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Leviapseudes tethys (Tanaidacea: Apseudidae), a new species from a submarine canyon of the French Mediterranean Sea, with remarks and a diagnosis for the genus

Benoit GOUILLIEUX [1,*], Céline LABRUNE [2] & Patricia ESQUETE [3]

[1] Université de Bordeaux, Station Marine d'Arcachon, 2 rue du Professeur Jolyet, 33120 Arcachon, France.
[2] CNRS, Sorbonne Université, Laboratoire d'Ecogéochimie des Environnements Benthiques, LECOB UMR 8222, F-66650 Banyuls-sur-Mer, France.
[3] Departamento de Biologia & CESAM (Center of Environmental and Marine Studies), Universidade de Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal.

[*] Corresponding author: benoit.gouillieux@u-bordeaux.fr
[2] Email: celine.labrune@obs-banyuls.fr
[3] Email: pesquete@ua.pt

[1] urn:lsid:zoobank.org:author:D0BE2D38-05DC-4DE0-BEE2-D458ED5C3299
[2] urn:lsid:zoobank.org:author:9200C8BA-E199-46B8-8727-BCF01DBC383A
[3] urn:lsid:zoobank.org:author:DD6A9296-5310-4816-A125-9E37691E14AF

Abstract. A new species of Apseudidae is described from a submarine canyon in the Mediterranean Sea, *Leviapseudes tethys* sp. nov. The species was sampled at 600 m depth on deep muddy sand. The new species is characterized by the presence of processes on both sides of the rostrum, a pinnate seta on the inner distal margin of the maxillipedal endite, smooth distal spines of the labium palp, two spines on the cheliped basis, three ventral spines on pereopod 1 basis and an unarticulated pleopod exopod. This is the second species and the third record of the genus in the Mediterranean Sea, and raises the number of tanaid species known from the deep Mediterranean Sea to a total of 16. The diagnosis of the genus is amended in light of the new data and re-evaluation of previous works. The new species presents a set of characters that provide novel insights to understanding the diversity and taxonomy of the Leviapseudinae, as well as their geographic distribution. Finally, a list of all deep-sea Tanaidacea known in the Mediterranean Sea is provided.

Keywords. Leviapseudinae, Lacaze-Duthiers Canyon, deep sea, list, biogeography.

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Introduction

Tanaidacea Dana, 1849 (Crustacea: Malacostraca) are a peracarid order inhabiting all types of marine and brackish habitats throughout the world, from shallow, estuarine waters to the deep sea (Błażewicz-

Paszkowycz *et al*. 2012). The taxon is one of the most abundant and diverse crustacean groups in the deep ocean, where almost every study entails the discovery of new species.

The genus *Leviapseudes* Sieg, 1983 belongs to the suborder Apseudomorpha Sieg, 1980, to the family Apseudidae Leach, 1814 and to the subfamily Leviapseudinae Sieg, 1983, which is characterised by having a maxilliped endite armed with a subdistal leaf-shaped spine. However, the validity of this character has been questioned owing to its high variability in supraspecific taxa (Guţu & Sieg 1999; Błażewicz-Paszkowycz & Larsen 2004) and the status of the subfamily remains unclear (Larsen 2012). As noted by Błażewicz-Paszkowycz & Larsen (2004), Larsen (2005) and later by Jóźwiak (2014), once the only character separating the subfamilies is questioned, there is currently no apomorphic character allowing the separation of the two subfamilies. Nonetheless, the genera within the Leviapseudinae remain valid, and Larsen (2012) provided the most recent diagnosis of *Leviapseudes* after describing a species from Macaronesia.

The genus *Leviapseudes* is composed of 25 species (WoRMS 2022) distributed in all oceans. It is a deep-sea genus found between 1000 and 6700 m depth, except for *L. segonzaci gasconicus* which was described at 400 m depth in the Atlantic Ocean (Bacescu 1984) and a manca stage of *L. angelikae* at 300 m depth in the Antarctic (Jóźwiak & Błażewicz-Paszkowycz 2007). While in the Atlantic Ocean the genus is well represented, with most of the species (a total of 14) described or cited in the region, the records of *Leviapseudes* in the Mediterranean Sea are very scarce. Bamber *et al*. (2009) reported and partially illustrated several specimens identified as *Leviapseudes* sp. from the Levantine Sea found at 1309 m depth. However, the specimens were severely damaged and lacking appendages, and the authors did not name them. In the western Mediterranean Sea, the only known record is of *Leviapseudes zenkevitchioides* Bacescu, 1981 at 2550 m (Fabri *et al*. 2022).

Studies have shown that tanaidaceans are among the dominant taxa in benthic macrofaunal assemblages in submarine canyons (e.g., Cunha *et al*. 2011; Gunton *et al.* 2015); however, to date only two studies make species-level references to Tanaidacea: García-Herrero *et al*. (2021) covering three canyons in the Portuguese margin, and Sganga & Roccagliata (2016) in Mar de Plata Canyon (SW Atlantic). Although Lacaze-Duthiers Canyon is one of the most studied canyons in the Mediterranean Sea (e.g., Got & Stanley 1974; Vénec-Peyré 1990; Fabri *et al*. 2014; Meistertzheim *et al*. 2016), our knowledge of the soft-bottom macrofauna community composition is scarce. The present study provides the description of a new species of *Leviapseudes* from the Lacaze-Duthiers Canyon, north-western Mediterranean Sea, based on morphological characters.

