Nerocila milesensis n.sp. (Isopoda:Cymothoidae) parasitic on devil firefish Pterois miles (Bennett,1828) from the South Aegean Sea, Turkey

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NEROCILA MILESENSIS N. SP. (ISOPODA: CYMOTHOIDAE) PARASITIC ON DEVIL FIREFISH *PTEROIS MILES* (BENNETT, 1828) FROM THE SOUTH AEGEAN SEA, TURKEY

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NEROCILA
LESSEPSIAN
INVASIVE
DEVIL FIREFISH
PTEROIS MILES
MEDITERRANEAN
TURKEY

ABSTRACT. – *Nerocila milesensis* n. sp is described from the Devil firefish, *Pterois miles* (Bennett, 1828) (Scorpaeniformes; Scorpaenidae), a lessepsian fish, in the South Aegean Sea along the coasts of Turkey. The new species is distinguished from its two congeners native to Mediterranean, *Nerocila orbignyi* (Guérin-Méneville, 1832), *Nerocila bivittata* (Risso, 1816) and one congener native to Atlantic and Pacific Ocean, *Nerocila acuminata* Schiödte & Meinert, 1881 by having pereonites 5-7 mostly gradually extended to posterior than others; pereonite longest/shortest; visibility of coxae in dorsal view; proportion of pleotelson length-width; number of setae on maxilliped; number of setae on articles of mandible; number of spine on pereopod 7; endopod and exopod length of uropod.

INTRODUCTION

The Devil firefish, *Pterois miles* (Bennett, 1828) is a native member of the Indian and Pacific Oceans ichthyofauna. It was recorded for the first time from the Mediterranean Sea in Haifa Bay, Israel Coast (Golani & Sonin 1992). Later, it was also reported from several countries along the Mediterranean coasts including Lebanon, Cyprus, Greece, Tunisia, Turkey, Italy, Libya, Syria, Egypt (Kochzius & Blohm 2005, Bariche *et al*. 2013, Evripidou 2013, Turan *et al*. 2014, Ali *et al*. 2016, Dailianis *et al*. 2016, Azzurro *et al*. 2017, Al Mabruk & Rizgalla 2019).

Cymothoid isopods are crustacean parasite species that have been reported from the Mediterranean such as *Anilocra physodes* (Linnaeus, 1758), *A. frontalis* H. Milne Edwards, 1840, *Ceratothoa capri* (Trilles, 1964), *C. collaris* Schiödte & Meinert, 1883, *C. italica* Schiödte & Meinert, 1883, *C. oestroides* (Risso, 1826), *C. oxyrrhynchaena* Koelbel, 1878, *C. paralella* (Otto, 1828), *Elthusa poutassouiensis* (Penso, 1939), *E. sinuata* (Koelbel, 1879), *Emetha audouini* (Milne Edwards, 1840), *Idusa dieuzeidei* Dollfus, 1950, *Livoneca pomatoi* Gaillat Airoldi, 1940, *Mothocya epimerica* Costa, 1851, *M. taurica* (Czerniavsky, 1868), *Nerocila orbignyi* (Guérin-Méneville, 1832) and *N. bivittata* (Risso, 1816) (Montalenti 1948, Trilles 1994, Charfi-Cheikhrouha *et al*. 2000, Papapanagiotou & Trilles 2001, Mladineo 2003, Öktener & Trilles 2004, Horton *et al*. 2005, Bariche & Trilles 2005, 2006, Ramdane *et al*. 2007, Ramdane *et al*. 2009, Shakman *et al*. 2009, Öktener *et al*. 2018).

The devil firefish being a non-indigenous fish, until now its parasitic fauna was not accurately investigated in the Mediterranean. *Nerocila milesensis* n. sp. and *N. bivittata* are reported on the devil firefish in this article.

MATERIAL AND METHODS

Devil firefish, *Pterois miles* (Scorpaeniformes; Scorpaenidae) were caught by gill nets from Bodrum (n = 8) and Kaş (n = 18), in the Aegean Sea, Turkey in July 2019 and fixed in 4 % formaldehyde. The specimens were dissected by using Wild M5 and Leica M140 stereo microscopes. All drawings were made with a drawing tube (Olympus BH-DA). Photos of host with their parasites were taken with a Canon camera (EOS 1100D). Measurements are given in millimeters. Identifications and comparisons were performed according to Trilles (1968, 1975), Bruce (1987), van der Wal (2019). Scientific names, synonyms of parasites and hosts were checked in WoRMS Editorial Board (2020) and Froese & Pauly (2019). Voucher specimens were deposited in the collections of Istanbul University, Science Faculty, Hydrobiology Museum, Istanbul.

