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AUSTROFILIUS MAJORICENSIS SP. NOV. (JANIRIDAE, ISOPODA, CRUSTACEA), A SECOND SPECIES OF AUSTROFILIUS IN THE MEDITERRANEAN SEA, WITH A DISCUSSION ON THE EVOLUTIONARY BIOGEOGRAPHY OF THE GENUS

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ISOPODA
ASELLOTA
JANIRIDAE
AUSTROFILIUS MAJORICENSIS SP. NOV.
MEDITERRANEAN SEA

ABSTRACT. – A new species of Janiroidean isopod, *Austrofilius majoricensis* sp. nov., from Majorca (Balearic Islands, Western Mediterranean), is described. This is the second record of the genus in the Northern Hemisphere. It is mainly distinguished from *A. mediterraneus*, the other Mediterranean species of the genus, by the female operculum, which displays 9-10 distolateral setae at each side compared with only four distolateral setae in *A. mediterraneus*. Furthermore, the palp segment 2 of the maxilliped has the distomedial margin serrated (with three teeth), and the proximal segment of antenna 1 does not display spines on the distal margin. In addition, the rostrum of *Austrofilius majoricensis* sp. nov. has a slightly concave distal margin and smooth distolateral margins, whereas the lateral margins of the head are also smooth. The presence of *Austrofilius* in the Mediterranean is discussed.

INTRODUCTION

Austrofilius majoricensis, a new species of the asellote isopod family Janiridae is described from the Balearic Islands, Western Mediterranean. To date, only three species of the genus were known: *A. furcatus* Hodgson, 1910 and *A. serratus* Vanhöffen, 1914, both from Antarctic waters, and *A. mediterraneus* Castelló, 2002, from the Columbretes Islands, Castellón de la Plana, on the Mediterranean coast of the Iberian Peninsula. The Antarctic species were compared to *A. mediterraneus* by Castelló (2002). This is the second record of the genus *Austrofilius* in the Northern Hemisphere, which confirms the presence of this genus in the Mediterranean Sea. The new species is compared with the other Mediterranean species of the genus. Furthermore, the evolutionary biogeography of *Austrofilius* is extensively discussed.

MATERIAL AND METHODS

The material was collected in June 1994 during the oceanographic expedition "Fauna III" off the eastern coast of the Iberian Peninsula (Columbretes and Balearic Islands). In this expedition, 99 sites were sampled with classical methods of trawling and pelagic fishing, as well as by scuba diving. Only one specimen (adult female) of *A. majoricensis* sp. nov. was collected: sample 186A, 25.06.94, by a trawling device on maërl bottom. The specimen was fixed in alcohol 70 % and examined in glycerine. Drawings were prepared with a Wild M5A stereoscopic microscope and an Olympus CH-2 microscope, both equipped with camera lucida. The type specimen is in the MNCN (Museo Nacional de Ciencias Naturales, Madrid).

TAXONOMY

Suborder Asellota Latreille, 1803

Superfamily Janiroidea Sars, 1897

Family Janiridae Sars, 1897

Genus *Austrofilius* Hodgson, 1910

Complete diagnosis in Wilson & Wägele (1994).

Austrofilius majoricensis sp. nov. (Figs 1-4)

Material examined: Sample 186A, Collection "Fauna III", MNCN. Data from recorder: maërl bottom. Holotype: adult female 1.4 mm (length excluding antennae and uropods), dissected and mounted on slides (MNCN 20.04/7969).

Type locality: Off Sóller, NW Majorca, Balearic Islands, Spain; trawling coordinates: Latitude N (initial-final) 39°49.66' - 39°47.64', Longitude E (initial-final) 02°40.78' - 02°38.71'; range depth: 61-59 m.

Etymology: From the Latin, *majoricensis*, referring to Majorca (Balearic Islands).

Diagnosis: Head with smooth lateral margins. Rostrum with smooth lateral margins and slightly concave distal margin. Maxillipedal palp segment 2 serrated (with three teeth). Female operculum with 9-10 distolateral setae at each side.

Description of the female holotype

Body depressed, broad, three times longer than broad, smooth dorsally (Fig. 1A). Head (Fig. 1A) broader than long, with smooth lateral margins bearing conspicuous distolateral tooth at each side, with few setae placed nearby. Rostrum with smooth distolateral margins; distal margin slightly concave. Eyes dorsal with two ocelli. Pere-

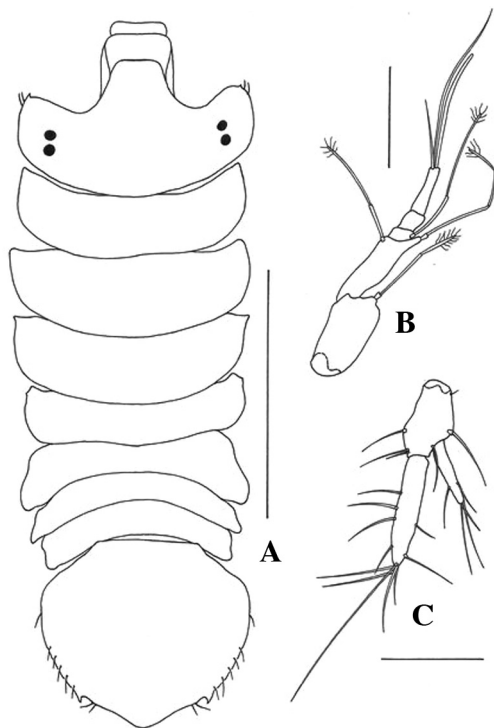


Fig. 1. – *Austrofilius majoricensis* sp. nov., female holotype: A, habitus in dorsal view; B, antenna 1; C, uropod. Scale bars A: 0.5 mm, B-C: 0.1 mm.

