can access this water more effectively. Earthworm burrows also enable plant roots easier passage into compact soils or soils with a hard-pan and provide aeration for these roots.

Increased growth of both pasture and crops has been demonstrated where earthworms have been introduced into soils either lacking them, or containing only low numbers. Scientific research has demonstrated pasture production increases of 25%, 20% and 10% in New Zealand, the Netherlands and Ireland, respectively. CSIRO research in Adelaide has also demonstrated wheat grain production increases of 35% in glasshouse trials, and



*Earthworm burrows at 20cm depth with plant roots growing through them.*

between 13% and 75% in paddock trials. Individual farmers like Bert Farquhar, who owns 30,000 ha of pastoral land in north-eastern Tasmania, claims that by introducing earthworms into his paddocks he has increased the fertility of his soil by 25%.

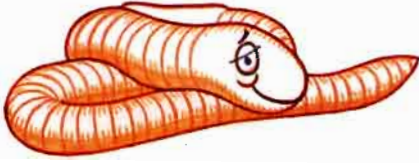
The impact that added earthworms have on soil fertility and plant growth will be influenced by:

- the type of earthworm added
- the number and types of earthworms already present
- the condition of the soil into which the earthworms are being added.

The choice of earthworm to add will depend on what is already there. It makes more sense to add a different type of earthworm that is not already there. If earthworm numbers and types are low, then there may be survival problems. If the soil condition is poor because it contains low levels of food and/or is prone to waterlogging, then the success of adding earthworms to improve plant growth, will be low. If, on the other hand, the soil condition is poor because of the presence of a pasture mat, earthworms can work through this and “unlock” a huge nutrient reserve. Plants can then use these nutrients for much improved growth.

## Likes

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Earthworms like moist, but not waterlogged soil. They also like plenty of good quality food. Soils containing large quantities of decaying plant material favours large and active earthworm populations. For example, in cropping

soils of north-eastern Victoria that contain mulched stubble, the population of earthworms can be 15 times greater than in soils where stubble has been burnt. Perennial pastures containing a good clover mix as well as annual crops sown in rotation with a legume phase, are also favourable farming strategies for maintaining earthworm populations. Earthworms, like above-ground stock, prefer nitrogen rich plant material as a food source. Soils with loam to clay textures are preferred to sandy soils.

## Dislikes

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Earthworms dislike dry soil as they need to keep their skin moist to breathe, nor do they like waterlogged soil because they drown. After heavy rain, earthworms can be seen on the soil surface because their burrows have flooded with water. They shun sunlight as they dry out and are prone to sunburn. Those earthworms that like to

crawl on the soil surface do so at night.

Soils that are excessively cultivated do not support large populations of earthworms. For example, in many cropping soils in southern Australia, populations can be between four and 30 times larger where soil is direct drilled rather than cultivated. Physical damage to the earthworms are the main reasons for such low numbers. Also cultivated soils tend to be drier, particularly early in the season, and contain less food. Earthworms dislike coarse, sandy soils and soils that are compacted.

## Other Factors

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Based on short-term (less than five year) studies, inorganic or mined fertilisers and herbicides, when used at recommended rates, do not reduce earthworm numbers although the effect of these chemicals may vary depending on the type of earthworm present. With fertilisers such as superphosphate, earthworm numbers may increase due to increases in pasture production and hence food supply.

Pesticides that are used to control insects, fungal and bacterial diseases of both crops and animals can be very toxic to earthworms, though few of these have been tested on paddock earthworms. Obviously those pesticides used to control worms (vermicides), including those used as stock drenches, are highly toxic, as are most fungicides. Earthworms will avoid areas that have been heavily dosed with these chemicals.

Some earthworm types are more sensitive than others to soil acidity. Again, if plant production is reduced due to acid soils, the earthworms food supply may be limited.

Predators and parasites of earthworms are not commonly observed except in some irrigated soils where the larvae of a parasitic fly can cause visible twisting and constrictions of the earthworm body. A potentially serious predator native to New Zealand, a planarian flatworm, though not yet found in Australia, has caused widespread devastation to earthworm populations in Ireland. Its requirement for temperatures lower than 20°C may limit its spread in Australia.



