

Consequences of the discovery of *Stenasellus* (Crustacea, Isopoda, Asellota)2 in the underground waters of Oman (Arabian Peninsula)

Stygofauna of Oman, 4*

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Abstract

An overview of the present knowledge of the family Stenasellidae (Asellota: Aselloidea) is presented, focusing on the success of recent investigations of the underground waters of Oman (S.E. Arabian Peninsula). We take up the discovery of four new species of the genus *Stenasellus*: small species adapted to interstitial biotopes and larger ones typical of karstic aquifers. These species cohabit in ecotones between interstitial and karstic water systems. The putative presence of stenasellids in hypogean waters of Yemen and South Iran is suggested. The taxonomic status of the genus *Stenasellus* auct. needs to be reconsidered in the future. A scenario to explain the origin and the presence of these isopods in continental underground waters is advanced.

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Introduction

The family Stenasellidae Dudich, 1924

At present, this isopod family (Asellota: Aselloidea) includes 10 genera and more than 70 taxa. All stenasellids are anophthalmous and lack integumental pigment, but they possess pink or red haemolymphatic pigment and live in continental underground waters. The smallest of the species is 2 mm long, the largest 26 mm. First discovered in 1896, in the sink-hole near Padirac, southwestern France, they also have been collected in many other places, in the Pyrenees, the Iberian Peninsula (1924), the Balkan (1924), Turkmenistan (1949), West Africa (1938), the Zaire Basin (1951), East Africa (1966), the Indochinese Peninsula (1971) and the western hemisphere from Mexico and Texas (1972) (cf. Coineau et al., 1994; Henry et al., 1986; Lanza, 1966; Magniez, 1983).

The investigation of underground waters in Oman

Between March, 23, 1996 and April, 9, 1996, Prof. J. H. Stock and Mr. J. J. Vermeulen made a very accurate survey of underground waters in the region of Jabal Akhdar (between J. Nakhl, Rostaq and Nizwa, S.W. of the city Muscat, Oman). Sampling was done mainly in the coarse alluvium of temporary surface streams (wadis), using the Bou-Rouch pump system, and also in some springs and

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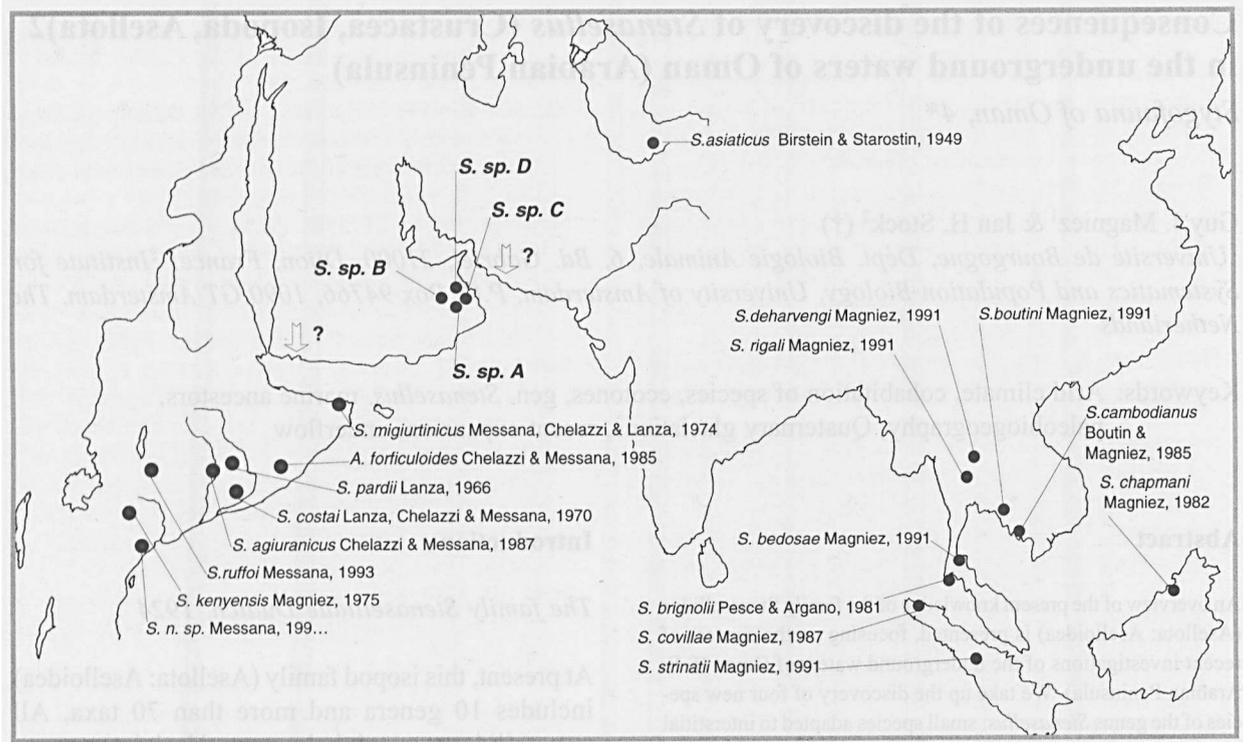


