The mineral composition of statoliths in relation to taxonomy and ecology in mysids

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ABSTRACT. Results of X-ray diffraction studies on the statoliths of several species of Mysidae show that calcareous (vaterite) statoliths are exclusively present in some species of the tribe Mysini. These species inhabit brackish-fresh waters or have some of their populations in such environments. They probably descend from brackish-water forms evolved in the Paratethys.

RÉSUMÉ. La composition minérale des statolithes de plusieurs espèces de Mysidae, étudiée par diffraction aux rayons X, est comparée avec la position taxonomique et l'écologie des espèces. On remarque que la présence de statolithes calcaires (en vatérite) est limitée à certaines espèces de Mysini dont quelques populations, du moins, vivent en eau saumâtre-douce, et dont les souches ont évolué, probablement, dans le milieu saumâtre de la Paratéthys.

The statoliths of the Mysidae are mineral concretions of biologic origin, that are discarded by the animal with each molt (COHEN & DIJKGRAAF, 1961). They consist of fluorite in some species (LOWENSTAM & McCONNELL, 1968; VOICU, 1981) whereas in others they are made of calcium carbonate (VOICU, 1981; ARIANI, 1981). It has been suggested (VOICU, 1981) that as a general rule the marine mysids have fluorite statoliths, and the brackish-fresh water mysids synthesize calcareous statoliths. This assumption is based on the occurrence of statoliths of calcium carbonate in some brackish-fresh water species of *Paramysis* from the Black Sea, as well as on the discovery of calcareous mysid statoliths in Miocene deposits of the brackish Paratethys. According to VOICU, in a marine medium the static function of the statolith demands the precipitation of a mineral (fluorite) with a greater specific gravity (3.2), whereas in a brackish-fresh water medium the animal synthesizes calcium carbonate that has a lower specific gravity (2.7). We add that fluorine, present in sea-water (35 ‰ S) in a 0.0013 g/kg amount, is more scarce or absent in brackish or fresh waters; this may make it difficult or impossible to synthesize calcium fluoride in such environments.

Table 1

Species	Locality (‰ S)	Mineral content of statoliths
Subfamily Siriellinae		
Siriella clausii G. O. Sars	Gulf of Salerno (37.5)	fluorite
	Lago di Faro, Sicily (33)	fluorite
Siriella jaltensis gracilipes Nouvel	Gulf of Salerno (37.5)	fluorite
Siriella castellabatensis Ariani & Spagnuolo	Gulf of Salerno (37.5)	fluorite
Subfamily Gastrosaccinae		
Gastrosaccus mediterraneus Bacescu	South Adriatic near Brindisi (38)	fluorite
Gastrosaccus roscoffensis Bacescu	English Channel near Roscoff (34.5)	fluorite
Haplostylus lobatus (Nouvel)	Gulf of Salerno (37.5)	fluorite
Anchialina agilis (G. O. Sars)	Gulf of Salerno (37.5)	fluorite
Subfamily Mysinae		
Tribe Leptomysini		
Leptomysis lingvura (G. O. Sars)	Gulf of Taranto (38)	fluorite
Leptomysis burgii Bacescu	Gulf of Taranto (38)	fluorite
Mysidopsis gibbosa G. O. Sars	Gulf of Trieste (36)	fluorite
Tribe Mysini		
Hemimysis lamornae mediterranea Bacescu	Gulf of Naples (37)	fluorite
Diamysis bahirensis (G. O. Sars)	Lake of Tunis (38)	vaterite
	Gulf of Naples (37)	vaterite
	Fiume Piccolo, Adriatic coast of Apulia (12.5)	vaterite
	Deransko jezero, Herzegovina (fresh water)	vaterite
Limnomysis benedeni Czerniavsky	Danube in Vienna (fresh water)	vaterite
Schistomysis spiritus (Norman)	English Channel near Roscoff (34.5)	fluorite
Paramysis helleri (G. O. Sars)	South Adriatic near Brindisi (38)	vaterite
Mesopodopsis slabberi (van Beneden)	Lake of Tunis (38)	fluorite
Acanthomysis longicornis (M.-Edw.)	Gulf of Trieste (36)	fluorite

It has recently been found (ARIANI et al., 1981 and in prep.) that in mysid statoliths calcium carbonate is precipitated in the form of vaterite, which has been discussed in relation to the mechanisms of calcium carbonate biomineralization. We now report the results of X-ray diffraction studies carried out on the statoliths of several mysid species (Table 1) in order to elucidate a possible connection between the mineral composition of statoliths and the taxonomy and ecology of the species.

Our data show that:

1) Within the subfamilies Siriellinae and Gastrosaccinae, all the species investigated have fluorite statoliths. These mysids are strictly marine, with the exception of *Siriella clausii* occasionally found in brackish environments (GENOVESE, 1956).

2) Either fluorite or vaterite statoliths occur in the Mysinae, more precisely in the Mysini. From a taxonomic point of view, the different mineral composition of the *Schistomysis* and *Paramysis* statoliths increases evidence that *Schistomysis* is a well-founded genus (TATTERSALL & TATTERSALL, 1951) and not a subgenus of *Paramysis* (ZIMMER, 1915). By contrast, *Diamysis* and *Limnomysis* both have calcareous statoliths, which provides a further confirmation of their close relationship (BACESCU, 1954). In regard to possible ecologic implications, some results conflict with the VOICU's hypothesis, as marine populations of *Diamysis bahirensis* and *Paramysis helleri* show calcareous statoliths. On the other hand, fluorite statoliths have been reported from the Atlantic brackish-water species *Neomysis integer* (LOWENSTAM & McCONNELL, 1968). However, significant correlations come out if one considers that the known marine mysids with calcareous statoliths have also populations in brackish-fresh waters. In fact, *D. bahirensis* occupies metahaline to fresh-water environments (ALMEIDA PRADO-POR, 1981), and *P. helleri* has been reported from a brackish-fresh water locality (HOLMQUIST, 1955). Furthermore, these are forms of presumably Paratethyan origin (BACESCU, 1954; ARIANI, 1981), which is supported for the genus *Paramysis* by paleontologic evidences (VOICU, 1981). Such an origin has been supposed (WEISH & TÜRKAY, 1975) also for *Limnomysis benedeni*, a typical brackish-fresh water species. Lastly, it is of interest to note that among the mineral phases of crystalline calcium carbonate vaterite has a specific gravity (2.54) lower than calcite (2.71) and aragonite (2.95). This might confirm the VOICU's hypothesis, but only if expressed in paleoecologic terms.

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