

# Spineless

ARE INVERTEBRATES SEC





# wonders

## SECOND-CLASS CITIZENS?



**BY JOHN BLYTH AND IAN ABBOTT**

MENTION INVERTEBRATES AND MOST PEOPLE THINK OF CENTIPEDES, SLUGS, MAGGOTS AND LARGE DARK SPIDERS - THE CLASSIC 'CREEPY-CRAWLIES'. BUT THEY ARE MUCH, MUCH MORE THAN THIS. INVERTEBRATES, OR ANIMALS WITHOUT BACKBONES, ACCOUNT FOR AS MUCH AS 98 PER CENT OF EARTH'S ANIMAL DIVERSITY, AND ARE OF FUNDAMENTAL IMPORTANCE IN ALMOST EVERY ECOSYSTEM ON EARTH.





**Previous page:**

Many species of flies, although small and insignificant individually, are important components of natural forests.

Photo - Jiri Lochman

Sawflies are a family of non-waisted wasps, whose larvae are important leaf eaters.

Photo - Jiri Lochman

Australian cockroaches help to break down forest leaf litter.

Photo - Michael Morcombe



**M**any invertebrates are very appealing, with an almost infinite variety of form, colour and behaviour. But there is a scale problem; while anyone can appreciate the beauty of a large birdwing butterfly, or a glossy, multicoloured jewel beetle, many invertebrates are so small that their colour and pattern can be seen only through a magnifying glass or microscope. Taking the trouble to look more closely at these tiny, but incredibly complex, creatures is well worth while.

Unfortunately, our attitudes towards invertebrates tend to be largely based on experience with a relatively few species which compete with people for food, or adversely affect our well-being, health or comfort in some way. Other species are held 'guilty by association', even though most are beneficial.

The ecological significance of invertebrates can be gauged from their immense diversity, as well as their biomass (weight of invertebrates per given area, which may be much greater than that of vertebrates in many habitats). In Australia there are about 2 000 recognised vertebrate species and about 108 000 species of invertebrates, with many thousands still to be described.

Invertebrates are vital parts of almost every ecological system on earth. They are consumers of plants and animals, decomposers and scavengers in food webs throughout terrestrial, inland aquatic and marine ecosystems. They degrade and release organic matter from plants and animals, putting it back into circulation for biological use. Invertebrates are an important, often primary, food for many other animals,

including fish, birds and mammals. And all over the world, invertebrates, from termites, ants, grasshoppers and snails to crabs, crayfish and squid, are important sources of food for humans.

Good management of ecosystems requires better knowledge of invertebrate species and the functions they provide. The jarrah forest is a good example of the vital role insects play in an ecosystem.

## THE FOREST FLOOR

The invertebrate fauna of the jarrah forest is one of the most studied in Australia. Its composition and the abundance of its various components are well known, although much remains to be done in naming individual species.

Invertebrates that live in forest soil and litter appear in greatest numbers during summer and autumn. 130 000 invertebrates can live in the top 10 cm of a square metre of soil and up to 3 000 invertebrates can live in the leaf litter over a square metre of soil. Some 90 per cent of soil invertebrates are mites (arachnids) and seven per cent are springtails (insects). In litter 53 per cent of the invertebrates are mites and 19 per cent are springtails. The rest of the litter invertebrates vary from minute symphylans and pauropods (tiny grub-like animals related to centipedes and millipedes) to the larger centipedes, millipedes, pseudoscorpions, beetles, bugs, larval flies, and ants. All of these groups are at least as widely separated from each other, in an evolutionary sense, as birds are from mammals or reptiles from fish.

Invertebrates have complex and important roles in the forest ecosystem. Some regulate the supply of nitrogen,

Although nitrogen is readily available in the forest, it is not always in a form that can be absorbed by plants. Some invertebrates are critical in converting nitrogen to a usable form for plants. Single-celled animals (protozoans) and eelworms (nematodes) do this by consuming bacteria and fungi, which otherwise immobilise nutrients. Earthworms can mineralise nitrogen directly by consuming soil. The nitrates and the other forms of nitrogen made available by invertebrates play a key role in increasing the growth of forest plants.