Fig. 1. Map with the localisation of the East African and Asiatic species of the genus *Stenasellus* Dollfus, 1897, car. emend. Racovitza, 1924.

wells. Similar sampling was undertaken by Dr. Wewalka, February 17-22, 1998. *Stenasellids* were present in 42 of the localities and point to the fact that the settlement of these stygobiontic isopods is very important in this southeastern corner of the Arabian Peninsula (Fig. 1).

The species of Oman: ecology and taxonomy

The four species

The study of these numerous samples (more than 42, as certain localities were sampled several times) show that four different species (Fig. 2) exist in this area. All belong to the genus *Stenasellus* Dollfus, 1897, car. emend. Racovitza, 1924, the same genus already represented in southwestern Europe, Kenya, Somalia and the Far East (Fig. 1) by some 34 taxa. These four new species are to be described in a separate paper (Magniez & Stock, in prep.). Their provisional appellations are:

- Stenasellus* sp. A – average size 12 mm (may be longer), present in 10 localities;
- Stenasellus* sp. B – average size 8 mm, present in 2 localities;
- Stenasellus* sp. C – average size of adults 3-4 mm, present in 32 localities;
- Stenasellus* sp. D – average size of adults 2-2.5 mm, present in 15 localities.

Some 28 of the localities harbor only 1 species, 11 others show the cohabitation of 2 species, and the remaining 3 localities contain 3 species together. Co-occurrences of *stenasellid* species were already known from cave waters, viz., *Mexistenasellus wilkensi* and *M. parzefalli* Magniez, 1972; and in interstitial biotopes: – in the phreatic layers of Guinea-Bissau or Ivory-Coast, viz., *Parastenasellus chappuisi* (Remy, 1938) and *Magniezia guinensis* (Braga, 1950) or *M. africana* (Monod, 1948); – in the water-table of the Guadalquivir River valley, S.W. Spain, viz., *Stenasellus escolai* Magniez, 1976 and *S. bragai* Magniez, 1977. Nevertheless, we bring

