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Symbiotic copepods from the ascidians, a hidden diversity of the Mediterranean Sea: *Haplostomides magnus* n. sp. (Cyclopoida: Botryllophilidae)

A. Badalucco ^{a,b}, I.-H. Kim ^c, F. Mastrototaro ^{d,e} and S. Lo Brutto ^{a,b}

^aDepartment of Earth and Marine Sciences, University of Palermo, Palermo, Italy; ^bNational Biodiversity Future Center (NBFC), Palermo, Italy; ^cKorea Institute of Coastal Ecology, Bucheon, Republic of Korea; ^dDepartment of Biosciences, Biotechnologies and Environment, University of Bari, Bari, Italy; ^eCoNISMa, National Interuniversity Consortium for Marine Sciences, Rome, Italy

ABSTRACT

This paper reports the first occurrence of five species of symbiotic copepods associated with ascidian species collected in two Sicilian harbours (southern Italy) in the central Mediterranean Sea. These findings integrate the poor information on the symbiotic copepods in ascidian species, with the description of *Haplostomides magnus* n. sp. (Cyclopoida: Botryllophilidae) found as commensal in the colonial ascidian *Polyclinum aurantium*. The morphological diagnostic features of the new species include a caudal ramus bearing two spines and two setae, a unique armature condition within this genus. Brief descriptive notes are also provided for several species of copepods associated with ascidian species: *Lichomolgus canui* Sars G.O., 1917 (Cyclopoida: Lichomolgidae), found in *Styela plicata*, *Doropygus pulex* Thorell, 1859 (Cyclopoida: Notodelphyidae), found in *Ascidella aspersa*, and *Pachypygus gibber* (Thorell, 1859) (Cyclopoida: Notodelphyidae) collected among the fouling community. A species belonging to the genus *Asterocheres* (Siphonostomatoida: Asterocheridae) was also found associated with *Styela plicata*.

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Introduction

The Mediterranean Sea hosts an exceptionally rich and diverse biota and is therefore recognized as a major global biodiversity hotspot (Coll et al. 2010). The richness of the Mediterranean Sea is largely due to the high variety of coastal environments, which is assisted by a vast number of islands and archipelagos. Sicily Island, situated at the centre of the basin, supports a remarkable diversity of marine organisms that has been demonstrated to reflect the biodiversity of the Mediterranean region (Bianchi & Morri 2000; Lo Brutto et al. 2021). Its marine fauna is relatively well known, except for some neglected taxa that have been overlooked due to the scarcity of specialists, inadequate sampling, or low occurrence (Lo Brutto et al. 2024).

Copepods are small aquatic crustaceans exhibiting a wide range of life strategies, including free-living (pelagic and benthic) and parasitic modes of existence. They also occur across all salinity and temperature regimes, from inland freshwater to the marine deep sea (Morales-Serna et al. 2012). Benthic copepods inhabit many coastal habitats; nevertheless, their specific contributions to biofouling communities remain poorly documented.

There is evidence that copepods are members of biofouling communities, where they graze on biofilm and microalgae (Weitere et al. 2018) and are parasitic of or commensal with sessile dominant species. However, significant knowledge gaps exist regarding their trophic role and the functional significance within specific host organisms or on basibionts. In a study of the biofouling developed on nylon net panels submerged in the central Red Sea, copepods were identified as one of the taxonomic groups colonizing the experimental substrates, alongside polychaetes, amphipods, isopods, bivalves, gastropods, ascidians, and macroalgae (Salama et al. 2018). This study documented the presence of copepods across different seasons and depths, indicating their consistent occurrence in biofouling assemblages.

A substantial yet often overlooked component of copepod diversity are parasitic species. Parasitic or symbiotic copepods form a highly diverse and morphologically polymorphic group, exhibiting a wide

CONTACT S. Lo Brutto  sabrina.lobrutto@unipa.it  Department of Earth and Marine Sciences, University of Palermo, Palermo, Italy

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spectrum of host–symbiont relationships ranging from temporary associations to permanent, obligate parasitism. These interactions are frequently accompanied by pronounced modifications in life cycles and body morphology relative to free-living forms.

Most of the known marine parasitic copepods belong to the orders Cyclopoida Burmeister, 1834 and Siphonostomatoida Burmeister, 1835.

Recent papers have reported the occurrence of some symbiotic copepod species as commensal of tunicates in biofouling communities in Sicilian harbours (Lo Brutto et al. 2024, 2025) which suggests that the sampling effort in some other biofouling communities needs to be improved. In particular, the commensal copepod *Bonnierilla similis* Illg and Dudley, 1961 (Cyclopoida: Notodelphyidae) was found inside the branchial sac of the solitary ascidian *Styela plicata* (Lesueur, 1823) (Lo Brutto et al. 2025). The authors discussed the possibility that these commensal species were undergoing a range expansion, potentially facilitated by maritime traffic, one of the most probable pathways for the spread of ascidian species (Mastrototaro et al. 2022; Montesanto et al. 2023), and emphasized the need for further sampling to clarify its distribution in the Mediterranean Sea.

Moreover, the further record of cyclopoid copepods of the family Botryllophilidae Sars G.O., 1921, in Sicily (central Mediterranean Sea) (Lo Brutto et al. 2024) needed a deeper taxonomic investigation, as they had not yet been identified to the species level. Since botryllophilids are obligate symbionts of ascidians, the authors emphasized that records of these tunicate-associated copepods in the Mediterranean are scarce, largely due to limited sampling and taxonomic expertise in both taxa.

This paper presents the results of a targeted sampling effort aiming at detecting the symbiotic relationship between ascidians and copepod species, and at describing a new species of botryllophilid copepod, *Haplostomides magnus* n. sp., currently known only from the Palermo site on the northern coast of Sicily. In addition, the survey was expanded to include the broader copepod assemblage associated with fouling communities along the Sicilian coast (central Mediterranean Sea, Italy), revealing a previously overlooked component of regional biodiversity.

Materials and methods

Two sampling sites were located within the ports of Palermo (La Cala station, 38.119867N, 13.369017E), and Licata (Molo Marianello station, 37.094288N, 13.934108E) (Figure 1). Palermo is located on the north-western coast of Sicily and overlooks the Tyrrhenian Sea, while Licata is located in the south-western coast of Sicily and faces the Sicilian Channel (Figure 1).

The Palermo site is a semi-natural enclosed marina close to the commercial and touristic harbour, characterized by low-energy hydrodynamics with an average depth of 7 m. Being located in a densely populated urban area and close to a large commercial port, the area is subject to significant anthropogenic impact (historical urban waste disposal, recreational boat traffic). The Licata site represents a more dynamic environment, characterized by transitional waters due to its proximity to the mouth of the Salso River, subject to greater variability in physicochemical parameters and moderate coastal hydrodynamics.

Fouling communities were sampled between 2023 and 2025 from mooring lines at depths between 0 and 2 m. The sampling at the Palermo marina was carried out on 5 December 2023, 28 March 2024, 18 April 2024 and 27 November 2024, while at the fishing port of Licata sampling occurred on 29 March 2025. The fouling community was sorted using a Nikon SMZ25 stereoscopic microscope. The tunicates were opened, and copepods were collected from inside the hosts. The copepods were collected alive. The specimens were identified to the lowest possible taxonomic level. The identification here reported focused on the copepod assemblage associated with the fouling invertebrates.

Prior to microscopic observation, the shrunken, alcohol-preserved specimen (see fig. 3 in Lo Brutto et al. 2024) was immersed in lactic acid for approximately 10 h to facilitate its expansion. Dissected appendages were observed using the reverse slide method of Humes and Gooding (1964). Drawings were made with the aid of a microscope (Olympus BH-2) equipped with a drawing apparatus and a magnification changer. Dissected appendages were mounted on two slides, using Hoyer's mounting medium. Identification keys were used for accurate morphological identification of tunicates (Brunetti & Mastrototaro 2017; Montesanto et al. 2022).