onites 1-3 with pointed anterolateral angles. Pleotelson (Fig. 1A) broader than long, with convex lateral margins and slightly pointed tip; margins each with many setae and with small distolateral pointed process. Antenna 1 (Fig. 1B) with proximal segment robust, lacking spines and with long penicillate seta on distal margin; segment 2 longest with two long penicillate setae, segment 3 shortest with one long penicillate seta. Flagellum 2-articulate, first article 40% length of second, naked; second with one aesthetasc and two apical setae. Antenna 2 (Fig. 3A) 1.2 mm in length, peduncle segments 1-3 short. Segment 2 bearing three setae on distomedial angle and proximolateral scale (exopod) with one seta. Segments 4-5 long and cylindrical, bearing simple setae. Flagellum 9-articulate, proximal article elongated (attaining 40% length of flagellum); articles bearing long simple setae. Mandible (Fig. 2A, B) palp 3-segmented, second segment longest with two stout setae, third segment with row of eight setulose setae, apical seta longest. Incisor of left mandible (Fig. 2A) 4-denticulate, of right mandible 5-denticulate (Fig. 2B); lacinia mobilis on left branch only, 4-denticulate. Spine row with four serrate spines on left branch, with five on right counterpart; few simple setae near serrate spines in both branches. Pars molaris cylindrical, truncate, with acute teeth on grinding surface; four setae

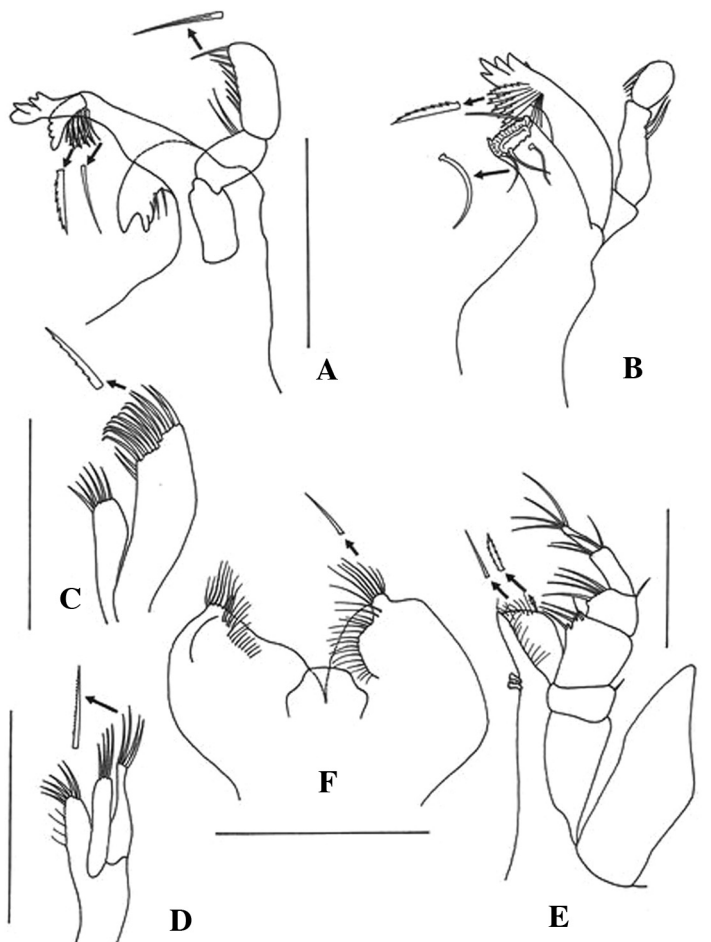


Fig. 2. – *Austrofilius majoricensis* sp. nov., female holotype: A, left mandible; B, right mandible; C, maxilla 1; D, maxilla 2; E, maxilliped; F, hypopharynx. Scale bar A-F: 0.1 mm.

