Cave shrimp more widespread than thought

CAPE PENINSULA

An endemic crustacean whose nearest living relative is found in South America, is not as vulnerable as previously feared.

The cave system housing the Table Mountain cave shrimp (*Spelaeogriphus lepidops*) is potentially much larger than previously suspected and the animal is more widely distributed than originally thought, according to research by the University of Cape Town's (UCT) Zoology Department.

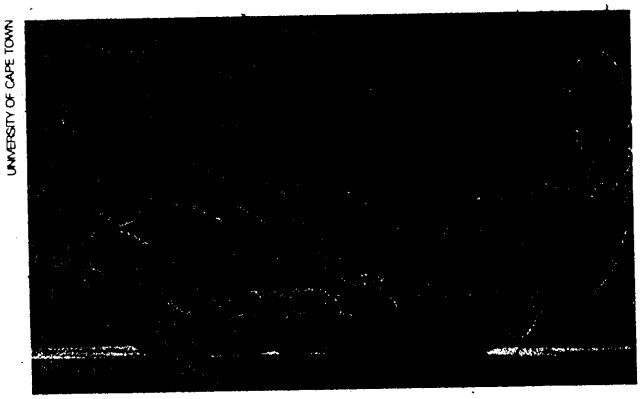
During a WWF-supported survey, the UCT team found the animal in two other caves apart from the original system. One of these caves does not appear to be connected to the original system at all. "The new discovery is particularly significant," says Prof George Branch of UCT's Zoology Department. "It indicates that the population is relatively large, and much less prone to extinction."

The survey team was surprised to also find specimens of the *Spelaeogriphus* in an outside pool under an overhang near one of the caves — the first record of the animal outside a cave. "Whether they occur there permanently is questionable, as they were not found on subsequent trips," says Branch. "They may simply have been washed out of a cave into this external pool."

Laboratory studies have revealed that the species once had eyes, the remnants of which now exist in small flaps on the front of the head in the adult. Investigations show that the shrimp is not nearly as closely related to crustacean groups previously thought to be its nearest relatives.

"*Spelaeogriphus* remains an intensely interesting animal," says Branch. "Accurate sampling of the population remains difficult because many areas of the caves are inaccessible. It appears, however, that the population — although rare and endemic — is not as vulnerable as previously thought."

The cave shrimp survey was conducted by Colleen Parkins of the University of Cape Town's Zoology Department in association with the South African Spelaeological Association, with support from WWF South Africa. The project was initiated by Prof Leslie Watling of the University of Maine.



UNIVERSITY OF CAPE TOWN

***Spelaeogriphus lepidops* – surviving on the Cape Peninsula:** *The Cape cave shrimp population is not as vulnerable as previously thought.*

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by John Yeld (2nd edition)

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THE RESPIRATORY MECHANISM OF *SPELAEOGRIPHUS* AND ITS PHYLOGENETIC SIGNIFICANCE (SPELAEOGRIPHACEA)

BY

J. R. GRINDLEY
Port Elizabeth Museum and Oceanarium, Port Elizabeth, South Africa

and

R. R. HESSLER
Scripps Institution of Oceanography, San Diego, California, U.S.A.

When *Spelaeogriphus lepidops*, the sole representative of the order Spelaeogriphacea, was described by Dr. Isabella Gordon (1957), only preserved material was available for study. Further specimens collected since then were also not examined alive, and additional notes by Siewing (1960, 1963) and Gordon (1960) have been based only on studies of this preserved material.

Recently we collected further specimens and were able to examine them alive in the laboratory and take moving pictures of them under the microscope. In particular, observations were made of their respiratory, locomotory and feeding mechanisms. A general description of these observations will be published elsewhere, but their respiratory mechanism appeared to be of sufficient general interest to warrant this separate note.

