Aquatic millipedes in Australia: a biological enigma and a conservation saga

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ABSTRACT

In 1989 a siphonotid millipede was discovered in moderate numbers under stones submerged in a creek on the Macquarie University campus in the northern suburbs of Sydney. There were no previous published reports of aquatic millipedes in Australia. The habitat of the population was subsequently threatened by construction of a lake. We describe efforts to protect the millipedes during construction and suggest improved strategies for conservation of locally threatened invertebrates.

INTRODUCTION

Considering the enormous diversity of the invertebrates, attempts at conservation are rare. In Australia and overseas, however, a more enlightened attitude is gradually developing. It is exemplified by public concern for butterflies and moths, jewel beetles and dragonflies — perhaps the equivalent of the more majestic vertebrates. The situation and the problems have been reviewed by New (1991, 1993) and the conservation status of Australian terrestrial invertebrates has been extensively summarized by Yen and Butcher (1994). At the research level, the Conservation Committee of the Australian Entomological Society has recently collected data on 146 projects related to invertebrate conservation (Hill 1994). In addition, a project funded by the Australian Heritage Commission has enabled 30 sites of significance in invertebrate conservation to be nominated for National Estate status (Greenslade 1994).

In this paper, we describe our experiences in seeking to protect a population of two newly-discovered fresh water millipedes threatened by construction works. Aquatic millipedes have been recorded on several occasions, starting from Causard's report (1903) of polydesmid millipedes under stones in French streams. Causard described observations of the millipedes making pumping movements of the rectal area and concluded that the rectal wall formed a respiratory surface. The best studied recent case is that of a species known from the black water swamps of the Amazon (Adis 1986; Hopkin and Read 1992). This species, *Gonographis adisi* (Pyrgodesmidae) lives submerged as sub-adults for periods of flooding of 5–6 months, feeding on algae and breathing cutaneously. There are other reports of aquatic millipedes from various parts of the world, but the phenomenon is not well enough known to rate a mention in general textbooks of invertebrate zoology. Even in specialist works on diplopods (Hopkin and Read 1992) their existence is little more than acknowledged. There are no published reports of aquatic millipedes in Australia: for example, Williams's authoritative handbook on freshwater invertebrates (Williams 1980) does not mention them.

In 1989, while collecting material on campus for class demonstration, one of us (DH) discovered several specimens of a millipede under stones submerged in Mars Creek, a tributary of the Lane Cover River. The millipedes were observed to occur in quite substantial numbers, leading us to wonder why, after many years of limnological work in the Sydney region, they had not previously been recorded. Consultation with Australian arachnologists and overseas millipede taxonomists confirmed that millipedes in fresh water were far from a commonplace finding. Dr Rickard R. Hoffman of the Virginia Museum of Natural History placed the species, on the basis of our brief descriptions and photographs, in the Family Siphonotidae (Order Polyzoniida), and this was subsequently confirmed by Dennis Black (La Trobe University). Further enquiries indicated that several specimens apparently of the same siphonotid were present in the Australian Museum collection, but these had been collected in pitfall traps near a creek. Their aquatic nature had not been suspected, since there is no other record of an aquatic siphonotid from anywhere in the world.

It became clear from correspondence that millipede taxonomy was a job only to be undertaken by experts, and that the experts were understandably too busy to spend time on identification or description of our species. So the matter rested: we continued with teaching and existing research projects, visiting the millipedes occasionally for recreation.

THREAT TO THE MILLIPEDES

In 1991, as part of the second phase of building for the Graduate School of Management, it was proposed that Mars Creek should be dammed (above the millipede site) to create a lake. The idea of building a lake to enhance the park-like surroundings of the University dated back to its beginnings, but had never been implemented because of lack of funds. The Graduate School of Management, however, was not restricted in this way, and the lake was planned to improve the outlook from its new multistar accommodation buildings. Work on the site was to commence within weeks.

The news of impending construction was extremely disturbing. Massive silting of the creek could be expected during excavation; as the lake filled, the stream flow would cease completely and the habitat would dry out. We knew nothing of the millipedes' requirements but such disturbance would inevitably be damaging. At the time, no other living populations were known.