RESULTS

Family Cymothoidae Leach, 1818
Genus *Nerocila* Leach, 1818
***Nerocila milesensis* n. sp**
Figures 1-5, 9C, D

Material examined

Holotype. Turkey – 1 ♀ (ovigerous, 12.08 mm TL, 7.23 mm W); Kaş, South Aegean Sea; 36°11'31.3"N

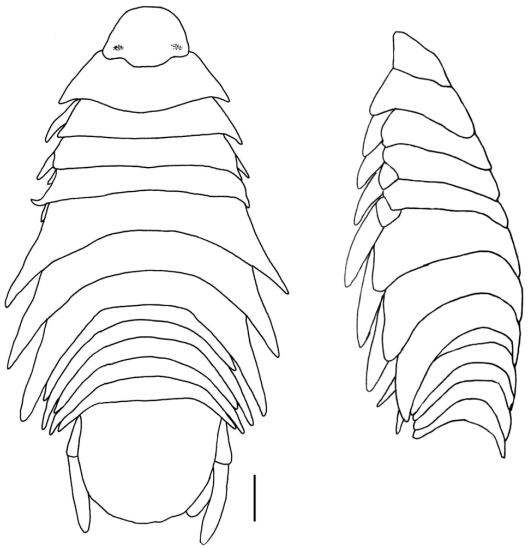

Fig. 1. – *Nerocila milesensis* n. sp on dorsal and ventral view (scale 1 mm).

Description: Female (Figs 1-3, 9C): Total length 12.08 mm. Body 1.7 times as long as greatest width; widest at pereonite 5, most narrow at pereonite 1; pereonite 1-4 lateral margins slightly, pereonites 5-7 mostly gradually extended to posterior. Posterolateral angles of 1-4 pereonites similar in size, posterolateral angles of pereonites 5-7 with very broad and distally acute. Cephalon 0.7 as long as wide, visible in dorsal view, anterior margin slightly rounded. Eyes ovoid and small, facets indistinct; eye 0.1 times width of cephalon, distance between eyes about 50 % of head width.

29°38'28.2"E; on the anal fin of the Devil firefish, *Pterois miles* (Bennett, 1828); IUSHM 20200406-01 (Fig. 10C, D).

Paratype. Turkey – 1 (transitional stage, 6.68 mm TL, 2.97 mm W); on the caudal fin of host, same data as holotype; IUSHM 20200406-02 (Fig. 10F).

Pereonites increased gradually and slightly from 1 to 5; sharply from 5 to 7 in width at posterior and lateral. Pereon widest at pereonite 5, the narrowest at pereonite 1. Pereonites progressively decreased from 1 to 5 and later increased from 5 to 6, pereonite 7 decreased in length. Pereonites 6 longest, pereonite 4 shortest. Posteroventral tips of pereonite 7 extending to posterior of pleon 5; to pleotelson. Coxae 2-4 partly visible in dorsal view; posteroventral angles of coxae 1-7 distally acute in ventral view; not extending beyond posterior pereonites. Posteroventral tips of coxae 7 extending to pleotelson.

Pleonite 1 partly concealed by pereonite 7, other pleonites visible, pleonite 5 slightly longest; pleonite 1 shortest, pleonites 2-4 subequal in length. Posterolateral angles of pleonites 1-2 sharply extended to posteriorly. Pleonite on widest at pereonites 2, the narrowest at pereonite 4 in width. Pleonite 2 extending to anterior margin of pleotelson. Pleotelson 0.8 times as long as anterior width, dorsal surface smooth; lateral margins straight; posterior margin sligthly rounded.

Table I. – List of the parasitic isopods reported from lionfish in worldwide.

Parasitic isopod	Host	Locality	Authors
Gnathia pilosus Hadfield, Smit & Avenant-Oldewage, 2008	*P. miles*	East Coast of South Africa	Hadfield *et al*. (2008)
Excorallana sp	*P. volitans*	Bonaire	Poole (2011)
Rocinela signata (Schioedte & Meinert, 1879)	*P. volitans* and *P. miles*	Florida Keys, United States, Atlantic Coast (Panama)	Simmons (2014)
Gnathia marleyi Farquharson, Smit & Sikkel, 2012	*P. volitans*	Bahamas, Virgin Islands sites	Sikkel *et al* (2014)
Aegiochus tenuipes (Schioedte & Meinert, 1879)	*P. volitans*	Puerto Rico, the Cayman Islands, the Bahamas	Ramos-Ascherl *et al*. (2015)
Carpias serricaudus (Menzies & Glynn, 1968),	*P. volitans*	Puerto Rico, the Cayman Islands, the Bahamas	Ramos-Ascherl *et al*. (2015)
Eurydice convexa Richardson, 1900	*P. volitans*	Puerto Rico, the Cayman Islands, the Bahamas	Ramos-Ascherl *et al*. (2015)
Excorallana quadricornis (Hansen, 1890)	*P. volitans*	Puerto Rico, the Cayman Islands, the Bahamas	Ramos-Ascherl *et al*. (2015)
Gnathia spp.	*P. volitans*	Puerto Rico, the Cayman Islands, the Bahamas	Ramos-Ascherl et al. (2015)
Rocinela signata Schioedte & Meinert, 1879	*P. volitans*	Puerto Rico, the Cayman Islands, the Bahamas	Ramos-Ascherl *et al*. (2015)
Rocinela signata (Schioedte & Meinert, 1879)	*P. volitans*	Gulf of Mexico	Fogg *et al.* (2016)
Alcirona krebsii Hansen, 1890	*P. volitans*	Gulf of Mexico	*Fogg et al.* (2016)
Nerocila acuminata Schiödte & Meinert, 1881	*P. volitans*	Gulf of Mexico	*Fogg et al.* (2016)
Cymothoa excisa Perty, 1833	*P. volitans*	Gulf of Mexico	Aguilar-Perera *et al.* (2018)
Nerocila bivittata (Risso, 1816)	*P. miles*	Cyprus	Antoniou *et al*. (2019)
Nerocila bivittata (Risso, 1816)	*P. miles*	Turkey	Present study
Nerocila milesensis n. sp.	*P. miles*	Turkey	Present study

