Ephemeral pools can be important sites of speciation and often are hotspots of microfaunal biodiversity.

Wendy Pyper seeks small signs of life amid the fickle floodplains of the Murray-Darling Basin.

Pond life worth preserving

For nine months of the year, the floodplains of the River Murray are pocked with shallow pools that teem with a biological diversity rivalling that of the Amazon Basin. But much of the life in these ephemeral waters is invisible to the naked eye, so its importance has been overshadowed by more charismatic megafauna such as birds and fish.

A few scientists, however, such as Dr Russell Shiel of CSIRO Land and Water and Dr John Green from New Zealand's University of Waikato, are working to identify and understand the microfauna and ecology of ephemeral floodplain pools.

'Microfauna are part of a complex food web in most Australian inland waters,' says Shiel, who is based at the CRC for Freshwater Ecology at Albury.

'In the dry season they provide food for larger invertebrates such as insects, and in the wet season, when the river breaks its banks, they are food for fish and other river inhabitants.

'So an understanding of microfaunal diversity, ecology and the pools in which they live is necessary to making informed decisions on matters affecting floodplain and river dynamics and biodiversity.'

This knowledge may come too late for some river systems, however, such as the Murray-Darling, where river regulation, land drainage and agricultural development have destroyed more than 70% of southern ephemeral habitats. This habitat loss in turn has potentially wiped out a large and uncharacterised component of floodplain biodiversity.

'Extensive river regulation and subsequent modification of river flow regimes has had deleterious effects on the floodplain communities of all Australian rivers,' Shiel says.

'Profound declines have been reported in most native aquatic macrobiota, yet the potential loss of species diversity represented by the floodplain microfauna 'seedbank', has hardly been addressed.'

Shiel believes that at least half the species that once existed in ephemeral pools have been lost. He and Green have been studying the ephemeral pool microfauna of the Murray floodplain since 1991, in an effort to characterise what remains.

Biodiversity hotspots

Ephemeral pools are harsh, isolated environments, characterised by an annual (and sometimes bi or tri-annual) cycle of filling, via rainfall or river flood, and drying. They are also geological dinosaurs.

'In global terms, ephemeral pools are ancient habitats,' Shiel says. 'The Murray has been in its present channel for more than two million years and the whole basin has been there since Gondwana, more than 65 million years ago.'

Earlier studies on Australia's ephemeral habitats had suggested their age, isolation and small size would make them important sites of speciation: sites in which species originate before migrating to larger freshwater habitats.

'So we thought ephemeral habitats might represent a previously under-recognised hotspot of biodiversity, particularly microfaunal diversity,' Green says.

To test this theory, Shiel and Green sampled the waters of 112 ephemeral habitats on the Murray floodplain. Back at the laboratory, a microscopic inspection of the catch confirmed their suspicions.

'The analysis showed that in these communities, microfaunal biodiversity is indeed high,' Green says.

While the scientists identified at least 500 microfaunal taxa, they found that there were extraordinary variations in species diversity and community size structure between ephemeral pools. 'Some sites had a few very large species while other sites had many small species,' Green says.

Of the large species, microcrustaceans called 'cladocerans' and 'copepods' (see boxed story) were well represented, particularly the huge four millimetre 'calanoid' copepod, *Boeckella major*.

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More **diversity** than meets the eye

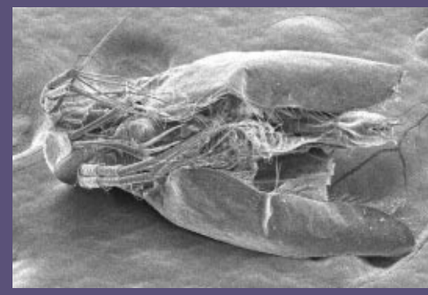
MICROCRUSTACEANS are important components of food webs in most inland and oceanic waters of the world. Marine microcrustacea are dominated by copepods, whereas those of fresh waters commonly include copepods and cladocerans. Few cladocerans have ventured into saline waters.

