Spiny mountain crayfish an evolutionary tale

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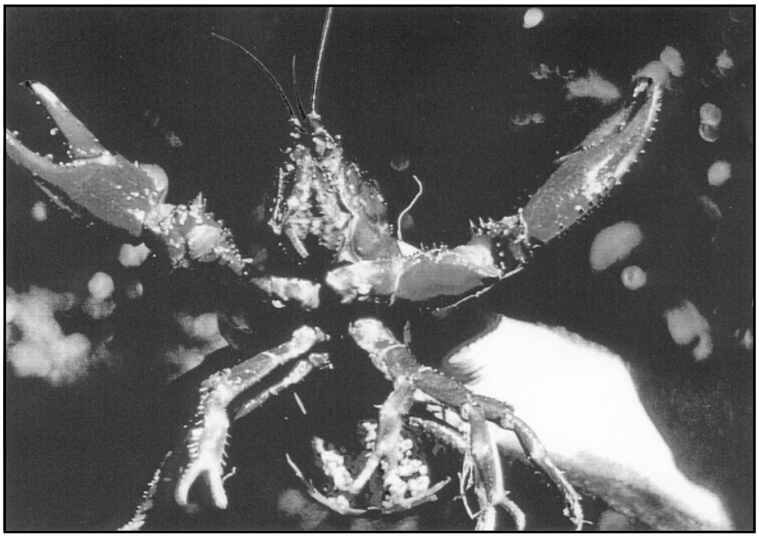
Rainforests in Queensland's mountains and tablelands contain well-shaded, cool and fast-flowing streams. These are the homes of the spiny mountain crayfish which are found all down the east coast of Australia. These crayfish vary enormously in size and colour, ranging from 10 cm to 90 cm. They are often colourful with some bright blue, and others bright red or even purple. Interestingly, on each mountain range you will find a different species of crayfish, and Rainforest CRC researchers are trying to work out why.

Why study the development of new species?

One of the reasons for studying how new species come about is related to conservation management. Conservation planning for rainforests has become increasingly important as habitats are reduced in area and degraded due to human pressures. A common management approach is to identify relatively undisturbed areas that are rich in a variety of species and protect them. More recently, areas considered irreplaceable are being identified to ensure that there is adequate representation of habitats. Consideration is also being given to maintaining as high a level of diversity across species and within species as possible.

What these approaches fail to do, however, is give consideration to protecting the *processes* that sustain diversity, like those that give rise to new species. Changes to the rainforest over time have an impact on the distributions, evolution and associations of rainforest animals, and are therefore important to understand for conservation planning.



A spiny mountain crayfish of the genus *Euastacus (Photograph: J. Hughes)*

Geographical history of the crayfish's range

During the early Miocene (5 million years ago) eastern Australia was predominantly covered by cool, wet forests which were more temperate than those found in the northern subtropical and tropical lowlands of today. Upland rainforests in Queensland, which are scattered along the mountain ranges, are thought to be remnants of these forests. A current theory suggests that the historical expansion, contraction and fragmentation of these remnants may have played a role in the evolution of new species of rainforest dwellers, such as the spiny mountain freshwater crayfish of the genus *Euastacus*.

Preference for cool habitats

There are now fifteen species of crayfish that have been identified in Queensland. Since they are adapted to cold water habitats, the further north they are found, the higher the altitude at which they occur. They occur only above 250m in south-east Queensland, above 750m in central Queensland and above 900m in north Queensland .

Previously, it has been suggested that the group probably had a wide-ranging common ancestor that receded to the cooler mountains when climatic conditions became hotter and drier. Once isolated on each of the mountains, the crayfish diverged sufficiently to be regarded

The Rainforest CRC is a research partnership involving the Commonwealth and Queensland State governments, the Wet Tropics Management Authority, the tourism industry, Aboriginal groups, CSIRO, James Cook University, Griffith University and The University of Queensland

as different, each with its own restricted distribution.

Mark Ponniah, a PhD student with the Rainforest CRC, has used genetic techniques to support the contention that the crayfish share a common ancestor dating from the Miocene Epoch (5-25 million years ago). In other studies he has examined the distribution of specific species which has provided information useful for conservation management issues, such as the levels of current dispersal among populations from different creeks.

Into the rainforest

To gather material for his genetic studies, Mark travels to the rainforest habitats of the crayfish where he collects the claws of a few samples of the Queensland species. Genetic material is isolated from the claws and a specific gene is studied to enable genetic comparisons to be made. Taking the claws may sound cruel, but in fact this causes little problem for the crayfish as their claws regenerate. In this way the crayfish can be studied and preserved.

For his genetic studies Mark uses mitochondrial DNA. Mitochondria are the powerhouses of cells - they are tiny organs found within every cell that provide energy. The DNA from mitochondria is particularly good for evolutionary studies as it is inherited from the mother, unlike other DNA which incorporates characteristics from the father. Using mitochondrial DNA enables evolutionary relationships of individuals to be assessed.

Examining the data

Mark's studies have provided data which suggests a common ancestor theory for the crayfish. In his hypothesis for Queensland crayfish evolution, Mark contends that a southern crayfish expanded its range into Queensland. Once established, the range of this early *Euastacus* contracted and this resulted in at least two ancestral Queensland forms developing. Another range expansion followed, at a time when temperatures were cooler and rainforest habitat less fragmented. A shift in climate, probably associated with the late Miocene drying of the continent, resulted in suitable habitat for these ancient crayfish being restricted to the cooler mountain tops. This caused the isolation of populations of crayfish which resulted in several different species each with restricted distributions.

The *Euastacus robertsi* story

Mark is also investigating the dispersal capabilities of four of the Queensland species of *Euastacus*. In this study he focuses on the mode of dispersal (in-stream versus overland) and the types of habitats that are barriers to dispersal. Data collected on one species, *E. robertsi*, have indicated that the species has very limited dispersal capabilities. This appears to be the case for dispersal between populations on different mountains and even between streams on the same mountain which are not connected by continuous rainforest. Mark's genetic data has identified three subpopulations of *E. robertsi*, and it is thought that due to its limited dispersal capabilities, these may eventually become separate species of *Eustacus*.

Conservation management implications

If the subpopulations of *E. robertsi* are on the road to becoming new species, then it is not only important to manage the rainforest to protect some *E. robertsi*, but to manage it so that processes affecting future evolution of the subpopulations are not interfered with. For example, any artificial changes in drainage patterns, such as joining creeks that previously flowed into separate catchments could halt the processes leading to genetic differentiation by bringing together subpopulations that may have been separated for thousands of years.

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