Paper 4

Lake Gregory: A Limnological Perspective on Proposed Research

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INTRODUCTION

Commonly held views concerning the biota, especially the fauna, of temporary bodies of fresh water are that their biological diversity is greatly reduced *vis-à-vis* that of permanent fresh waters, that the fauna is characterised above all by taxa of the Branchiopoda (Notostraca, Anostraca and Conchostraca), and that all species, because they need to be resistant to desiccation, are widely dispersed (since the resistant stage is usually the egg stage, it is small and therefore easily dispersed) and, consequently, have large gene pools.

Increasingly, it is becoming clear that these views do not coincide closely with reality. It appears that they represent more a set of preconceptions based on some few studies in the northern temperate region than observations based on actual studies of temporary fresh waters outside the northern temperate region.

Studies of temporary fresh waters in Australia are now showing that in many such waters biological diversity (richness) is extremely high; it is certainly higher than expected and often much higher than in nearby permanent bodies of water. Further, rigorous taxonomic investigations are beginning to reveal considerable regional endemicity: the taxa of temporary waters are not widespread with large gene pools - selection has been for local adaptation. Indeed, many features formerly thought to be devices to ensure good dispersal may be devices to prevent dispersal. The hooks on the ephippia of certain Cladocera are a case in point; rather than being a means of promoting dispersal (by catching on to the feet of birds) they are a means of preventing it (they catch on to the substratum). Finally, the fauna of many temporary fresh waters is not characterised by species of Notostraca, Anostraca and Conchostraca: these groups occur, if they do, only in the early part of the season before the appearance of predators (beetles, tadpoles, dragonfly nymphs). The characteristic fauna of temporary waters is similar to that of permanent waters: it comprises Cladocera, Copepoda and Rotifera among the zooplankton, and, *inter alia*, Hemiptera, Diptera, Coleoptera and Trichoptera among the zoobenthos.

The generally accepted view of evolutionary relationships between the fauna of temporary fresh waters and permanent fresh waters is that the former is a subset of the latter. That is, those elements of the fauna of permanent fresh waters able to withstand desiccation and with good dispersal mechanisms colonized temporary fresh waters. My view is that evolution largely proceeded in the reverse direction: the fauna of permanent fresh waters is a subset of that present in temporary fresh waters. A more complete exposition of this view is given in Williams (1988).

SIGNIFICANCE OF LAKE GREGORY

This rather lengthy introduction to a consideration of the limnological significance of Lake Gregory needs little explanation given that Lake Gregory is a large temporary body of water in a part of Australia where such bodies of water have been little studied. However, its significance goes beyond a simple regional extension of our knowledge. It has added significance because Lake Gregory is situated in an area of Australia where rainfall variability is not excessively high (that is, the lake is predictably filled), and where rain falls in summer (i.e. the warm season). In southern Australia temporary bodies of water mostly contain water in the winter (cool) season.

These two facts are considered important because of recently proposed ideas concerning the evolution of the fauna of Australian salt lakes, ideas which are probably equally applicable to the fauna of temporary fresh waters in Australia (Williams 1984).

In brief, it is suggested that past climatic changes have been a major evolutionary force during speciation in the fauna of temporary fresh (and salt) waters. The suggestion involves several hypotheses:

(1) That the fauna of temporary inland waters evolved only in predictably-filled localities. Localities which fill episodically contain only easily dispersed species.

(2) That single environmental factors (such as salinity in the case of salt lakes) are not important *per se*; it is the temporal combination of environmental factors which is important (such as salinity, temperature and rainfall pattern).

(3) As climate changed in Australia, so areas of predictably-filled temporary waters moved as a consequence, with their assemblages of biota being subjected to different patterns of climate: in the north they were subjected to warm, wet summers and in the south to cold, wet winters. Such fundamentally different climatic patterns would have caused adaptive changes, and these could easily come to have a genetic basis given the discrete nature of many temporary water-bodies and the poor dispersal powers of the fauna. In other words, exposure to selectively different environmental factors under conditions of geographical isolation led to speciation.

Under this scenario, the present major distributional areas of temporary water in Western Australia can be envisaged as:

(1) A northern area including part of the Kimberley and the regions immediately to the south (this area includes the Lake Gregory system). These water-bodies are predictably filled and contain water mostly in summer.

(2) A central area where water-bodies are episodically filled.

(3) A south-western area where water-bodies are again predictably filled but contain water mostly in winter.

Of these areas, only (3) has been studied to any degree, and most of the localities that have been investigated are saline.

Water-bodies of the central area (2) are amenable to study only with difficulty. Apart from their isolation, and therefore inaccessibility, study of them must follow unpredictable events - and for this reason alone is difficult, given the present nature of grant support. It is not surprising that very little is known about their biology. Presumably, waters in this area will prove to have a fauna in general character not dissimilar to that in Lake Eyre, as recently studied by Williams and Kokkinn (1988), i.e. it will comprise widely distributed forms having good dispersal mechanisms.

Within the present context, of course, it is area (1) that is of greatest interest, for it is here that Lake Gregory lies. Its fauna seems most likely to be one of two possible sorts. It could consist of an entirely new set of northern endemics, which evolved under conditions of predictably wet summers, and which have been able to withstand the vagaries of past climatic change (and thus extinction during periods of aridity when perhaps, unlike the south, few refugia existed). Or it could consist of a subset, or the whole of the fauna, presently also found in the second area which in the absence of a persistent local endemic assemblage has colonized the otherwise 'evolutionarily' empty niches.

Thus an investigation of the fauna of lakes in the northern areas of Western Australia, wherein Lake Gregory lies, will be of much interest to a variety of biologists. It will be of interest to taxonomists for whom there will be species either locally endemic or representative of the easily dispersed, widespread but little investigated fauna of episodically filled waters of central Australia. It will be of interest to ecologists concerned with temporary waters; for these biologists, interest will focus on the 'reversed' seasonal patterns of inundation and growth. And it will be of interest to biogeographers, for it has the potential to provide significant evidence concerning the evolution of the fauna of Australia's temporary bodies of water.

Even a single collecting trip when the lake is full should provide a great deal of data to illuminate much of the speculation outlined above.

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