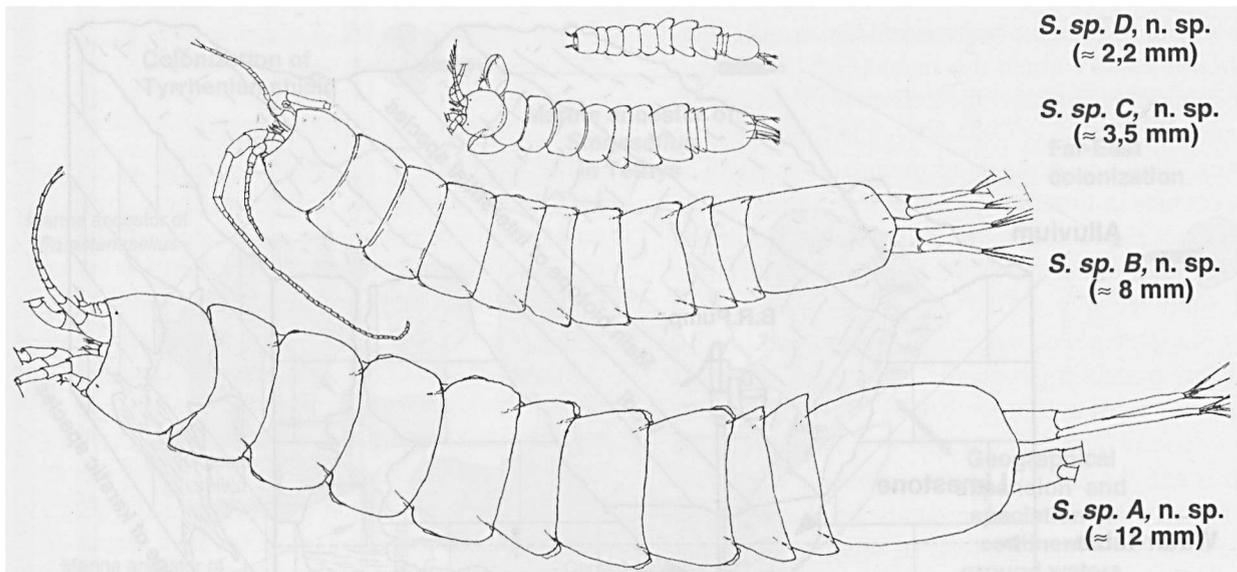


Fig. 2. Relative size of the adults of the four species of *Stenasellus* living in the underground waters of Oman.

here the first record of the presence of three species in the same biotopes. This situation requires the study of each specimen of each sample, to avoid any confusion between adults of dwarf species with juveniles of large ones!

Ecological relationships

The study of the material shows that the samples of *Stenasellus sp. C* and *Stenasellus sp. D* include a large number of specimens, juveniles and adults. Among these, numerous females in reproductive intermolt, their brood pouches full of embryos, or empty after release of the larvae. This observation points to two facts: 1) We really know the size of these species (females of 2 mm of *S. sp. D* and females of 3 mm of *S. sp. C* are in reproductive stage). More important, 2) The underflow of the wadis represents the true biotope of these two species, as it harbours true populations. However, the large species, *S. sp. A* and *S. sp. B* are present only in a few number of localities. The composition of their samples is never representative of a population: we find them for the most part only as young stages (with sizes similar to adults of *S. sp. C* or *S. sp. D*), and only a small number of larger subadults

and “young adults”. We noticed that females with a brood pouch and even females with small oostegites are absent. We conclude two things. 1) The normal adult size of these species is larger than the size of the largest specimen captured. For instance, we think that for *S. sp. A*, the maximum size could be similar to that of the karstic European form *Stenasellus buili* Remy, 1949 (14 mm for the male and 15-16 mm for the female). 2) The samples are not taken in the true biotope of these species, as they are not representative of a normal population. So, these samples are composed of erratic specimens, wandering in an ecotone, beyond their actual biotope. This region of Oman is rich in limestone and has caves with a karstic aquifer with even troglobiotic fish in some of them. We can consider that the two large stenasellid species are actually karstic taxa and propose a scheme (Fig. 3) to explain the local occurrences together between the little interstitial and the larger troglobiotic species. The communication between a karstic aquifer and an alluvial habitat is well known by hydrogeologists, and permits the expansion of stygobiotic species from one type of underground aquifer to the other (cf. Magniez, 1979 and Fig. 4).