Material and methods

Specimens of the new species of *Leviapseudes* were sampled in June 2019 during the MEDDESCENT cruise (Le Bris 2019), which aimed at linking environmental variables with organic matter transfers to better assess the sensitivity of the ecosystem in submarine canyons to climate change. The sampling station was located in the Lacaze-Duthiers Canyon (French Mediterranean Sea; WGS84: 42°32.149′ N, 3°26.214′ E and 42°32.204′ N, 3°26.300′ E; ca 600 m depth; Fig. 1). Specimens examined in this study were collected using a van Veen grab (0.1 m² sampling area), sieved through 1 mm mesh size, fixed in 5% formaldehyde seawater solution and transferred to 70% ethanol for morphological analyses. Specimens were observed under a stereo microscope and a compound microscope, and dissected appendages were mounted on permanent slides using Dimethyl Hydantoin Formaldehyde. Body length (BL) was measured with NIS-Elements Analysis software. Drawings were performed using Inkscape software (ver. 0.92). Morphological terminology follows the one proposed by Blazewicz-Paskowicz & Bamber (2007). Specimens were deposited in the Muséum national d'histoire naturelle (MNHN, Paris, France).

While the common practice for Tanaidacea is using female individuals as holotypes, and basing original descriptions and the corresponding illustrations on female specimens, in this case only male specimens were found in the samples. Therefore, only males are described herein.

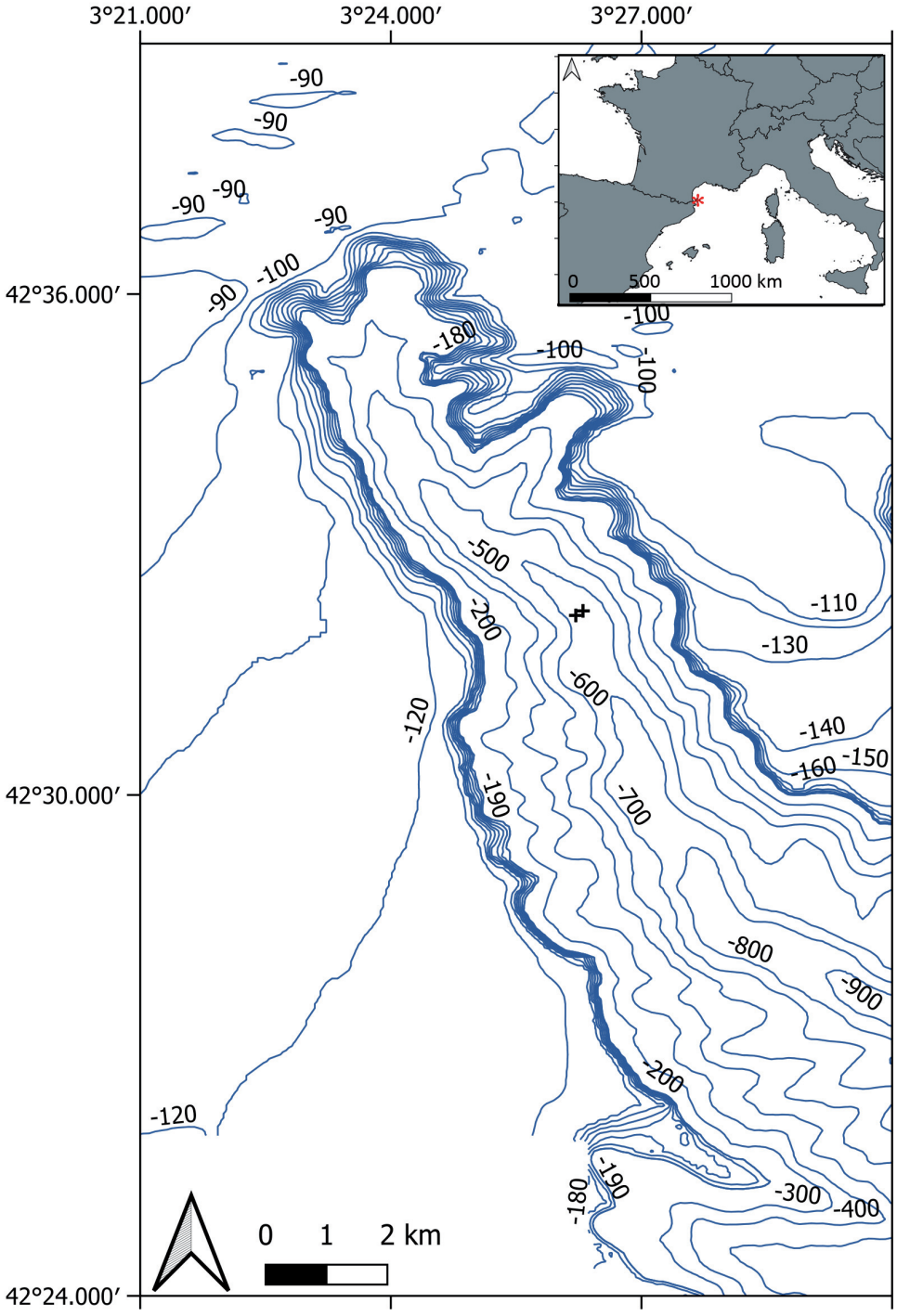

Fig. 1. Bathymetric map showing the sampling sites inside the Lacaze-Duthiers Canyon in the Mediterranean Sea. Labels indicate the depth of the bathymetric lines.

