MYSIDACEA

by

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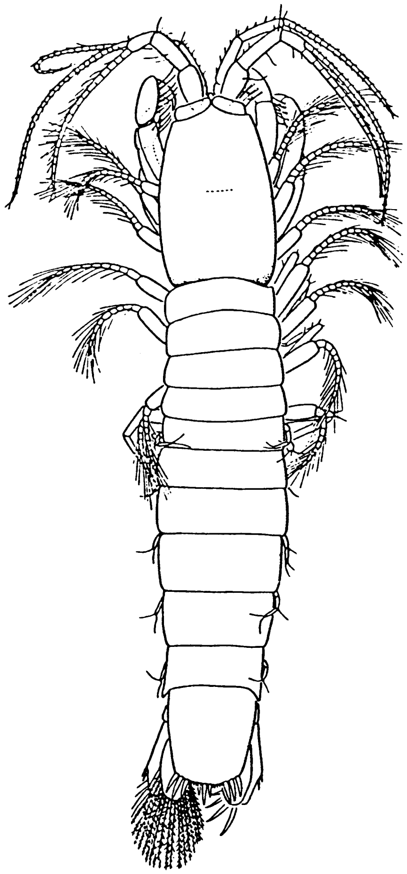

Fig. 1 - *Stygiomysis holthuisi* Gordon (From Gordon, 1960).

I - GENERALITES

The Crustacean order Mysidacea (BOAZ, 1883) currently includes about 800 species, distributed in widely differing environments such as open and coastal sea waters and brackish waters, a few taxa occuring in freshwaters and in intersitial coastal belts and in different groundwater habitats.

The majority of the localities from which both fresh surface and groundwater species have been reported are close inshore, suggesting that freshwater mysids, as a whole, evolved recently from marine ancestors.

The groundwater mysids are most prolific in the Caribbean area and in central America (Mexico), as well as in the Mediter-ranean basin; only two species are known respectively from south-east Africa (Kenya, Zanzibar, Aldabra) and south India.

II - HYPOGEAN SPECIES

The first mysids to be recorded from underground aquatic habitats were *Spelaeomysis servatus* described by FAGE (1924) on material from the little lake Machumwi-Ndogo at Zanzibar, and *Spelaeomysis bottazzii*, described by CAROLI, in the same year, from specimens collected at the Zinzulusa cave in the Salentine Peninsula (south Italy).

Later on and of recent years more attention has been given to the taxonomy, ecology and biology of stygobiont mysids, numerous groundwater species were discovered and very valuable works and papers were produced (CALMAN, 1932; CREASER, 1936; CAROLI, 1937; VILLALOBOS, 1951; GORDON, 1958, 1960; CLARKE, 1961; PILLAI and MARIAMMA, 1963; BACESCU and ORGHIDAN, 1971, 1977; BACESCU and ILIFFE, 1986, 1987; PESCE, 1976; JUBERTHIE-JUPEAU, 1976, 1978; BOTOSANEANU, 1980; DE MATTHAEIS a.o., 1981; ARIANI, 1980, 1982; BOWMAN, 1973, 1976, 1977; BOWMAN a.o., 1984; CROUAU, 1978, 1981, 1983, 1985, 1987, 1988; LEDOYER, 1963, 1965, 1969, 1989).

At present 17 stygobiont species, for the most part endemic, are known from coastal caves, phreatic waters (wells) and anchialine habitats of inland caves, the majority of which colonized the groundwater nets owing to stranding and uplifting of their marine ancestors during the Pliocenic regressions of the Mediterranean; other ones, such as *Spelaeomysis cardisomae* Bowman (San Andrés island), *Heteromysoides cotti* Bacescu (Jameos de Agua, Lanzarote), *Antromysis anophelinae* Tattersall, *Anisomysis vasseuri* Ledoyer, *Hemimysis speluncola* Ledoyer, *Leptomysis burgii* Bacescu and *Leptomysis peresi* Bacescu, etc., are to be considered stygophiles or stygoxenes.

III - ADAPTATIONS

Troglobitic mysidaceans show the typical features of most troglobites, viz. they are usually blind and unpigmented, as well as they are characterized by a rather vermiform body, reduced carapace, thoracopods from 2 to 4 with prehensile endopods and slighth sexual dimorphism of the second pair of pleopods.

Sensory organs. Stygobiont mysids are eyeless. *Heteromysoides cotti*, a stygophile which may be observed in a part of Jameos de Agua not completely dark, has small coumpound eyes. Some features are thought to represent an archaic nature of eye which exhibits both signs of degeneration and signs of adaptation to improve photon capture. It will be able to distinguish different light intensities and direction from which the light arrives.

