Morphological description of the first protozoeal stage of the deep-sea shrimps *Aristeus antennatus* and *Gennadas elegans*, with a key

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Accurate information on commercial marine species larvae is key to fisheries science, as their correct identification is the first step towards studying the species’ connectivity patterns. In this study, we provide a complete morphological description of the first protozoeal stage of the valued deep-sea blue and red shrimp *Aristeus antennatus* and of the small mesopelagic shrimp *Gennadas elegans*. These two larval morphologies previously posed a risk of misidentification, thus hindering the study of *A. antennatus* larval ecology and dynamics in the context of fisheries science. Using specimens caught in the plankton at various locations in the Northwestern Mediterranean Sea and identification confirmed by molecular methods, the larvae of *A. antennatus* and *G. elegans* are distinguished from each other by the ornamentation of the antennula. A possible confusion in previous descriptions of Aristeidae larvae is addressed and a new key for the identification of Dendrobranchiata larvae provided.

Fisheries science depends on reliable and sufficient data about exploited species to build efficient strategies that ensure the durability of marine resources. One fundamental aspect of fisheries science is the study of species connectivity, as this information can shape the definition of stocks and set the range and scope of management instruments. Regardless of their adult habitat, many species have planktonic larvae. During this life phase, organisms are easily transported by currents; this plays a key role in terms of dispersal strongly influencing species’ connectivity and recruitment patterns. For crustacean decapods, there is a well-documented body of knowledge about the larval stages of some exploited species. However, this is not the case for deep-sea Dendrobranchiata, for which information is lacking despite the economic relevance in fisheries of some species. The scarcity of these larvae in plankton samples and the challenges of rearing these species in the laboratory are probably one of the main causes of the limited number of descriptive studies on the subject. As a result, observed data on deep-sea Dendrobranchiata larval abundance and distribution are scarce, and many of their larval stages are still undescribed.

The deep-sea blue and red shrimp *Aristeus antennatus* (Risso 1816) is targeted by bottom trawlers in the entire Mediterranean Sea and the Northwestern coast of Africa. Its global catch reached 2,988 tonnes in 2016 and in some areas like the Spanish Mediterranean coast, this species alone can represent up to 50% of fishermen associations’ yearly revenues. Its adult biology has been thoroughly studied, particularly in the Northwestern Mediterranean Sea, where it has been subject to a long-term co-management plan at a local scale. The reproductive period of *A. antennatus* spans from May to September, with a peak in July and August, when females aggregate at the continental shelf break. As for the mesopelagic shrimp *Gennadas elegans*, its distribution englobes the whole Atlantic Ocean and the Mediterranean Sea. It has no commercial interest but it is often caught...
Table 1. Summary of most relevant differential morphological characters between *Aristeus antennatus* and *Gennadas elegans* protozoa I larvae and the previous morphological description of the same larval stage attributed to *A. antennatus*. a: aesthetascs, s: setae.