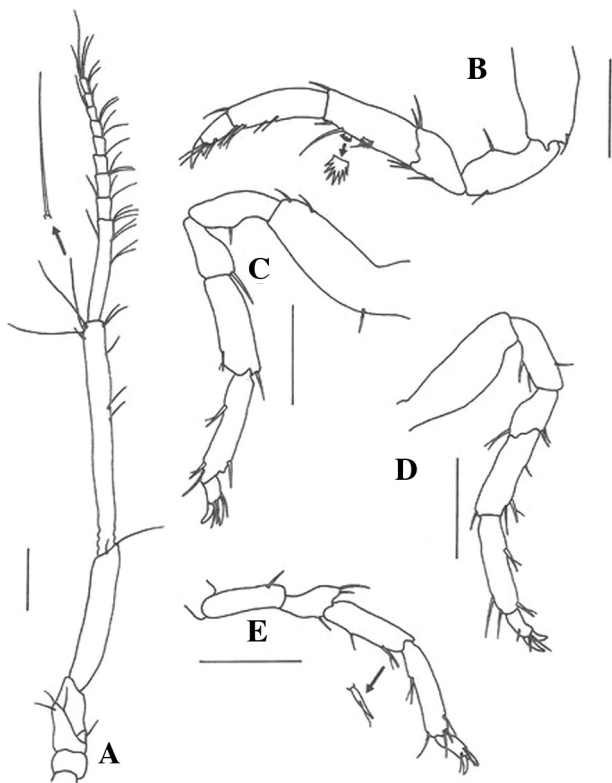


Fig. 3. – *Austrofilius majoricensis* sp. nov., female holotype: A, antenna 2; B-E, pereopods 1-4. Scale bar A-E: 0.1 mm.

placed near apex. Maxilla 1 (Fig. 2C) lateral lobe bearing 12 strong apical serrate setae and two smaller setae distally on inner margin; medial lobe with 6 setae. Maxilla 2 (Fig. 2D) with 5 apical setulose setae on medial lobe and 4 on both other lobes. Maxillipedal basal endite (Fig. 2E) with slender simple setae distally, plus one fan-shaped seta; two coupling hooks on medial margin. Epipod almost reaching distal margin of palp segment 2. Relative length of palp segments 2-5 as 1.9 : 1 : 1.4 : 1.2. Segment 2 with three teeth and four simple setae on distomedial angle; third segment with one tooth and three setae on medial margin; segments 4-5 slender, each bearing four apical setae. Pereopods 1-7 (Figs 3B-E, 4A-C) similar, first stouter than rest, last three slender. Pereopod 1 (Fig. 3B) more setose than rest, bearing cuticular scales on medial margin of carpus, and two types of setae (simple and apically bifid, latter absent from basis, ischium and dactylus). Dactylus bearing two unguis, ventral unguis short. Female pleopod 2 (operculum; Fig. 4D) ovate with 9-10 distolateral long simple setae and four (2+2) shorter simple setae and several short setules on distal margin, latter slightly indented. Pleopod 3 (Fig 4E) with exopod 2-segmented, distal segment shorter; both segments lacking apical setae and with outer margin lined with fine setules. Endopod with two distolateral plumose setae; no distomedial seta observed, probably lost during dissection. Pleopod 4 (Fig 4F) with oval endopod and reduced exopod. Uropod (Fig 1C) long with sympod bear-

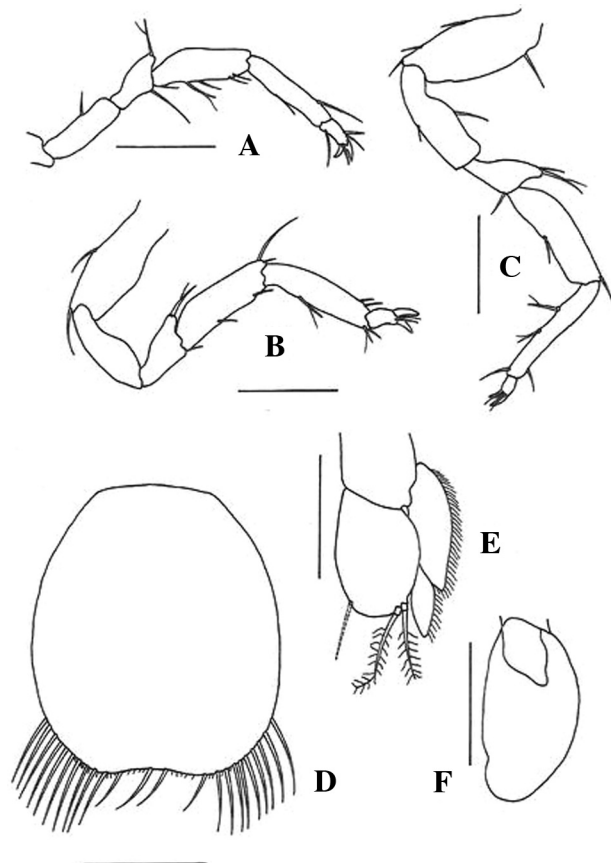


Fig. 4. – *Austrofilius majoricensis* sp. nov., female holotype: A-C, pereopods 5-7; D, operculum; E, pleopod 3; F, pleopod 4. Scale bar A-F: 0.1 mm.

ing five setae. Endopod longer and broader than exopod, both bearing simple setae.