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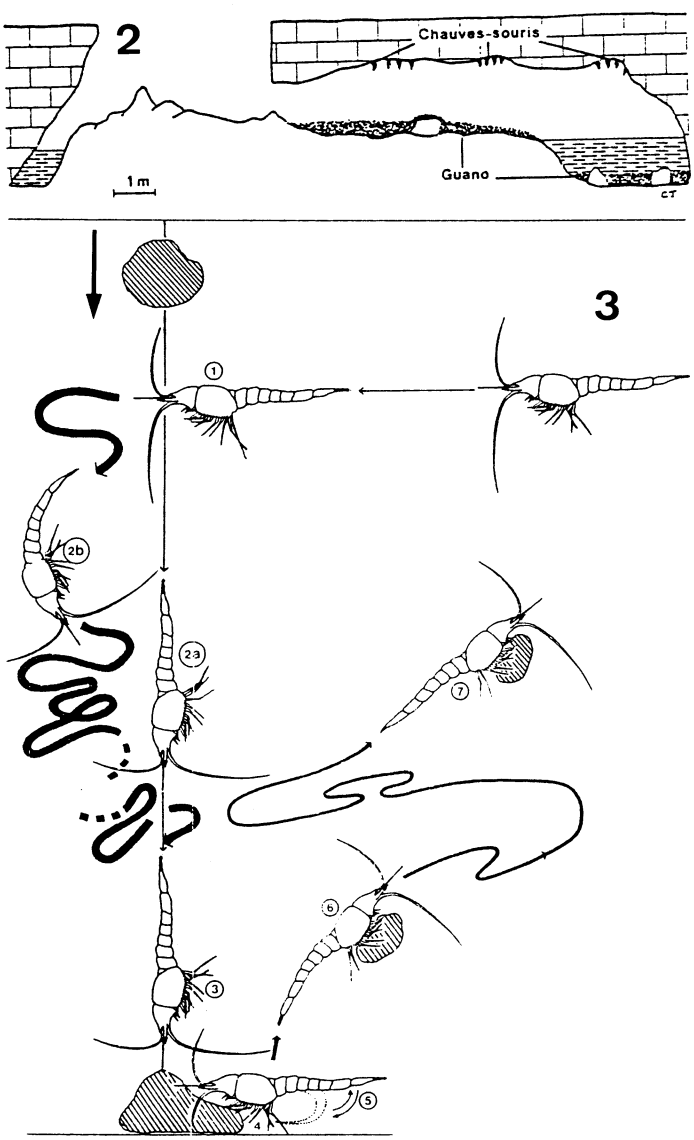

Fig. 2 - Schema of the Cueva de los Murcielagos in the Pinos Island (Cuba) (JUBERTHIE, 1983). Fig. 3 - Foraging behaviour of *Antromysis juberthiei* (CROUAU, 1983). 1. Detection of food ; 2 a. and 2 b. Rectilinear run (2 a) or sinuous run (2 b) of the animal after detection of food. 3. Contact of antennae with food. 4. Contact of pereiopods with food. 5. Grasping of a piece of food and abdominal contractions. 6. Carriage of a piece of food; animal swims quickly in various directions. 7. Food is placed before the gnathopods.

Other sensory organs in stygobiont mysids are very numerous. In *Antromysis juberthiei* 18 morphologic types of setae on the antennae and 12 on the mouth-parts and the thoracic appendages are present. On the antennae they are mechanosensitive, chemosensitive or both mecano- and chemosensitive. Their ultrastructural features show some differences with similar organs of epigean mysids which may improve their sensitiveness: thinness of the aesthetasc wall, structural diversity of the mechano and chemosensitive setae concerning their fine morphology, the various structure of the cuticular wall of their shafts and the number of their dendrite types.

IV - ECOLOGY AND BEHAVIOUR

As to the ecology cave mysids can be found generally in groundwater environments close to the marine coasts and characterized by variable salinity, oxygenation and temperatures. In Cuba the total mineralization of water is 830 mg/l in Juanelo Piedra cave where *Antromysis cubanica* lives and 1470 mg/l in the Cueva de los Murcielagos where *Antromysis juberthiei* is found, meanwhile in Lanzarote in Jameos de Agua inhabited by *Heteromysoides cotti*, the salinity of the water which varies from 36,83 to 37,10 ‰ is only a little lower than the salinity of the sea water going from 37,10 to 37,99 ‰. Temperatures in tropical caves are high, 25,5°C in Juanelo Piedra, 24°C in los Murcielagos and lower in Canarian Islands: 18 or18,5°C, in Jameos de Agua.