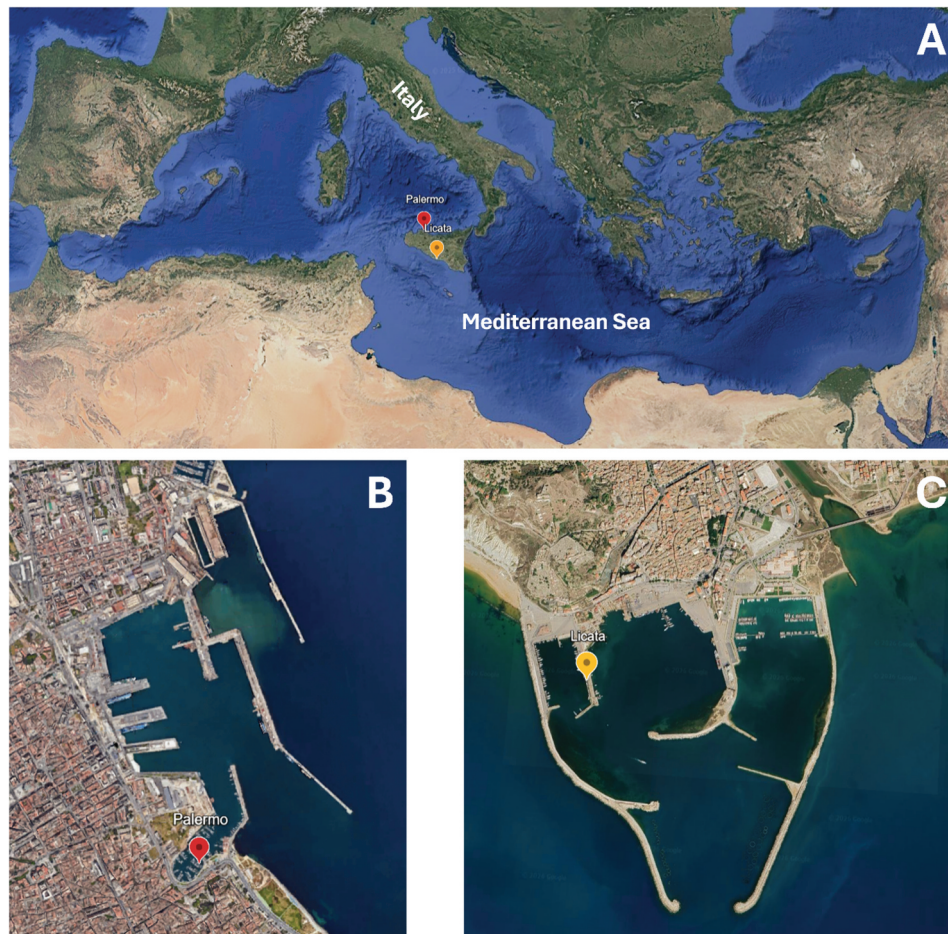


Figure 1. Sampling sites. A, Map showing the sampling area within the Mediterranean Sea, along the Sicilian coast. The two sites are indicated: Palermo – the La Cala marina (red) and Licata – Molo Marianello (yellow). B, Map of the Palermo marina located within the harbour area of Palermo. C, Map of the Licata station located within the fishing port area of Licata. The maps were generated using Google Earth (<https://www.google.it/intl/it/earth/index.html>); (A) satellite pictures by ©2026 Google, Landsat/Copernicus and (B, C) ©2026 Google, Airbus.

Results

In both Sicilian ports, the fouling community appeared to be diverse, mainly composed of poriferans, cnidarians (anthozoans and hydrozoans), polychaetes (serpulids and syllids), molluscs (bivalves and gastropods), bryozoans, and ascidians. Regarding this last taxon, the solitary *S. plicata* and the compound *Polyclinum aurantium* Milne Edwards, 1841 were present in Palermo harbour; while the solitary *Phallusia mammillata* (Cuvier, 1815) and *Ascidella aspersa* (Müller, 1776) were present in Licata harbour.

The copepod fauna comprised the free-living harpacticoid *Eudactylopus andrewi* Sewell, 1940 (Harpacticoida: Thalestridae), here reported for the first time from Italian waters.

The list of symbiotic copepod species presented here includes a species that was sampled during the sampling effort and previously published as the first record of the region (Lo Brutto et al. 2025); specifically, the *B. similis* records were included in the dataset.

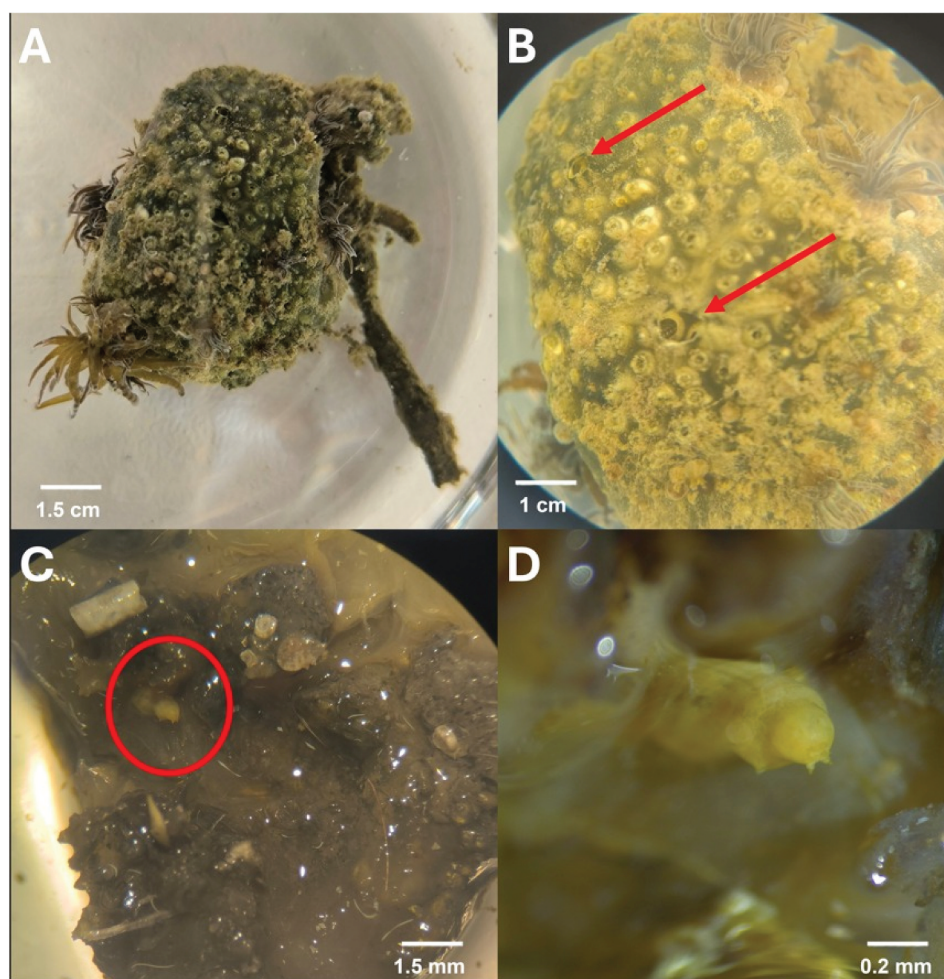
Six symbiotic copepod species were recorded (Table 1), five belonging to the order Cyclopoida, identified at the species level, and one to the order Siphonostomatoida identified at the genus level. A new species, *H. magnus* n. sp., is herein described and figured. Only four females were found at the Palermo site, one collected on 5 December 2023, two on 28 March 2024, and one on 27 November 2024. All specimens were found within the colonial ascidian *P. aurantium* (Figure 2).

Table 1. Copepod species collected in the fouling communities of the central Mediterranean Sea. N, number and sex of the collected individuals.

Order	Family	Species	N	Host/association	Locality
CYCLOPOIDA					
	Botryllophilidae	<i>Haplostomides magnus</i> n. sp.	4 ♀	<i>Polyclinum aurantium</i> Milne Edwards, 1841	Palermo
	Lichomolgidae	<i>Lichomolgus canui</i> Sars G.O., 1917	6 ♀	<i>Styela plicata</i> (Lesueur, 1823)	Palermo
	Notodelphyidae	<i>Bonnierilla similis</i> Illg and Dudley, 1961*	35 ♀	<i>Styela plicata</i> (Lesueur, 1823)	Palermo
	Notodelphyidae	<i>Pachypygus gibber</i> (Thorell, 1859)	2 ♀	Found among fouling animals**	Licata
	Notodelphyidae	<i>Doropygus pulex</i> Thorell, 1859	7 ♀	<i>Asciidiella aspersa</i> (Müller, 1776)	Licata
SIPHONOSTOMATOIDA					
	Astrocheridae	<i>Astrocheres</i> sp.	1 ♂	<i>Styela plicata</i> (Lesueur, 1823)	Palermo

Note: *In Lo Brutto et al. (2025).

**The copepods accidentally escaped from the host.

**Figure 2.** A, Colony of the compound ascidian *Polyclinum aurantium*. B, Red arrows point to the common cloacal apertures of *Polyclinum aurantium* colony. C, D, a specimen of *Haplostomides magnus* n. sp. within the tunic of *P. aurantium*.

On 18 April 2024, at the Palermo site, six female specimens of the cyclopoid *Lichomolgus canui* Sars G.O., 1917 and one siphonostomatoid (*Astrocheres* sp.) were found associated with *S. plicata*, presumably after being expelled by the tunicates.

A total of 35 specimens of *B. similis* were recorded in the branchial sac of *S. plicata* collected at the Palermo site (see Lo Brutto et al. 2025 for details).

At the Licata site, two notodelphyid species were found: two females of *Pachypygus gibber* (Thorell, 1859) among fouling organisms and seven females of *Doropygus pulex* Thorell, 1859 inside three *Asciidiella aspersa*.

Supplementary descriptions of the females of *L. canui*, *P. gibber* and *D. pulex* are presented, along with some updates and remarks.