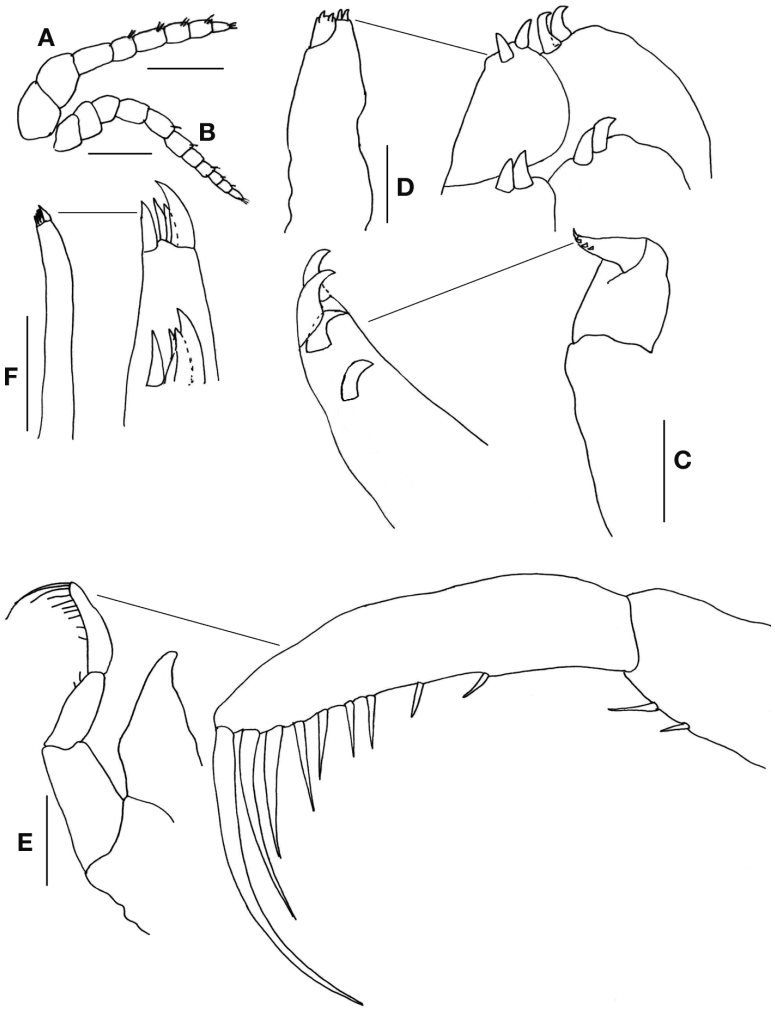

Fig. 2. – *Nerocila milesensis* n. sp. **A**: Antennule (0.71 mm); **B**: Antenna (0.61 mm); **C**: Maxilliped (0.37 mm); **D**: Maxilla (0.21 mm); **E**: Mandible (0.26 mm); **F**: Maxillule (0.32 mm).

Antennula longer than antenna, consisting of 8 articles, 1 and 2 articles larger than other articles, article 4-8 with esthetes. Antenna consists of eleven articles, 1 and 2 articles slightly larger than other articles, article 8 with esthetes and some articles with slender setae. Maxilliped distal palp with four apical recurved setae (seen as 9 setae at maxilliped because of molting) on article 3, without oostegial lobe. Mandible palp article 1 largest, article 2 shortest, article 3 with 9 setae on distolateral margin decreasing in size from longest distal seta, article 2 with 2 setae. Maxillula with four terminal robust setae. Maxilla lateral lobe with 2 recurved robust setae; medial lobe with 2 large recurved robust setae, including also with four robust setae at interior because of a pre-molting stage.

Pereopods 1, 3, 6-7 with slender setae. Pereopod 1 with one seta on posterior margin of propodus; pereopod 3 with two setae on posterior margin of propodus and two setae on ventral margin of basis; pereopod 6 with two setae on posterior margin of propodus; pereopod 7 with two rows of five setae and three setae of posterior margin of propodus, three setae of posterior margin of carpus; two setae of posterior margin of merus, one seta on posterior margin of ischium. Pereopods similar in size, pereopod 1 the shortest, pereopod 5 longest. Pereopod 1 basis 1.2 times as long as greatest width; ischium 0.6 times as long as basis; propodus 1.7 times as long as wide; dactylus slender, 1.8 times as long as propodus, 3.6 times as long as basal width. Pereopod 7 basis 2.2 times as long as greatest width; ischium 0.5 times as long as basis, merus 0.8 times as long as wide, 0.4 times as long as ischium; carpus as long as wide, 0.4 times as long as ischium; propodus 1.8 times as long as wide, 0.8 times as long as ischium; dactylus slender, 1.2 times as long as propodus, 3.6 times as long as basal width.