Two mechanisms are put forward to explain feeding in Mysidadea. In the first, small food particles are obtained by filtration of a hydrodynamic current through the setae of the maxillae. In the second, large food masses are grasped with periopodal endopods then eated. In tropical caves, the fundamental element of large food pieces is provided by bat guano. The search of a food mass dropping in water is induced by physical stimuli produced by its impact on the water surface then by chemical stimuli or physical stimuli due to currents generated by the wake of the piece of food going down. Mysids are able to detect various degrees of hydrodynamic currents and show a rheotactic behaviour at fast current flows (100 cm3/min.) perhaps related to the necessity to resist to stream of floods during the rains.

Reproduction. Few data are available on reproduction and development of troglobitic mysids. They lay few eggs, from 4 (*Heteromysoides cotti*, *Antromysis juberthiei*) until 9 (*Spelaeomysis longipes* observed by PILLAI and MARIAMMA) but their fecundity, compared to epipelagic species (MAUCHLINE), is not reduced as it appears in other subterranean groups. In *Antromysis juberthiei* vitellogenesis, cycles of which follow one another without interruption, and embryonic development occur between 20 and 27°C. Whatever the temperature, this latter is always longer than the embryonic development of an epigean species *Mesopodopsis orientalis* (Nair). Vitellogenesis is stopped at 18°C but restored by a higher temperature. The vital cycle is the shortest at 24°C, higher or lower temperatures lengthen it. There is no endogenous rythm of reproduction.

Migrations of stygophile *Hemimysis speluncola*. With the development of dive, the observations on marine cavernicolous mysids are becoming more frequent. The dark marine caves of the North-West Mediterranean and the near Atlantic are inhabited essentially by the genus *Hemimysis* Sars, 1869. These mysids show no typical feature: they are neither unpigmented, nor blind, and have, on the contrary, well developed eyes. Some sea caves in Marseille's area (France) give cover to large populations of the species *Hemimysis speluncola* Ledoyer, 1963, which has been sometimes mistaken for *H. lamornae* (Couch, 1856).

The *H. speluncola* carry out diel horizontal migrations homologous of the diel vertical migrations of the deep-sea plankton. Located in the daytime in dark parts of the caves, where the irradiance ranging about 10^{-9} $W.m^{-2}$ corresponds with the one recorded at 350-400 m in depth in the open sea, these mysids accomplish an outward migration at dusk and an inward migration at dawn, at the rate of 20-27 $m.s.^{-1}$. In absence of moonlight, they leave the cave at night. The stages of the migration coincide with the civil, nautical and astromical twilights. These migrations, closely connected with the solar and lunar irradiances changes, proceed from three rhythms : dial, lunar, annual.

The light direction is the orientating cue, and the corresponding locomotor response is a real phototaxis, positive at the time of the outward migration. The irradiance is the temporal cue. So, the determinism of the migration involves a double photodependence.

The *Hemimysis speluncola* show a strong positive rheotaxis, in which statocysts intervene, and are apt to resist currents, up to 12 cm s-1 and more, susceptible of sweeping them along on their coming out at night.

Carnivorous, as well as omnivorous or detritivorous, theses mysids, the swarms of which can number several millions of individuals, release inside the caves great quantities of fecal pellets. They are themselves the preys of cerianthids, shrimps and fishes. Thus, the dial horizontal migrations of *Hemimysis speluncola* play a preponderant part in the organic matter fluxes between the inside of marine caves and outside environment.

V - TAXONOMY AND DISTRIBUTION

The Mysidacea are divided in two suborders: the Lophogastrida composed of pelagic species without stygobiont species, the Mysida composed of 4 families.

From a taxonomic point of view, all the stygobiont species of this group belong to the suborder Mysida and, according to GORDON (1957, 1960), most taxa are to be placed in the Lepidomysidae and Stygiomysidae families, the others in the family Mysidae.

Stygobitic species

All the known stygobitic species, together with their ecology and geonemy, are listed below.

The distribution of the nominate species over the World is figured in fig. 4.

Family LEPIDOMYSIDAE Clarke, 1961

Genus *SPELAEOMYSIS* Caroli, 1924

S. bottazzii Caroli, 1924; cave and phreatic water dwelling (stygobiont); endemic to south Italy (Zinzulusa cave and wells).

