AUSTRALIAN AQUATIC CAVERNICOLOUS AMPHIPODS

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Abstract

The purpose of this paper is to acquaint speleologists with preliminary results of recent researches into the amphipodan fauna from aquatic ecosystems of Australian caves, with particular reference to Western Australia. Attention is focussed particularly on the systematic and zoogeographic significance of this fauna.

INTRODUCTION

The phylum, or subphylum, or superclass, or class Crustacea (the rank allocated this taxon depends upon whichever authority you follow (Bowman and Abele, 1982)) is defined for an assemblage of principally aquatic invertebrates which display wonderfully confusing morphological diversity. The larger crustaceans such as crabs, crayfish and shrimps tend to be better known generally than are the majority of forms, most of which range in size from about 1-2cm to microscopic (less than 1mm). Crabs, crayfish and shrimps belong to the taxon Malacostraca, as do those crustaceans classified within the orders Amphipoda and Isopoda. Amphipods and isopods are sufficiently small (few exceed a length of about 2cm) and inconspicuous so that fortunately only a limited vernacular vocabulary has developed about them. Amphipods are sometimes referred to by the ugly name 'scuds' in America and by the confusing term 'freshwater shrimps' in Europe (Williams, 1980). How many crustaceans are colloquially called 'shrimps'?! Terrestrial isopods, 'slaters', are well known to most urban dwelling Australians.

It is quite usual in discussions on crustacean issues for amphipods and isopods to be bracketed together, and certainly there are similarities which serve to generate confusion and create difficulties for the novice unprepared for the subtleties of crustacean taxonomy and professional carcinologist alike essaying to identify specimens. Amphipods and isopods, for example, lack a carapace but whatever similarities do exist between both groups are not indicative of close phyletic relationship (Siewing, 1963). Furthermore, they are predominantly littoral marine crustaceans but members of both groups have successfully invaded most available aquatic habitats, including those of surface and subterranean fresh waters. It is convenient to refer to the fauna from open surface fresh waters as epigean; those from underground or phreatic habitats as hypogean. Indeed, amphipods and isopods are the best represented of the crustacean groups found in ground water (Vandel, 1965); others include syncarids, mysids, decapods, ostracods and copepods) and in some areas dominate the fauna of cave streams - for example in the Appalachian cave streams of eastern America (Culver, 1982).

The situation in Australian cave streams seems, given our present limited knowledge, more akin to that pertaining to caves in Britain and the Caribbean, for example, where although ispods do occur in cave streams, amphipods are much more commonly encountered and presumably contribute more to the biomass and ecosystem dynamics. Just why amphipods should be more successful than ispods in the underground poses an interesting problem which will be neatly sidestepped here so that for the remainder of this paper attention can be focussed on the aquatic amphipods from Australian caves. Significant discoveries of amphipods from Australian caves have been made during the past few years, but it is also fair to warn you that this paper really is a little premature, for considerable taxonomic work remains to be carried out and what follows is a litany of taxonomic uncertainties.

Amphipod taxonomy is in a state of flux at all levels of the taxonomic hierarchy from familial to species level. Different family arrangements have been proposed by Bousfield (1977) and Barnard and Barnard (1983) for example; and Karaman and Barnard were not always unanimous in their conclusions in their jointly authored paper presented to the International Conference on the Biology and Evolution of Crustacea held in Sydney in 1983 (Barnard and Karaman, 1983,pp.59-60). Bousfield (1977) has suggested that the taxonomic dificulties may stem from the possibility that amphipods are undergoing a phase of adaptive radiation; the fault may lie, however (if fault there be), with taxonomists not having given due cognisance to character variation. Prof. W. D. Williams of Adelaide University has been revising the Australian freshwater amphipods for more than a decade now, and the results of his studies await publication. Quite understandably so; character variation in the Western Australian forms alone presents a most formidable problem. In a paper included in a forthcoming publication on the groundwater fauna of the world being edited by Dr. L. Botosaneano, Williams (in press) summarises the published information on the distribution and systematics of Australian freshwater amphipods as follows and following Barnard and Karaman (1983) comments "that Australia has been a major evolutionary centre and refuge for freshwater amphipods.

Williams cites 26, possibly 27, species of epigean, and 3, possibly 5, species of hypogean amphipod, none from caves. I think it is safe to assume that this is a very conservative estimate of the number of species of freshwater amphipods in Australia. Of the 3 forms listed as definitely hypogean, all are endemic to southern-western Western Australia and two, *Protocrangonyx* sp. and *Uroctena* sp., have been collected only from epigean situations but are regarded as hypogean because they possess one or more characteristics commonly considered as adaptations to a subterranean existence: slender transparent body, creamy-white colour, eyeless. Thus *Protocrangonyx* sp. has been collected only from the mouth and outflow runnel of springs, and *Uroctena* sp. are typically found now in temporary streams, particularly at the base of granite areas of the jarrah forest. Only *Hurleya kalamundae* has been collected from a well, and then but once, in the suburb which gave the species its name.