Results

Phylum Arthropoda von Siebold, 1848
Class Malacostraca Latreille, 1802
Order Tanaidacea Dana, 1849
Family Apseudidae Leach, 1814
Subfamily Leviapseudinae Sieg, 1983

Genus ***Leviapseudes*** Sieg, 1983

Diagnosis (amended after Larsen 2012)

Female

Rostrum present. Cephalothorax with spiniform processes on branchial chambers. Pereonites with lateral processes. Pereonite 6 longer than wide. Pleonites narrower than pereonite 6. Cheliped carpus as long as or longer than fixed finger. Pereopod 1 merus longer than carpus. Pereopod 4 dactylus/unguis sometimes reduced to a claw.

Male

As female, but pereonite 6 with clearly identifiable genital cone. Antennule after terminal molt with numerous aesthetascs. Pereopod 4 dactylus/unguis, if reduced to a claw, less evident than in female. Pleonites always with lateral epimera, and epimera larger than in female.

Remarks

The most recent diagnosis of *Leviapseudes*, provided by Larsen (2012), included a bi-articulated pleopod exopod, when present, as a distinguishing character. However, a number of species within the genus present a pleopod endopod with one article, namely: *L. aberrans* (Lang, 1968), *L. angelikae*, *L. demerarae* Bacescu, 1984 and *L. longissimus* Bacescu, 1982. Therefore, we amend the diagnosis deleting this character. The presence of a rostrum (absent in *Fageapseudes* Bacescu & Gutu, 1971), as well as the presence of spiniform processes on the branchial chambers and presence of lateral processes on the pereonites (verified for all species of *Leviapseudes*) have been added.

Leviapseudes tethys sp. nov.
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Figs 2–4

Etymology

Tethys, noun in apposition; the species is named after the Tethys Sea that existed from the end of the Palaeozoic Era to the Mesozoic Era and from which the Mediterranean Sea is a present remnant; it also corresponds to the name of the research vessel used to sample the new species.

Material examined

Holotype

FRANCE • ♂, BL = 8.39 mm, rostrum–telson, appendages damaged; Gulf of Lion, Lacaze-Duthiers Canyon; 42.53582° N, 3.43690° E; depth 600 m; 1 Jun. 2019; replica sample LDTH – site 2 – C1; van Veen grab; MNHN-IU-2016-3391.

Paratype

FRANCE • 1 ♂, broken, BL = 8.06 mm, rostrum–pleonite 2, appendages damaged; Gulf of Lion, Lacaze-Duthiers Canyon; 42.53673° N, 3,43833° E; depth 600 m; 1 Jun. 2019; replica sample LDTH – site 2 – C5; van Veen grab; MNHN-IU-2016-3390.

Description

Body (Fig. 2A–B). 8.39 mm long; carapace 17% of total body length. Cephalothorax, including rostrum, longer than pereonites 1–2 combined. Ocular lobes well developed, spiniform, without pigmentation. Lateral spiniform apophyses slightly developed. Rostrum reaching half-length of first antennular article, triangular. Pereonites decreasing in width distally; pereonites 1–2 with posterolateral spiniform apophyses, pereonites 3–6 with anterolateral and posterolateral spiniform apophyses. Pereonite 1–3 wider than long, 4–6 longer than wide. All pereonites with ventral hyposphenia. Pleon 20% of total body length. Pleonites all wider than long, each of equal length, with posterolateral apophysis. Pleotelson shorter than last three pleonites combined.

Antennule (Fig. 2C). Subequal to carapace and pereonite 1–2 combined. Peduncle article 1 about twice as long as two succeeding articles combined, with some simple setae of various lengths on both margins; article 2 longer than article 3, with a few scattered simple setae; article 3 with four distal simple setae; article 4 naked. Outer flagellum longer than peduncle, consisting of 20 segments. Inner flagellum reaches 0.62 length of outer flagellum, consists of 10 segments.

Antenna (Fig. 2D). Article 1 naked with ventral process, twice as wide as other articles, half as long as article 2. Article 2 with one inner and two distal short simple setae. Article 3 distinctly shorter than article 4. Article 5 longer than articles 3 and 4 combined, with three simple medial setae and three distal setae comprised of two simple and one pinnate seta distally; following articles (6–16) diminishing successively in length and width; each article with 1–4 simple setae. Squama longer than articles 3 and 4 combined, with 12 simple setae.

Labrum (Fig. 3K). With lateral margins covered by a few simple setae and minute setation distally.

Mandible (Fig. 3A–B, G). With very broad molar process with numerous minute distal setae. Palp article 1 less than half as long as article 3, with 10 simple setae; article 2 2.25 times as long as article 1, with 10 bipinnate setae decreasing in length distally (except first seta shorter than second) and 10 shorter simple setae; article 3 with a single, followed by 11 pairs of bipinnate setae increasing in length distally and two distal simple setae (longest). Left mandible incisor broad, with five blunt denticles. Lacinia mobilis slender, with blunt denticles and three small spines. Setal row consists of nine simple and multifurcated setae.