| Features | *Gennadas elegans* (this study) | *Aristeus antennatus* (this study) | *Aristaeomorpha foliacea* as *Aristeus antennatus* (Heldt, 1955) |
|----------|---------------------------------|------------------------------------|--------------------------------------------------|
| Total length (mm) | 0.86–1.22 | 1.12–1.25 | 1.55 |
| Carapace length (mm) | 0.33–0.44 | 0.37–0.49 | Not available |
| Naupliar eye | Present | Present | Present |
| Eyes | Compound eyes feebly dark | Compound eyes well formed and dark | Compound eyes well formed and dark |
| Pereion, frontal organs | Present | Present | Present |
| Antenna, number of setae (s) and aesthetascs (a) on somites | 0, 1 s, 1 s + 3 a + 3 s | 1 s, 4 s, 3 s + 3 s | 1 s, 4 s, 2 a + 3 s |
| Antenna, protopod and endopod setal formula | 2 + 2 + 2 | 2 + 2 + 2 | Not available |
| Maxillula | Basial endite: 4 s; Endopod: 2 s, 2 s, 2 s + 3 s | Basial endite: 5 s; Endopod: 3 s, 2 s, 2 s + 3 s | Basial endite: 4 s; Endopod: 2 s, 2 s, 1 s, 3 s |
| Maxilla | Basial endite: 5 s + 4 s + 3 s, plumose | Endopod: 2-segmented, 2 s + 2 s + 2 s, 3 s | Endopod: 1 s, 2 s, 2 s, 3 s |
| | Exopod: 5 s, long plumose | Exopod: 4 s | Exopod: 5 s |
| First maxilliped | Endopod: 4-segmented, 2 s, 1 s, 2 s, 4 s | Endopod: 3 s, 3 s, 2 s, 5 s | Endopod: 2 s, 2 s, 3 s |
| | Exopod: 2-segmented, 1 + 1 + 1 s, 3 s, 2 plumose setae on distal margin | Exopod: 1 + 4 s | Exopod: 1 + 1 + 4 s |
| Second maxilliped | Endopod: 2 s, 1 s, 2 s, 4 s | Endopod: 1 s, 1 s, 2 s, 5 s | Endopod: 2 s, 2 s, 1 s, 1 s, 5 s |
| | Exopod: 1 + 4 s | Exopod: 1 + 4 s | Exopod: 1 + 4 s |
| Third maxilliped | Endopod: as bud Exopod: 2 long plumose setae | Endopod: as bud Exopod: 2 long plumose setae | Endopod: as bud Exopod: 3 s (1 short, 2 long) |

Knowledge about Dendrobranchiata PZ I is particularly useful for fisheries science as this stage generally occurs from a few hours to a few days after hatching and can provide information on the spawning areas of the species. Furthermore, information on larval behavior and distribution is essential to determine the connectivity patterns of commercial species and establish effective management strategies. In this context, accurate identification of the larvae is key. The objective of this study was to accurately and comprehensively describe the first protozoal stage of the deep-sea shrimps *A. antennatus* and *G. elegans*, to compare them in search for morphological distinguishing characters, and how the findings relate to previously available information.
Figure 1. *Aristeus antennatus* first protozoea larva. (A) Dorsal view; (B) antennula; (C) antenna; (D) mandible; (E) maxillula; (F) maxilla; (G) first maxilliped; (H) second maxilliped; (I) third maxilliped. Drawn with GIMP software (v. 2.10.18, https://gimp.org).
Figure 2. *Gennadas elegans* first protozoea larva. (A) Dorsal view; (B) antennula; (C) antenna; (D) mandible; (E) maxillula; (F) maxilla; (G) first maxilliped; (H) second maxilliped; (I) third maxilliped. Drawn with GIMP software (v. 2.10.18, https://gimp.org).
Figure 3. Drawings of known protozoa I larvae of Dendobranchiata species. (A) Dorsal view of *Lucifer penicillifer*; (B) telson of *Petalidium* sp.; (C) dorsal view of *Solenocera membranacea*; (D) dorsal view of *Parasergestes vigilax*; (E) dorsal view of *Sergestes atlanticus*; (F) dorsal view of *Eusergestes arcticus*; (G) dorsal view of *Deosergestes corniculum*; (H) dorsal view of *Sergia remipes*; (I) dorsal view of *Deosergestes henseni*; (J) antenna of *Penaeus kerathurus*; (K) antenna of *Penacopsis rectacuta*; (L) dorsal view of *Sicyonia carinata*; (M) antenna of *Parapenaeus longirostris*; (N) third maxilliped of *Aristaeomorpha foliacea*. All figures redrawn with GIMP software, (v. 2.10.18, https://gimp.org) from: A. 36; B and I. 27; C. 37; D, E, G and H. 38; F. 39; J, L and M. 5; K. 40; N. 30. Drawings not to scale.
(e.g. Fig. 3K, J, M), the exopod is composed by a long plumose outer ramus with several ringlets throughout its length, and the endopod is the inner ramus. The mouth appendices are composed by a pair of mandibles, with incisor and molar processes, and two pairs of maxillae. The larvae also present 2 pairs of biramous maxillipeds where the outer ramus is the exopod and the inner ramus is the endopod. The third pair of the maxillipeds, when present, is still rudimentary.