Pleopods gradually decreasing from 1 to 5; pleopods 1-2 and 3-4 similar in size. Endopod of all pleopods shorter than exopod. Pleopod 1 exopod 1 times as long as wide, lateral margin straight, medial margin slightly rounded, distally rounded; endopod 1.1 times as long as wide, lateral and medial margin straight, distally rounded; peduncle 0.3 times as wide as long. Pleopods 1-5 with four coupling hooks on protopod medial margin; pleopod 2 with appendix masculina about 0.6 length of endopod; Pleopods 3-5 with well developed proximomedial lobe. Pleopods 3-5 with folds. Exopod of uropod longer than endopod; endopod not extending beyond posterior margin of pleotelson.

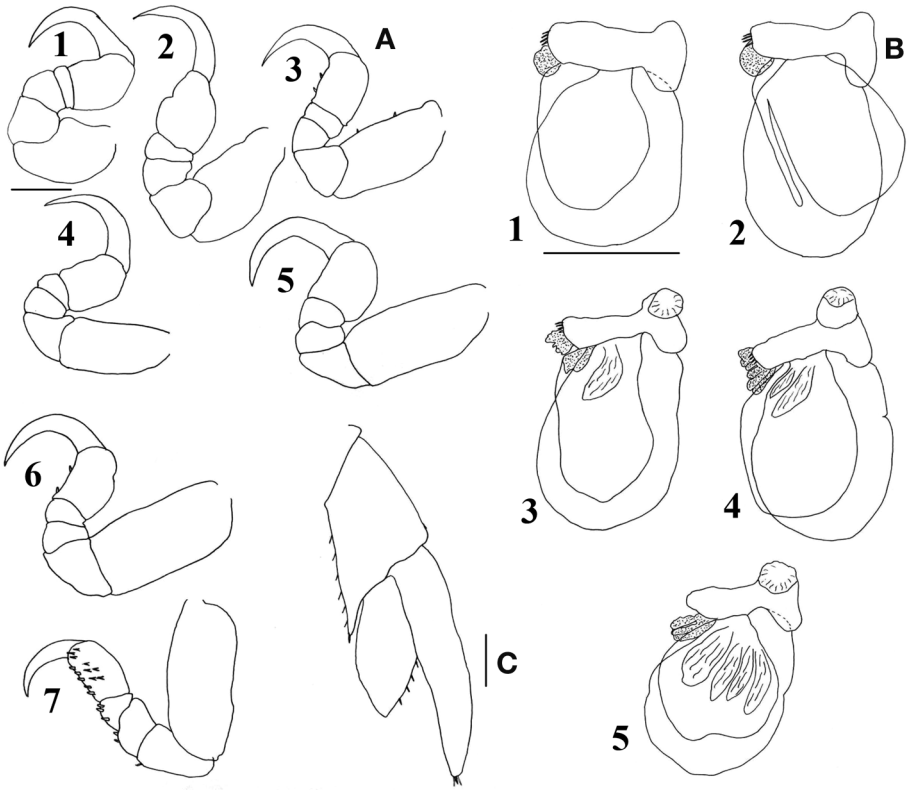

Fig. 3. – *Nerocila milesensis* n. sp. **A**: Pereopods 1 to 7 (0.76 mm for pereopod 1); **B**: Pleopods 1 to 5 (1.73 mm for pleopod 1); **C**: Uropod (0.5 mm).

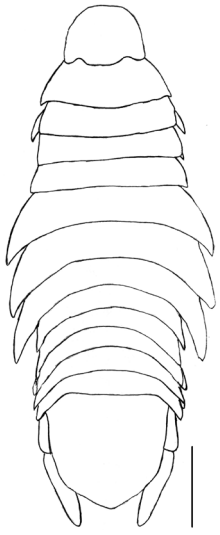

Fig. 4. – *Nerocila milesensis* n. sp transitional stage (scale 1 mm).

Endopod wide, apically rounded, 2.1 times as long as greatest width, lateral and medial margin slightly rounded, lateral margin with four setae. Exopod extending to end of endopod, 4.2 times as long as greatest width, apically rounded, lateral and medial margin straight, apices with three setae. Uropod peduncle margins with setae.

Description-transitional stage (Figs 4, 5, 9D, 10F)

Total length 6.68 mm. Body 2.4 times as long as greatest width. Proportions of long/width of pereonites, proportion of cephalon long/width, eye width/cephalon width, proportion of coxae, proportions of pleonite and pleotelson, number of antennule and antenna, setae at maxillula and maxilla, proportions of articles of pereopod 1 and 7; pleopods similar in size; proportions of endopod and exopod of pleopods; proportion of appendix masculina and pleopod endopod similar ovigerous female.

Pereonites 5 longest, pereonite 3 shortest. Pereonite on widest at pereonites 2, the narrowest at pereonite 3 in width. Pleonite 2 not extending to anterior margin of pleotelson. Maxilliped distal palp with four apical recurved setae (seen as 7 setae at maxilliped because of molting) on article 3, without oostegial lobe. Mandible palp article 1 largest, article 2 shortest, article 3 with 6 setae on distolateral margin decreasing in size from longest distal seta.