Labium (Fig. 3F). Lobe setulated on distal part of outer margin and on middle of inner side. Palp with numerous simple setae on both margins, tipped by three spines.

Maxillule (Fig. 3H–I). Outer endite tipped with 12 spines, two simple subdistal setae, setules on both margins. Inner endite with four setulated and one simple distal setae, setules on both margins. Palp with two articles; article 1 distinctly longer than article 2, naked; article 2 tipped by 12 distally finely serrated setae.

Maxilla (Fig. 3J). Outer lobe of movable endite with six long setulated setae and two long setulated feathered setae on outer margin. Inner lobe of movable endite with row of nine setulated setae. Outer lobe of fixed endite with three setulated, two simple, and three multifurcate spines. Inner lobe of fixed endite with row of eight setulated setae distally and row of numerous (>30) simple setae subdistally.

Maxilliped (Fig. 3C–E). Endite with 13 distal setae, outer ones slender and long, inner ones larger and shorter; one subdistal inner pinnate seta and one outer long simple seta; inner margin with a row of 14 setulated setae and four coupling hooks. Palp article 1 with four inner simple distal setae and one outer seta. Article 2 inner margin with a row of numerous simple and pinnate setae of same size and five longer simple setae, outer margin with one distal simple seta. Article 3 with seven long simple and seven

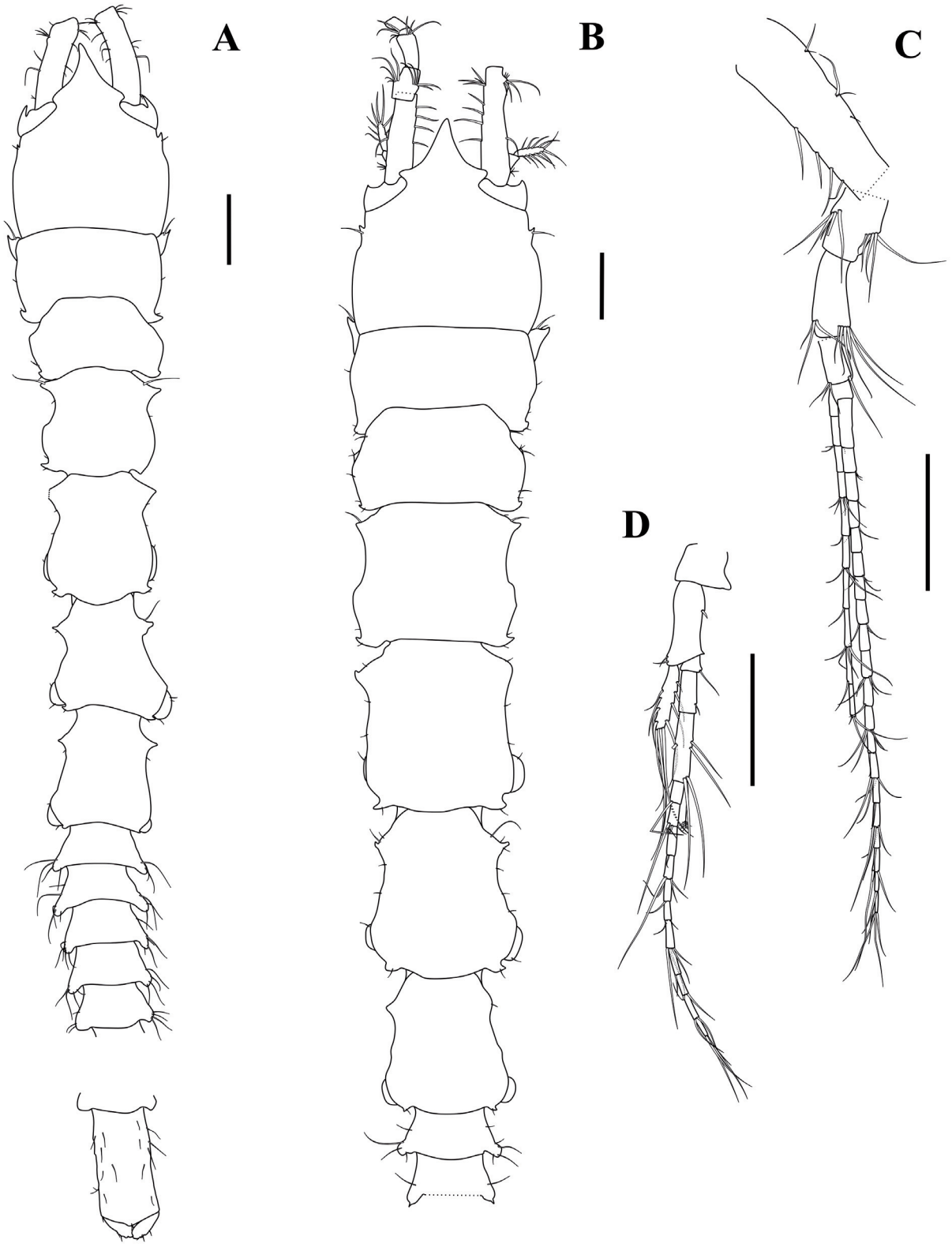

Fig. 2. *Leviapseudes tethys* sp. nov. **A**. Holotype, ♂ (MNHN-IU-2016-3391), dorsal view. **B–D**. Paratype, ♂ (MNHN-IU-2016-3390). **B**. Dorsal view. **C**. Antennule. **D**. Antenna. Scale bars = 0.5 mm.

shorter pinnate setae, all increasing in length distally. Article 4 tipped with nine pinnate setae. Pinnate setae very difficult to distinguish from simple setae.