**Morphological description of Protozoea I of *Aristeus antennatus* (Fig. 1).** Size: TL (total length) = 1.12–1.25 mm; CL (carapace length) = 0.37–0.49 mm; N (number of protozoa examined) = 13.

Carapace (Fig. 1A): carapace almost rounded, longer than wider, reaching the level of the second maxilliped, with frontal organs visible at the anterior part; naupliar eye present flanked by a pair of compound eyes that are already visible through the carapace; 6 thoracic somites visible.

Antennula (Fig. 1A,B): first paired uniramous appendage in the cephalotorax, consisting of 3 articles: proximal article subdivided in 5 ringlets, bearing 1 short serrulate seta on the posterior end; second article with 1 positioned at mid-length of article and 3 serrulate setae distally; distal article with 3 aesthetascs subterminally and 3 long sparsely plumose setae on the posterior end.

Antenna (Fig. 1A,C): second paired biramous appendage in the cephalotorax, longer than antennula, consisting of a peduncle, an endopod and an exopod. Peduncle 3-segmented with 1 + 1 sparsely plumose setae on distal segment; endopod 2-segmented with 2 + 2 lateral plumose setae in proximal segment and 4 long plumose and 1 simple setae in the posterior segment; exopod with 11 ringlets, 3rd ringlet with a transversal incomplete separation, ringlets 4th to 11th each with a long plumose setae along inner margin and two more long plumose setae on the terminal position of the 11th ringlet, 4th and 6th ringlets each with an additional plumose setae on outer margin.

Mandible (Fig. 1D): the first paired appendage following the mouth placed in the ventral side of the cephalotorax, with distinct incisor and molar processes; incisive part with 2 + 2 teeth (the one placed near the molar part is short serrated); molar part with numerous small conate and uncinate teeth; without palp.

Maxillula (Fig. 1E): the second paired appendage following the mouth placed in the ventral side of the cephalotorax, divided in coxa, basipod, endopod and exopod. Coxal coxa, divided in coxa, basipod, endopod and exopod. Coxa with 7 (1 simple and 6 papposerrate) setae; basipod with 5 (1 simple and 4 papposerrate) setae; endopod 3-segmented with 2 sparsely plumose and 1 small simple setae on the proximal segment, 2 sparsely plumose setae on second segment and 2 + 3 sparsely plumose setae on distal segment; exopod as a small knob-like structure with 4 long plumose setae.

Maxilla (Fig. 1F): the third paired appendage following the mouth placed in the ventral side of the cephalotorax, composed of coxa, basipod, endopod and scaphognathite. Coxal endite bilobed with 3 + 4 plumose setae; basal endite trilobed with 3 + 2 + 4 plumose setae; endopod 4-segmented bearing 1, 1 + 1, 1 + 1, 1 + 1 long plumose setae; scaphognathite with 4 marginal long plumose setae.

First maxilliped (Fig. 1A,G): biramous paired appendage placed in the penultimate thoracic somite covered by the carapace, consisting of a protopod, an endopod and an exopod. Protopod 2-segmented (coxa and basipod), proximal coxal portion with 10 papposerrate setae; distal basal portion with 2 + 5 papposerrate setae along margin and 3 papposerrate setae on distal end; endopod 4-segmented with 3, 3, 2, 5 papposerrate setae; exopod unsegmented with 3 long and 4 plumose setae on distal margin.

Second maxilliped (Fig. 1A,H): biramous paired appendage placed in the last thoracic somite covered by the carapace, divided in coxa, basipod, endopod and exopod. Coxa with 1 seta; basipod with 1 + 2 + 2 papposerrate setae; endopod 4-segmented with 1, 1, 2, 4 papposerrate setae; exopod unsegmented with 1 + 4 long plumose setae.

Third maxilliped (Fig. 1A,I): biramous paired appendage placed in the first thoracic somite not covered by the carapace, consisting of an endopod and an exopod. Endopod represented by a small bud tapered at the end; exopod unsegmented with 2 long plumose setae distally.