Systematics

Class Copepoda Milne Edwards, 1840

Order Cyclopoida Burmeister, 1834

Family Botryllophilidae Sars G.O., 1921

Genus *Haplostomides* Chatton and Harant, 1924

***Haplostomides magnus* n. sp.**

Figures 3, 4, 5(A)

Etymology. The specific name, derived from the Latin *magnus*, meaning “large”, refers to the large body size of the new species in comparison with the size of the known species of the same genus. It is in the nominative singular, gender masculine.

Differential diagnosis. Body vermiform, unsegmented. Caudal ramus small, incompletely articulated from abdomen, tapering, about 1.3 times longer than wide, armed with 2 distal spines. Antennule unsegmented, bearing 10 setae. Antenna 2-segmented, with 2 claw-like spines on second segment. Mandible indistinctly 2-segmented. Maxillule 2-segmented, with 2 and 4 setae on first and second segments, respectively. Maxilla as broad lobe, bearing 2 setae. Maxilliped 4-segmented; first and third segments unarmed; second and fourth segments with 2 setae and 1 claw, respectively. Leg 1 biramous; protopod bearing 1 outer seta; exopod with 1 seta on outer margin and 1 claw-like, bifurcate spine distally; endopod small, unarmed, bearing nipple-shaped knob at inner distal corner. Legs 2–4 like leg 1, but inner distal knob of endopod not prominent. Leg 5 absent.

Description

Type material. Holotype (female, dissected and mounted on two slides) from the compound ascidian *Polyclinum aurantium*, Palermo Port (La Cala station, 38.119867N, 13.369017E), Sicily, Italy. Collector: Antonina Badalucco, date 5 December 2023. Holotype has been deposited in the Honam National Institute of Biological Resources, South Korea (deposition code HNIBR IV25093). Three additional voucher specimens (females) were collected along with the holotype and were kept by S. Lo Brutto for future molecular analyses.

Female. Body (Figure 3(A,B)) vermiform, elongated, slightly depressed dorsoventrally, unsegmented, but with slight ventral and dorsal constrictions defining cephalothorax, second and third pedigerous somites, and remaining posterior parts (Figure 3(B)). Body length 4.40 mm in holotype. Maximum width 773 µm at level of leg 4. Posterior part of body bearing no constriction. Cephalic region small (Figure 3(A–C)), bearing small apical prominence. Distal genito-abdominal part of body abruptly depressed in lateral view (Figure 3(B)) and strongly tapering in dorsal and ventral views (Figure 3(A,D)). Genital apertures oblique, positioned dorsally at subdistal region of body (Figure 3(B–D)); each aperture (Figure 3(G)) slit-like, externally bearing 1 strong, spiniform process and 1 spine, and internally bearing 6 denticles. Caudal ramus (Figure 3(F)) incompletely separated from abdominal region, remarkably small, tapering posteriad, 1.33 times longer than wide (28 × 21 µm), armed with 2 distal spines of which one visibly larger, and 2 transparent setae (1 in middle of lateral margin and 1 subdistal dorsally). Egg string 3.33 × 0.32 mm, containing 4 or 5 rows of eggs; each egg about 135 µm in diameter.

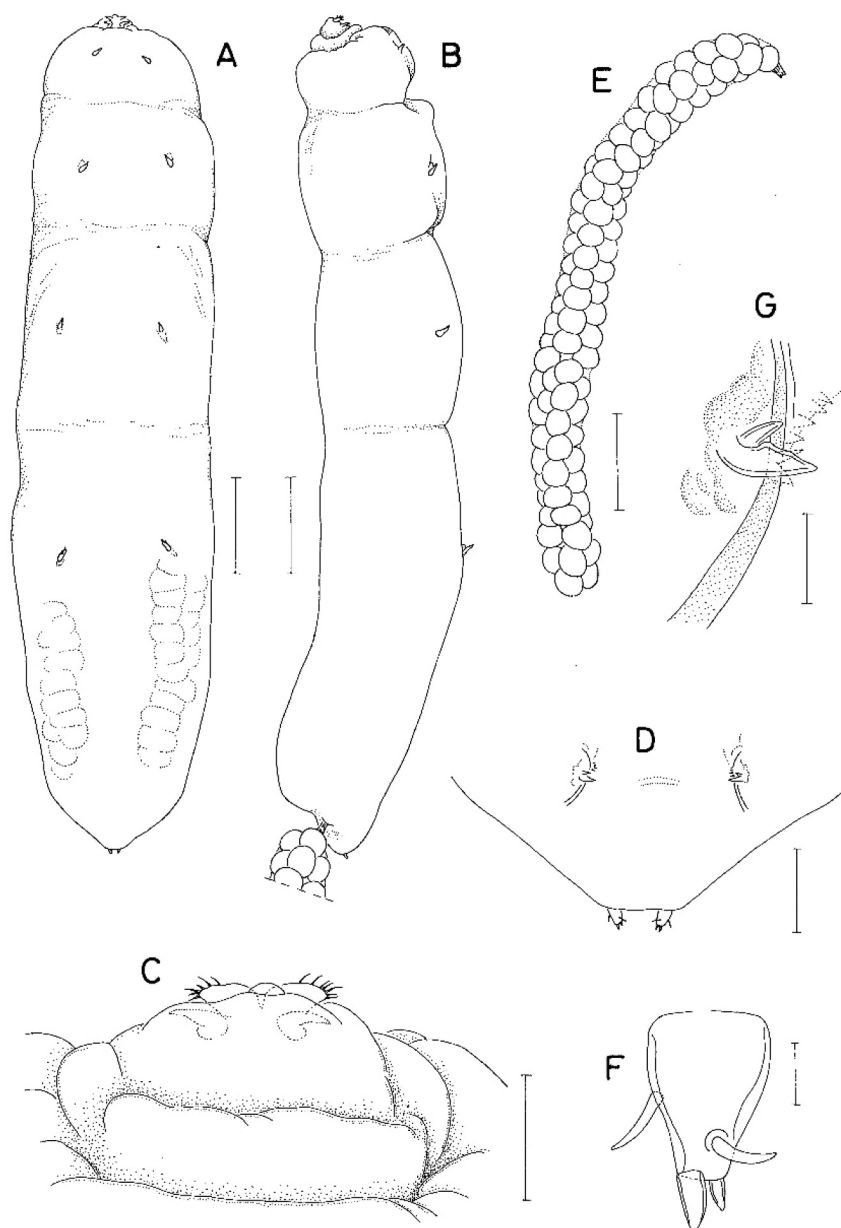


Figure 3. *Haplostomides magnus* n. sp., female. A, habitus, ventral; B, habitus, lateral; C, cephalic region, dorsal; D, abdominal region showing genital apertures and caudal rami, dorsal; E, egg string; F, left caudal ramus, dorsal; G, left genital aperture. Scale bars: A, B, E = 0.5 mm; C, D = 0.1 mm; F = 0.01 mm; G = 0.02 mm.

Rostrum (Figure 4(A)) weakly developed, represented by sclerotized circular region and elongated posterior ridge.

Antennule (Figure 4(A,B)) strongly tapering, unsegmented, but with trace of articulation near middle, armed with 10 setae, arranged in 3 groups of 2, 5, and 3 setae; largest seta on posterior margin inserted into protuberance; anteroventrally with 4 pits.

Antenna (Figure 4(C)) 2-segmented, consisting of coxobasis and endopod equal in length; coxobasis unarmed; endopod with 2 claw-like spines (1 distal and 1 subdistal) and 1 large unsclerotized area at proximal third.

Labrum inconspicuous.

Mandible (Figure 4(D)) composed of 2 imperfectly separated segments, with 2 setae on small distal part.