DISCUSSION

Taxonomical remarks

The specimen (1.4 mm in length) was first identified as *A. mediterraneus* Castelló, 2002. A more detailed study revealed that it had 22-24 setae on the posterolateral margin of the operculum (*vs.* eight in a female paratype of *A. mediterraneus* 1.7 mm in length), inner margin of maxillipedal palp segments 2-3 conspicuously serrated (*vs.* smooth in the female of *A. mediterraneus*), and distal margin of first segment of antenna 1 lacking spines (*vs.* stout spines on margin in the female of *A. mediterraneus*). A complete comparison between the two Mediterranean species is shown in Table I. There is no doubt that *A. majoricensis* sp. nov. is closely related to *A. mediterraneus* because of common features such as body shape, the loss of pereopodal setation in comparison with the two Antarctic species, and the smooth lateral margins of pleotelson, with only a small distolateral pointed process in the two Mediterranean species

Table I. – Comparison of Mediterranean *Austrofiliius* species. Derived from Castelló (2002) and the present study.

SPECIES	<i>A. mediterraneus</i> Castelló, 2002	<i>A. majoricensis</i> sp. nov.
SIZE	Female paratype: 1.7 mm	Female holotype: 1.4 mm
ROSTRUM	Produced with convex distal margin. Distolateral margins smooth (occasionally serrated in the male).	Produced with slightly concave distal margin. Distolateral margins smooth.
HEAD	Lateral margins smooth (occasionally serrated in the male). Inconspicuous dorsal eyes, with two ocelli.	Lateral margins smooth. Inconspicuous dorsal eyes, with two ocelli.
PLEOTELSON	One-sixth broader than long, with convex lateral margins and slightly acute apex. Margins with many setae, one more robust than the rest directed laterally, near the distolateral pointed process (not observed in the male).	One-tenth broader than long, with convex lateral margins and slightly acute apex. Margins with many setae, one more robust than the rest directed laterally, near the distolateral pointed process.
ANTENNA 1	Proximal segment with robust spines on distal margin (not observed in the male).	Proximal segment without spines on distal margin.
MAXILLIPED	Relative length of palp segments 2-5 as 1.3 : 0.8 : 1 : 1. No teeth on inner margin of segments 2-3.	Relative length of palp segments 2-5 as 1.9 : 1 : 1.4 : 1.2. Second segment showing three teeth on inner margin. Third segment with one tooth on inner margin.
OPERCULUM (female)	Broadly ovate, with four distolateral setae at each side and some short setules on indented distal margin.	Broadly ovate, with 9-10 distolateral setae at each side and four shorter setae and several short setules on indented distal margin.

compared to the serrated margin of both Antarctic species.

ORIGIN OF THE MEDITERRANEAN SPECIES

Until the discovery of *A. mediterraneus* in the Mediterranean Sea (Castelló 2002) the genus *Austrofiliius* Hodgson, 1910 was considered endemic to the Antarctic and sub-Antarctic areas. Both species of the genus, *A. furcatus* and *A. serratus*, described by Hodgson (1910) and Vanhöffen (1914), respectively, and re-described by Winkler & Brandt (1993), have been found in shallow waters, up to 260 m, and therefore belong to the benthic fauna of the continental shelf. Castelló (2002) briefly pointed out that the presence of *Austrofiliius* in the Mediterranean Sea might be due to its ascent along the western coast of Africa, after the complete separation from South America (Late Cretaceous, 90 m.y. ago). The discovery of *A. majoricensis* sp. nov. confirms the presence of *Austrofiliius* in the Northern Hemisphere, and at present shows a clear disjunct distribution (*A. furcatus* is distributed in South Patagonia, sub-Antarctica, Antarctica, Scotia Arc, South Shetland, Kerguelen, and South Africa; *A. serratus* range covers Eastern Antarctica (Gauss Station), Weddell Sea, and Antarctic Peninsula; *A. mediterraneus* and *A. majoricensis* live in the Western Mediterranean). Considering that the first known fossils of Isopoda date back to the Carboniferous time and that the genus *Austrofiliius* can be considered relatively old within the Janiridae (Wilson 1994), its origin can be estimated to be Jurassic or Lower Cretaceous. Hypotheses regarding the biogeographical evolution of the genus should consider factors such as the

paleogeographical evolution of the continents and oceans, phylogenetic relationships with other genera, and the present distribution of genera and species (Antarctica and the Mediterranean Sea). The potential factors that might have an influence on the evolution of *Austrofiliius* are then briefly mentioned (and further discussed) as follows:

a) Origin, dispersal centre, and biogeographical scenario

Three hypotheses may be proposed:

1. The origin and dispersal centre of the genus were in the southern Gondwana (Fig. 5C, D). Dispersal might have occurred along the eastern coast of the African continent as far as the Mediterranean basin, before its closure during the Lower Miocene 24 m.y. ago (Fig. 6A).

2. The origin and dispersal centre were also in the south of the Gondwanian continent. In this case, dispersal beyond the African continent progressed along the western continental shelf, following the complete separation of Africa and South America in the Late Cretaceous 90 m.y. ago (Fig. 5C, D).