In the original description it was noted that the exopods on each of the three anterior pairs of peraeopods are natatory whereas those on peraeopods 4 to 6 respectively, as well as occasionally that on peraeopod 7, are reduced and modified to serve as gills. There is also a cup-like epipod on the base of the maxilliped which is assumed to be respiratory and is referred to as a "gill".

When living specimens are examined, it is immediately obvious that the anterior three pairs of exopods which had been regarded as natatory on the basis of preserved material, actually perform a respiratory function in ventilating the cup-like epipod and the exopodal gills. These segmented exopods fringed with setae keep up a constant antero-posterior beating movement irrespective of the activity of the animal. They continue to beat rhythmically several times (estimated at 5 to 10) per second, whether the peraeopods on which they are placed are moving or stationary. The positions of the anterior exopods, when the peraeopods are in normal positions, are such that the first are under the spreading postero-lateral margins of the carapace and the second and third just posterior to these margins. Addition of fine carbon particles to the water indicated that the movement of these anterior exopods produced a respiratory current flowing backwards from

under the carapace, where the cup-like epipod is situated, and over the gills on the posterior peraeopods. In Malacostraca, where the gills are enclosed by a carapace, the respiratory current usually flows forwards.

The anterior exopods do not appear to have any function other than respiratory ventilation. They might thus be referred to as "ventilatory exopods", rather than natatory exopods, as it is now apparent that the latter term is misleading.

Examination of the living specimens also enabled some observations to be made on the functioning of the exopods on the posterior peraeopods, confirming Gordon's (1957) interpretation of them as gills. When examined under high magnification, the streaming of the haemolymph through the gills was clearly apparent because of the corpuscles in the fluid. The gill-cuticle is sufficiently thin to be transparent and the current of haemolymph can be seen to flow distally on the anterior surface and proximally on the posterior surface, separated by a thick opaque septum. (The septum is shown stippled in Dr. Gordon's illustrations but in life there is more space around the septum for the circulation of haemolymph than shown in the original illustrations). There is thus no evidence of counterflow of the haemolymph in relation to the respiratory current, but it is probable that in a simple unenclosed system counterflow would have little influence on efficiency of respiratory exchange. The rate of the flow of the haemolymph through the

TABLE I

Respiratory structures in the Malacostraca and their correlation with the extent of the carapace fold. T1 = 1st thoracopod, T2 = 2nd thoracopod, etc. $\leq$ means the given amount or less, depending upon the taxon.

		Epipod			Exopod			
Taxon	Extent of carapace	Presence	Branchial	Ventilatory	Presence	Branchial	Ventilatory	Other branchial structures
Leptostraca	T1-8	T1-8	T1-8	T1-8	T1-8	T1-8	T1-8	?
Hoplocarida	T1-5	T1-5	T1-5	?	T6-8	—	—	Pleopods
Syncarida (Anaspidacea)	—	T1-7	T1-7	—	$\leq$T1-7	$\leq$T1-7	T2-6	—
Euphausiacea	T1-8	T1-8	T1-8	—	$\leq$T1-8	—	$\leq$T1-8	—
Decapoda (Natantia)	T1-8	T1-8	T1-8	—	$\leq$T1-8	—	—	—
Mysidacea	T1-8	$\leq$T1-8	$\leq$T1-8	T1	T1-8	—	—	$\leq$Carapace
Amphipoda	—	$\leq$T3-8	$\leq$T3-8	—	—	—	—	—
Thermosbaenacea	T1-3	T1	—	T1	$\leq$T1-8	—	—	Carapace
Cumacea	$\leq$T1-4	T1	T1	T1	$\leq$T1,3-7	—	—	—
Spelaeogriphacea	T1-2	T1	T1	T1?	T2-8	$\leq$T5-8	T2-4	Carapace? *
Tanaidacea (Monokonophora)	T1-2	T1	T1	T1	T2-3	—	T2-3	Carapace
Isopoda	—	T1	—	—	—	—	—	Pleopods

* The "oval patch" on the inside of the carapace fold (Gordon, 1957: 33) might well be a respiratory surface.

gills is more rapid than in those other parts of the body in which the circulation is visible. The gills move slightly with the bases of the legs during locomotion, but they also sometimes twitch independently. Presumably this is a mechanism to rid them of any adhering debris. It was not possible to observe the functioning of the epipodal gill on the maxilliped in the living specimens.