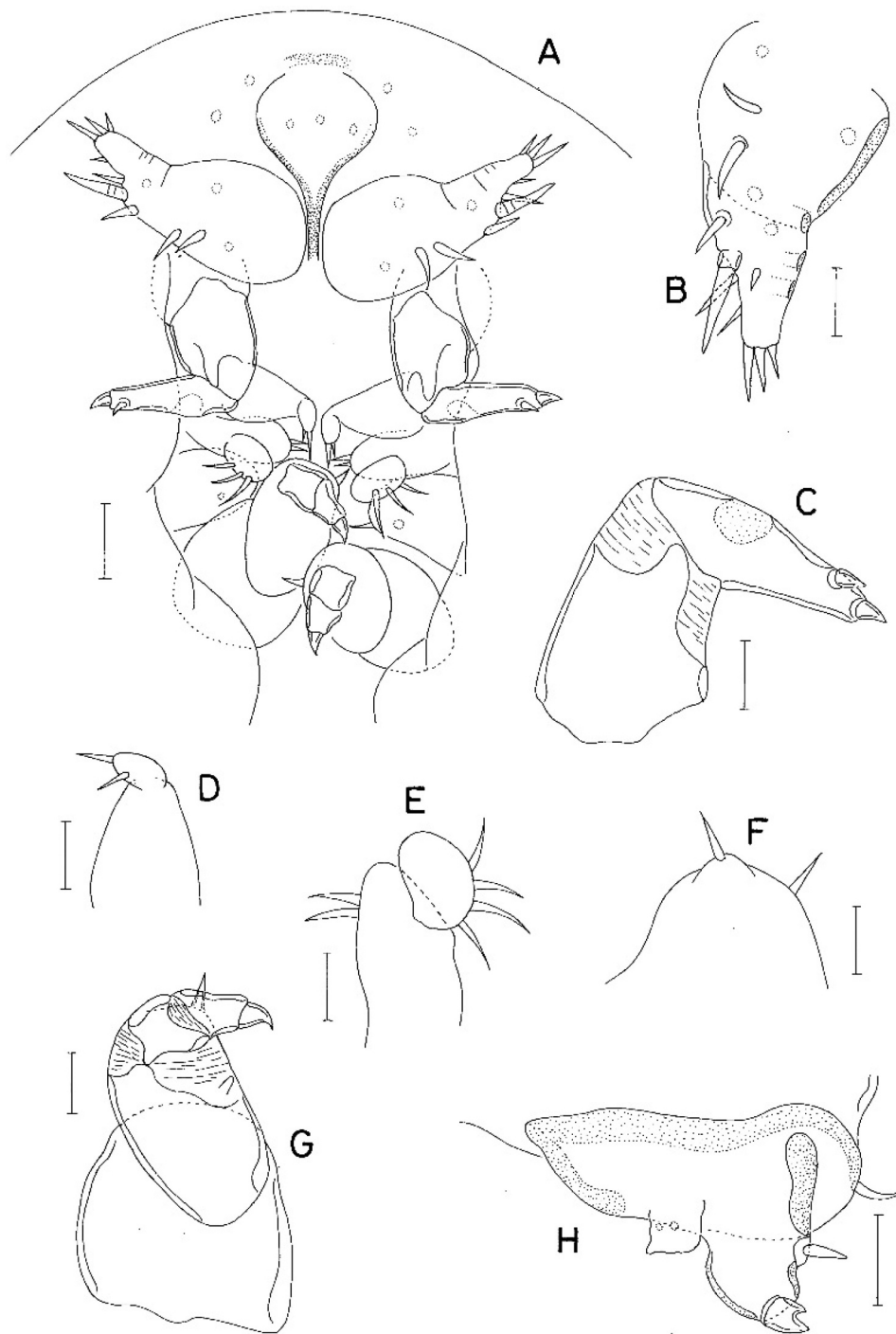


Figure 4. *Haplostomides magnus* n. sp., female. A, arrangement of cephalic appendages; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, maxilliped; H, leg 1. Scale bars: A, H = 0.02 mm; B–G = 0.01 mm.

Maxillule (Figure 4(E)) clearly 2-segmented; first segment (praecoxa) armed with 2 medial setae; foliaceous second segment (palp) with 4 setae on outer margin.

Maxilla (Figure 4(F)) as broad lobe, bearing 2 setae, apical one inserted on slight prominence.

Maxilliped (Figure 4(G)) 4-segmented, consisting of syncoxa, basis, and 2-segmented endopod; syncoxa large, wider than long, unarmed; basis with 1 medial transparent seta, and 1 spiniform distal seta; first endopodal segment unarmed; second endopodal segment tipped, with acutely pointed claw.

Leg 1 (Figure 4(H)) biramous, consisting of protopod, exopod, and endopod. Protopod bearing 1 seta on outer margin. Both rami fused with protopod. Exopod with sclerotized outer and inner margins, 1 seta on outer margin, and distally 1 claw-like, bifurcate spine. Endopod small, pale, subquadrate, unarmed, bearing nipple-shaped knob at inner distal corner and 2 small pits on ventral surface.

Legs 2–4 like in leg 1, but inner distal knob of endopod not prominent. Intervals between anterior and posterior legs gradually increasing posteriorly (Figure 3(A)).

Leg 5 absent.

Male. Unknown.

Remarks. Based on its vermiform body, the two-segmented maxillule, and the lobate maxilla, the examined copepod was identified as a species of *Haplostomides*. The genus *Haplostomides* currently includes 13 known species, which can be easily distinguished from each other by differences in the armature of the caudal ramus, antenna, mandible, maxillule, maxilla, and exopods of legs 1–4, as summarized in the table provided by Kim and Boxshall (2021a, 131, table 4). A detailed comparison of the examined material with the 13 known species, using the table of Kim and Boxshall (2021a), has shown that the examined specimen represents a new species. The shape and armature of the cephalic appendages, mouth parts, and exopods of legs 1–4 of *H. magnus* n. sp. are similar to those of related species as follows:

- (1) The caudal ramus bears 2 spines and 2 setae, which is a unique armature condition in the genus, since the other 13 species bear 1 spine and 1 to 4 setae.
- (2) The antenna is armed with 2 spines, an armature condition shared with *H. hawaiiensis* Ooishi, 1994, *H. hibernicus* (Scott T. and A., 1895), and *H. similis* Kim I.H. and Boxshall, 2021 (Ooishi 1994, 2005; Kim & Boxshall 2021a).
- (3) The mandible bears 2 setae, an armature state shared with *H. brementi* Chatton and Harant, 1924, *H. bermudensis* Kim I.H. and Boxshall, 2021 and *H. partitus* Kim I.H. and Boxshall, 2021 (see Ooishi 2008; Kim & Boxshall 2021a).
- (1) The maxillule is armed with 2 setae on the proximal segment and 4 setae on the distal segment, an armature condition shared only with *H. hibernicus*, which was redescribed by Ooishi (2005).
- (2) The maxilla is armed with 2 setae. This setation is shared with *H. brementi*, *H. gottol* Ooishi, 2008, *H. hawaiiensis*, *H. hibernicus*, *H. scotti* Chatton and Harant, 1924, *H. similis*, and *H. partitus* (Kim & Boxshall 2021a).
- (3) The exopods of legs 1–4 are armed with 1 bifurcate spine (or 2 spines fused at base) and 1 seta, which is an armature condition shared only with *H. similis* (see Kim & Boxshall 2021a).

Since *H. magnus* n. sp. shares a maximum of only 50% (3 out of 6) of the character states with its congeners, specifically *H. hibernicus* (sharing character states 2, 4, and 5) and *H. similis* (sharing character states 2, 5, and 6), the new species can be easily distinguished from them. A notable feature of *H. magnus* n. sp. is its large body size, measuring 4.40 mm in length. Previously, the longest known body length was 4.20 mm for *H. bermudensis*, described from the West Atlantic (Kim & Boxshall 2021a). *Haplostomides brementi* is the only species in the genus recorded in the Mediterranean Sea, which was found by Chatton and Harant (1924) as an associate of an ascidian of the genus *Aplidium* (originally as *Aplidium coeruleum* Lahille, 1890) in the Gulf of Lion. Although this Mediterranean species was inadequately described in the original record (Ooishi 2008) and has never been redescribed, it is clearly distinguished from the new species by the armature differences in the caudal ramus, antenna, maxillule, and legs. In particular, Ooishi (2008) confirmed that the armature (spines plus setae) of the exopods of legs 1–4 of *H. brementi* are 5, 4, 3, 3, respectively, in contrast to 2, 2, 2, 2 in the new species.

The ascidian host of the new species, *Polyclinum aurantium*, is known to harbour two other copepod species of *Haplostomides*, *H. scotti* and *H. hibernicus*. However, both are known only from the Atlantic coast of North Europe (Chatton & Harant 1924; Ooishi 2002, 2005).

Habitat. Hosts of *Haplostomides* species are ascidians of the families Polyclinidae and Didemnidae (Boxshall & Halsey 2004; Kim & Boxshall 2021a).

Family Lichomolgidae Kossmann, 1877

Genus *Lichomolpus* Thorell, 1859

***Lichomolpus canui* Sars G.O., 1917**

Figure 6

Material examined. 6 ♀♀ were found associated with 1 specimen of *Styela plicata*, 1 ♀ dissected, Palermo Port (La Cala station, 38.119867N, 13.369017E), Sicily.

Collector: Antonina Badalucco, 18 April 2024.

Supplementary description of female. Body (Figure 6(A,B)) glabrous, with thin exoskeleton. Body length of the dissected specimen 1.11 mm. Prosome $650 \times 432 \mu\text{m}$, dorsally swollen. Fifth pedigerous somite $113 \mu\text{m}$ wide. Genital double-somite $170 \times 145 \mu\text{m}$. Urosome (Figure 6(C)) 5-segmented. Three free abdominal somites, 54×78 , 43×67 , and $52 \times 64 \mu\text{m}$, respectively. Caudal ramus 3.41 times longer than wide ($99 \times 29 \mu\text{m}$), with 6 setae; distal caudal setae usually eroded, with blunt tip. Egg sac $578 \times 185 \mu\text{m}$; eggs small, $47 \mu\text{m}$ in diameter.

Antenna (Figure 6(D)) armed with 1, 1, 3, and 5 + 2 claws on first to fourth segments, respectively. Two terminal claws, an inner one thicker but shorter, an outer one longer but narrower, both annulated. Maxilliped (Figure 6(E)) 3-segmented; terminal segment (endopod) curved at distal third.