Pereiopods: absent.

Pleon (Fig. 1A): pleomeres not completely differentiated, united with the telson and unarmed.

Uropods: absent.

Telson (Fig. 1A): broadly bifurcate with two distinct branches, each branch with 7 long plumose spines except the outermost one that is simple.

**Morphological description of Protozoea I of *Gennadas elegans* (Fig. 2).** Size: TL = 0.86–1.22 mm; CL = 0.33–0.44 mm; N = 9.

Carapace (Fig. 2A): carapace almost rounded, longer than wider, reaching the level of the second maxilliped, with frontal organs visible at the anterior part; naupliar eye present flanked by a pair of compound eyes that are already visible through the carapace; 6 thoracic somites visible and not covered by the carapace.

Antennula (Fig. 2A,B): first paired uniramous appendage in the cephalotorax, consisting of 3 articles: proximal article subdivided in 5 ringlets; second article with 1 very small simple spine distally; distal article with 3 aesthetascs subterminally and 3 long sparsely plumose setae.

Antenna (Fig. 2A,C): second paired biramous appendage in the cephalotorax, longer than antennula, consisting of a peduncle, an endopod and an exopod. Peduncle 3-segmented with 2 sparsely plumose setae on distal segment; endopod 2-segmented with 2 + 2 lateral plumose setae in proximal segment and 4 long + 1 short plumose setae in the distal somite; exopod with 11 ringlets, ringlets 4th to 11th each with a long plumose setae along inner margin and two more long plumose setae on the terminal position of the 11th ringlet, 4th and 6th ringlet each with an additional plumose setae on outer margin.

Mandible (Fig. 2D): the first paired appendage following the mouth placed in the ventral side of the cephalotorax, with distinct incisor and molar processes; incisive part with 3 (one minute) + 2 (the one placed near the molar part is serrated) teeth; molar part with numerous small conate and uncinate teeth; without palp.
Maxillula (Fig. 2E): the second paired appendage following the mouth placed in the ventral side of the cephalotorax, divided in coxa, basipod, endopod and exopod. Coxa with 7 (1 simple and 6 papposerrate) setae; basipod with 4 (2 cuspidate and 2 papposerrate) setae; endopod 3-segmented with 2 sparsely plumose setae on the proximal segment, 2 sparsely plumose setae on second somite and 2 + 3 sparsely plumose setae on distal segment; exopod as a small knob-like structure with 4 long plumose setae.

Maxilla (Fig. 2F): the third paired appendage following the mouth placed in the ventral side of the cephalotorax, composed of coxa, basipod, endopod and scaphognathite. Coxal endite bilobed with 7 (1 small simple) + 2 plumose setae; basial endite trilobed with 5 + 4 + 3 plumose setae; endopod 2-segmented bearing 2 + 2 + 2, 3 long plumose setae; scaphognathite with 5 marginal long plumose setae.

First maxilliped (Fig. 2A,G): biramous paired appendage placed in the penultimate thoracic somite covered by the carapace, consisting of a protopod, an endopod and an exopod. Protopod 2-segmented (coxa and basipod), proximal coxal portion with 7 papposerrate setae; distal basial portion with 1 + 3 papposerrate setae; endopod 4-segmented with 2, 1, 2, 4 papposerrate setae; exopod 2-segmented with 1 + 1 + 1 + 2 setae along margin of proximal segment and 2 plumose setae on distal margin of terminal segment.

Second maxilliped (Fig. 2A,H): biramous paired appendage placed in the last thoracic somite covered by the carapace, divided in coxa, basipod and endopod. Coxa with 1 papposerrate seta; basipod with 1 + 2 + 2 papposerrate setae; endopod 4-segmented with 2, 1, 2, 4 papposerrate setae; exopod unsegmented with 1 + 1 + 2 + 2 long plumose setae.

Third maxilliped (Fig. 2A,I): biramous paired appendage placed in the first thoracic somite not covered by the carapace, consisting of an endopod and an exopod. Endopod represented by a small bud rounded at the end; exopod unsegmented with 2 long plumose setae distally.