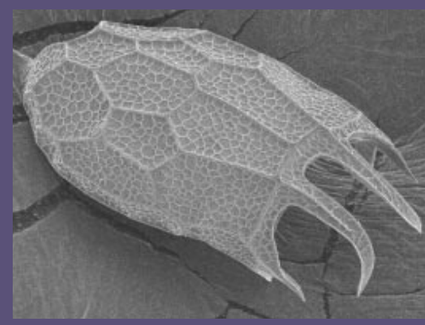
Cladocerans range in size from 0.2–5mm, have a bivalved carapace that covers the body, a head with two large branched antennae for swimming, and a large compound eye. *Daphnia* or 'pond fleas' are the better known cladocerans, which use their limbs to filter algae from the water.

Copepods are 'oar-footed' animals from 0.5–5 mm in size with long, sensory antennae. Their body is divided into three segments with many limbs used for swimming, jumping and feeding. 'Calanoid' copepods (such as *Boeckella major*) are planktonic copepods that use their mouthparts to create currents that direct food towards them, which they can then grasp.

There are two other types of copepod: cyclopoid and harpacticoid. These differ from calanoid copepods in that they tend to be benthic (bottom dwelling), rather than planktonic. Their antennae length, body shape, limbs, feeding methods, diets and habitats also differ.

Rotifers are often the most abundant animals in inland waters and globally, there are some 2000 species known. They range in size from 40 µm–3 mm and have fine hairs called cilia around their head which beat in a rotary manner (hence the name), bringing food to the mouth. They have a tubular body, a head often contained in a protective case and (in littoral species) a foot with two toes and adhesive glands.





Top: This unique cladoceran, viewed under a scanning electron microscope, was collected in the WA wheatbelt as part of the State Salinity Strategy (see story on page 15). Although not yet formally described, it is closely allied to the Macrothricidae family.

Above: This rotifer, *Keratella javana*, was collected from a salinising wetland in the WA wheatbelt.

The 'calanoid' copepod, *Boeckella major*.

Small
successions

MICROFAUNA produce a variety of reproductive structures known as resting eggs, cysts, ephippia and diapausing stages. These are deposited in the sediments of ephemeral pools until favourable conditions return.

While such conditions may take years to arrive, studies have shown that the microfaunal 'eggbank' is extremely durable. In North America, microfauna have been hatched from sediment cores dated at more than 300 years old. In the Murray-Darling, microfauna have been seen to hatch from 22-year-old floodplain sediments.

In the flood/drought ecology of the Murray-Darling basin, scientists say eggbank dormancy would be expected to last through several catastrophic drying events, in order to provide an effective buffer against local extinction.

Exactly what the environmental cues are that stimulate hatching is unknown, but a range of stimuli are implicated, including a flush of rainwater, a period of cold after high temperatures and abrupt changes in electrical conductivity.

In the ephemeral pools of the Murray-Darling floodplain, Dr Russell Shiel and Dr John Green have found that large (4 mm), carnivorous microfauna called 'calanoid copepods', tend to dominate the pool community when it first forms. Within weeks, however, smaller species replace their voracious counterparts.

'Calanoids such as *Boeckella major* mature and reproduce within one to three weeks of flooding, then drop resting stages into the sediments and disappear,' Shiel says.

'Later hatching rotifers and other small species are not subject to the same predation pressure and so have a chance to mature and reproduce.'

The decline of *B. major* makes way for other predators such as protists (single celled organisms), flatworms, smaller copepods and beetle larvae, which, like *B. major*, are thought to be 'significant organisers of biodiversity'.

'So predation may indirectly favour certain species at some times more than others and so increase the biodiversity in these habitats,' Green says.

'*Boeckella major* is a real giant in the copepod world and it was very abundant – between 15 and 30 animals per litre – in some habitats,' Green says.

Among the smaller species identified were 'rotifers' (40 µm–3 mm), one of the most abundant animals in inland waters, both numerically and in terms of species numbers. Curiously, Shiel and Green found few, if any rotifers in pools containing *B. major*.

Community carnivore

The dominance of *B. major* in pools lacking smaller inhabitants led Shiel and Green to question the role of the copepod in the community structure. Was *B. major* carnivorous and was its presence correlated with the absence of smaller animals?

When the pair examined the mouthparts and gut contents of *B. major*, they found that it was indeed the *Tyrannosaurus rex* of the microfaunal world.

'The gut contents showed *B. major* was the most carnivorous of the large copepods and although it consumed a range of dietary items, it showed a preference for rotifers,' Green says.

Shiel and Green say *B. major* and other large copepods cause variations in species diversity and community size structure between ephemeral pools by weeding out smaller species.