Epignath. Not recovered.

Cheliped (Fig. 4A). Basis shorter than carpus, with two ventral spines and a cluster of simple setae distoventrally; merus almost half as long as carpus, with many simple setae ventrally and no setae

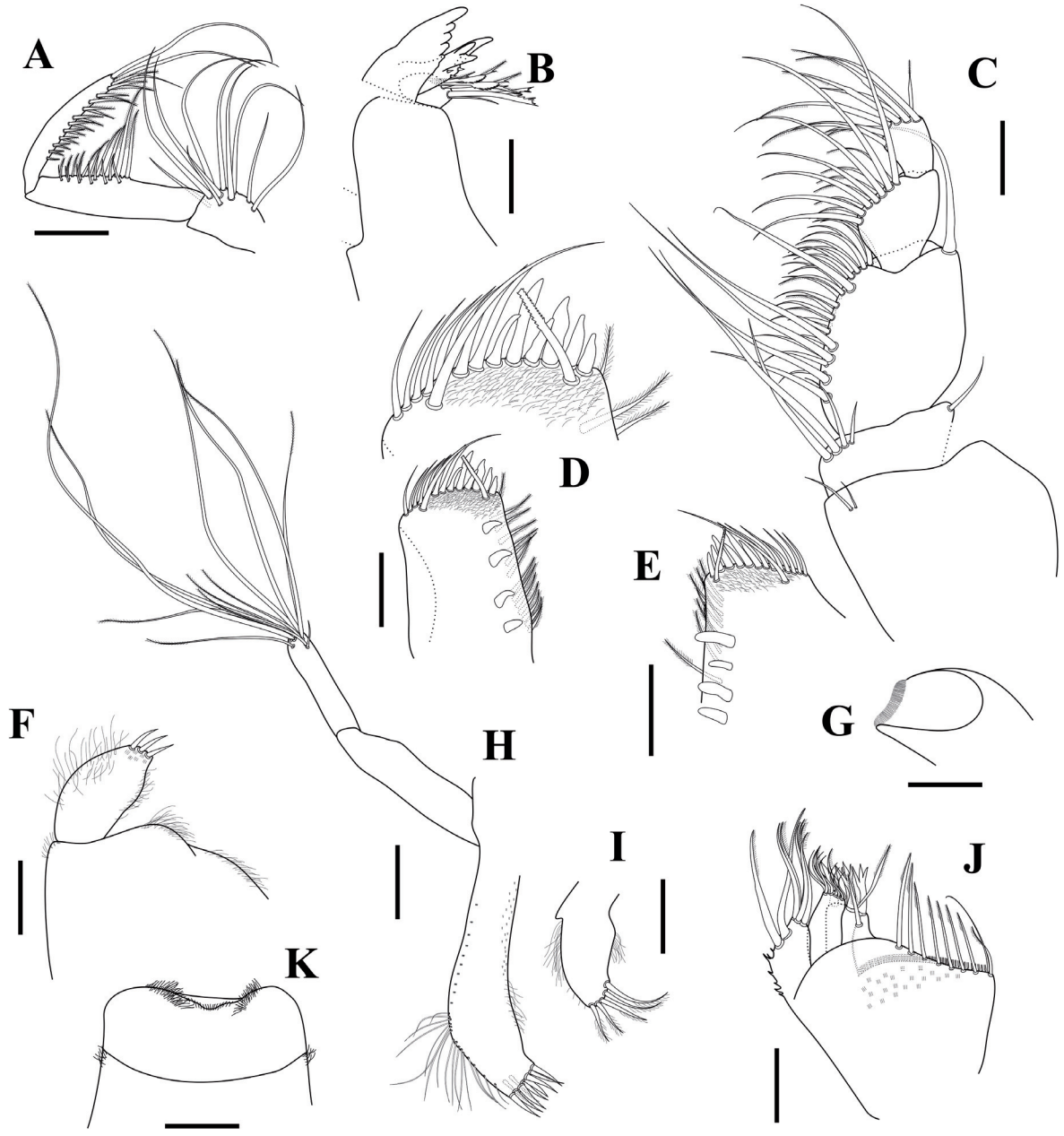

Fig. 3. *Leviapseudes tethys* sp. nov. Paratype, ♂ (MNHN-IU-2016-3390). **A**. Mandibular palp, right. **B**. Mandible, left. **C**. Maxilliped. **D**. Maxilliped endite, left, with close-up of distal part. **E**. Maxilliped endite, right. **F**. Labium, left. **G**. Molar process distal part. **H**. Maxillule. **I**. Maxillule endite. **J**. Maxilla. **K**. Labrum. Scale bars = 0.1 mm.