Decomposer invertebrates, such as certain mites and springtails, consume fungi and bacteria, while other springtails consume leaf litter and faeces produced by other invertebrates. Decomposers thus help to return organic matter to the soil and release carbon dioxide into the atmosphere. In turn, some predatory invertebrates help regulate the population size of decomposer invertebrates. Pseudoscorpions, centipedes, and certain groups of mites prey on small to medium-sized invertebrates.

Larger invertebrates such as earthworms, termites and ants play an important role in fragmenting leaf litter and mixing organic matter. Their burrows aerate the soil, allowing roots to penetrate, increasing the soil's capacity both to hold water and drain efficiently. By keeping the soil friable, these subterranean cultivators help prevent surface crusting and topsoil erosion.

Many soil and litter invertebrates help disperse bacteria and fungi evenly,

promoting a more uniform rate of decomposition. Some soil and litter invertebrates stimulate plant growth. Eelworms and soil insects, such as larval beetles, feed on roots; this can stimulate the plants' rates of growth.

## PLANT DWELLERS

Invertebrates also live above the forest floor and can profoundly influence the growth and distribution of forest plants.

Like the invertebrates that live in soil and litter, those in the forest crown play an important role in nutrient and carbon cycling. Herbivores such as beetles and caterpillars convert green leaves into faeces, which fall to the forest floor and are decomposed by bacteria and soil/litter invertebrates. Too many herbivores, such as during an outbreak of jarrah leaf-miner, can cause premature shedding of leaves, contributing to the litter on the forest floor. Borers (the larvae of many species of beetles and moths) and termites feed on wood, and can destroy trees, but their faeces return nutrients locked up in wood back into the forest ecosystem. They have an important role in clearing dead and decaying wood from the forest to make way for new growth.

Without invertebrates some forest plants could not reproduce. Insects such as flies, beetles and wasps pollinate plant species in the forest. Without them, plants would tend to produce fewer seeds because of less efficient pollination.

While many invertebrates stimulate plant growth, others play an important role by delaying or preventing plant growth altogether. Some ant species thief seed released from fruits and bury it in their

nests, inhibiting germination either permanently or until the soil is disturbed, as in the case of a fire. Sap-sucking bugs are a sizeable component of the forest's insect fauna, and it is believed they cause growth losses in plants and may help spread plant viruses. (Home gardeners are familiar with this process when they see the viruses that affect tomato plants.)

Many invertebrates are also critical in the food chain of other animals. Invertebrates living in foliage are a major source of food for birds, and invertebrates in leaf litter are an important part of the diet of many reptiles and small mammals. Invertebrates can also be a major source of food for other invertebrates. In the forest crown, the main invertebrate predators are spiders. Some small flies and wasps, known as parasitoids, act like parasites, except their larvae eventually kill the host. Many of these are important in regulating numbers of herbivores and potential pest species of insects.

This biological control, inhibiting or promoting the growth of plants and controlling populations of certain pests, is becoming an integral part of agriculture, forestry, and human health management throughout the world.

## CONSERVING INVERTEBRATES

Many invertebrates, including those about which we have little information, may act as keystone species - they are

instrumental in controlling the relative abundance of other species and playing a vital role in ecosystem function. Inadequate conservation of invertebrates may lead to unintended disruption of many ecological processes.

More and more documents and books are being published outlining the significance of invertebrates and the importance of protecting their diversity. The World Conservation Union (IUCN) has formally recognised invertebrate conservation as part of its program of listing threatened species since 1976, and the US Endangered Species Act has included invertebrates since 1973.

Despite their ecological significance, research and management committed to the conservation of invertebrates lags far behind that for vertebrate animals. In Australia, only a handful of invertebrate species are gazetted as threatened. In Western Australia the rare ant genus, *Nothomyrmecia*, and the highly attractive jewel beetles are classed as protected fauna.

Some of Australia's invertebrates are as scientifically interesting, and as uniquely Australian, as are marsupials or eucalypts, and as a group they contribute the vast majority of Australia's biological diversity. The more we know about them, the better we can manage natural ecosystems and conserve the State's biodiversity.