# Important Agricultural Earthworms

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Although there are thousands of different types of earthworms world-wide, only about six are commonly found in paddocks of south-eastern Australia. These have all been introduced from the northern hemisphere, mainly from the United Kingdom and western Europe, either in the ballasts of ships or by early settlers in the potting soils of exotic plant varieties. The spread of these earthworms throughout Australia coincides with the opening up of land for agriculture. It is thought that these exotic types replaced the resident native earthworms because they were better suited to an environment where the exotic pastures and crop varieties

replaced the native bush and scrubland.

The six introduced types of earthworms are well distributed across south-eastern Australia. The most widespread of these is the "purple worm", otherwise known by its scientific name, *Aporrectodea trapezoides*. In north-eastern Victoria and southern NSW it was found in 88% of all sites surveyed. Another closely related type, the "grey worm" or *A. caliginosa*, though not as widely distributed, occurred in the highest densities.

All types of introduced earthworms were about three times more abundant in pasture than in cropping soils.

**Table 1. Abundance of six common types of Earthworms in north-eastern Victoria and southern NSW.**

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Scientific Name	Common Name	Density (No./m <sup>2</sup> )
FAMILY "LUMBRICIDAE"		
<i>A. caliginosa</i>	grey worm	36
<i>A. trapezoides</i>	purple worm	32
<i>A. rosea</i>	rosy-tip worm	10
<i>L. rubellus</i>	red worm	2
FAMILY "ANCANTHODRILIDAE"		
<i>M. phosphoreus</i>	phosphorescent worm	6
<i>M. dubius</i>	orange-saddle worm	3

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# The 3 Steps for Describing your Paddock Earthworms

## Step 1. Collection

In winter, when soil is wet, go out into the paddock well away from fence lines and stock camps. If you are familiar with the soil types on your farm, try and sample within common soil types.

Cut a block of soil of surface area of about one square metre and to a depth of 10cm. This is about two by two spade widths (or 30 x 30cm) to just over one-third spade length (or 10cm).



Lift the block out and turn it over onto the ground or onto a plastic sheet.

Gently break the block apart and sort through the soil collecting all the earthworms into a container as you go. Most earthworms will be found close to plant roots. Ensure that all earthworms are collected, including

the very small or juvenile ones. You may also find cocoons which you can collect as well.

After this is done, walk approximately ten paces and cut a second block. Repeat this process in a straight line until a total of five blocks have been sorted through. Note the soil type, pasture composition and the location of the five sites.

## Step 2. Counting

Count all earthworms in your container (which hopefully will be full!!!) and multiply this number by two to obtain the number per square metre. (NB: If you had only sorted through one block of soil then you would multiply by ten).

Although scientists are still trying to decide what is the ideal number, a comparison with the local averages given below will indicate if there is room for improvement in your paddocks.

**Pasture paddocks: 160/m<sup>2</sup>**

**Crop paddocks: 50/m<sup>2</sup>**

Refer to Table 1 (on page 6) for average densities of common earthworm types.

# Describing your Paddock Earthworms ... continued.

## Step 3. Identification

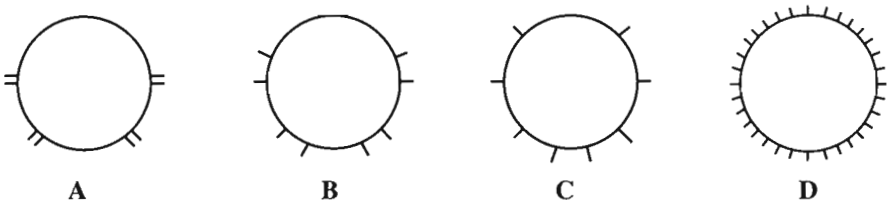
For identification, always select a mature or adult earthworm. The presence of a saddle or “clitellum” indicates that you have a mature specimen.

Look at the following features:

- **Saddle** is it raised? colour?
- **Colour** upper and lower surfaces of the body?
- **Size** length and thickness of the relaxed worm?
- **Shape** head - pointed, bulbous or “bull-nose”?  
tail - flat, blunt, square or pointed?
- **Location** in the bulk soil, in soil near roots, under dung pats, in or near a drain, etc?