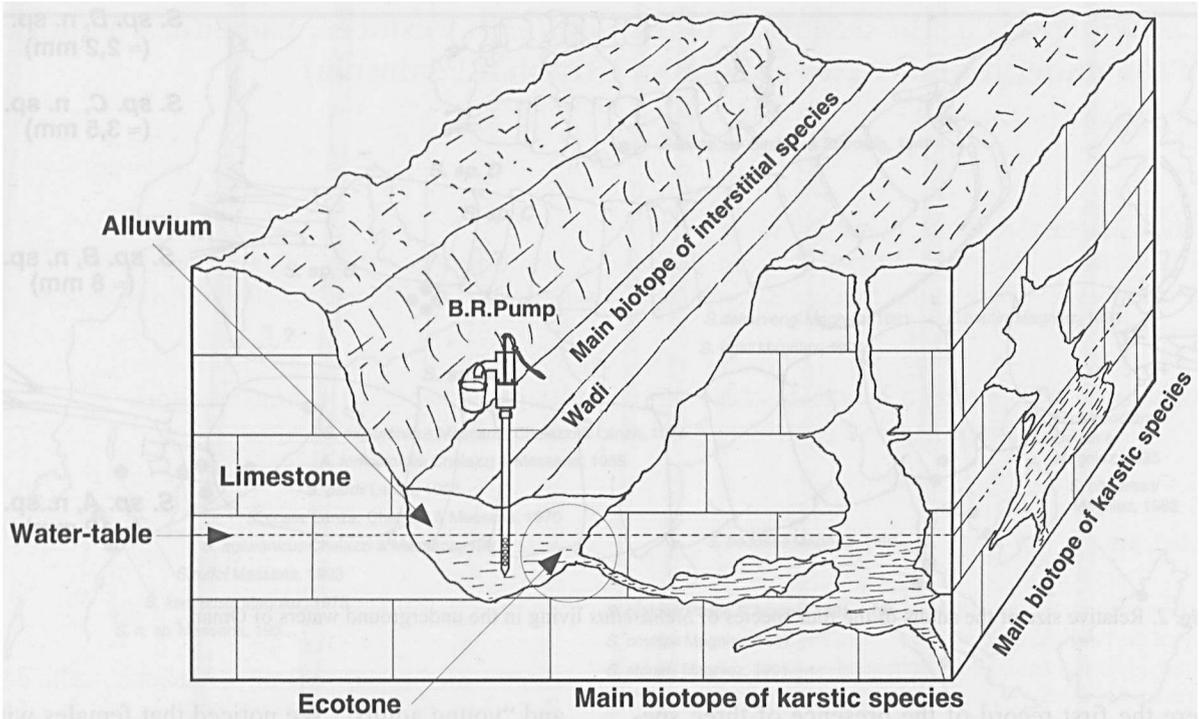


Fig. 3. Sampling with the Bou-Rouch pump (strongly magnified) in the alluvial deposits of a wadi. Local cohabitation of dwarf interstitial species and juveniles of large karstic species in the ecotone between free water of limestone cavities and interstitial water of alluvial gravel.

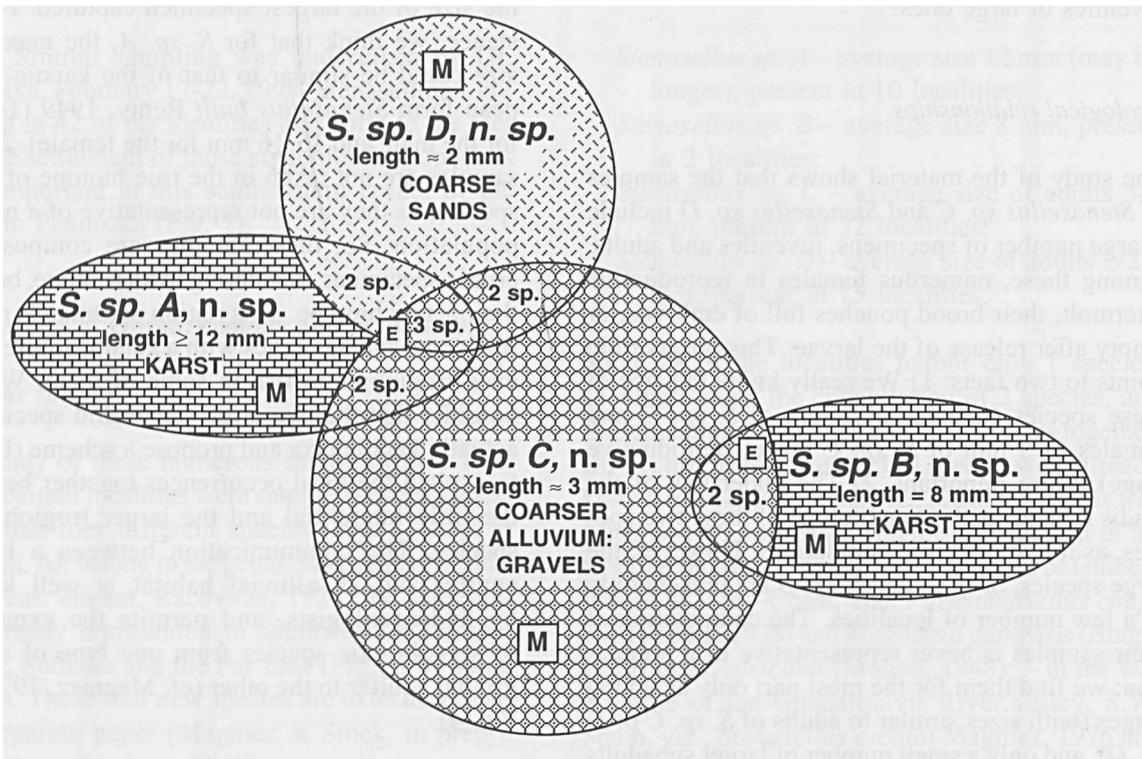


Fig. 4. Ecological relationships between the four *Stenasellus* species of Oman; M = main biotopes, E = ecotones.