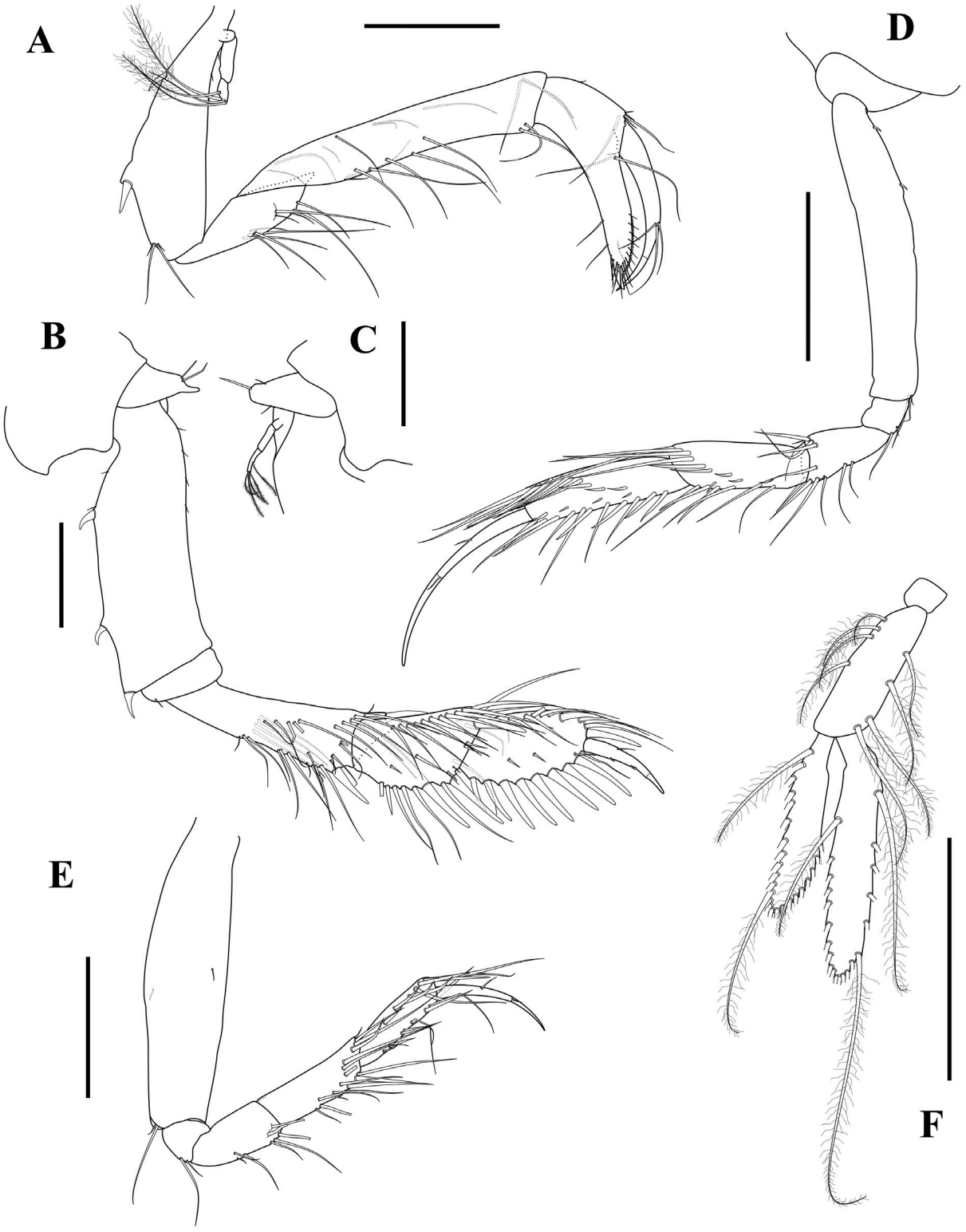

Fig. 4. *Leviapseudes tethys* sp. nov. **A–C, E**. Paratype, ♂ (MNHN-IU-2016-3390). **D, F**. Holotype, ♂ (MNHN-IU-2016-3391). **A**. Cheliped, right. **B**. Pereopod 1, right. **C**. Pereopod 1, left, proximal part of basis. **D**. Pereopod 2, left. **E**. Pereopod 3, right. **F**. Pleopod 2. Scale bars = 0.5 mm.

distodorsally; carpus with numerous long setae on ventral and dorsolateral margins; propodus with one short seta dorsally, near dactylus insertion of two long and three short dorsal setae, and two long and one short ventral setae. Fixed finger inner margin with a row of well calcified teeth and a row of short setae, outer margin with two long setae, distal part with many short setae. Dactylus narrow, longer than fixed finger, with three long simple setae. Exopod biarticulated, distal article with one median and three distal plumose setae.

Pereopod 1 (Fig. 4B–C). Basis longer than merus, with minute proximal setae and three ventral spines; ischium with a minute ventral seta; merus about 1.5 times as long as carpus, with numerous simple setae, and one ventrodistal and one dorsodistal spine; carpus subequal in length to propodus, with two ventral and one dorsodistal spine, six ventral simple setae, a row of dorsolateral simple long setae and multiple simple lateral setae; propodus with a row of eight spines ventrally, a row of simple long setae and two spines dorsolaterally; dactylus 0.6 times as long as propodus, with 2–5 ventral and one dorsal short seta; unguis 0.3 times as long as dactylus. Exopod biarticulated, distal article with one medial and three distal plumose setae.