ACTION

Our initial action was to revisit the site and confirm the presence of the organism. Small numbers were found, but in the course of the search, something totally unexpected was discovered — a second species of aquatic millipede! Later it was tentatively identified by Drs Black and Hoffman as a pyrgodesmid, somewhat similar in general appearance to the Amazonian species.

REACTION

Driven by concern for the survival of these biologically interesting and potentially rare species, we approached the University Executive. Their response was rapid and positive. If no other populations of the millipedes were found, the dam would not be constructed. We were invited to a institute a search of other tributaries of the Lane Cover River to determine if the species occurred elsewhere and were given a small enabling grant of $1,000. This was a very gratifying reaction from the Vice-Chancellor (Professor Yerbury) and Deputy Vice-Chancellor (Professor Martin), whose backgrounds were much more closely aligned with management than with biology.

To keep faith with the Executive and to prevent delay to the building programme (the contract had already been signed), speed in carrying out the search was essential. This was an ideal project for RUBB (Research Unit for Biodiversity and Bioresources), a loose consortium of members of staff of the School of Biological Sciences, with interests in whole organism biology.

Within a month, Millisearch 91 had been devised and implemented, and a report produced. Seventeen sites on 15 creeks in the Lane Cover River catchment had been investigated and the siphonotid millipede had been found in nine of them. The smaller millipede was also found in some places. The millipedes appeared widespread, although a few of the sites were free of any threat from urban and road development. Since neither species seemed limited to the campus area, there was no compelling argument to delay the building of the dam. In our report to the administration, we requested that water flow to the creek below the dam be maintained and that habitat disturbance should be kept to a minimum, in the hope of preserving the local population. We were particularly concerned about siltation and about damage to the clay walls of the creek, where we suspected that the millipedes laid their eggs.

THINGS FALL APART

So far all had proceeded smoothly. The University Executive were interested and supportive, and since the millipedes were widespread, building works could proceed without delay. Our recommendations would ensure that habitat damage was limited and there was a good chance that the millipedes would survive on campus (they had already become a local icon, with regular appearances in *Passing Show*, the student Union magazine, an account in *Arena*, the student newspaper, one in *University News*, and coverage by Sydney newspapers, radio and television). Members of RUBB returned to the backlog of regular business.

Then we realized that lines of communication had broken down. Work commenced and proceeded rapidly in late winter and spring of 1991. Almost before the ink had dried on our report, a deep silt trap was gouged out of the creek bed in the midst of the millipede habitat. To make matters worse, the creek upstream was diverted around the site of the dam wall, by cutting a new channel through easily erodable clay subsoil. This resulted in a heavy load of silt being carried downstream. Silting in the trap area was particularly bad. Several millipedes were found (as it happened, under the eyes of Channel 7 cameras) covered in silt and moribund. Others were dead in deep silt on the rock ledges of the creek. We had little hope that any members of the original population would survive. Our requests for further measures to reduce silting were met sympathetically by the construction company (Civil & Civic), whose on-site representatives were patient and helpful. But the damage had already been done. Gradually, all sign of the millipedes disappeared.

Why did this happen, in an atmosphere apparently of good will and co-operation? We suspect that, by oversight, our recommendations were not passed on from the Executive to the Building and Grounds section responsible for organizing the works. They received only the summary page which reported the finding of other populations and the green light for the project to go ahead, and were unaware of suggestions for minimizing damage. We expected to be consulted on the recommendations of our report, but we were not. Possibly too many people and administrative entities were involved, without clear lines of communication. Possibly, with assurance that other populations existed, it was not considered worth the expense of modifying predetermined procedures. In any case, it is clear in hindsight that we should have followed up our recommendations more actively.