If the epipod of the maxilliped does have a respiratory function, spelaeogriphaceans are unusual in having two sets of respiratory structures approximately equally well developed. In the anaspidacean Syncarida, all the epipods and one or two exopods have branchial functions (Siewing, 1959), but the exopods are less well developed. In stomatopods, the development of the respiratory epipods of thoracopods 1 to 5 is feeble compared to the well developed pleopodal branchiae.

There has been little question that among living Peracarida the Mysidacea are most primitive (Calman, 1909; Siewing, 1963). Their well developed caridoid facies and their resemblance in this respect to the most primitive Eucarida (Euphausiacea, Natantia) is strong evidence for this hypothesis. The presence of epipodal gills in the mysids (especially the primitive Lophogastrida), eucarids, and syncarids suggests this is a primitive eumalacostracan feature. The exopodal gills in spelaeogriphaceans should, then, be regarded as a secondary specialization.

Secondary modification of the branchial system in peracaridans is a common feature, concomitant with reduction and loss of the carapace. (See table I). Only in the mysids is the carapace fold fully developed, and only here are branchial epipods present on all thoracopods, at least primitively. In the cumaceans, spelaeogriphaceans, and tanaids the carapace covers only the more anterior thoracomeres, and only the first thoracopod (maxilliped) possesses a branchial epipod. The carapace is totally lacking in isopods and amphipods. In isopods, epipodal respiration has been completely abandoned, and the pleopods have become the respiratory structures. Amphipods appear to have retained epipodal gills on as many as six thoracopods, but these gills have migrated to a protected position medial to the limbs.

In spite of the above correlation within the Peracarida, the functional relationship between carapace and epipodal gills is not clear. Well developed epipodal gills have survived the loss of the carapace in the Syncarida, and the large epipodal gills of the Euphausiacea are exposed beneath the margins of the carapace.

Gordon (1960) and Siewing (1960) placed the Spelaeogriphacea and Tanaidacea close to each other in peracaridan phylogeny. The condition of their respiratory systems is strong evidence for this view. Both have a cup-shaped branchial maxillipedal epipod sheltered beneath the carapace as already noted by Gordon. Tanaids usually lack exopods on the thoracic limbs, but in primitive apseudids, the second and third thoracopods have minute exopods whose vibration aid in ventilating the branchial chamber (Calman, 1909). This is completely homologous to the vibratory exopods of *Spelaeogriphus*. Thus, the situation in the tanaids is easily derived from the spelaeogriphacean condition. However, there is not sufficient evidence to allow us to conclude that the ancestral tanaid also possessed

exopods that were purely branchial. This may well be merely a spelaeogriphacean specialization.

ACKNOWLEDGEMENTS

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ZUSAMMENFASSUNG

Der Mechanismus der Atmungsorgane der *Spelaeogriphus lepidops* Gordon wird auf Grund von Laboratoriumsuntersuchungen und mikroskopisch-kaleidoskopischen Bildern analysiert. Die Atmungsorgane bestehen aus Kiemen an den Pereiopoden 4 bis 6 (und manchmal an Pereiopod 7) und einer Epipod an der Basis der Maxillipeden. Offensichtlich erfüllen die äußeren Exopoden der ersten drei Pereiopoden eher Ventilator- als Schwimmfunktionen (wie früher geglaubt wurde). Die Beschaffenheit des Atmungssystems der Spelaeogriphacea beweist, daß sie phylogenetisch — innerhalb der Peracarida — in der Nähe der Tanaidacea stehen.

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