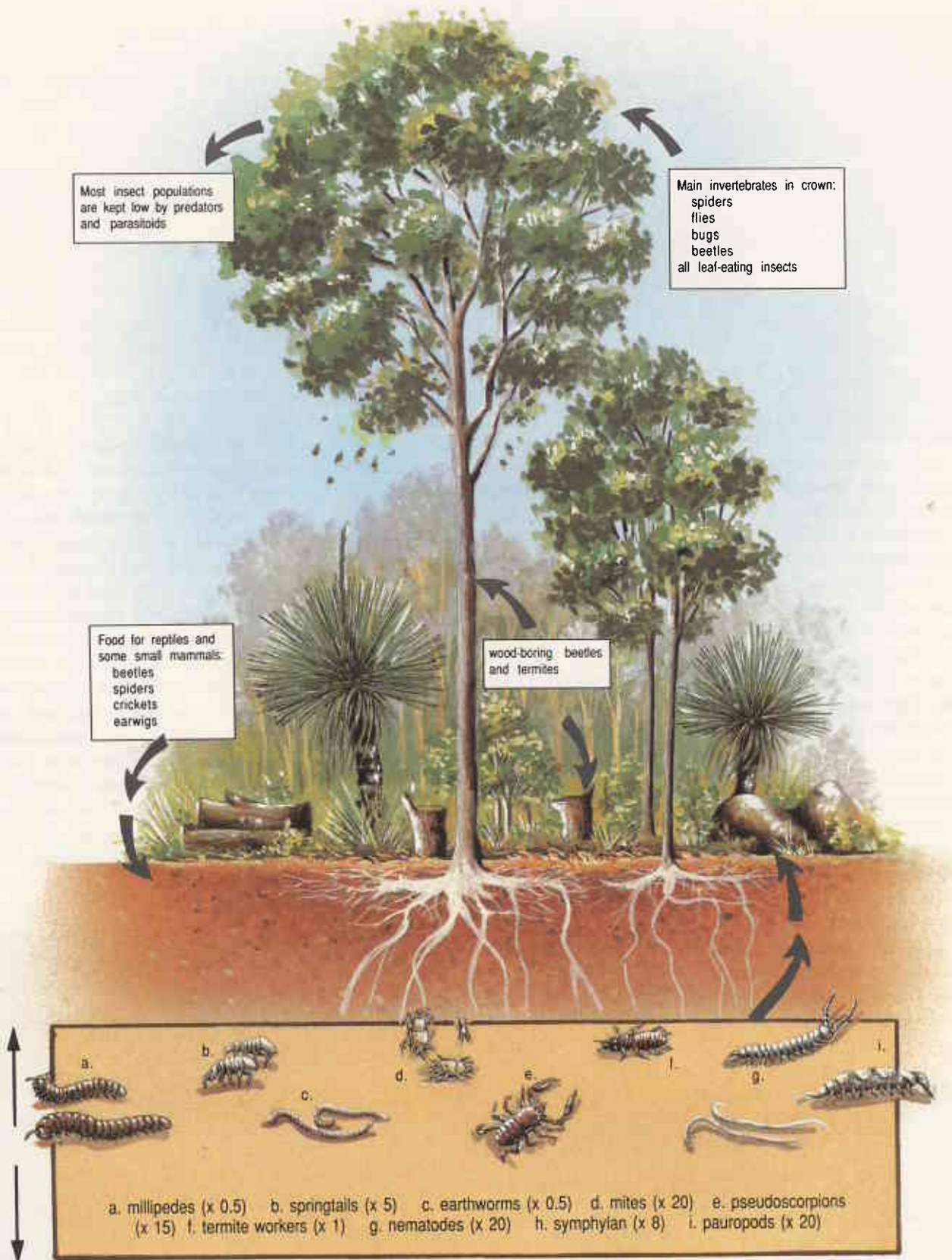
**Previous page:** Termites, like ants and bees, are highly social insects.  
Photo - Jiri Lochman ◀◀

Famous for their bright metallic colours and patterns, jewel beetles are important pollinators.  
Photo - Michael Morcombe ◀◀

**This page:** Long-legged and fast-moving centipedes are ferocious predators of small invertebrates on the forest floor.  
Photo - Jiri Lochman ▶







Some of the processes carried out in a jarrah forest by invertebrates, and a 'magnified' look at the invertebrates found in 5 cm of leaf litter on the forest floor.