RESURRECTION

In a somewhat desultory and irregular fashion, we continued to visit the site of the apparently local extinction. In the following autumn, we again found some specimens of the siphonotid. With increased expectation of their survival, we undertook a fortnightly sampling programme, but were disappointed when they again disappeared in October. However, continued regular sampling indicated that this cycle is characteristic of the biology of the species. It is present in quite large numbers in and near the water from autumn to late spring, but is somewhere else during the summer, perhaps burrowed into damp soil, or even in the bed of the creek. It leaves the water in large numbers during early winter to mate and presumably to lay eggs in cracks in the banks. Unlike the French polydesmids, it does not breathe by rectal ventilation, but apparently breathes cutaneously. There are no signs of special modifications related to aquatic life. Both adult and juvenile forms have been found submerged, and long-term submergence is a normal part of its behaviour.

When the Buildings and Grounds engineers heard of the millipedes' survival, they were a bit inclined to say "I told you so! A lot of fuss about nothing!" Nevertheless we consider that the attempt to preserve the local population was justified. Survival in the circumstances was more due to good luck than anything else. The timing of the construction may have been favourable, coming, as it did, just after the breeding season. In addition, the weather remained fine through most of the period, reducing erosion from the heaps of loose clay resulting from the excavations.

We have continued to collect data on the biology of the millipedes. Both species are still present, but the smaller pyrgodesmid is so uncommon (as it has always been) that nothing is known of its biology. Following initial publicity (Dayton 1991; Hales 1991), reports were received of the siphonotid from fresh water and from wet terrestrial environments in Victoria (see Black, in prep.), so it seems to be both widespread and secure. Nonetheless, our investigations gave us cause for concern about urban creeks as endangered habitats, which would benefit from active conservation efforts.

The siphonotid species is now recognized as being new, and is being described as part of a revision of the Australian Siphonotidae (Black, in prep.). There is no further information on the identity of the pyrgodesmid. Our biological observations on both species will be published elsewhere.

LESSONS

1. It is possible to get institutional and public support for projects in invertebrate conservation, even if the subject organisms are rather obscure (though at the hands of the students, they developed a certain unexpected charisma).

2. One should assume nothing about the communication of recommendations, and make sure they appear on the one page summary of any report. (Busy administrators or engineers may only read the summary.)

Recommendations must be followed through, preferably by a single person taking responsibility for the project.

3. The basis of concerns should be explained at the outset. In this present case, one of the main problems was lack of knowledge about the biology of the group. Hence we could not be sure of the likely effect of the dam on the population and could not speak confidently about the conservation status of the species. The final favourable outcome was not a result of our recommendations, but occurred unpredictably despite the habitat destruction.

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BOOK REVIEWS — BOOK REVIEWS

"Cranial Nerves of the Coelacanth *Latimeria chalumnae* (Osteichthyes: Sarcopterygii: Actinistia) and Comparisons with other Craniata by R. Glenn Northcutt and William E. Bemis.
Karger: Sydney. RRP $95.50.

Coelacanths were first known only as fossils, the most recent being some 66 million years old. They were, therefore, believed to be extinct until, in 1938, *Latimeria chalumnae* was first discovered and to this day remains the only living actinistian fish. The Actinistia belong to a larger grouping, the lobe-finned fish or sarcopterygians, which are the ancestors of the land vertebrates. Since that first specimen of a living coelacanth was trawled up from the deep waters off the east coast of Africa, some 130 other specimens have been caught near a group of small islands, the Comoros, in the Indian Ocean. The majority of these have been studied anatomically in an effort to unravel their phylogenetic links with other vertebrates.

This book represents one such study. It provides a detailed account of the cranial nerves of a serially sectioned prenatal pup of *Latimeria* and includes the first complete colour reconstructions of the cranial nerves of coelacanths. It also represents the first attempt to use characters of the cranial nerves for broad-scale phylogenetic comparisons among vertebrates. Thirty-eight characters of the cranial nerves are described and compared across a diversity of vertebrates, including hagfish, lampreys, chondrichthyans, actinopterygians, lungfishes (the only other group of living sarcopterygian fish) and salamanders.

"Cranial Nerves of the Coelacanth . . ." is not recommended general reading but for evolutionary biologists and palaeontologists, the detailed descriptions and carefully prepared diagrams represent a level of anatomical description that is very satisfying. For all afficionados of the fish-tetrapod transition it is a must.

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