## On closer examination:

- Location of the saddle - count the number of rings or segments from the front. (The saddle is always closer to the front.) Refer to the photo on the facing page and to the diagram inside the back cover for assistance in recognising these features.
- Position of male pores - before or after the saddle?
- Arrangement of bristles or setae - to the naked eye these appear as raised dots (may be paler than body) positioned on each ring, or segment, along the length of the body; may be paired or unpaired, and widely or closely spaced; best observed near the tail in good light!



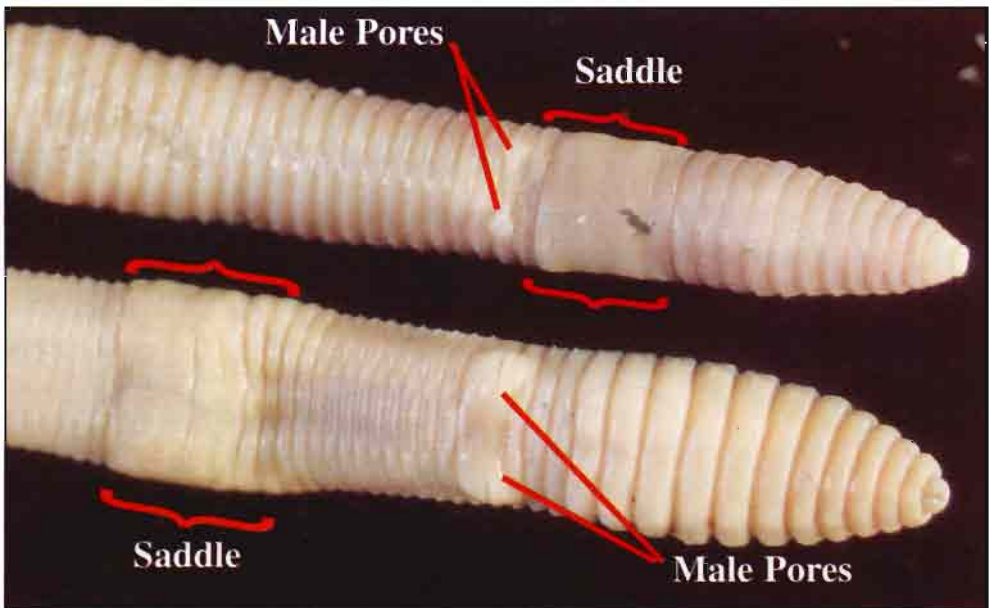
**Figure 2. Arrangement of the setae of earthworms.**  
*(A) closely paired, most common; (B) widely paired; (C) distant and (D) numerous, surrounding body (natives).*

# Native or Introduced Earthworms?

This question can only be answered by referring to the three features described in the “on closer examination” section on the previous page.

1. Natives have the saddle closer to the head; at about segment 17 if you count back from the front, compared to at about 25-30 in the introduced earthworms.
2. Natives have paired male pores (raised, pale lumps) just behind the saddle; introduced species have them in front of the saddle.
3. Native earthworms feel rough because they have lots of short bristles, or setae, evenly spaced around their body; introduced species have fewer setae, grouped in pairs (up to four pairs) on each segment (refer to previous page).

If this sounds daunting, don't despair! The following earthworm photograph gives you an idea what to look for.



*Underside of Native (above) and Introduced (below) Earthworms (x4).*

# Common Introduced Paddock Earthworms

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## The purple worm (*Aporrectodea trapezoides*)

- colour** purple-brown on upper side (sometimes with green sheen or coloured like the rainbow) and pale on underside.
- size** one of the largest paddock worms; length 80 to 140 mm; diameter 3.5-8 mm.
- shape** “bull-nose” shaped head; slightly flattened tail.
- markings** large, pale and swollen male pores (between mouth and saddle).
- feeding behaviour** soil feeder; active to about 20 cm depth; close to roots.
- benefit to soil fertility** active; creates burrows larger than 2 mm diameter; capable of mixing organic matter and surface-applied lime to 20 cm depth.
- distribution** very widespread and abundant.