Pereopods with seta except for 5. Pereopod 1 and 2 with one seta on ventral margin of merus; pereopod 3 with three setae on posterior margin of propodus and two setae on posterior margin of carpus; pereopod 4 with two setae on posterior margin of carpus and one seta on posterior margin of merus; pereopod 5 without seta; pereopod 6 with two setae of posterior margin of propodus, two setae of posterior margin of carpus, one seta of posterior margin of merus; pereopod 7 with two rows of 5 setae, three setae of posterior margin of carpus, one seta of posterior margin of merus. Pereopods similar in size, pereopod 1 the shortest, pereopod 6 longest.

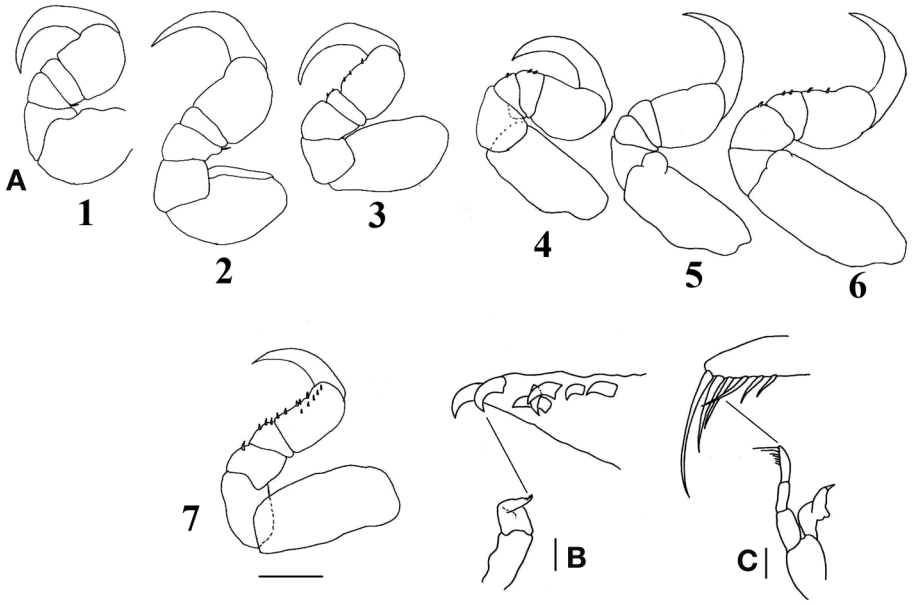

Fig. 5. – *Nerocila milesensis* n. sp. **A**: Pereopods 1 to 7 (0.38 mm for pereopod 7); **B**: Maxilliped (0.17 mm for pleopod 1); **C**: Mandible (0.15 mm).

Etymology

The new species is named according to the specific name of the type-host: *miles* is an adjective used as a substantive in the genitive case.

Size

Ovigerous female (12.08 mm TL, 7.23 mm W), transitional stage (6.68 mm TL, 2.97 mm W).

Distribution

Currently only known from Kaş, South Aegean Sea (the Mediterranean Sea)

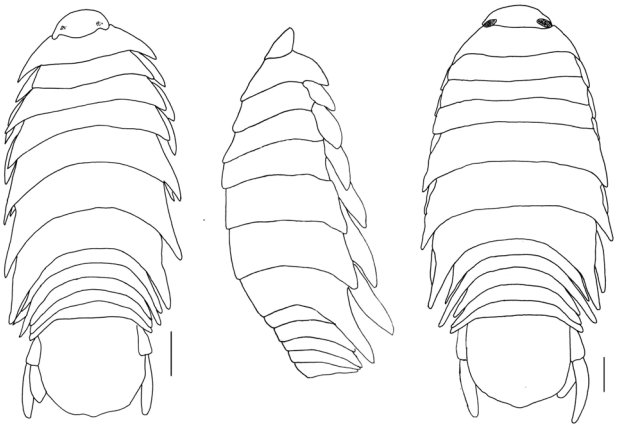

Fig. 6. – *Nerocila bivittata* on dorsal view (scale 0.5 mm for left, scale 1 mm for right).

Description: Female total length 12.18-22 mm; width 6.5-8.7 mm. Body 1.8-2.1 times as long as greatest width; all pereonite lateral margins mostly posteriorly and laterally broadly acuted. Cephalon 0.5 as long as wide, visible in dorsal view, anterior margin slightly rounded. Eyes ovoid and small, facets indistinct; eye 0.1 times width of cephalon, distance between eyes about 50 % of head width.

Hosts

Devil firefish, *Pterois miles* (Bennett, 1828).

***Nerocila bivittata* (Risso, 1816)**
Figs 6-8, 9A, B

Material examined

Turkey – 2 ♀ (ovigerous, 12.18-22mm TL, 6.5-8.7mm W); Bodrum, South Aegean Sea, Turkey, 37°10'N 27°25'E; Kaş, South Aegean Sea; 36°11'31.3"N 29°38'28.2"E; On the pectoral fin of the Devil firefish, *Pterois miles* (Bennett, 1828) (Fig. 10A, B, E); IUSHM 20200406-03, IUSHM 20200406-04.