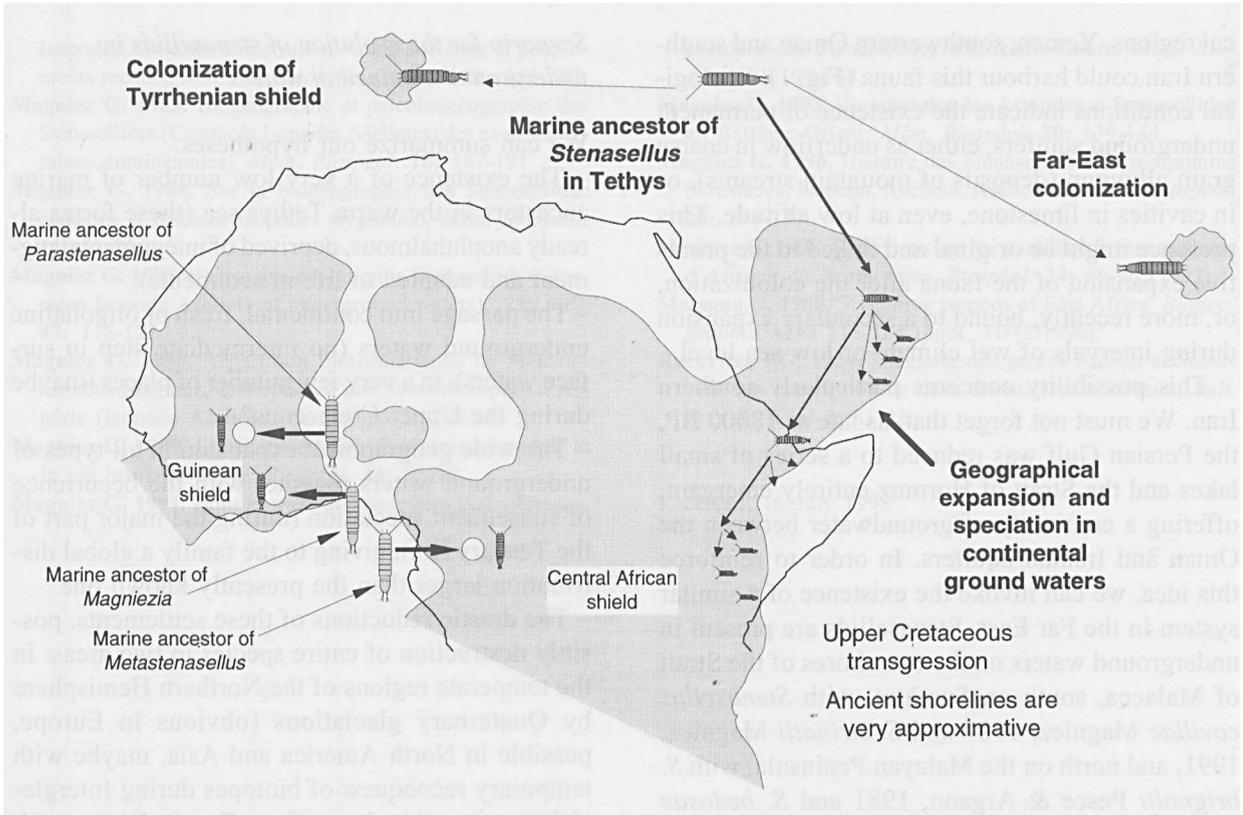


Fig. 5. Paleogeographical map of the African and Arabian region during the upper Cretaceous, showing the putative installation and expansion of the *Stenasellus* ancestor in continental groundwaters (the colonization of West Africa by ancestors of the African genera *Magniezia*, *Metastenasellus* and *Parastenasellus* is recalled, as given in Magniez, 1998, fig. 2).

Taxonomic relationships

Even though they are genetically independent (specific morphological characters and sizes quite different), these four species appear closely related to each other; obviously, they arose from a single original stock.