3. The origin and dispersal centre were in the deep Atlantic, after the formation of the Atlantic Ocean during the Late Cretaceous. In this case, the entrance of the genus in the Mediterranean basin might be more recent than in the preceding hypotheses – possibly during the Cenozoic (Fig. 5D).

b) Phylogenetic relationships of *Austrofiliius* within the Janiridae

Within the Janiroidea, the family Janiridae has been considered a paraphyletic basal taxon (Wägele 1989). Wilson (1994) also indicates that “some taxa in the Janiridae are derived early in the evolution of the Janiroidea”,

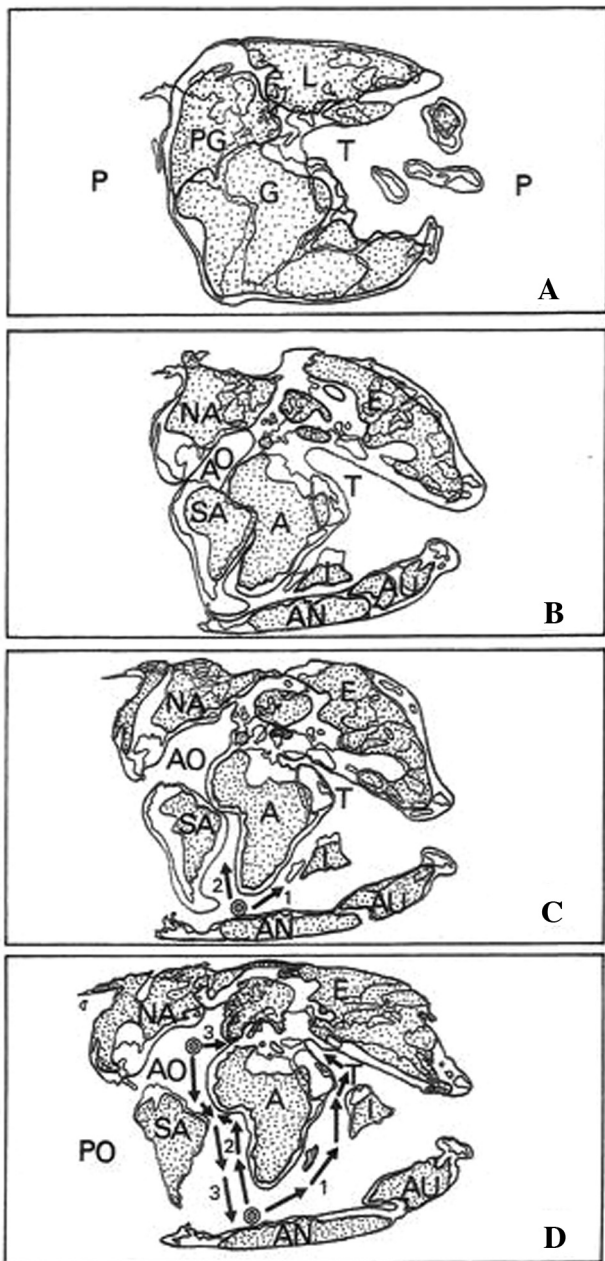


Fig 5. – Geographical evolution of continents: A, Triassic (Mesozoic) 210 m.y. ago; B, Early Cretaceous (Mesozoic) 120 m.y. ago; C, Late Cretaceous (Mesozoic) 90 m.y. ago; D, Paleocene (Cenozoic) 60 m.y. ago. Redrawn from Hofrichter (2004). Continents, shown in dotted lines. A, Africa; AO, Atlantic Ocean; AN, Antarctica; AU, Australia; E, Eurasia; G, Gondwana; I, India; L, Laurasia; NA, North America; P, Panthalassa; PG, Pangea; PO, Pacific Ocean; SA, South America; T, Tethys.

and that “the Janiridae cannot be considered a monophyletic taxon”. In the phylogeny offered by Wilson (1994), *Caecianiropsis* Menzies et Petit, 1956 clusters with *Microjaera* Bocquet et Lévi, 1955, forming the sister group of *Austrofiliius*.

c) Geographical distribution of the genera of Janiridae

Among the genera of Janiridae with species from shallow marine waters, the distribution of *Caecijaera* Men-