## THERE'S A LOT OF THEM ABOUT

The animal kingdom is broken up into two unequal divisions: invertebrates and vertebrates. Invertebrates, the first animals, probably evolved about 600 million years ago, while the first vertebrates appear in the fossil record about 400 million years ago.

Invertebrates range from microscopic single-celled protozoans such as the jelly-like amoeba, through simple multi-celled groups like hydra and the corals, all the way to large and complex organisms such as crayfish and giant squid.

Although invertebrates first evolved in the world's oceans, it seems clear that terrestrial ecosystems now support the greatest diversity of invertebrate species. This diversity is dominated by the arthropods, especially insects and mites, which have adapted in a remarkable way to take advantage of the many new evolutionary opportunities provided by the similarly remarkable adaptations of flowering plants.

In fact, Terry Erwin in 'Tropical Forests: Their Richness in Coleoptera and Other Arthropod Species' (*The Coleopterists' Bulletin*, 1982) has demonstrated that one species of tree in the Panamanian rain forest supported a total of 1 200 species of beetles alone, including 163 species specific to that one species of tree. Beetles are believed to comprise 40 per cent of all arthropods. Taking into account the diversity of the forest, Erwin estimated a total of over 41 000 species of invertebrates per hectare. Further, assuming 50 000 species of trees in tropical forests, he calculated a possible world figure, for arthropods alone, of 30 million species! This calculation has generated much discussion and counter-argument.

Currently, about 1.5 million species are described, and most entomologists assume a world total of somewhere between two and 10 million. However, as many as 20 000 new species of invertebrates are being described by scientists every year, and Erwin has claimed that new work in rich tropical forests in Brazil and Venezuela indicates that the world's total invertebrate diversity may be closer to a staggering 100 million species. Whatever the true figure, many of the world's major ecosystems contain

vast numbers of undescribed, often unknown, invertebrates.

The forest ecosystem of south-western Australia provides a good local example. Covering an area of some two million hectares, the jarrah and karri forest contains 32 species of mammals, 94 species of land birds, 67 species of reptiles and 19 species of frogs. The number of insect species has recently been estimated at 16 000, and the number of other invertebrate species at 1 500. These calculations indicate that invertebrate species comprise 99 per cent of all animal species in this ecosystem.

To date only about 10 per cent of the insect species present in South West forests have been formally named by zoologists, although 99 per cent of all the vertebrate species present have formal names. This discrepancy probably reflects the training of zoologists, the considerable scientific progress made in formally naming WA species of vertebrates, the comparative ease of studying these organisms, and the interest shown by the wider community - who seem to like their animals soft, furry or feathered!



The common orb weaver can limit populations of flying insects, such as midges and mosquitoes.  
Photo - Jiri Lochman ▲

The Tuart borer is a member of the Cerambycidae, whose larvae feed within the trunks of many trees.  
Photo - Jiri Lochman ▼



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Visitors from around Australia are discovering what those who live nearby already know - D'Entrecasteaux...C'est Magnifique. Turn to page 10.



Seabirds nest on Pelsaert Island in the Houtman Abrolhos by the million. See page 17.

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There's more to invertebrates than slugs, maggots and spiders. Turn to page 28 to find out just why invertebrates are so important.



What has happened to Fitzgerald River National Park since the 1989 wildfire? See page 34.



Explore the Dampier Archipelago, a group of rocky islands with a violent past and a wealth of wildlife. Turn to page 48.

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## C O V E R

*Invertebrates play an important role in the ecosystem of WA's jarrah forest. Earthworms, termites and ants fragment leaf litter and mix organic matter. Some soil and litter invertebrates stimulate plant growth. Soil insects such as larval beetles feed on roots, stimulating the plants' growth rate. Our cover illustration is Philippa Nikulinsky's impression of this process at work in the jarrah forest.*



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