Pereiopods: absent.

Pleon (Fig. 2A): 2 pleomeres differentiated, all the others united with the telson and unarmed.

Pleopods: absent.

Uropods: absent.

Telson (Fig. 2A): broadly bifurcate with two distinct branches, each branch with 7 long plumose spines.

Identification key for the first protozoal stage of Dendrobranchiata larvae of the Northeastern Atlantic and Mediterranean Sea.

|   |   |   |   |   |
|---|---|---|---|---|
| 1 | Rostrum present (Fig. 3A) | 2 |   |   |
| 2 | Rostrum absent (Fig. 3C–I, L) | 3 |   |   |
| 2 | Telson with 5 pairs of spines (Fig. 3A) | Lucifer and Belzebub |   |   |
| 3 | Telson with 6 pairs of spines (Fig. 3B) | Petalidium |   |   |
| 4 | Pereion margin with spines or processes (Fig. 3C–I) | 4 |   |   |
| 5 | Pereion margin smooth (Fig. 3L) | 10 |   |   |
| 6 | Pereion octagonal with a pair of robust spines at each vertex (Fig. 3C) | Solenocera membranacea |   |   |
| 7 | Pereion with anterior, lateral and posterior processes (Fig. 3D–I) | 5 |   |   |
| 8 | Pereion anterior process with 3 branches (Fig. 3D–F) | 6 |   |   |
| 9 | Pereion anterior process with 4 branches (Fig. 3G–I) | 8 |   |   |
| 10 | Median branch of the anterior process of pereion with denticles only (Fig. 3D) | Parasergerges vigilax |   |   |
| 11 | All branches of anterior pereion process with denticles (Fig. 3E, F) | 7 |   |   |
| 12 | Telson branches long and narrow, length more than 3 times the width (Fig. 3E) | Sergestes atlanticus |   |   |
| 13 | Telson branches short, length only slightly greater than width (Fig. 3F) | Euserges arcticus |   |   |
| 14 | Posterior process of pereion swollen at base (Fig. 3G) | Desogestes corniculum |   |   |
| 15 | Posterior process of pereion not swollen at base | 9 |   |   |
| 16 | Lateral process with 7 long spines at the base (Fig. 3H) | Sergia remipes |   |   |
| 17 | Lateral process with 3 long spines at the base (Fig. 3I) | Desogestes henseni |   |   |
| 18 | Setal formula of antennal protopod and endopod is 1,1,2, third maxilliped absent (Fig. 3I) | Penaeus (Melicertus) kra- thurus |   |   |
| 19 | Setal formula of antennal protopod and endopod is 1,2,2 (Fig. 3K) | Penaeopsis |   |   |
| 20 | Setal formula of antennal protopod and endopod is 1,2,3 (Fig. 3M) | 11 |   |   |
| 21 | Setal formula of antennal protopod and endopod is 2,2,2 (Figs. 1C, 2C) | 12 |   |   |
| 22 | Length of antennula 2 × longer than antenna (Fig. 3L) | Sicymia carinata |   |   |
| 23 | Length of antennula approximately equal to that of antenna | Parapenaeus longirostris |   |   |
| 24 | Exopod of the third maxilliped with 3 setae (Fig. 3N) | Aristaeomorpha foliacea |   |   |
| 25 | Exopod of the third maxilliped with 2 setae (Figs. 11, 21) | 13 |   |   |
Discussion. Although morphologically quite similar in most of their characters, the first protozoal stages of *A. antennatus* and *G. elegans* bear some differences that will allow to distinguish them, as shown in Table 1 and in the identification key proposed. The first protozoa of *A. antennatus* presents 1, 4, 3 setae along the segments of the antennula, whereas in the case of *G. elegans*, the setal formula is 0, 1, 4. These characters are relatively easy to observe at the stereomicroscope, in most cases without the need of dissecting the specimens, and should provide an easy guide to differentiating the first protozoa of these two species.

