AUSTRALIAN CAVE PLANTHOPPERS (FULGOROIDEA: CIXIIDAE): REGRESSIVE EVOLUTION OR PROGRESSIVE ADAPTATION ?

Hannelore Hoch
Museum für Naturkunde der Humboldt-Universität, Institut für Systematische Zoologie, Invalidenstr. 43, D-10115 Berlin, Germany

Obligate cavernicolous (troglobitic) arthropods are often characterized by morphological alterations including the reduction and eventual loss of compound eyes, ocelli, wings and bodily pigment. These reductive morphological trends (troglomorphies) have often been interpreted as response to adverse environmental conditions. Reduction of morphological structures in seemingly energy-poor habitats such as caves apparently supported the assumption of selection for energetically economical morphological displays (Poulson, 1964) or indirect effects of pleiotropy (Barr, 1968). Alternatively, so-called regressive evolution has been attributed to effects caused by neutral mutations (Culver, 1982).

The monophyletic cixiid genus *Solonaima*, endemic to Northern Queensland, provides an excellent model system to test these hypotheses. At present, *Solonaima* contains 2 epigean and 6 cavernicolous species. The cavernicolous species feed on tree roots, presumably *Ficus* spp., which penetrate the cavernous rock. Examination of the male genitalia of the cave species revealed the existence of four morphological groups which we interpreted to represent four separate evolutionary lines which have invaded caves in Queensland ranging from 5-10 m.y. old limestone caves to 190,000 years young lavatubes (Hoch and Howarth, 1989).

The cavernicolous species display reductive evolutionary trends which usually accompany adaptation to cave environments, such as the reduction of eyes, body pigmentation and other exoskeletal features. The different evolutionary lines simulate the stepwise evolution of cave species, as they display varying degrees of troglomorphy, ranging from only slightly modified, troglophilic taxa to blind, flight- and pigmentless, troglobitic species.

Surprisingly, the degree of troglomorphy of adults of cave-dwelling *Solonaima* species correlates with the physical parameters (e.g., light availability, relative humidity, CO_2-content) of the cave environment where they are found rather than with age of the caves or food availability. Studies on the morphology, behavior and ecology of the cave species have revealed the adaptive value of morphological structures (specializations), behavioral traits and ecological strategies. These findings suggest that evolution of cave species involves active adaptation to novel habitats rather than passive coping with unfavorable conditions.

Similar morphological and adaptational phenomena have been observed in several other cave planthoppers of the families Cixiidae (genus *Undarana*) and Meenoplidae (genus *Phaconeura*) from Queensland which in some caves were found to co-exist with *Solonaima*.

Molecular approaches will be necessary to understand the evolutionary processes underlying the observed patterns. Gene sequence data may not only help to elucidate the phylogenetic relationships between populations and species, and to determine rates of evolution, but provide important information on potential *evolutionarily significant units* (sensu Moritz 1994) which is crucial for the development of adequate conservation strategies.

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