Remarks. Kim and Boxshall (2021b) redescribed this species based on a female found in the solitary ascidian *Molgula helleri* Drasche, 1884 collected from Taranto, Mar Grande, Italy, in the Ionian area of the Mediterranean Sea. They noted that the terminal segment of the female maxilliped is abruptly bent, a distinctive feature of *Lichomolpus canui*. Our specimens from Palermo also exhibit this characteristic. The shape of the genital double-somite and caudal setae, as well as the armature and shape of the antenna, do not differ from the redescription provided by Kim and Boxshall (2021b).

Lichomolpus canui is distributed from Norway to the Netherlands in northern Europe and at Sicily in the Mediterranean Sea (Humes & Stock 1973).

Family Notodelphyidae Dana, 1853–1855

Genus *Doropygus* Thorell, 1859

***Doropygus pulex* Thorell, 1859**

Figures 7(A–D), 5(B)

Material examined. 7 ♀♀ were found inside the solitary ascidian *Ascidella aspersa* (Müller, 1776), 1 ♀ dissected, Licata (Molo Marianello station, 37.094288 N, 13.934108 E), Sicily.

Collector Antonina Badalucco, 29 March 2025.

Supplementary description of female. Body as in Figure 7(A). Prosome unsegmented, somites discernible by constrictions between them. Fourth pedigerous somite forming brood pouch, fusiform in lateral view. Length of prosome 2.68 mm. Urosome (Figure 7(B)) inserted into middle of ventral margin of prosome, perpendicular to prosome. Urosomal somites indistinctly segmented. Anal somite with deep posteromedian notch. Caudal ramus (Figure 7(B)) 5.05 times longer than wide ($377 \times 75 \mu\text{m}$); caudal setae rudimentary, setule-like. Mandible (Figure 7(C)) with 4 equally large setae on 3-segmented exopod; endopod 2-segmented, with 3 setae on first segment, and 8 setae on second; first endopodal segment ornamented with row of

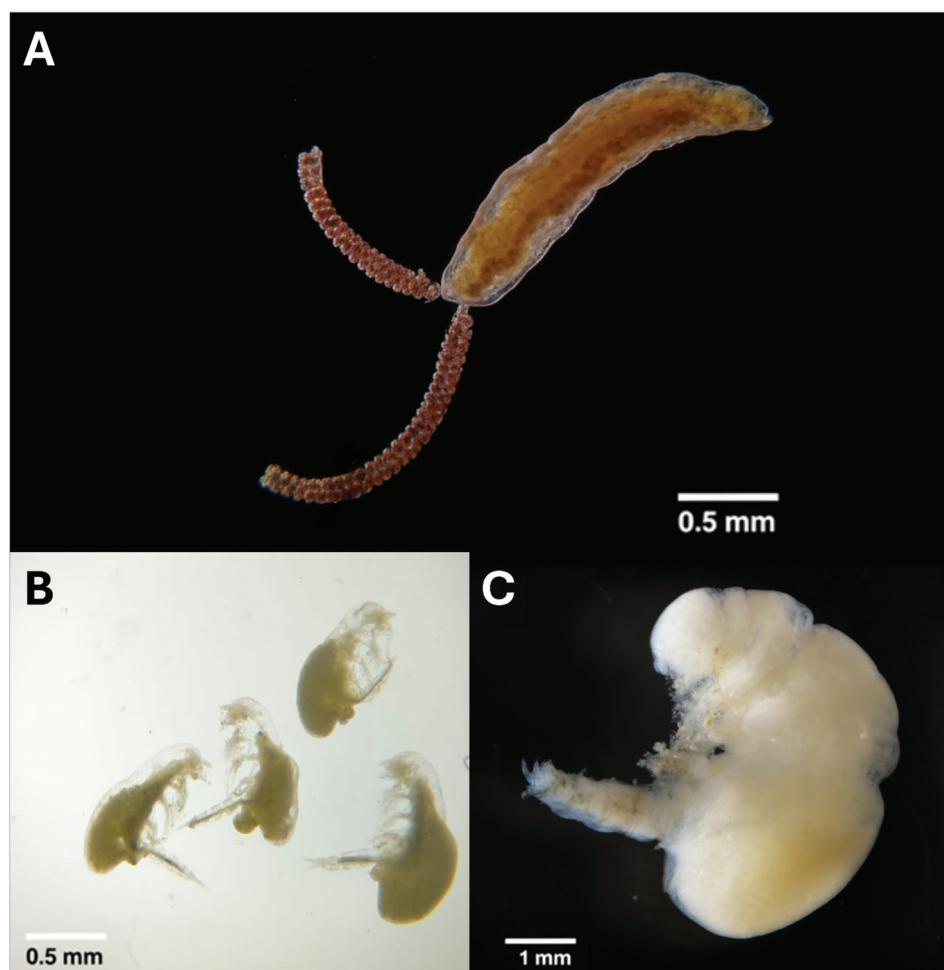


Figure 5. A, *Haplostomides magnus* n. sp., holotype deposited in the Honam National Institute of Biological Resources, South Korea, voucher code HNIBR IV25093; B, *Doropygus pulex* Thorell, 1859; C, *Pachypygus gibber* (Thorell, 1859).

spinules along distal and medio-distal margins. Maxillule (Figure 7(D)) with 9 setae on praecoxal arthrite, 3 setae on medial margin of basis, and 2 and 4 setae on endopod and exopod, respectively.

Remarks. *Doropygus pulex*, as the type species of the genus, was redescribed and redefined by Kim and Boxshall (2020).

The examined females from Licata closely correspond to the redescription provided by these authors. In particular, the armature and ornamentation of the mandible exhibit distinctive characteristic features of this species, such as the presence of the four setae on the exopod, three and eight setae, respectively, on the first and second endopodal segments, and a row of spinules along the outer and distal margins of the first endopodal segment.

Genus *Pachypygus* Sars G.O., 1921

***Pachypygus gibber* (Thorell, 1859)**

Figure 7(E), 5(C)

Material examined. 2 ♀ found living freely in the sample during sorting, Licata (Molo Marianello station, 37.094288N, 13.934108E), Sicily. Collector Antonina Badalucco, 29 March 2025.

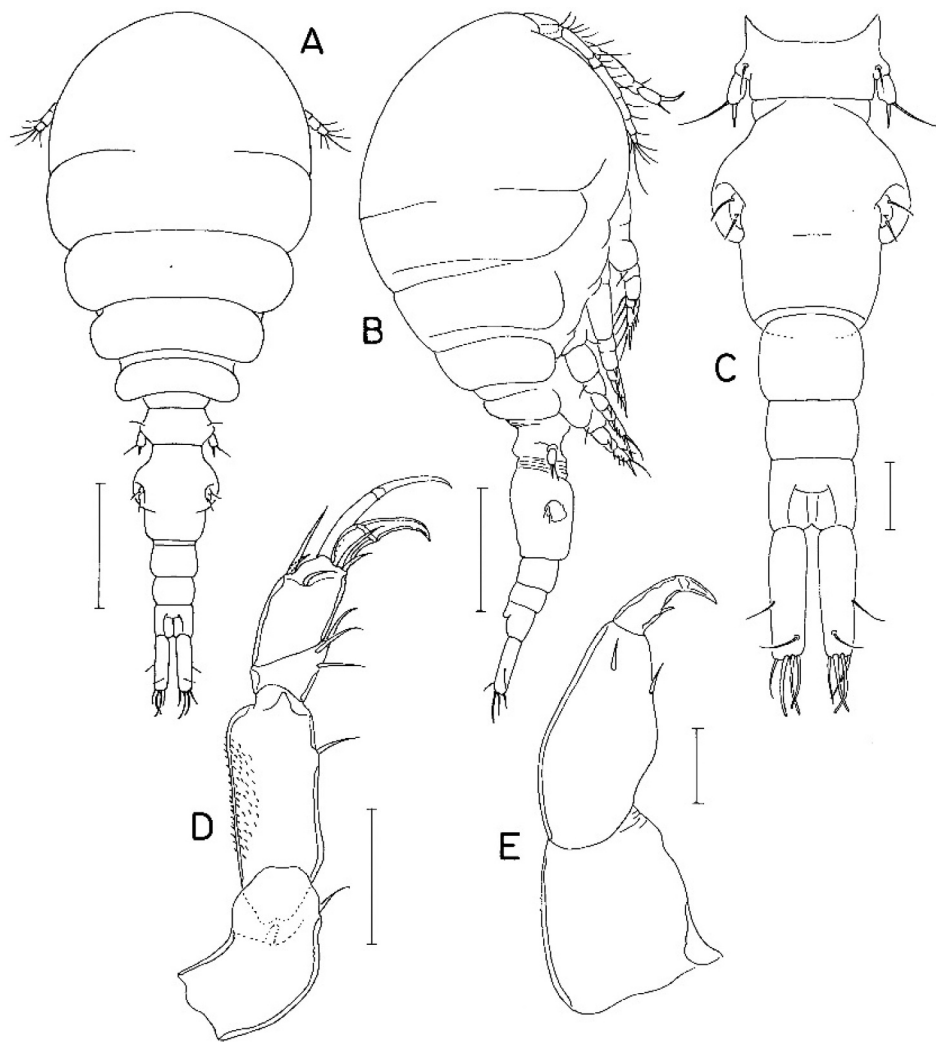


Figure 6. *Lichomolgus canui* Sars G.O., 1927, female. A, habitus, dorsal; B, habitus lateral; C, urosome, dorsal; D, antenna; E, maxilliped. Scale bars: A, B = 0.2 mm; C, D = 0.05 mm; E = 0.02 mm.