When describing new species of *Stenasellus* from the Far-East (Cambodia, Borneo, Thailand, Sumatra), we were struck by their strong relationship with those of East Africa (Kenya and Somalia). The Oman species, geographically situated between the East-African and the Far-Eastern ones, fully belong to this taxonomic entity. Moreover, we can say that the species of East Africa, the Arabian Peninsula and maybe the species *Stenasellus asiaticus* Birstein & Starostin, 1949 from a thermal brook in southern Turkmenistan represent a single center of settlement (Fig. 5).

So, the genus *Stenasellus* appears to be composed of three nuclei: 1) a western one in the Tyrrhenian

region (Iberian Peninsula, S. France, Corsica, Sardinia, small part of W. Tuscany), 2) a central one: the horn of Africa (Messana, 1988) and the Middle-East region, and 3) the Indochinese Peninsula and the ancient Sunda continent (now reduced to islands) (Magniez, 1989, 1993). Thus, the history of the genus *Stenasellus* appears more complicated than that of the West-African genera (*Magniezia*, *Metastenasellus*, *Parastenasellus*), which represent endemic taxa confined to paleobiogeographic units (Magniez, 1984, 1986, 1998).

Conclusions

Presence of stenasellids in Yemen and South Iran?

Species of *Stenasellus* are present in Somalia + Kenya, the southeastern corner of the Arabian Peninsula and southeastern Turkmenistan. So we might ask if they are present in intermediate geographi-

cal regions. Yemen, southwestern Oman and southern Iran could harbour this fauna (Fig. 1). Ecological conditions indicate the existence of permanent underground aquifers, either as underflow in coarse grain alluvium (deposits of mountain streams), or in cavities in limestone, even at low altitude. This presence might be original and linked to the primitive expansion of the fauna after the colonization, or, more recently, bound to a secondary expansion during intervals of wet climate or low sea level.

This possibility concerns particularly southern Iran. We must not forget that, as late as 18000 BP, the Persian Gulf was reduced to a series of small lakes and the Strait of Hormuz entirely emergent, offering a continuity of groundwater between the Oman and Iranian aquifers. In order to reinforce this idea, we can invoke the existence of a similar system in the Far East. *Stenasellids* are present in underground waters on the two shores of the Strait of Malacca, south on Sumatra, with *Stenasellus covillae* Magniez, 1987 and *S. strinatii* Magniez, 1991, and north on the Malayan Peninsula, with *S. brignolii* Pesce & Argano, 1981 and *S. bedosae* Magniez, 1991. However, recent exchanges of fauna across the Bab-El-Mendeb Strait do not seem to be possible.

Unity or heterogeneity of the genus Stenasellus auct.

As stated above, the status of this genus, with its 17 taxa in southwestern Europe, 12 in the Middle East and 9 in the Far East, is difficult to understand. Two groups of species appear in the European stock: the “*virei*” group and the “*breuili*” group (Magniez, 1996). The “*virei*” group, Middle-Eastern and Far-Eastern species are so strongly related that we can imagine that they are derived from a same, but widely distributed marine ancestor of the Tethys that succeeded in three different passages to continental underground waters. It remains difficult to explain the present distribution, from Portugal to Borneo and to Kenya with a single settlement, as the paleogeography of the Mediterranean-Tethysian region is more complex than that of the African plates. The genus *Stenasellus* needs a general revision sometime in the future.

Scenario for the evolution of stenasellids in underground continental waters

We can summarize our hypotheses:

- The existence of a very low number of marine ancestors in the warm Tethys sea (these forms already anophthalmous, deprived of integumental pigment and adapted to life in sediments).
- The passage into continental, fresh or oligohaline underground waters (no intermediate step in surface waters), in a very few number of places (maybe during the Upper Cretaceous?).
- The wide geographical expansion in all types of underground waters together with the occurrence of subsequent speciation (during the major part of the Tertiary Era), giving to the family a global distribution larger than the presently known one.
- The drastic reductions of these settlements, possibly destruction of entire species in two areas: in the temperate regions of the Northern Hemisphere by Quaternary glaciations (obvious in Europe, possible in North America and Asia, maybe with temporary reconquest of biotopes during Interglacial times), and in the northern Tropical zone; with the development of an arid climate (the case is obvious for West-African genera, possible for the Middle-Eastern settlement of *Stenasellus*).
- The recent expansion of some eurytopic species, adapted to life in cool water (Magniez, 1985), that rapidly colonized new interstitial biotopes developed in coarse post-glacial channels of alluvium, which is the case in southwestern Europe, in the underflow of the hydrographic basins north and south of the Pyrenees (Magniez, 1996).

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