Pereonites increased gradually from 1 to 6 in width at posterior and lateral, decreased from 6 to 7. Pereon widest at pereonite 5-6, the narrowest at pereonite 1. Pereonites progressively decreased from 1 to 4 and later increased from 4 to 6, pereonite 7 decreased in length. Pereonites 6 longest, pereonite 3 shortest. Posteroventral tips of pereonite 7 extending to middle of pleon 5; not to pleotelson. Coxae 2-5 visible, 1, 6-7 invisible in dorsal view; posteroventral angles of coxae 1-7 acuted in ventral view; not extending beyond posterior pereonites. Posteroventral tips of coxae 7 not extending to pleon 5.

All pleonites visible, pleonite 5 slightly longest; pleonites 1–4 subequal in length. posterolateral angles of pleonites 1-2 sharply extended to posteriorly. Pleonite on widest at pleonites 2, the narrowest at pleonite 5 in width. Pleonite 2 extending to anterior margin of pleotelson. Pleotelson 0.9 times as long as anterior width, dorsal surface smooth; lateral margins straight; posterior margin sligthly rounded.

Antennula longer than antenna, consisting of 8 articles, 1 and 2 articles larger than other articles, article 8 with esthetes. Antenna consists of eleven articles, 1 and

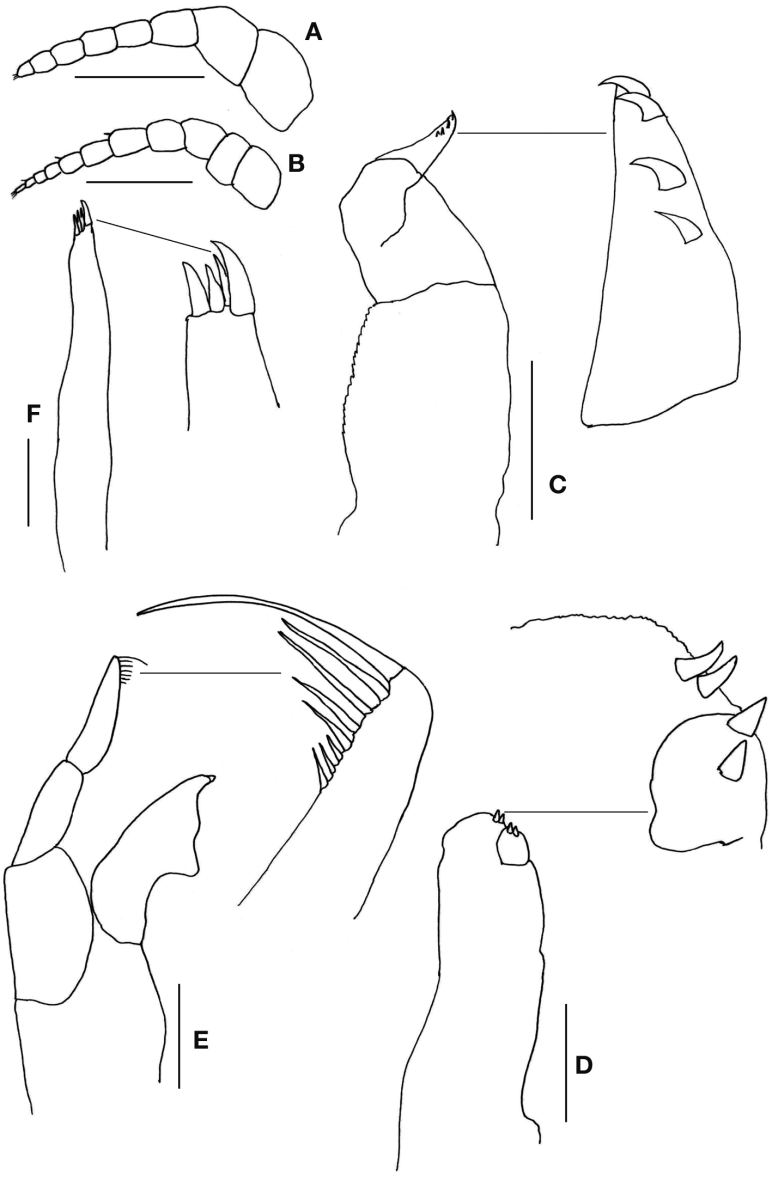

Fig. 7. – *Nerocila bivittata*. **A**: Antennule (1.03 mm); **B**: Antenna (0.68 mm); **C**: Maxilliped (0.45 mm); **D**: Maxilla (0.37 mm); **E**: Mandible (0.41 mm); **F**: Maxillule (0.3 mm).

2 articles slightly larger than other articles, article 8 with esthetes and some articles with seta. Maxilliped distal palp with four apical recurved setae on article 3, without oostegial lobe. Maxilliped distal palp with four apical recurved setae on article 3; some setae on outer margin of oostegial lobe at other sample (Fig. 8d). Mandible palp article 1 largest, article 2 shortest; article 3 with 8 setae on distolateral margin, decreasing in size from longest distal seta. Maxillula with four terminal robust setae. Maxilla lateral lobe with 2 recurved robust setae; medial lobe with 2 large recurved robust setae.