Remarks. The female of this species is easily identifiable by its distinctive body shape, characterized by a gibbous back and a unique arrangement of caudal claws (one large and three small). The body of the single examined specimen is large, with the prosome measuring 5.07 mm in length along the midline. The type host is the common species *Ciona robusta* Hoshino and Tokioka, 1967 [= *Ciona intestinalis* (Linnaeus, 1767) type A (see Brunetti et al. 2015 and references cited therein)] from the Mediterranean Sea.

Discussion

Most of the marine biofouling studies have focused on macro taxa (e.g. Bae et al. 2023), and the role of smaller invertebrates has received comparatively little attention (e.g. Lo Brutto et al. 2024). Therefore, the fouling copepod fauna has often been underreported because of the small size of the specimens and the sampling methods employed. Further, parasitic or symbiotic copepods have been documented only in scattered studies that were planned to search for them in their hosts (Lo Brutto et al. 2024, 2025).

This study provides the description of *Haplostomides magnus* n. sp., which represents the first record of a botryllophilid copepod associated with an ascidian species in the investigated area of the central Mediterranean Sea, Sicily Island (Lo Brutto et al. 2024).

Other localities within the central Mediterranean are *loci typici* for commensal or parasitic copepods associated with ascidians. Notably, the Gulf of Naples in the Tyrrhenian Sea (Illg & Dudley 1980) and the Gulf

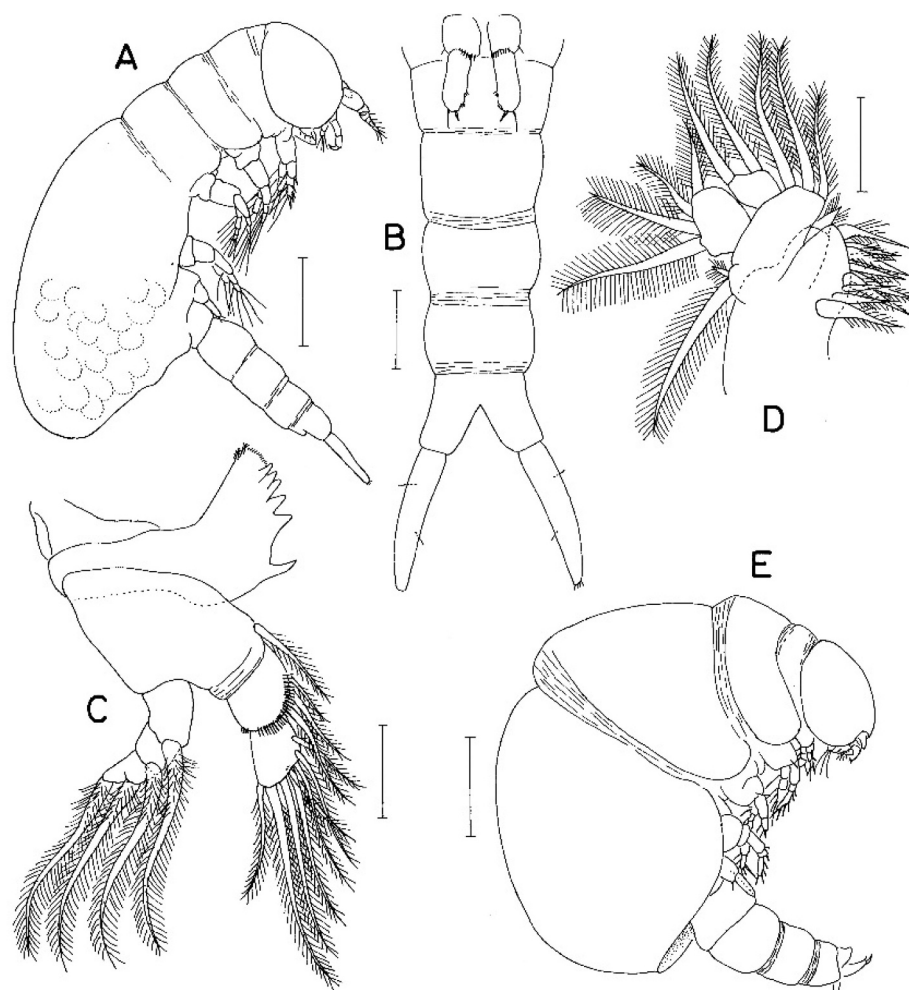


Figure 7. *Doropygus pulex* Thorell, 1859, female: A, habitus, lateral; B, urosome, ventral; C, mandible; D, maxillule. *Pachypygus gibber* (Thorell, 1859), female: E, habitus, lateral. Scale bars: A = 0.5 mm; B = 0.2 mm; C, D = 0.05 mm; E = 1 mm.

of Taranto in the Ionian Sea (Pastore 2001) are among the areas where new species have been originally described, highlighting the central Mediterranean as an important reservoir of biodiversity for this ecological group, or more simply, as the area most investigated by specialists of ascidians and parasitic copepods (Kim & Boxshall 2020 and references therein).

Among ascidian-associated copepods, the species belonging to Notodelphyidae and Botryllophilidae are the most commonly reported, possibly reflecting their relatively large size and consequent detectability (Tovar-Hernández et al. 2010; Kim & Boxshall 2021a). Notodelphyids exhibit considerable morphological diversity, ranging from cycloform to vermiform, lobate, or stellate body forms, and typically brood their eggs within a dorsal or dorsolateral incubatory pouch formed by modification of the fourth pedigerous somite (Kim & Boxshall 2020). In contrast, botryllophilid genera (e.g. *Botryllophilus* Hesse, 1864) possess a single egg-carrying structure, including a single egg sac (Ooishi 2006).

Previous records of botryllophilids from the Mediterranean Sea are restricted to the western basin (López-González et al. 1997; Ooishi 2004, 2006), though a wider distribution could be assumed.

The present study supports the hypothesis that harbour fouling communities, particularly those dominated by ascidians, may function as reservoirs for small-sized symbiotic copepods and potentially facilitate their dispersal. A comparable case was reported by Tovar-Hernández et al. (2010), who documented the copepod *Haplostomides hawaiiensis* Ooishi, 1994 associated with the ascidian *Polyclinum constellatum* Savigny, 1816 in fouling communities of the Gulf of California. This *Haplostomides*–*Polyclinum* association is consistent with the findings presented here; however, in that instance, both the copepod and its ascidian host were non-native and appeared to have been joined together during an invasion process.

The available literature so far indicates that all three ascidians reported in this study, namely *S. plicata*, *A. aspersa* and *P. aurantium*, host diverse symbiotic copepods, underlining no species-specific associations. *Styela plicata* has been reported as a host for numerous copepod species across a wide geographic range, with records from the Mediterranean and the Pacific region (Matsuzaki & Ogawa 1989; Lo Brutto et al. 2025). These include species of *Doropygus*, *Pachypygus*, *Lichomolgus*, and *Haplostomella* Chatton and Harant, 1924, reflecting a broad spectrum of host–symbiont associations (Moon & Kim 2011; Kim 2012).

Similarly, *A. aspersa* supports a rich copepod fauna, with records largely concentrated in European waters, particularly the north-eastern Atlantic and the Mediterranean Sea. Reported associates include multiple species of *Notodelphys* Allman, 1847, *Doropygus*, *Ascidicola* Thorell, 1859 and *Bonnierilla* Canu, 1891, as well as representatives of less frequently recorded genera such as *Goniodelphys* Buchholz, 1869, *Buprurus* Thorell, 1859 and *Gonophysema* Bresciani and Lützen, 1960 (e.g. Holmes & Gotto 2000; Kim 2012).

The notodelphyid *D. pulex*, herein collected in *A. aspersa*, was previously collected from other sea squirts, such as *C. robusta* in the Gulf of Taranto (southern Italy), reported in a comprehensive survey of ascidian-associated copepods, including *P. gibber* and *L. canui*, both found in *C. robusta* and *Phallusia mammillata* (Pastore 2001). In addition to Italian records, *D. pulex* has historically been reported from Atlantic European coastal waters and from the Mediterranean basin more broadly (Gotto 1960; Illg & Dudley 1965; Kim & Boxshall 2020). *Pachypygus gibber* was also detected in *Molgula* spp., and in *Polycarpa* spp., and shows a cosmopolitan distribution (Kim & Boxshall 2020), while *L. canui* was previously collected from *Molgula helleri* (Kim & Boxshall 2021b) and is distributed in northern Europe and the Mediterranean Sea (Humes & Stock 1973).