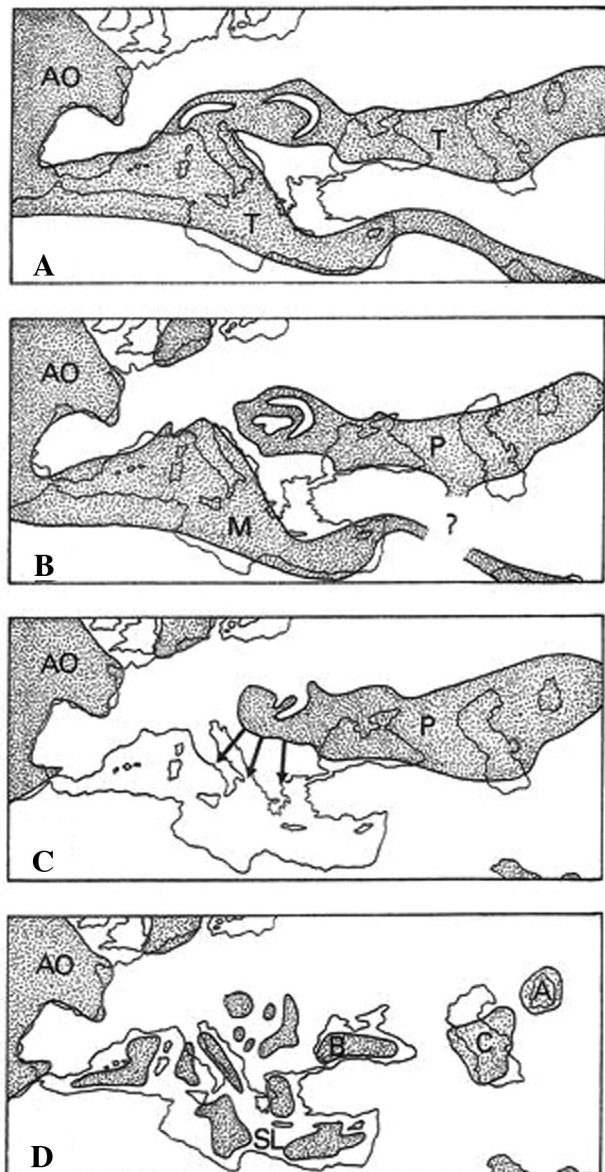


Fig 6. – Masses of water evolution in the Mediterranean basin: A-D, Miocene (Cenozoic); A, 20 m.y. ago; B, 15 m.y. ago; C, 6 m.y. ago; D, 5.5 m.y. ago. Redrawn from Flos (1985). Bathed areas, shown in dotted lines. A, Aral Sea; AO, Atlantic Ocean; B, Black Sea; C, Caspian Sea; M, Mediterranean Sea; P, Paratethys; SL, Salt lakes; T, Tethys.

zies, 1951, *Hawaiianira* Miller, 1967, *Jaera* Leach, 1814, *Janira* Leach, 1814, *Janiralata* Menzies, 1951, *Microjaera* Bocquet et Lévi, 1955, and *Microjanira* Schiecke et Fresi, 1970 is restricted to the Northern Hemisphere, while *Ectias* Richardson, 1906, *Iathrippa* Bovallius, 1886, *Janaira* Moreira et Pires, 1977, and *Neojaera* Nordenstam, 1933 occur in the Southern Hemisphere. Only *Austrofiliius*, *Caecianiropsis*, *Carpis* Richardson, 1902, *Iais* Bovallius, 1886, *Ianiropsis* Sars, 1897, and *Protocharon* Chappuis, Delamare Debutteville et Paulian, 1956 are found in both hemispheres. As regards the closest genera, *Caecianiropsis* includes three species, two of them

Table II. – Distribution of the Janiroidea families (Asellota) in North Atlantic/Northern Seas (1), Mediterranean Sea (2), and Antarctica/sub-Antarctic region (3). After: (1) Menzies (1962), Wolff (1962), Svavarsson *et al.* (1993), and Junoy & Castelló (2003); (2) Walker (1901), Schiecke & Fresi (1972), Schiecke & Modigh-Tota (1976), and Junoy & Castelló (2003); (3) Brandt (1991), and Winkler (1994); A, absent; P, present; (*) there are unconfirmed records of *Munella danteci* Bonnier, 1896 in the Bay of Naples (Cunha & Wilson 2003).

Families of Janiroidea	North Atlantic Ocean / Northern Seas	Mediterranean Sea	Antarctica / sub-Antarctic region
Acanthaspidiidae	P	A	P
Dendrotionidae	P	A	A
Desmosomatidae	P	P	P
Echinothambematidae	P	A	A
Haplomunnidae	A	A (*)	P
Haploniscidae	P	A	P
Ischnomesidae	P	P	P
Janirellidae	P	P	A
Janiridae	P	P	P
Joeropsidae	P	P	P
Katianiridae	P	A	A
Macrostylidae	P	A	P
Mesosignidae	P	A	P
Microparasellidae	P	P	A
Munnidae	P	P	P
Munnopsididae			
Acanthocopinae	P	A	P
Eurycopinae	P	P	P
Ilyarachninae	P	P	P
Lipomerinae	P	A	P
Munnopsinae	P	A	P
Syneuricopinae	P	A	P
Nannoniscidae	P	P	P
Paramunnidae	P	P	P
Pleurocopidae	A	P	A
Santiidae	A	A	P
Thambemathidae	P	A	A
Vermectiadiidae	A	A	P

from the Northern Hemisphere (*C. psammophila* Menzies & Petit, 1956 from North California, and *C. birsteini* Kusakin, 1979 from the Bering and Okhotsk Seas) whereas the third lives in the Southern Hemisphere (*C. ectiformis* (Vanhöffen, 1914) from Kerguelen, Saint Paul, and possibly Marion and Prince Edward Islands in the South Indian Ocean). However, the latter species may not belong to this genus (Wilson & Wägele 1994). *Microjaera* was monotypic (including only *M. anisopoda* Bocquet & Lévi, 1955, which occurs in the north-eastern Atlantic and Mediterranean) until the discovery of *M. morii* (described from Japan) by Shimomura (2005).