Pereopods 1-6 without setae. Pereopod 7 with one seta on posteromargin margin of ischium; two setae on posteromargin margin of merus; two rows of 2 and 3 setae respectively on posteromargin margin of carpus; two rows of 5 and 3 setae on posteromargin margin of propodus. Pereopods similar in size, pereopod 1 the shortest, pereopod 5 longest. Pereopod 1 basis 1.4 times as long as greatest width; ischium 0.6 times as long as basis; propodus 1.6 times as long as wide; dactylus 1.8 times as long as propodus, 4.6 times as long as basal width. Pereopod 7 basis 2.3 times as long as greatest width; ischium 0.5 times as long as basis, merus as long as wide, 0.5 times as long as ischium; carpus 0.8 times as long as wide, 0.4 times as long as ischium; propodus 2 times as long as wide, 0.8 times as long as ischium; dactylus slender, 1.3 times as long as propodus 4 times as long as basal width.

Pleopods gradually decreasing from 1 to 5; pleopods 1-2 and 3-4 similar in size. Endopod of all pleopods shorter than exopod. Pleopod 1 exopod 1.2 times as long as wide, lateral margin straight, medial margin slightly rounded, distally rounded; endopod 1.5 times as long as wide, lateral and medial margin straight, distally rounded; peduncle 0.3 times as wide as long. Pleopods 1-5 with

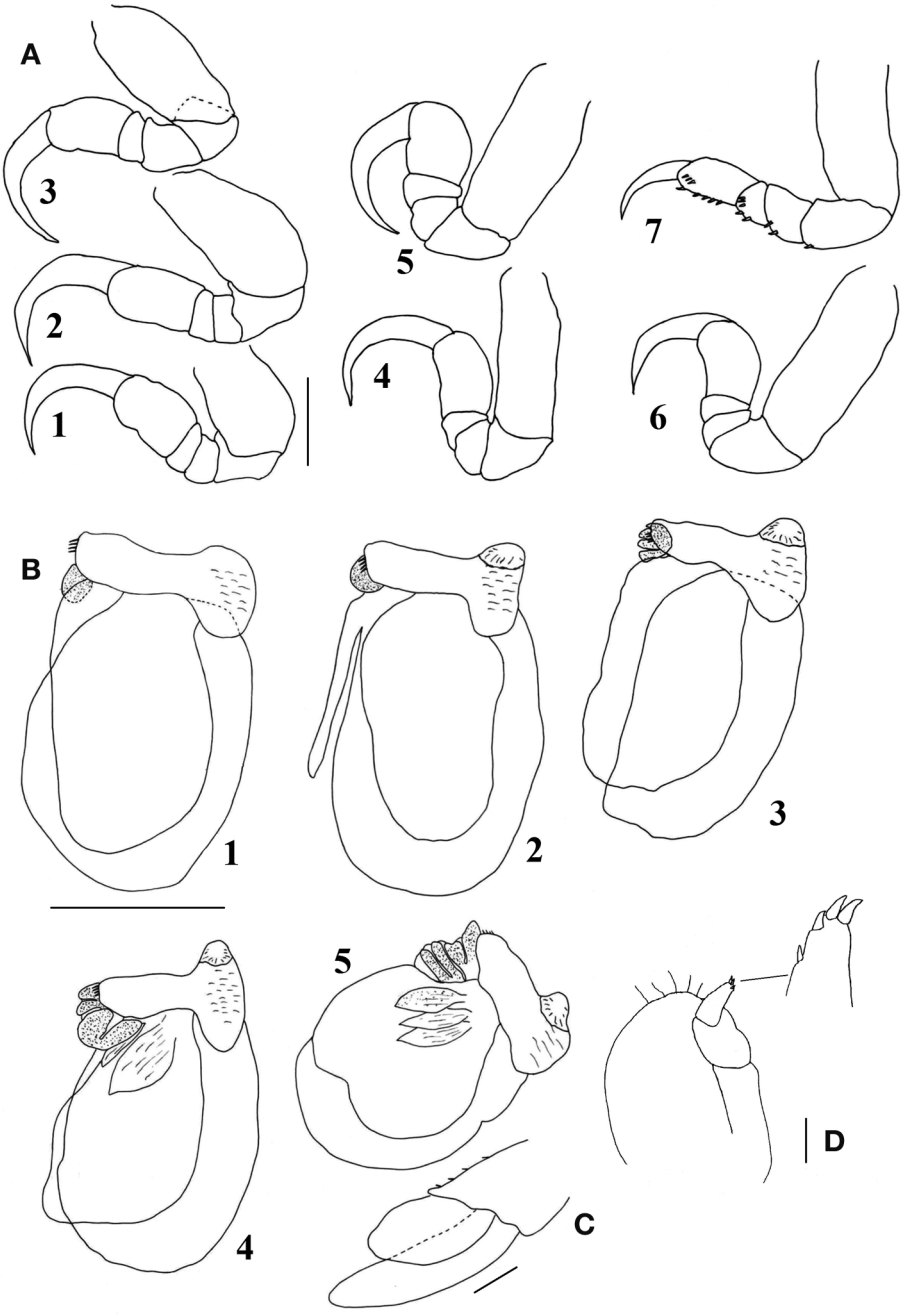

Fig. 8. – *Nerocila bivittata*. **A**: Pereopods 1 to 7 (1.11 mm for pereopod 1); **B**: Pleopods 1 to 5 (2.45 mm for pleopod 1); **C**: Uropod (0.81 mm); **D**: Oostegial maxilliped (0.21 mm).

four coupling hooks on protopod medial margin; pleopod 2 with appendix masculina about 0.7 length of endopod; pleopods 3-5 with well developed proximomedial lobe. Pleopods 3-5 with folds. Exopod of uropod longer than endopod; endopod not extending beyond posterior margin of pleotelson. Endopod wide, apically rounded, 2.2 times as long as greatest width, lateral and medial margin slightly rounded, apices without setae. Exopod extending to end of endopod, 4.2 times as long as greatest width, apically rounded, lateral and medial margin straight, apices without setae. Uropod peduncle margins with setae.