Pereopod 2 (Fig. 4D). Basis long and slender, about 5.5 times as long as wide, marginally shorter than carpus and propodus combined, with two minute setae proximally and three simple distoventral setae. Ischium with two ventrodistal setae. Merus 0.5 times as long as carpus, with seven ventral, four dorsodistal and one distolateral simple setae. Carpus slightly smaller than propodus, with seven ventral setae and a medio-distal diagonal row of setae. Propodus with a medio-distal diagonal row of simple setae and many simple ventral setae. Dactylus longer than propodus, with one minute dorsal seta at midlength and one minute distal seta. Unguis smaller than dactylus.

Pereopod 3 (Fig. 4E). Similar to pereopod 2 except less setose and basis about 4 times as long as width.

Pleopod (Fig. 4F). Basal part divided into two articles, first article small and naked, second article longer with four outer and four inner plumose setae; endopod and exopod with many (>20) plumose setae, exopod longer than endopod and consisting of one article only.

Uropods. Lost.

Ecological data

Leviapseudes tethys sp. nov. was sampled at 600 m depth on deep muddy sand (D50 = 9.3 µm and 88% of silt <63 µm). Sediment organic content at this location was about 6.5% AFDW (Ash Free Dry Weight). In total, three individuals were collected over five grabs (two in C1 grab and one in C5 grab). Unfortunately, a juvenile specimen was lost during the study (specimen collected in LDTH – Site 2 – C1). The new species was mainly collected with Polychaeta Grube, 1850 and represents the only Tanaidacea (Table 1).

Discussion

Taxonomic remarks

The new species fits the diagnosis of *Leviapseudes* provided by Larsen (2012) and amended herein well. Although the presence of a pinnate seta instead of a leaf-like spine on the inner distal margin of the maxillipedal endite would allocate this species within the Apseudinae instead of the Leviapseudinae (see above), it should be noted that the character is variable amongst the species currently included in the genus. In *L. aberrans* and *L. conspicuous*, the leaf-like spine is present only on the endite on one side of the animal and not on the other (Lang 1968), and in *L. tenuimanus* Blazewicz-Paszkowycz & Larsen, 2004 there is a seta similar to the one in *L. tethys* sp. nov. instead of a leaf-like spine. As mentioned

Table 1. Species list of macrofauna collected with *Leviapseudes tethys* sp. nov. Abundances correspond to the number of individuals collected per van Veen grab.

Higher taxonomic level	Species	LDTH Site 2 C1	LDTH Site 2 C5
Echinoidea	*Brissopsis lyrifera* (Forbes, 1841)		1
Crustacea	Amphipoda Latreille, 1816		1
Crustacea	*Leviapseudes tethys* sp. nov.	2	1
Crustacea	*Diastylis echinata* Bate, 1865		2
Crustacea	*Leucon (Epileucon) longirostris* Sars, 1871	3	
Crustacea	*Leucothoe oboa* Karaman, 1971	1	
Nemertea	Nemertea indet.	1	
Polychaeta	Capitellidae indet.	1	
Polychaeta	*Leiocapitella dollfusi* (Fauvel, 1936)		1
Polychaeta	*Euclymene* sp.		1
Polychaeta	*Maldane sarsi* Malmgren, 1865	1	
Polychaeta	*Galathowenia oculata* (Zachs, 1923)	3	
Polychaeta	*Chloenopsis atlantica* (McIntosh, 1885)	1	
Polychaeta	*Nephtys ciliata* (Müller, 1788)		1
Polychaeta	*Polydora* sp.	1	
Polychaeta	*Prionospio ehlersi* Fauvel, 1928	4	1
Polychaeta	*Prionospio steenstrupi* Malmgren, 1867	2	
Polychaeta	*Anobothrus gracilis* (Malmgren, 1866)	2	2
Polychaeta	*Pista* sp.		1
Polychaeta	Terebellidae indet.	4	
Polychaeta	*Terebellides lilasae* Lavesque, Hutchings, Daffe, Nygren & Londoño-Mesa, 2019		1
Sipuncula	*Nephasoma (Nephasoma) diaphanes diaphanes* (Gerould, 1913)	2	

Table 2. Deep-sea Tanaidacea (>200 m) recorded in the Mediterranean Sea. Only references with deep-sea records are provided.