*The purple worm (x1).*

# Common Introduced Paddock Earthworms

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## The grey worm (*Aporrectodea caliginosa*)

**colour** pale pink, grey or yellow (depending on soil type).

**size** medium; length 50-85 mm, diameter 3.5-5 mm.

**shape** narrow coned-shaped head; slightly flattened tail.

**markings** large swollen male pores.

### feeding behaviour

soil feeder; active to about 20 cm depth; close to roots.

### benefit to soil fertility

active; creates burrows larger than 2 mm diameter; capable of mixing organic matter and surface applied lime to 20 cm depth.

**distribution** widespread and very abundant.



*The grey worm (x1 1/2).*

# Common Introduced Paddock Earthworms

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## The rosy-tip or mucous worm (*Aporrectodea rosea*)

- colour** pale pink or grey with pink head region.
- size** medium/short; length 25-40 mm; diameter 2.5-4 mm.
- shape** bluntly rounded head.
- markings** clear rosy-pink head region, prominent red vein on the upper side of the body.
- feeding behaviour**  
active in upper 10 cm of soil.
- benefit to soil fertility**  
creates small burrows.
- distribution** localised distribution, abundant.
- other features**  
exudes mucus through its skin when handled.



*A rosy-tip worm (x 1/2 and x3).*

# Common Introduced Paddock Earthworms

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## The orange-saddle worm (*Microscolex dubius*)

- colour** pale, white to yellow.
- size** medium; length 40-60 mm; diameter 2.5-4 mm.
- shape** rounded head region; blunt tail.
- markings** orange saddle close to head region, white flecks visible through skin (calciferous glands), with white-tipped tail.
- feeding behaviour** less active than purple, grey or rosy-tip earthworms.
- benefit to soil fertility** unknown; thought to dominate in recently disturbed soils.
- distribution** widespread, less abundant.



*The orange-saddle worm (x1).*



# Common Introduced Paddock Earthworms

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## The phosphorescent worm (*Microscolex phosphoreus*)

- colour** pale pink to white.
- size** very small; length 10-35 mm; diameter 1-1.5 mm.
- shape** thin with pointed ends.
- markings** none but phosphoresces (glows) in the dark when disturbed.
- feeding behaviour**  
less active than purple, grey or rosy-tip earthworms.
- benefit to soil fertility**  
unknown but small burrows suggest minimal impact on infiltration and mixing.
- distribution** widespread, less abundant.



*The phosphorescent worm (x1).*

# Common Introduced Paddock Earthworms

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## The red worm (*Lumbricus rubellus*)

- colour** port-wine red colour with purple sheen on upper side, pale on underside (tending to yellow).
- size** large; length 60-130 mm; diameter 3-5 mm.
- shape** pointed mouth region then bulbous; pronounced flattening of the tail (sometimes half of body).
- markings** male pores small and barely visible.
- feeding behaviour** shallow feeder, mainly confined to dung pats or areas of high fertility (garden soils).
- benefit to soil fertility** limited due to confinement to high fertility areas.
- distribution** widespread, low abundance (but dominant under dung pats).



*The red worm (x1).*

# Common Introduced Paddock Earthworms

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## The yellow-tail worm (*Octolasion cyaneum*)

- colour** pale grey/unpigmented.
- size** largest of the species listed here; length 80-180 mm; diameter 5-8 mm.
- shape** blunt head region; slightly pointed tail.
- markings** conspicuous yellow pigment on tail (4 segments) and sometimes before saddle (near head region), soft-bodied.
- feeding behaviour** active to soil depth 40 cm.
- benefit to soil fertility** creates large, deep burrows, useful for improving water infiltration.
- distribution** common in higher rainfall (> 750 mm) pastures, never abundant.



*The yellow-tail worm (x1).*

# “A Potential” introduced Paddock Earthworm

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## The long worm (*Aporrectodea longa*)

*A paddock earthworm that we don't have on mainland Australia but wish that we did!*

- colour** brown-purple on upper side (sometimes with green sheen) and pale on underside.
- size** larger than the purple worm; length 90-170 mm; diameter 4-9 mm.
- shape** coned-shaped head region; rounded tail.
- markings** prominent glandular region.
- feeding behaviour** surface-feeding, deep vertical burrower.
- benefit to soil fertility** increase infiltration, mixes organic matter and lime to depth.
- distribution** confined to Tasmania.
- other features** able to survive on mainland Australia when introduced from Tasmania.



