A psammaspid syncarid (family Psammaspidae) from the alluvial aquifer of the Pages River in the Hunter Valley region of New South Wales. Total length is 18 mm. Peter Hancock

Peter Hancock and Bob Sorrenson sampling a groundwater monitoring bore in the Pioneer Valley near Mackay in Queensland with a stygofauna sampling net. Michael Connor

# The underground conservation frontier

**Groundwater ecosystems are, in many ways, the final unexplored aquatic frontier on Earth. Now new research into these zones warns that a lack of knowledge and adequate management could not only lead to a decrease in biodiversity but also a loss of essential Ecosystem Service Providers (ESPs), many of which are imperative to human life.**

Until quite recently, groundwater ecosystems were considered to be lifeless, yet in the past few decades, studies have revealed a diverse range of stygofauna existing below the Earth's surface. Eyeless and completely unpigmented, these creatures range in size from less than a millimetre to more than a centimetre, largely depending on the pore size of their subterranean living space. To compensate for their lack of eyes, they have developed long legs or antennae in order to find their way around, feed and mate.

In recent research published in the journal *Invertebrate Systematics*, Professor Andrew Boulton from the University of New England in NSW suggests that there may be a direct link between this recently discovered biodiversity in groundwaters and vital ecosystem services either provided or facilitated by stygofauna.

Many of these services are essential to our survival. Professor Boulton lists some of them as prevention of land subsidence, erosion and flood control through absorption of runoff, the reception and bioremediation of wastes and other by-products of human economic activity, and the improvement in water quality through biogeochemical water purification.

As the unexplored frontier, he says, 'our knowledge of this biodiversity is fragmentary; our understanding of its functional significance virtually non-existent,' and he warns that we cannot assume stygofauna are resilient, and nor can we take the services they provide for granted.

In 2005, Claire Kremen of Princeton University, proposed several approaches to developing the research between biodiversity, ecosystem function and the provision of ecosystem services.[1] While her focus was on terrestrial ecosystems, Boulton believes that these same approaches can be applied to groundwater ecosystems.

Extending the notion originally proposed for pollinators in Kremen's study, Boulton says we can surmise that if there is high biodiversity, there are also high levels of ecosystem goods and services. In order to preserve vital ecosystem service providers in groundwater systems therefore, the gaps in knowledge need to be filled.

Boulton believes that rather than simply documenting the numbers and types of species we can find, 'we should be asking if there is some sort of functional importance to this species diversity'. Past studies have shown that a reduction in biodiversity has often had a negative effect on ecosystem function.

Recent studies have identified several 'hot-spots' of high groundwater biodiversity internationally and within Australia. Western Australia's arid zone is home to a diverse range of groundwater faunas, yet it is also one of the many regions where human pressures on the ecosystems are heaviest. Boulton's plans for further research include sampling the groundwater in south-western Australia to identify any decline in stygofauna due to increasing salinity over the past decade.

In Australia's current climate of drought, our reliance on groundwater ecosystems is rapidly increasing. Boulton believes that two major threats affecting stygofaunal ecosystem service providers today are uncontrolled groundwater usage and its contamination.

He believes that if we continue to 'use and abuse' groundwater, we may face a series of consequences. Aside from an almost inevitable loss of biodiversity, the recently discovered species carrying out potentially important ecosystem services may become extinct. As we know little about the re-colonisation of stygofauna, this could result in an irreversible breakdown of ecosystem services and likely effects on human communities.

While predicting the outcomes of changes in biodiversity in groundwater ecosystems is difficult, Boulton believes it is necessary to identify the roles of environmental variables in maintaining the ecosystem services. In doing so, conservation management strategies can be established in order to preserve what is an essential and exciting resource.

In the future, like National and Marine Parks, Professor Boulton believes that Groundwater Reserves may become necessary to protect stygofauna and their ecosystem services.

● **Emily Quillinan**

**More information:**
Boulton AJ, Fenwick GD, Hancock PJ and Harvey MS (2008). Biodiversity, functional roles and ecosystem services of groundwater invertebrates. *Invertebrate Systematics* **22**, 103–116.

1 Kremen C (2005). Managing ecosystem services: what do we need to know about their ecology? *Ecology Letters* **8**, 468–479.