The identification and morphological description of the larval series of *A. antennatus* found in the plankton off the Balearic archipelago by Heldt in 1955[20] has proven to be fundamentally correct, as the descriptions of the rest of known stages of the species—PZ II, PZ III and mysis I—have been recently confirmed[25]. However, when comparing the *A. antennatus* PZ I from the present study with the one described by Heldt[20], we found differences in the size of the larvae—the sole specimen in the cited study measured 1.55 mm, whereas in the present study the average total length is 1.2 mm. Moreover, we found differences between the two studies in the number of aesthetasc on the antennula, and in the number of setae on the exopod of the third maxilliped. While the possibility of an error can never be excluded, Heldt’s meticulous work and thorough descriptions in all her publications on Penaeid larvae make it unlikely that she would draw and describe a morphological character that she did not observe. We here expose our considerations about this contradiction.

First, Heldt’s study refers that one single specimen of first protozoal stage was caught for each of the studied species, *A. antennatus* and *A. foliacea*, but that the latter was apparently lost during manipulation and could not be described. Second, as seen in Table 1, the total length of the *A. antennatus* PZ I specimen measured by Heldt is 1.55 mm, while the next stage, PZ II, measured 1.50–2.03 mm[20]: this would mean that the PZ II was smaller than its previous stage. Variability in total length of these larvae has not been studied and might allow for such values, but Carreton et al.[21] found an average total length of only 1.2 mm (± 0.05) for the PZ I. On the other hand, the PZ II of *A. foliacea* examined by Heldt measured 1.9 mm[20] which is more in agreement with the length of the PZ I larva described as *A. antennatus*. Finally, Heldt’s description of *A. antennatus* PZ I accounts for 3 setae on the exopod of the third maxilliped (mxp3), whereas in our findings, all individuals presented only 2 setae. Furthermore, it seems that, in Heldt’s description, *A. foliacea* PZ II larvae present more developed characters than *A. antennatus* PZ II, as the mxp3 is described in *A. foliacea* with 3 setae on the exopod and 2 on the endopod, while in the case of *A. antennatus*, it only presents setae on the exopod. It would then be possible that, in the case of the PZ I, the more setose (3-setae) third maxilliped belongs to *A. foliacea* and the less setose (2-setae) one belongs to *A. antennatus*. For these reasons, we conclude that Heldt’s description of *A. antennatus* PZ I is probably that of *A. foliacea*. The PZ I of *A. antennatus* would then have remained undescribed until now.

The present study provides the first detailed morphological description of the protozoa I larvae of *A. antennatus* and *G. elegans* according to modern standards, made from plankton samples after identification being confirmed with molecular analysis. The protozoa I larvae of the two studied species can be morphologically distinguished from one another mainly by the setation of the antennula. An identification key is provided allowing for the morphological identification of all first protozoa larvae of Dendrobranchiata for the Mediterranean Sea and Northeast Atlantic Ocean known today.

In a context where fisheries science is increasingly drawing on marine connectivity to design regional-scale management strategies for commercial species, larval distribution studies are one of the first stepping stones to effective planning, as they broaden the knowledge on species dispersal patterns. It is then essential to ensure a correct identification of these larvae, and morphological characters provide accurate, at-hand information even when molecular methods are not applicable. Our results set a starting point for *A. antennatus* connectivity studies in the frame of fisheries management, and we are confident that the identification key provided will make classification of the featured early larval stages accessible to both taxonomists in the field and non-specialists.

Method

Specimen collection. For *A. antennatus* larvae, the sampling was carried out in August 2016 in various locations off the Spanish Mediterranean coast (Table 2). We used a neuston sled with a 300-µm mesh net between 0.5 and 1 m depth over bottoms of 123 to 1626 m. For *G. elegans* larvae, we sampled 3 stations off the Catalan coast in February 2017 (Table 2). The selection of this second sampling interval outside of the reproductive period of *A. antennatus* was deliberate in order to avoid collecting a mix of the two species. We used a 60-cm diameter bongo with a 300-µm mesh net in oblique tows between 500 m depth and the surface, over bottoms of 1,952 and 1,790 m. All PZ I larvae from both samplings were sorted and identified at the stereomicroscope using the available keys and descriptions[20,21,31] and stored individually in 96% ethanol.