*Top: Long worm; Bottom: Purple worm ( $x^3/4$ ).*

## Where to go from here ...

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After following the three steps for describing your paddock earthworms, you will have some idea of how your total numbers compare with the average (refer back to page 8), and also how your numbers for each type compare with the averages (refer back to page 6, Table 1). You must then consider the agricultural management history of the paddock sampled and soil type and relate these factors to the likes and dislikes of earthworms. For example, if you have lower than average numbers, management factors such as cultivation, stubble burning, and excessive and repeated use of some pesticides may be restricting population growth. Waterlogging and extremes of pH may also be factors.

● **By modifying these agricultural practices, you may be able to build-up earthworm numbers to levels greater than the average.**

Unfortunately there is little one can do about modifying soil type.

The number of different types of

earthworms you have in your paddock is usually indicative of the “health” of the soil. In other words, the more types you have, the “healthier” your soil. For the whole of south-eastern Australia, the average number of different types found per paddock is between one to three. Sometimes, in paddocks under pasture, five different types may be identified. In comparison to western Europe, where the average is between five and ten types per paddock, our average is low and suggests a lot of room for improvement. If you have the common “purple worm” amongst your population you have a good basis for improvement.

● **Supplementing your paddock population by transferring the “purple worm” from one well-populated location on your farm to another poorly populated part and/or introducing new types from outside (such as the “long worm”) may accelerate improvement.**

This latter option must also be part of an improved paddock management strategy.

# Common Native Earthworms

Native species are much more difficult to identify than the introduced species and many hundreds of species are currently undescribed. The most common native earthworms to be found in paddocks in north-eastern Victoria and southern NSW are referred to as *Spenceriella spenceriella*. Within this broad grouping there are a number of different forms. Around Adelaide, another type of native earthworm, *Gemascolex* is more common.



*Paddock natives, Spenceriella (x 1/2).*

Native earthworms are dark in colour but vary widely in size and many hundreds are thought to remain undescribed. The “scrub worm”, and “the giant Gippsland earthworm” are well-known examples of large natives. It is not known if these types improve soil fertility but their occurrence in high numbers in some paddocks (refer back to Figure 1, page 7), both under pasture and crops indicates they may have a role to play.



*A common native - the “scrub worm” (x 1/2).*

# Paddock, Garden and Compost Worms

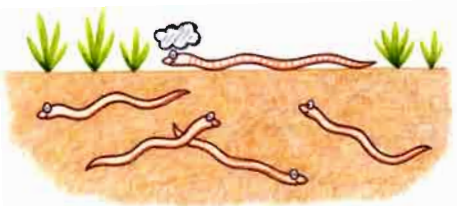
Just as particular plant species prefer to grow in particular environments, earthworms too have specific requirements for growth and breeding.

If an earthworm is not in its preferred location, and without its preferred food, it is unlikely to survive.

An example of the different needs of different earthworms can be illustrated by looking at paddock and compost earthworms. As we now know, paddock earthworms feed on soil whilst compost earthworms feed on the pure organic matter found in compost heaps.

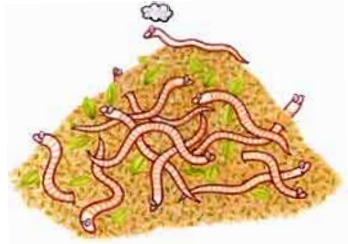
**It is this basic difference that makes compost earthworms unsuitable for introduction into paddock soils.**

Because the paddock earthworms work a lot harder to extract nourishment from their food source,



they reproduce at a much slower rate. In contrast, compost worms, of which the tiger worm (*Eisenia*

*foetida*) is the best example, live on a much richer food source and hence reproduce much more rapidly. It is this feature that makes the tiger