AMPHIPODS IN W.A. CAVES

Jennings (1975) delineated 5 major areas of Karst in Western Australia, and caves occur in 4. Cavernicolous amphipods have been found in the 3 areas surveyed to date - south-west, Nullarbor and Exmouth.

Caves are not uniformly distributed throughout the south-west zone, but are restricted to circumscribed areas (Lowry, 1980) such as at Yanchep, where the shallow cave streams have yielded the most extensive fauna of aquatic cavernicoles from Australia known to date. In all, 18 species of aquatic cavernicole have been discovered from caves at Yanchep. An account of the studies on the Yanchep cave fauna is being prepared for publication elsewhere.

Yanchep

Amphipods representing 3 genera, 4 species in all, are known from Yanchep. All are associated for the most part with the mats of tree roots lining the streams. This fact in itself is quite significant. The almost complete absence of primary producers in cave ecosystems means that food must usually be imported and that cave communities tend to be dominated by decomposer organisms (Culver, 1982). Tree roots serving as an important energy source for cavernicoles is evidently more frequently observed in caves of tropical than temperate areas and is particularly important in the lava tube and limestone caves of Havaii (Howarth, 1983).

The amphipods from Yanchep are as follows:

1) *Austrochiltonia subtenuis*, from 4 out of 16 study sites.
2) *Perthia*, 2 species; one, *P.acutitelson*, from 5 out of 16 study sites, the second, *Perthia* sp. nov., found at only one site.
3) ?*Hurleya* sp. from 3 of the 16 study sites.

Austrochiltonia subtenuis: we cannot even be certain about either name! It has been suggested (see the Barnards, 1983) that the genera *Afrochiltonia* (described in 1955) and *Austrochiltonia* (described in 1959) are synonymous, and if this view is upheld (a view doubted by some local amphipodologists at least), then *Afrochiltonia* takes precedence. *A.subtenius* is reasonably widespread in south-western Western Australia, and also occurs in Western Victoria and Tasmania (Williams, 1962). Another species, *A.australis*, occurs in eastern Victoria and Tasmania, and the suggestion has been made than *subtenuis* and *australis* are synonymous. If so, *australis* takes precedence since it was described in 1901, a year before *subtenuis*. Now the cave specimens from Yanchep called *Austrochiltonia subtenuis* do exhibit some morphological differences from the surface dwelling counterparts, even from Loch McNess, and these differences have been described in detail by Burt (1982). For example, the cavernicoles are smaller, and white (not green/brown), and show some small regression in eye expression. Burt also found that the number of segments in the first antennae is significantly correlated with body length in both hypogean and epigean specimens, but slopes of the regression of antennal segment number against body length were significantly different, with proportionately greater increase in segment number per unit body length occurring in the hypogean specimens. Furthermore, Burt also found that mean clutch size per female was significantly lower in hypogean than in epigean specimens. However, the mean egg volume in hypogean specimens was significantly greater than for epigean specimens. Vandel (1965) regarded the larger egg volume of cavernicoles to be an adaptation to a subterranean existence, the slower maturation leading to more advanced embryonic development being a response to limited food supplies. Nevertheless, a limited allozyme study on proteins from cave and surface specimens from Yanchep indicates very little genetic divergence between the two stocks, insufficient to validly recognise separate species status for the cavernicoles, but clearly they are undergoing incipient speciation.

Perthia: of the two species of *Perthia* from the Yanchep caves, the most widely occurring is tentatively identified as the species *P.acutitelson*; the second, clearly a new species, was found at only one site.

The genus *Perthia* was described for amphipods abundant in permanent steams in both the forested areas and the sandy coastal plains of south-west Western Australia. Two species have been described, but again doubt must be raised about the validity of each. Cavernicolous amphipods previously recorded from Mammoth, Calgardup and Strong's caves by Lowry (1980) probably belong to the species *P.acutitelson*, a suggestion based upon specimens collected from the former 2 caves during the last two or three years. All these cave forms tentatively named as *P. acutitelson* show some slight morphological change from their epigean counterparts, but it must be emphasised that the genetic and taxonomic relationships between the hypogean and epigean populations of *Perthia* remain an interesting and significant study for the future.

The second species of *Perthia* from Yanchep is a true cavernicole in that it is colourless, and eyeless. Allozyme studies confirm it to be genetically distinct from *P.acutitelson* and other epigean samples of the genus collected from Perth.