From the total of PZ I larvae caught in each sampling (527 in the summer and 11 in the winter), Carreton et al.[22] performed extraction, amplification and sequencing of the Cytochrome Oxidase I (COI) and 16S rDNA molecular markers on randomly-selected individuals (24 in the summer and 4 in the winter). All summer individuals analysed were identified as *A. antennatus* and all winter individuals as *G. elegans*. The genetic distance values were 0.00 within each species and 0.15 between species, the latter calculated with 16S rDNA data. Carreton et al.[22] also took Scanning Electron Microscopy (SEM) images and measurements of total length and carapace length for individuals of both taxa and sampling season.

Drawings and measurements. Drawings and measurements were made following the methods and equipment presented by Bartilotti et al.[29]. Additionally, and since they are transparent, the larvae were stained
Table 2. Information on the larvae observed.

| Date          | Lon (°E) | Lat (°N) | Gear            | Mesh size (µm) | Sampling depth (m) | Bottom depth (m) | Number of individuals observed | Species                  |
|---------------|----------|----------|-----------------|----------------|-------------------|------------------|-------------------------------|--------------------------|
| 2016–08-25    | 3.5862   | 41.6697  | Neuston sledge   | 300            | 0.5–1             | 704              | 3                             | Aristeus antennatus       |
| 2016–08-20    | 2.9417   | 41.5080  | Neuston sledge   | 300            | 0.5–1             | 507              | 10                            | Aristeus antennatus       |
| 2017–02-19    | 2.7630   | 41.2000  | Bongo            | 300            | 0–500             | 1,173            | 4                             | Gennadas elegans          |
| 2017–02-21    | 3.7199   | 41.2885  | Neuston sledge   | 300            | 0–618             | 2,401            | 3                             | Gennadas elegans          |
| 2017–02-17    | 2.8811   | 41.3418  | Bongo            | 300            | 0–500             | 1,790            | 3                             | Gennadas elegans          |
| 2017–02-17    | 2.8811   | 41.3418  | Bongo            | 300            | 0–500             | 1,790            | 2                             | Gennadas elegans          |

with Chlorozol Black and Hematoxylin before being drawn. The long aesthetascos on the antennulae as well as the long plumose setae on the distal end of the exopods and on the uropods and telson were drawn truncated; the setules from setae were omitted from drawings when necessary. The drawings were then improved and digitally organized using GIMP software. The observed individuals have been deposited at the Biological Reference Collection at the Institut de Ciències del Mar (ICM-CSIC) in Barcelona, Spain, under reference numbers ICMD002660 for *A. antennatus* and ICMD002661 for *G. elegans*.

Data availability

Data from this paper are available to readers upon request. The observed larvae have been deposited at the Biological Reference Collection at the Institut de Ciències del Mar (ICM-CSIC) in Barcelona, Spain, under reference numbers ICMD002660 for *A. antennatus* and ICMD002661 for *G. elegans*.

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Author contributions

MC wrote the main manuscript text. ADS prepared the descriptions and the identification key, and reviewed the text. LFDS prepared the figures. GR and JBC contributed to the conception of the experiment, sampling of coastal marine ecosystems- Jellyfisheries” 2015-2018 FEDER 16772, FCT, IP - PTDC/MAR-BIO/0440/2014. Supported by the project “Towards an integrated approach to enhance predictive accuracy of jellyfish impact on fisheries”. L. Faria de Sousa was supported by a grant from the Spanish Ministerio de Economía y Competitividad (MINECO). The authors would like to thank Dr. A. Sabatés for providing the win- ter zooplankton samples from project WINFISH (CTM2015-68543-R). M. Carreton benefited from a FPU2015 grant from the Spanish Ministerio de Educación y Formación Profesional. L. Faria de Sousa was supported by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

Competing interests

The authors declare no competing interests.

Additional information

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