d) Composition of the isopod fauna of the Mediterranean

The Mediterranean fauna of Isopoda includes a sizeable contribution of species of Atlantic origin and distribution. In contrast, the presence of species belonging to genera distributed in Antarctica or in the Southern Hemisphere is very low. In terms of families of Janiroidea, there are 11 families in the Mediterranean fauna (Desmo-

somatidae, Ischnomesidae, Janirellidae, Janiridae, Joeropsidae, Microparasellidae, Munnidae, Munnopsididae, Nannoniscidae, Paramunnidae, and Pleurocopidae), of which only the latter is not present in the Atlantic Ocean. Furthermore, eight of them (Desmosomatidae, Ischnomesidae, Janiridae, Joeropsidae, Munnidae, Munnopsididae, Nannoniscidae, and Paramunnidae) are also found in Antarctica or the sub-Antarctic region (Table II). As regards the genera of Janiridae, the following are present in Antarctica or the sub-Antarctic region according to the checklists of Brandt (1991) and Winkler (1994): *Austrofilius*, *Ectias*, *Iais*, *Ianiropsis*, *Iathrippa*, and *Neojaera*. Of these, only *Austrofilius* and *Ianiropsis* (*I. breviremis* (Sars, 1883)) are found in the Mediterranean Sea. Svavarsson *et al.* (1993) studied the deep-sea asellote fauna from Northern seas (Norwegian, Greenland, Iceland, and North Polar Seas) and reported the genera *Caecijaera*, *Ianiropsis*, *Jaera*, *Janira*, and *Tole* Ortmann, 1901 (as *Iolella*), the latter considered as Janiroidea *incertae sedis* by Wilson & Wägele (1994). Furthermore, Junoy and

Table III. – Distribution of the Janiridae genera in North Atlantic/Northern Seas (1), Mediterranean Sea (2), and Antarctica/sub-Antarctic region (3). After: (1) Svavarsson *et al.* (1993), and Junoy & Castelló (2003); (2) Schiecke & Fresi (1970), and Junoy & Castelló (2003); (3) Brandt (1991), and Winkler (1994); A, absent; P, present; (*) considered as Janiroidea *incertae sedis* by Wilson & Wägele (1994).

Genera of Janiridae	North Atlantic Ocean / Northern Seas	Mediterranean Sea	Antarctica / sub-Antarctic region
<i>Austrofiliius</i>	A	P	P
<i>Caecijaera</i>	P	A	A
<i>Carpias</i>	P	P	A
<i>Ectias</i>	A	A	P
<i>Iais</i>	A	A	P
<i>Ianiropsis</i>	P	P	P
<i>Iathrippa</i>	A	A	P
<i>Jaera</i>	P	P	A
<i>Janira</i>	P	P	A
<i>Microjaera</i>	P	P	A
<i>Microjanira</i>	A	P	A
<i>Neojaera</i>	A	A	P
<i>Tole</i> (*)	P	A	A

Castelló (2003), in their checklist of isopod species from the Iberian Peninsula, included *Carpias* and *Microjaera* in both the Mediterranean and the Atlantic. The Mediterranean Sea harbours the following genera of Janiridae: *Austrofiliius*, *Carpias*, *Ianiropsis*, *Jaera*, *Janira*, *Microjaera* and *Microjanira*. Five genera (*Carpias*, *Ianiropsis*, *Jaera*, *Janira*, and *Microjaera*) are common to the Atlantic and the Mediterranean, and some species are present even on both sides of the Strait of Gibraltar (Table III).

With regard to the first hypothesis, some alternatives may be: to suppose that *Austrofiliius* originated in the Indian Ocean and then dispersed to the Mediterranean (before the eastern closure) and to the Antarctic regions; and also, although much earlier in time, that ancestors of *Austrofiliius* originated in the Tethys, and then reached the future Mediterranean (during the separation of Gondwana from the Eurasian plate) and the Antarctic (during the separation of Western Gondwana from Eastern Gondwana when the Tethys formed a gulf between the latter). This first hypothesis presupposes that the ancestor of *Austrofiliius* survived what is known as the “Messinian salinity crisis” (end of the Miocene, 6 m.y. ago) (Fig. 6C, D). The increase of salinity transformed the Mediterranean Sea into a series of salt lakes with large amounts of precipitates, causing the extinction of almost all the species except those located near fluvial contributions. This situation ended with the opening of the Strait of Gibraltar at the beginning of the Pliocene, 5 m.y. ago. However, although Veuille (1979) attributed the evolution of the genus *Jaera* in the Mediterranean and Atlantic to this process, this scenario seems improbable. *Jaera* (separated from *Iais* when the Mediterranean became cut off from the Indian Ocean (Veuille, 1979)) shows a huge number of species distributed into three groups (Atlantic, Mediterranean, Pontocaspian). The Mediterranean group con-

tains the species derived from those of the Pontocaspian group which survived thanks to the formation of the “Iago mare”, 5.5 m.y. ago. In the case of *Austrofiliius* there is no Atlantic species. *Carpias* is another genus that might have had a similar evolution because of its distribution in the Indian Ocean, along with the presence of one species in the Mediterranean and the Atlantic (*C. stebbingi* (Monod, 1933)). Its origin can be attributed to the Tethys and its access into the Mediterranean prior to the eastern closure. Therefore, many species of the Atlantic fauna might have originated in the Tethys; obviously, this would mean that the third hypothesis is not independent of the first one, but would represent a later stage.