Siphonostomatoid copepods of the family Asterocheridae live in association with various marine invertebrates. The genus *Asterocheres* Boeck, 1859 is the most speciose within the family Asterocheridae, living in association with cnidarians, bryozoans, echinoderms, and ascidians, though most of the species (about 56%) have been found associated with sponges (Ivanenko & Smurov 1997; Bandera et al. 2005; Kim & Min 2013). Still, the hosts of many species are unknown (Boxshall & Halsey 2004). The great majority of the species have been recorded from European and tropical seas, with very few recorded in the Pacific region. According to Mariniello (2010), six species of *Asterocheres* are present in the Italian waters. Subsequent studies have added Mediterranean records. Crescenti et al. (2010) described *Asterocheres faroensis* Crescenti, Baviera and Zaccone, 2010, found in association with the sponge *Hymeniacidon perlevis* in Lake Faro (Messina, Sicily, southern Italy). Conradi and Bandera (2011) reported two female specimens of *Asterocheres minutus* (Claus, 1889) in the island of Tarifa (Spain), associated with the sea urchin *Paracentrotus lividus* (L), highlighting that this species is a Mediterranean endemic having already been reported in France and Italy (Claus 1889; Giesbrecht 1897; Bocquet et al. 1963), although it was not included in the last Italian fauna checklist (Mariniello 2010).

Overall, the summarized records highlight the high diversity and taxonomic breadth of copepods associated with ascidian hosts, while also underscoring the uneven geographic coverage and fragmentary nature of available data. The predominance of records from well-studied regions contrasts with the paucity of information from large areas of the Mediterranean, suggesting that the diversity of ascidian-associated copepods remains substantially underestimated.

In conclusion, this study provides the description of *Haplostomides magnus* n. sp. and documents the occurrence of five additional species of ascidian-associated symbiotic copepods from the central Mediterranean Sea. These findings contribute substantially to current knowledge by addressing a long-standing gap, especially for species such as *L. canui*, *D. pulex*, and *P. gibber*, of which no confirmed occurrences were reported from Italy since 2010 or earlier. Moreover, the results underscore the need for systematic and targeted surveys of copepods, a taxonomic group whose diversity, distribution, and ecological roles remain markedly underestimated.

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Author contributions

CRedit: **A. Badalucco**: Conceptualization, Investigation, Writing – review & editing; **I.-H. Kim**: Conceptualization, Investigation, Writing – review & editing; **F. Mastrototaro**: Conceptualization, Investigation, Writing – review & editing; **S. Lo Brutto**: Conceptualization, Funding acquisition, Investigation, Supervision, Writing – review & editing.

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ORCID

A. Badalucco  <http://orcid.org/0000-0002-5003-0692>
 I.-H. Kim  <http://orcid.org/0000-0002-7332-0043>
 F. Mastrototaro  <http://orcid.org/0000-0002-4890-2949>
 S. Lo Brutto  <http://orcid.org/0000-0002-9964-904X>

References

- Bae S, Lee SH, Kim JM, Yi CH, Choe K, Choi KH. 2023. The effects of initiation season on succession patterns of benthic fouling organisms in coastal waters from two regions. *Regional Studies in Marine Science* 66:103150. DOI: [10.1016/j.rsma.2023.103150](https://doi.org/10.1016/j.rsma.2023.103150).
- Bandera ME, Conradi M, Lopez-Gonzalez PJ. 2005. *Asterocheres hirsutus*, a new species of parasitic copepod (Siphonostomatoida: Asterocheridae) associated with an Antarctic hexactinellid sponge. *Helgoland Marine Research* 59(4):315–322. DOI: [10.1007/s10152-005-0007-2](https://doi.org/10.1007/s10152-005-0007-2).
- Bianchi CN, Morri C. 2000. Marine biodiversity of the Mediterranean Sea: Situation, problems and prospects for future research. *Marine Pollution Bulletin* 40(5):367–376. DOI: [10.1016/S0025-326X\(00\)00027-8](https://doi.org/10.1016/S0025-326X(00)00027-8).
- Bocquet C, Stock JH, Louise F. 1963. Copépodes parasites d’invertébrés des côtes de France. XV. Le problème systématique d’*Asterocheres violaceus* (Claus) et d’*Asterocheres minutus* (Claus). *Koninkl Neder. Akademie van Wetenschappen Amsterdam, Series C* 66:37–53.
- Boxshall GA, Halsey SH. 2004. An introduction to copepod diversity. London: The Ray Society. pp. 966.
- Brunetti R, Gissi C, Pennati R, Caicci F, Gasparini F, Manni L. 2015. Morphological evidence that the molecularly determined *Ciona intestinalis* type a and type B are different species: *Ciona robusta* and *Ciona intestinalis*. *Journal of Zoological Systematics & Evolutionary Research* 53(3):186–193. DOI: [10.1111/jzs.12101](https://doi.org/10.1111/jzs.12101).
- Brunetti R, Mastrototaro F. 2017. Ascidiacea of the European waters. *Fauna D’Italia* 51. Editore: Edagricole-new business media (carderini): 472.
- Chatton É, Harant H. 1924. Notes sur les copépodes ascidicoles XVII. Le nouveau genre *Haplostomides* et deux espèces nouvelles de ce genre: *Haplostomides scotti* et *Haplostomides brementi*. *Bulletin de la Société Zoologique de France* 49:406–412.
- Claus C. 1889. Über neue oder wenig bekannte halbparasitische Copepoden-und Ascomyzontiden-Gruppe. *Arbeiten des Zoologischen Institut der Universität Wien* 8:1–4.
- Coll M, Piroddi C, Steenbeek J, Kaschner K, Ben Rais Lasram F, Aguzzi J, Ballesteros E, Bianchi CN, Corbera J, Dailianis T, Danovaro R, Estrada M, Frogia C, Galil BS, Gasol JM, Gertwagen R, Gil J, Guilhaumon F, Kesner-Reyes K, Kitsos MS, Koukouras A, Lampadariou N, Laxamana E, de la Cuadra CM L-F, Lotze HK, Martin D, Mouillot D, Oro D, Raicevich S, Rius-Barile J, Saiz-Salinas JJ, San Vicente C, Somot S, Templado J, Turon X, Vafidis D, Villanueva R, Voultsiadou E. 2010. The biodiversity of the Mediterranean Sea: Estimates, patterns, and threats. *PLOS ONE* 5(8):e11842. DOI: [10.1371/journal.pone.0011842](https://doi.org/10.1371/journal.pone.0011842).