"*Hurleya*": blind, white amphipods cited in Burt's thesis as *Hurleya* sp. were found at 3/16 sites at Yanchep. This name is probably wrong, for Williams considers these amphipods to be neoniphagids. However, no attempt has been made either in Burt's thesis or here to correct the name for we do not wish to pre-empt Williams' studies. The centre of neoniphagid diversity is south-eastern Australia and Tasmania, but a species occurs near Albany, W.A. The Yanchep forms, if neoniphagids, then, must be regarded as zoogeographical relicts.

It is also appropiate to record here that neoniphagids were found recently in caves of the Florentine Valley by Tasmanian speleologist S.Eberhard.

In summary, of the Yanchep Cave amphipods, there is evidence for at least two separate invasions into the underground, "*Hurleya*" and *Perthia* sp. nov. taking the plunge first and in the long distant past. The second invasion is currently under way with *A.subtenuis* and *P.acutitelson*, and it is extremely doubtful whether the epigean and hypogean populations have yet achieved reproductive isolation. It is, of course, a moot point whether either invasion was synchronous for the two species involved.

Nullarbor Caves

In view of the statement by Richards (1971, p.29) in her comprehensive study on cavernicoles from the Nullarbor Plain that "no aquatic fauna has been discovered in any of the Nullarbor lakes", the finding by Messrs. Barnes and Poulter of amphipods in Nurina Cave is unexpected. The discovery has already been recorded in the A.S.F. Newsletter (Knott, 1983), and brief descriptions of the water chemistry and systematic position of the amphipods given therein.

All told, 9 specimens have been collected, the last collection of 6 being made on 4/12/82 when it was estimated by Poulter (pers. comm.) that 30 specimens were swimming in the lake. Salinity of Nurina Lake is near sea water (31.7% compared with salinity of 36.0% of water from the Great Australian Blight (Lowry, 1970). The amphipods represent a new species probably of *Melita*. The Barnards (1983) describe *Melita* as a 'basic kind of gammarid to which many other taxa bear comparison'. They recognise 61 species, mostly marine, cosmopolitan ranging from littoral to abyssal but with some estuarine and anchialine species. Three species are recorded from Australia, two from the Swan River estuary and the other marine littoral. Undoubtedly this is but a fraction of the Australian *Melita* fauna.

The Nurina population probably represents a marine relict remaining from the transgression of a higher sea level. Stock (1980) considers that population stranded inland by receding sea levels have been important in the evolution of the genus *Pseudoniphagus*, amphipods distributed predominantly about the area of the western Mediterranean and coastal Iberian peninsula.

Exmouth

The subterranean fauna of blind fish and shrimps from the Pleistocene reef about North-West Cape has been known now for two decades and more. Cape Range itself provides numerous caves, dry for the most part, but fresh water occurs in two - a small stream in Shot Hole Tunnel, a pool in Dry Swallett.

Both aquatic habitats harbour large populations of an amphipod belonging to the *Victoriopisa-Eriopisa* complex. Both populations are apparently conspecific. Judging by the disjunct distribution of the fish and shrimps on the surrounding Pleistocene reef, and amphipods in the caves of the Cape Range, there are two quite discrete water bodies involved.

Other species of this generic complex show a difficult to interpret, although basically circum Indian Ocean, distribution. Species of *Victoriopisa* have been described from Chilka Lake in Orissa, East India, the Andaman Islands, South Africa - and S.E. Australia!

CONCLUSIONS

To conclude: amphipods there certainly are in Australian caves. Williams (in press) makes the point that these crustaceans are absent from northern Australia (and New Guinea) because the climate is either too warm or too dry. The discovery of amphipods at Exmouth extends the known northern limit of their range quite significantly, but they may well occur even further north - in caves of the Kimberley or Chillagoe areas, for example. 'Shrimps' from the Chillagoe caves may be decapod crustaceans (as Ikin (1980) noted with extreme reservation) - they may also be amphipods. Certainly warmth cannot be invoked to explain an absence of amphipods from an area - for amphipods occur in ground waters of the Caribbean, and in the caves in Sarawak.

Help would be greatly appreciated from speleologists, particularly those venturing into caves in remote areas. Even mere reports on the occurrence of animals and/or tree root mats are valuable pieces of information to have. Aquatic cavernicoles are generally delicate organisms and extremely difficult to keep alive for any extended period of time out of the cave environment. Consequently animals should not be removed unless there are good facilities immediately available to maintain the animals alive, or else properly fix and curate them. If good fixatives such as 70% ethanol, or formalin diluted to a strength of 5-10% using water the animals actually live in, are available with the caving expedition, then one or two specimens carefully preserved along with complete collection data (site, date, name of collector, microhabitat from which animals were collected) would be gratefully received, duly acknowledged, and must inevitably advance the cause of Australian speleology.

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