The first two hypotheses also presuppose that the ancestor of *Austrofiliius* survived the mass extinction of the Antarctic species during the Neogene, due to the climatic chill produced by the widening of the Drake Passage and the subsequent isolation of the Antarctic continent; this was pointed out by Menzies *et al.* (1973) and Sieg (1988), who assumed that Antarctica was recolonized during the Pliocene via South America, meaning that the crustacean fauna might be relatively recent. However, Sieg (1988) noted that new phylogenetic data on certain groups, including the Isopoda, indicate that some current species may be ancient; this rather undermines his hypothesis (Brandt 1992). Furthermore, Hessler & Thistle (1975), Hessler *et al.* (1979), and Hessler & Wilson (1983) argued that the Antarctic crustacean fauna mainly originated from deep-water species. Referring to the origin of Isopoda from Antarctica, Brandt (1992) indicated that the fauna comprises species originating at low depth which have undergone significant bathymetric dispersion (submergence), like some species of Joeropsidae, Paramunnidae, Munnidae, and Acanthaspidiidae, and also species that, in contrast, colonized the continental shelf

(emergence), as representatives of the Nannoniscidae, Desmosomatidae, Lipomerinae (Munnopsididae), Ilyarachninae (Munnopsididae), Eurycopinae (Munnopsididae), and Ischnomesidae. *Austrofilius*, with a bathymetric distribution on the continental shelf, thus seems to be a case of emergence.

In the case of the first two hypotheses, there should be some traces of species of *Austrofilius* on both sides of the African continent. Other genera of Janiridae such as *Iais* and *Carpías*, whose distribution covers both the Indian Ocean and the Atlantic may support these hypotheses. *Iais* occurs in Singapore (Menzies & Barnard 1951), and in the Southern Atlantic at St Helena Island (Coineau 1977); and *Carpías*, in the Red Sea (Stebbing 1910), Travancore, India (Pillai 1954), Sri Lanka (Stebbing 1905), Mozambique (Kensley & Schotte 2002), and in Senegal (Monod 1961), reaching as far as the Central coast of America. *Neojaera* has a southern distribution and has not yet reached the Northern Hemisphere.

The third hypothesis is more credible, regardless of whether *Austrofilius* or its ancestor entered the Mediterranean after the definitive opening of the Strait of Gibraltar, and it also seems to be supported by the phenomenon of emergence, because the entrance of less saline water in the Mediterranean is produced superficially and makes it easier to reach the continental shelf.

The most probable hypothesis on the origin of *Austrofilius* is its derivation from a deep-sea ancestor in the Central or Northern Atlantic Ocean. It could not have reached the Antarctic regions before the Late Cretaceous because the African and South American continents were not completely separated before. Fauna exchanges between Northern and Southern Atlantic took place in the Late Cenomanian (Riccardi 1991, Néraudeau & Mathey 2000). The same applies to the Ischnomesidae, which originated in the Northern Hemisphere and reached Antarctica via the deep Atlantic (Brandt 1999). Other families of Asellota, such as Nannoniscidae and Desmosomatidae, probably originated in the Northern Hemisphere; they may have evolved from deep-sea ancestors and may have been distributed throughout Eastern Antarctica by the circumpolar stream (Brandt 1991 1999).

As a whole, the idea that *Austrofilius* may be an Antarctic genus argues in favour of the first two hypotheses. However, the first one is debatable due to the geographical scenario mentioned above, though it is likely that the ancestor of *Austrofilius* might have been introduced into the Atlantic Ocean through the Mediterranean Sea, before their separation. The second hypothesis is also unlikely; the genus *Austrofilius* lives on the continental shelf and has lower dispersal ability than other groups of Isopoda, such as Serolidae and Arcturidae, which reached as far as North America. The third hypothesis (Atlantic origin) is the most probable. *Austrofilius* may have originated from deep-sea ancestors and may have adapted to life on the continental shelf through a process of emergence. The

fact that *Austrofilius* shows inconspicuous eyes is not, by itself, a reason to reject this hypothesis, because there are ocellated species of Asellota living at great depths and vice-versa (Raupach *et al.* 2004). The presence of eyes in all the species of *Austrofilius* could be interpreted as an adaptation to life in shallow waters, with *A. serratus* being the most evolved species since it displays the most developed eyes. *Austrofilius* could have colonised the Mediterranean via the Strait of Gibraltar after its definitive opening, and at present a process of speciation might be underway. As regard the related genera (*Caecianiropsis*, *Microjaera*), both have a northern distribution. Interestingly, Castelló (2002) recorded *Microjaera* (*M. anisopoda*) as an accompanying species of *A. mediterraneus* in the Columbretes Islands; the evolution of both genera might be parallel, with an origin in the Northern Hemisphere. This would be consistent with the third hypothesis.

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