Species	Area	Reference
Araphura hyphalus Bird, 2022	Levantine sea	Lubinevski *et al*. (2022)
Carpoapseudes laubieri Bacescu, 1982	Aegean Sea	Fabri *et al*. (2022)
Fageapseudes retusifrons (Richardson, 1912)	Tyrrhenian Sea	Kudinova-Pasternak (1982)
Leviapseudes zenkevitchioides Bacescu, 1981	Balearic Sea	Fabri *et al*. (2022)
Leviapseudes tethys sp. nov.	Gulf of Lion	This work
Obscurapseudes graciloides (Stephensen, 1915)	Ionian basin	Kudinova-Pasternak (1982)
Leptognathia vitjazi (Kudinova-Pasternak, 1982)	Tyrrhenian Sea	Kudinova-Pasternak (1982)
Leptognathia longa (Kudinova-Pasternak, 1982)	Ionian basin	Kudinova-Pasternak (1982)
Pseudakanthophoreus nanopsenos (Bamber & Bird, 2009)	Levantine sea	Lubinevski *et al*. (2022)
Typhlotanais aequiremis (Lilljeborg, 1864)	Tyrrhenian Sea	Kudinova-Pasternak (1982)
Typhlotanais spinipes Kudinova-Pasternak, 1982	Ionian basin	Kudinova-Pasternak (1982)
Paranarthrura insignis Hansen, 1913	Balearic Sea	Fabri *et al*. (2022)
Paranarthrura intermedia Kudinova-Pasternak, 1982	Adriatic Sea	Kudinova-Pasternak (1982)
Paranarthrura lusitanus Bird & Holdich, 1989	Gibraltar strait, Levantine sea	Fabri *et al*. (2022), Lubinevski *et al*. (2022)
Pseudotanais stiletto Bamber, 2009	Levantine sea	Lubinevski *et al*. (2022)
Typhlotanais scalenus Bird, 2022	Levantine sea	Lubinevski *et al*. (2022)

above, the validity of the character and the division of the Apseudidae into families is currently under discussion and would be the subject of a thorough revision that is beyond the scope of this paper.

Of these species, *L. tenuimanus* can be distinguished from *L. tethys* sp. nov. by the absence of processes on both sides of the rostrum, the number of articles of the antennule inner flagellum (7 vs 9), the presence of a spiniform process on the cheliped basis instead of two spines, the dactylus of the chela reaching well beyond the fixed finger, the presence of two ventrodistal spines on the pereopod 1 basis instead of one spine and the number of ventral spines on the pereopod 1 propodus (5 vs 8), inter alia. *Leviapseudes aberrans* is similar to the new species in having the pleopod exopod uniarticulated, but differs in the absence of processes on both sides of the rostrum, the number of articles of the antennule inner flagellum (5 vs 10), the presence of a spiniform process on the cheliped basis instead of two spines, the dactylus of the chela extending beyond the fixed finger, the absence of spines on the pereopod 1 basis and the number of ventral spines on the propodus (5 vs 8), inter alia. Only two other species have the pleopod exopod uniarticulated, *L. angelikae* and *L. longissimus* Bacescu, 1982, but both have a subdistal fan-shaped seta on the maxillipedal endite. In the case of *L. angelikae*, the species has the pleopod exopod uniarticulated in the male and biarticulated in females. Furthermore, it differs from *L. tethys* sp. nov. in the number of articles of the antennule inner flagellum (7 vs 10), the dactylus of the chela reaching well beyond the fixed finger, and the presence of only one ventrodistal spine on the pereopod 1 basis. *Leviapseudes longissimus*,

on the other hand, differs from *L. tethys* sp. nov. in the ventral process of antennary article 1 (rounded vs triangular), the setation of the mandibular palp article 1 (3 vs 10) and of the maxillule palp article 2 (7 vs 12), and in the distal spines of the labium palp (serrate vs smooth).

Ecology and biogeography

The available records of deep-sea Tanaidacea in the Mediterranean Sea (i.e., below 200 m depth) are very scarce (see Table 2). Three works dedicated to species of the group mention deep sea ecosystems. The first was the one of Kudinova-Pasternak (1982), who listed six species of deep-sea Tanaidacea throughout the region. Later on, Bamber *et al*. (2009) studied the species of Tanaidacea off Israel, finding an unnamed species of *Leviapseudes*. More recently, Lubinevsky *et al*. (2022) completed the work made by Bamber, adding five new records and two new species to the deep Levantine Sea (among others from the shallow coasts of Israel). The publication of a deep-sea benthic fauna database in the Ocean Biodiversity Information System (Fabri *et al*. 2022) added four more records for the Strait of Gibraltar, Balearic Sea and Aegean Sea.

As mentioned above, the only records of *Leviapseudes* in the Mediterranean Sea are *L. zenkevitchioides* (Fabri *et al*. 2022) and *L.* sp. (Bamber *et al*. 2009); therefore, *L. tethys* sp. nov. represents the third record of a *Leviapseudes* in the Mediterranean Sea, and the second valid species, raising the number of confirmed species of tanaidacean in the deep Mediterranean Sea to a total of 16 (Table 2).

The biodiversity of Tanaidacea in submarine canyons is largely understudied; however, the recent works available included the discovery of new taxa that provided significant information for the understanding of the systematics of the group. For instance, Sganga & Roccatagliata (2016) described *Deidamiapseudes*, a genus of an uncertain position between the Apseudidae and Metapseudidae Lang, 1970, and García-Herrero *et al*. (2021) described *Tirana* Esquete, 2021, a genus of the recently established family Paranarthrurellidae Błażewicz, Jóźwiak & Frutos, 2019, with intermediate characteristics of two pre-existing genera. It can be expected that increasing taxonomic research in canyons and other understudied environments will throw new light on the intriguing systematics of Tanaidacea, expanding our knowledge of the still widely unknown biodiversity of the deep sea.

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