S. quinterensis (Villalobos, 1951); cave dwelling (stygobiont); endemic to Mexico (Grutas de Quintero).

S. longipes (Pillai and Mariamma, 1964); phreatic waters dwelling (stygobiont); endemic to India (Kerala).

S. nuniezi Bacescu and Orghidan, 1971; cave dwelling (stygobiont); endemic to Cuba (Cueva Juanelo Piedra).

S. olivae Bowman, 1973; cave dwelling (stygobiont); endemic to Mexico (Cueva de Nacimiento del Rio San Antonio).

Family STYGIOMYSIDAE Caroli, 1937

Genus *STYGIOMYSIS* Caroli, 1937

S. hydruntina Caroli, 1937; cave and phreatic waters dwelling (stygobiont); endemic to South Italy (Buco dei Diavoli, L'Abisso).

S. holthuisi (Gordon, 1960); cave dwelling (stygobiont); West Indian islands of St. Martin (Devil's Hole), Anguilla (Salt Well, The Fountain), Puerto Rico (Cueva de los Murcelagos, Guanica Fores) and Grand Bahama (Lucaya).

S. major Bowman, 1976; cave dwelling (stygobiont); endemic to Jamaica (Jacks bay).

S. clarkei Bowman, Iliffe and Yager, 1984; cave dwelling (stygobiont); Turks and Caicos Islands (Conch Bar Cueva).

Genus *ANTROMYSIS* Creaser, 1936

A. cenotensis Creaser, 1936; cave dwelling (stygobiont); endemic to Yucatan (Mexico).

A. cubanica Bacescu and Orghidan, 1971; cave dwelling (stygobiont); endemic to Cuba (Cueva de Juanelo Piedra).

A. juberthiei Bacescu and Orghidan, 1977; cave dwelling (stygobiont); endemic to Cuba (Cueva de Los Murcielagos, Isla de Pinos).

A. reddelli Bowman, 1977; cave dwelling (stygobiont); endemic to Mexico (Cueva de la Maravillosa).

A. peckorum Bowman, 1977; cave dwelling (stygobiont), endemic to Jamaica.

Genus *TROGLOMYSIS* Stammer, 1936

T. vjetrenicensis Stammer, 1936; cave dwelling (stygobiont); endemic to Yugoslavia (Vjetrenica Jama).

Family MYSIDAE Dana, 1850

Genus *HETEROMYSOIDES* Bacescu, 1968

H. cotti (Calman, 1932); brackish water pool, Cueva Los Verdes, Lanzarote (Canary Islands).

Genus *BURRIMYSIS* Jaume and García, 1993

Burrimysis palmeri Jaume and García, 1993; anchialine waters, Balearic Islands.