'*Boeckella major* appears to be a top predator in these habitats, as many fish are in larger lakes,' Green says. 'But whereas fish prey on larger zooplankton, causing smaller species to dominate, *B. major* seems to have the opposite effect.'

Boeckella's reign is short lived however (see boxed story), and as its numbers decline, smaller species such as rotifers appear. But the effect this microfaunal giant has on pool biodiversity is long lasting.

'On a broad scale, considering all pools on the floodplain, the presence of *B. major* may actually enhance the biodiversity of these habitats by favouring the success of larger species, which might otherwise be unable to establish because of competition from smaller species,' Green says.

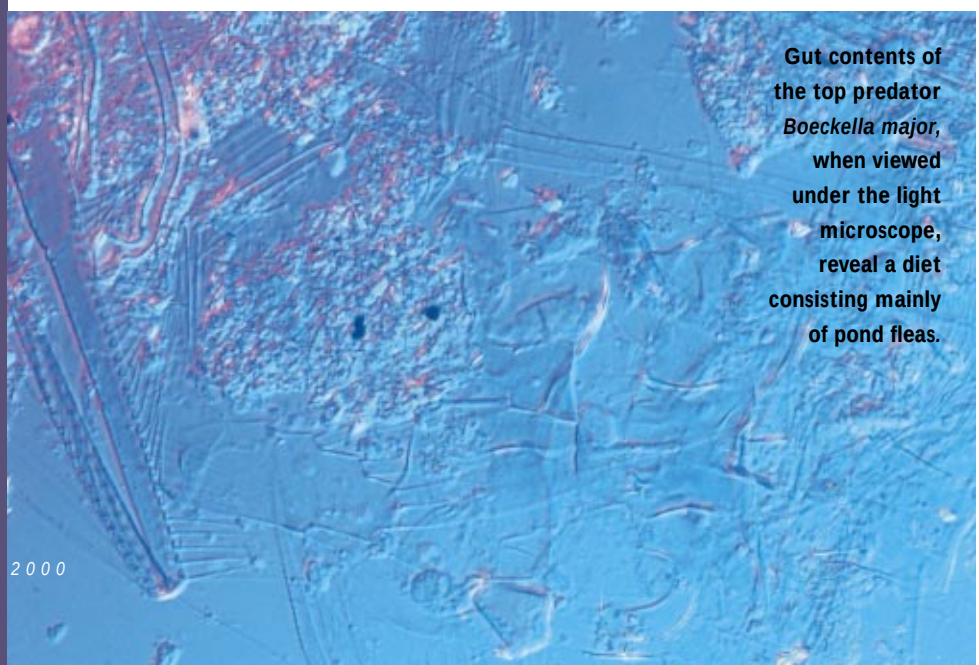
Shiel and Green say the dynamics and biodiversity of ephemeral pools are unmatched by other freshwater bodies such as billabongs and rivers, making them an essential part of any conservation effort.

'These are important and ancient habitats that contain an enormous store of biodiversity, much of which is still virtually unknown,' Green says.

'Efforts must be made to preserve them, but it is not good enough to preserve just a few pools. These habitats are very heterogeneous, with differing suites of microfaunal species in each. As predation is one factor influencing this diversity, it will be important to ensure that enough habitats are conserved to maintain varying types, densities and proportions of predators.'

Abstract: Microscopic animals that live in the temporary pools of the River Murray floodplain are an important but poorly understood part of the river ecosystem. Large, predatory microfauna are now known to play a significant role in the composition and biodiversity of individual pool communities. Conservation of these habitats is essential to maintain this biodiversity and the food source it represents to fish and other aquatic fauna during times of flood. Microfauna are also proving useful in the fight against salinity in Western Australia. By looking at changes in wetland communities of waterbirds, vegetation and aquatic invertebrates, scientists can document areas and species at risk from salinity, and the effect of management interventions.

Keywords: ephemeral waters, floodplains, Murray-Darling Basin, biodiversity, microfauna, invertebrates, cladocerans, copepods, rotifers, *Boeckella major,* reproductive structures,egg dormancy, wetlands, salinity, environment management, invertebrates, Western Australian wheatbelt.



Gut contents of the top predator *Boeckella major,* when viewed under the light microscope, reveal a diet consisting mainly of pond fleas.