- Conradi M, Bandera ME. 2011. Asterocherids (Copepoda: Siphonostomatoida) associated with marine invertebrates in the Strait of Gibraltar. *Zootaxa* 2925(1):1–18. DOI: [10.11646/zootaxa.2925.1.1](https://doi.org/10.11646/zootaxa.2925.1.1).
- Crescenti N, Baviera C, Zaccone D. 2010. *Asterocheres faroensis*, a new species (Copepoda, Siphonostomatoida, Asterocheridae) associated with *Hymeniacidon perlevis* (Montagu, 1812) (Porifera) from Lake Faro, Mediterranean Sea. *Crustaceana* 83(3):299–311. DOI: [10.1163/001121609X12596543952414](https://doi.org/10.1163/001121609X12596543952414)
- Giesbrecht W. 1897. System der Ascomyzontiden, einer semiparasitischen Copepoden-Familie. *Zoologischer Anzeiger* 20:253–255.
- Gotto RV. 1960. A key to the ascidicolous copepods of British waters with distributional notes. *Annals and Magazine of Natural History* 3(28):211–229. DOI: [10.1080/00222936008650917](https://doi.org/10.1080/00222936008650917).
- Holmes JMC, Gotto RV. 2000. A checklist of the Cyclopoida (Crustacea: Copepoda) of Ireland. *Bulletin Irish Biogeographical Society* 24:2–42.
- Humes AG, Gooding RU. 1964. A method for studying the external anatomy of copepods. *Crustaceana* 6:238–240. DOI: [10.1163/156854064x00650](https://doi.org/10.1163/156854064x00650).
- Humes AG, Stock JH. 1973. A revision of the family Lichomolgidae Kossman, 1877, cyclopoid copepods mainly associated with marine invertebrates. *Smithsonian Contributions to Zoology* 127(127):1–368. DOI: [10.5479/si.00810282.127](https://doi.org/10.5479/si.00810282.127).
- Illg PL, Dudley PL. 1965. Notodelphyid copepods from the vicinity of Naples. *Pubblicazioni della Stazione Zoologica di Napoli* 34:373–451.
- Illg PL, Dudley PL. 1980. The family Ascidicolidae and its subfamilies (Copepoda, Cyclopoida), with descriptions of new species. *Mémoires du Muséum National d'Histoire Naturelle Série A. Zoologie* 117:1–192.
- Ivanenko VN, Smurov AV. 1997. *Asterocheres flustrae* n. sp. (Copepoda: Siphonostomatoida: Asterocheridae) associated with *flustra foliacea* L. (Bryozoa) from the White Sea. *Systematic Parasitology* 38(2):111–130. DOI: [10.1023/A:1005817307084](https://doi.org/10.1023/A:1005817307084).
- Kim IH. 2012. Arthropoda, Maxillopoda, Copepoda, Cyclopoida: Ascidicolous copepods. *Invertebrate Fauna of Korea, National Institute of Biological Resources, Incheon, Korea* 21(20):138.
- Kim IH, Boxshall GA. 2020. Untold diversity: The astonishing species richness of the Notodelphyidae (Copepoda: Cyclopoida), a family of symbiotic copepods associated with ascidians (Tunicata). *Megataxa* 4(1):1–660. DOI: [10.11646/megataxa.4.1.1](https://doi.org/10.11646/megataxa.4.1.1).
- Kim IH, Boxshall GA. 2021a. Copepods (Cyclopoida) associated with the ascidian hosts: Ascidicolidae, buproridae, Botryllophilidae, and enteropsidae, with descriptions of 84 new species. *Zootaxa* 4978(1):1–286. DOI: [10.11646/zootaxa.4978.1.1](https://doi.org/10.11646/zootaxa.4978.1.1).
- Kim IH, Boxshall GA. 2021b. Copepods associated with ascidian hosts (Tunicata): Intramolidae and Lichomolgidae, with descriptions of four new genera and 13 new species. *Zootaxa* 5013(1):1–75. DOI: [10.11646/zootaxa.5013.1.1](https://doi.org/10.11646/zootaxa.5013.1.1).
- Kim IH, Min GS. 2013. Three species of *Asterocheres* (Copepoda: Siphonostomatoida: Asterocheridae) from shallow Antarctic water. *Journal of the Marine Biological Association of the United Kingdom* 93(6):1567–1577. DOI: [10.1017/S0025315412002007](https://doi.org/10.1017/S0025315412002007).
- Lo Brutto S, Badalucco A, Mastrototaro F, Bernot JP. 2025. First occurrence of *Bonnierilla similis* Illg and Dudley, 1961 (Copepoda: Notodelphyidae) in the central Mediterranean Sea. *European Zoological Journal* 92(1):1248–1254. DOI: [10.1080/24750263.2025.2562896](https://doi.org/10.1080/24750263.2025.2562896).
- Lo Brutto S, Badalucco A, Musco L. 2024. First occurrence of the family Botryllophilidae Sars GO, 1921 (Copepoda, Cyclopoida) in Sicily, central Mediterranean Sea. *Crustaceana* 97(3–4):321–328. DOI: [10.1163/15685403-bja10374](https://doi.org/10.1163/15685403-bja10374).
- Lo Brutto S, Badalucco A, Smit H. 2024. First occurrence of the mite *Litarachna duboscqi* Walter, 1925 (acariformes: Pontarachnidae) in the central Mediterranean Sea. *Ecologica Montenegrina* 74:21–26. DOI: [10.37828/em.2024.74.3](https://doi.org/10.37828/em.2024.74.3).
- Lo Brutto S, Calascibetta A, Pavan G, Buffa G. 2021. Cetacean strandings and museum collections: A focus on Sicily Island crossroads for Mediterranean species. *Diversity* 13(3):104. DOI: [10.3390/d13030104](https://doi.org/10.3390/d13030104).
- López-González PJ, Conradi M, García-Gómez JC. 1997. New records of copepods associated with marine invertebrates from Strait of Gibraltar and nearby areas. *Miscellània Zoològica* 20(1):101–110.
- Mariniello L. 2010. Parasitic and associated copepods. *Biologia Marina Mediterranea* 17(suppl. 1):438–451.
- Mastrototaro F, Gasparini F, Montesanto F. 2022. The clubbed tunicate *Styela clava* has arrived in the Lagoon of Venice. *European Zoological Journal* 89(1):502–509. DOI: [10.1080/24750263.2022.2052989](https://doi.org/10.1080/24750263.2022.2052989).
- Matsuzaki K, Ogawa K. 1989. A new lichomolgid copepod associated with the simple ascidian *halocynthia roretzi*. *Proceedings of the Japan Society of Systematic Zoology*, 40, 13–20.
- Montesanto F, Chimienti G, Gissi C, Mastrototaro F. 2022. *Polyclinum constellatum* (Tunicata, Ascidiacea), an emerging non-indigenous species of the Mediterranean Sea: Integrated taxonomy and the importance of reliable DNA barcode data. *Mediterranean Marine Science* 23(1):69–83. DOI: [10.12681/mms.28311](https://doi.org/10.12681/mms.28311).
- Montesanto F, Hadjez R, Mastrototaro F, Huchon D, Gissi C, Novak L, Shenkar N. 2023. Against the flow: Integrated taxonomy and environmental suitability of a cold-water species dispersing to warmer waters. *Biological Invasions* 26(4):953–973. DOI: [10.1007/s10530-023-03222-0](https://doi.org/10.1007/s10530-023-03222-0).
- Moon SY, Kim IH. 2011. Five new species of lichomolgid copepods associated with ascidians from Korea, with proposal of two new genera (Crustacea, Copepoda, Lichomolgidae). *Ocean Science Journal* 46(3):155–177. DOI: [10.1007/s12601-011-0014-y](https://doi.org/10.1007/s12601-011-0014-y).
- Morales-Serna FN, Gomez S, Pérez-Ponce de León G. 2012. Parasitic copepods reported from Mexico. *Zootaxa* 3234(1):43–68. DOI: [10.11646/zootaxa.3234.1.2](https://doi.org/10.11646/zootaxa.3234.1.2).

- Ooishi S. 1994. *Haplostomides hawaiiensis*, new species (Copepoda: Cyclopoida: Ascidicolidae), associated with the ascidian *Polyclinum constellatum* at Honolulu, Hawaii. *Hydrobiologia* 292(294):89–96. DOI: [10.1007/BF00229927](https://doi.org/10.1007/BF00229927).
- Ooishi S. 2002. Female and male *Haplostomides scotti* (Copepoda: Cyclopoida) living in the compound ascidian *Polyclinum aurantium*. *Journal of Crustacean Biology* 22(2):249–267. DOI: [10.1163/20021975-99990232](https://doi.org/10.1163/20021975-99990232).
- Ooishi S. 2004. Female and male *Haplostoma brevicauda* (Copepoda: Cyclopoida: Ascidicolidae), living in compound ascidians. *Journal of Crustacean Biology* 24(3):422–439. DOI: [10.1651/C-2465](https://doi.org/10.1651/C-2465).
- Ooishi S. 2005. *Haplostomides hibernicus* (Copepod: Cyclopoida) living in the compound ascidian *Polyclinum aurantium*. *Journal of Crustacean Biology* 25(2):181–189. DOI: [10.1651/C-2537](https://doi.org/10.1651/C-2537).
- Ooishi S. 2006. Two species of *Botryllophilus* (Copepoda: Cyclopoida) living in compound ascidians, and a revision of female morphotype a of the genus. *Journal of Crustacean Biology* 26(1):23–47. DOI: [10.1651/C-2613.1](https://doi.org/10.1651/C-2613.1).
- Ooishi S. 2008. *Haplostomides gottoi*, new species (Crustacea: Copepoda: Cyclopoida: Ascidicolidae), living in a compound ascidian from Madagascar. *Proceedings of the Biological Society of Washington* 121(1):85–93. DOI: [10.2988/07-33.1](https://doi.org/10.2988/07-33.1).
- Pastore M. 2001. Copepods associated with *Phallusia mammillata* and *Ciona intestinalis* (Tunicata) in the area of Taranto (Ionian Sea, southern Italy). *Journal of the Marine Biological Association of the United Kingdom* 81(3):427–432. DOI: [10.1017/S0025315401004052](https://doi.org/10.1017/S0025315401004052).
- Salama AJ, Rabaoui L, Qurban MA, Krishnakumar PK, Colaco A, Abdurahiman P. 2018. Development of biofouling communities on nylon net panels submerged in the central red Sea: Effects of season and depth. *Thalassas: An International Journal of Marine Sciences* 34(1):345–355. DOI: [10.1007/S41208-017-0052-Z](https://doi.org/10.1007/S41208-017-0052-Z).
- Tovar-Hernández MA, Suarez-Morales E, Yanez-Rivera B. 2010. The parasitic copepod *Haplostomides hawaiiensis* (Cyclopoida) from the invasive ascidian *Polyclinum constellatum* in the southern Gulf of California. *Bulletin of Marine Science* 86(3):637–648.
- Weitere M, Erken M, Majdi N, Arndt H, Norf H, Reinshagen M, Traunspurger W, Walterscheid A, Wey JK. 2018. The food web perspective on aquatic biofilms. *Ecological MoHesseographs* 88(4):543–559. DOI: [10.1002/ecm.1315](https://doi.org/10.1002/ecm.1315).