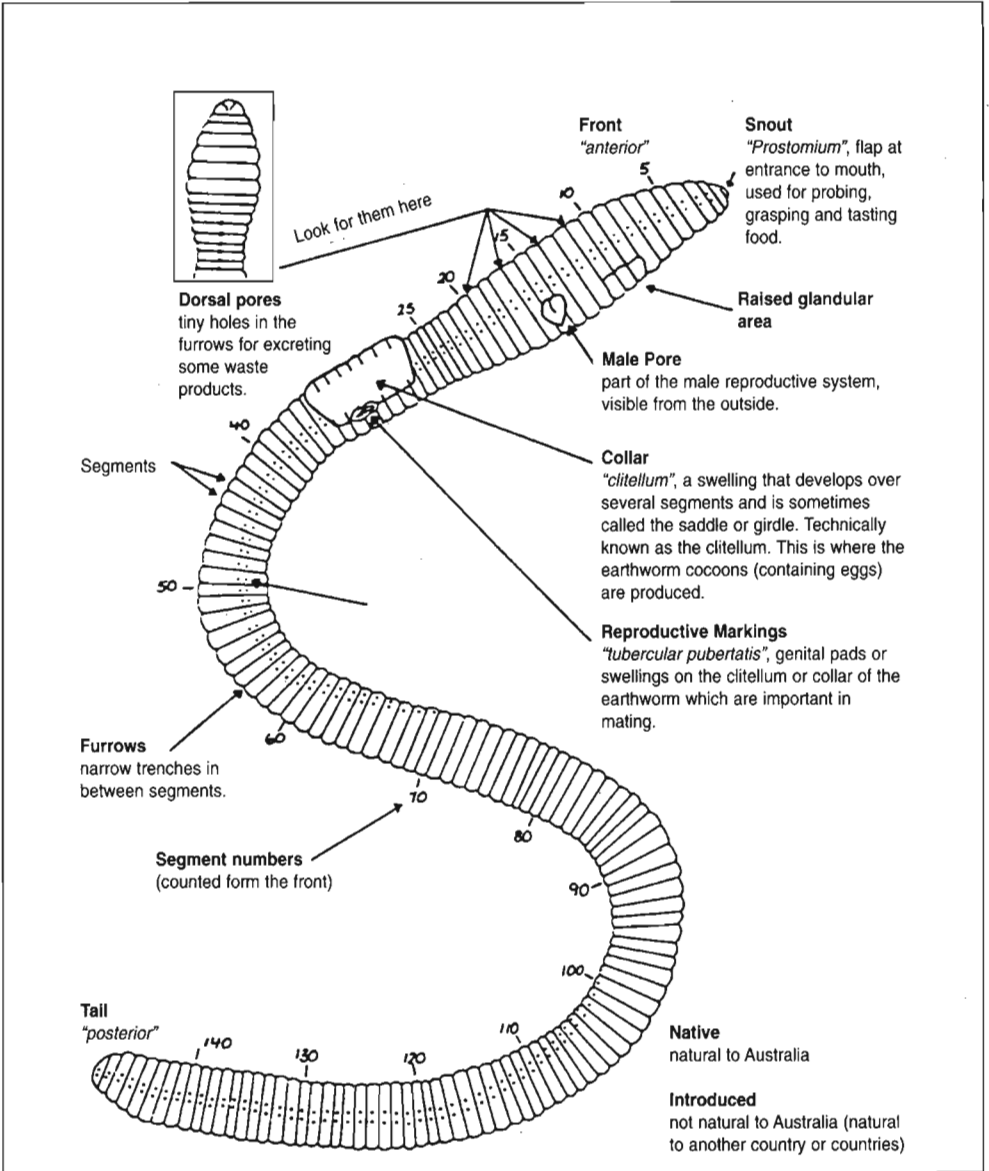
worm the most common commercial species.

In our gardens, we find both soil-feeders (paddock earthworms), and organic matter feeders (compost earth worms). The balance between the two types depends on how much organic matter, as mulch, animal manure, or compost, you have put into your garden.



Compost or tiger worm (x2).

# Earthworm Diagram



Acknowledgment for the use of this diagram: Dr Geoff Baker, Gaby Kilpin and CSIRO's Double Helix Science Club.