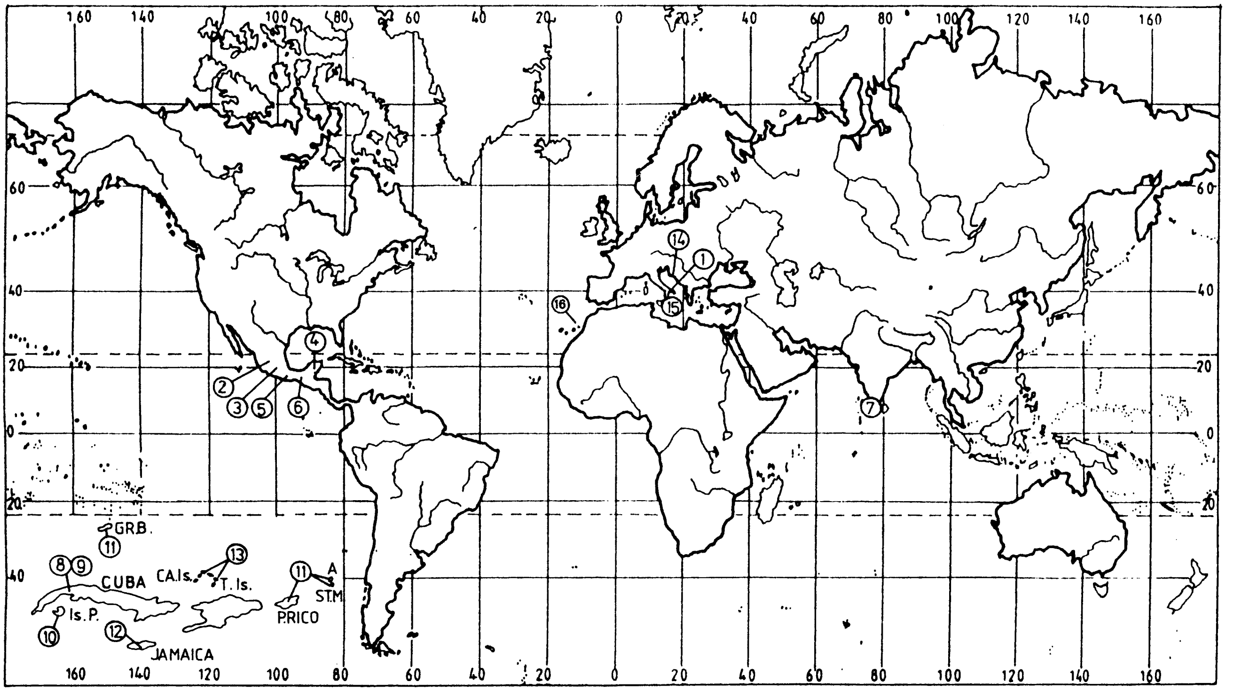

Fig. 4 - Biogeographical range of stygobitic Mysidacea. 1. *Spelaeomysis bottazzii*; 2. *Spelaeomysis quinterensis*; 3. *Spelaeomysis olivae*; 4. *Antromysis cenotensis*; 5. *Antromysis peckorum*; 6. *Antromysis reddelli*; 7. *Spelaeomysis longipes*; 8. *Spelaeomysis nuniezi*; 9. *Antromysis cubanica*; 10. *Antromysis juberthiei*; 11. *Stygiomysis holthuisi;* 12. *Stygiomysis major*; 13. *Stygiomysis clarkei*; 14. *Troglomysis vjetrenicensis*; 15. *Stygiomysis hydruntina*; 16. *Heteromysoides cotti*; 17. *Burrimysis palmeri*.

Stygophilic species

Some stygophilic, cave marine or land crab burrows dwelling species present a particular interest.

Family LEPIDOMYSIDAE Clarke, 1961

Genus *SPELAEOMYSIS* Caroli, 1924

S. servatus (Fage, 1924); cave dwelling; Kenya, Zanzibar, Aldabra.

S. cardisomae Bowman, 1973; cave dwelling and land crab burrows dwelling; Columbia, San Andrés.

S. cochinensis Panampunnayil and Viswakumar,1991; prawn culture field, India.

Family MYSIDAE Dana, 1850

Genus *HEMIMYSIS* Sars, 1869

H. speluncola Ledoyer, 1963; marine cave dwelling; North-West mediterranean coasts (Provence, Medes Islands).

H. lamornae mediterranea Bacescu, 1936; North-West Mediterranean (Provence).

H. margalefi Alcaraz, Riera, Gili, 1986; North-West Mediterranean (Majorca, Provence).

H. maderensis Ledoyer, 1989; East Atlantic (Madeira).

H. sophiae Ledoyer, 1989; East Atlantic (Portugal).

H. spinifera Ledoyer, 1989; East Atlantic (Portugal).

Genus *LEPTOMYSIS* Sars, 1869
L. burgii Bacescu, 1966; submarine caves dwelling; Banyuls-sur-Mer, France.
L. peresi Bacescu, 1966; submarine caves dwelling; Banyuls-sur-Mer, France.

Genus *ANISOMYSIS* Hansen, 1910
A. vasseuri Ledoyer, 1974; coral reef caves dwelling, Madagascar.

Genus *HARMELINELLA* Ledoyer, 1989
H. mariannae Ledoyer, 1989; North-West Mediterranean (Provence, Tremis cave, Cosquer cave).

Genus *BERMUDAMYSIS* Bacescu and Iliffe, 1986
B. speluncola Bacescu, Iliffe, 1986; West Atlantic (Bermuda).

Genus *PLATYOPS* Bacescu and Iliffe, 1986
P. sterreri Bacescu, Iliffe, 1986; West Atlantic (Bermuda).

Genus *ABEROMYSIS* Bacescu and Iliffe, 1987
A. muranoi Bacescu, Iliffe, 1986; West Pacific, Palau.

Genus *PALAUMYSIS* Bacescu and Iliffe,1987
P. simonae Bacescu, Iliffe, 1986; West Pacific, Palau.

Genus *ANTROMYSIS* Creaser, 1936
A. anophelinae Tattersall, 1951; land crab burrows dwelling; Costa Rica.

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