DISCUSSION

Devil firefish usually lives from 25 to 85 m in depth. This exotic species is known as coral reef fish belonging to the family Scorpaenidae (Froese & Pauly 2019). This species has been found in different habitats including rocky and sandy bottoms, coral reefs, seagrass and in crevices (Fishelson 1975, Schultz 1986, Khalaf & Kochzius 2002, Morris *et al*. 2009, Claydon *et al*. 2012). There are very few data dealing with parasitic isopods of lionfish, *Pterois miles* and *Pterois volitans* (Linnaeus, 1758) in the world (Table I).

Fig. 9. – **A**: *Nerocila bivittata* (scale 1 mm); **B**: *N. bivittata* (scale 1 mm); **C**: *N. milesensis* (scale 1 mm); **D**: *N. milesensis* (scale 1 mm).

Trilles *et al*. (2013) reported that several species belonging to the genus *Nerocila* are morphologically highly variable and their identification often difficult. Two species, *Nerocila bivittata* and *N. orbignyi* (Guérin-Méneville, 1832), are known in the Mediterranean. Although *N. bivittata* and *N. orbignyi* are often reported in the Mediterranean, their morphological characters were seldom described (Trilles 1975, Bruce 1987).

Nerocila milesensis is similar in body shape to *N. orbignyi*. *Nerocila orbignyi* differs, as figured by Trilles (1975) and Bruce (1987) from *N. milesensis* n. sp, in having body length-width proportions; being slightly smaller of cephalon length-width rate; being slightly smaller of pleotelson length-width rate; having maxilla lateral lobe with 2 and medial lobe with 1 setae; mandible palp with article 1 longest and other articles subequal and article with 12 setae; being different number of spines having articles at pereopod 7; being sligthly smaller of appendix masculina-endopod length rate; being larger of endopod and exopod length-width rate; not being extended pereonites 5-7 than other pereopods; being subparallel of lateral and medial margin and oblique of distal margin at uropod endopod.

Nerocila milesensis can be separated from *N. bivittata* described by Trilles (1975) according to some characters, including mainly extended of pereonites 5-7, also being sligthly smaller of cephalon length-width rate; longest and shortest of pereonites; visibility of coxae; number of article at antennula; number of setae at maxilla and maxillula; number of setae on maxilliped (possibly much more than four); number of setae at article 1 and 2 of mandible; proportion of appendix masculina and pleopod endopod sligthly larger.

Nerocila acuminata Schiödte & Meinert, 1881 aster form is also similar in body shape to *N. milesensis*. *Nerocila acuminata* is known from the Pacific and Atlantic Ocean. Its occurrence is reported from about 40 fish species (Brusca 1981). The preferred hosts of *N. acuminata* are schooling and demersal fishes such as species belonging to the families Engraulidae, Atherinidae, Serranidae, Mugilidae, and Embiotocidae. Brusca (1981) indicated that *N. acuminata* is less host-specific than most cymothoid species.

Antoniou *et al*. (2019) reported *N. bivittata* on *Pterois miles* in Cyprus. They determined the difference of a sample in their study, morphologically. This sample may be an *aster form* of the Pacific-Atlantic *N. acuminata* in having the extension of pereonites and coxae similar to them. However, they assigned this sample as *N. bivittata*. We also observed one sample resembling to Antoniou *et al*. (2019)'s material in the present study. Therefore, *Nerocila acuminata aster form* differs, as figured by Brusca (1981), from *N. milesensis*, in having body length-width rate posterolateral angles of all pereonites strongly and acute, reaching beyond posterior borders of their respective segments; pereonite VII typically reaching at least the anterior border of pleotelson; coxae 2 reaching to or slightly beyond distal angle of their pereonite. Er & Kayiş (2015) reported the occurrence of *Nerocila acuminata* on *Pegusa nasuta*, *Symphodus* spp., *Uranoscopus scaber*, *Scorpaena porcus* using only molecular method in the eastern Black Sea coast of Turkey.

Although *Nerocila milesensis* is similar to *N. arres* Bowman & Tareen, 1983 and *N. sigani* Bowman & Tareen, 1983 with the pereopods 5-7 extended mainly, it differs from them by the absence of serrations at uropod endopod.

Nerocila bivittata is mainly reported from Labridae, Sparidae, Scorpaenidae. It is also reported on fishes belonging to different families such as Syngnathidae, Sciaenidae, Serranidae. *Nerocila orbignyi* parasitizes especially Mugilidae (Trilles 1994). It may be said that *Nerocila* in the Mediterranean prefers demersal fish including also benthopelagic, reef-associated more than pelagic, when the life types of the host species infected by parasite are examined. It may be said that *Nerocila* prefers carnivorous and omnivorous fish rather than herbivorous

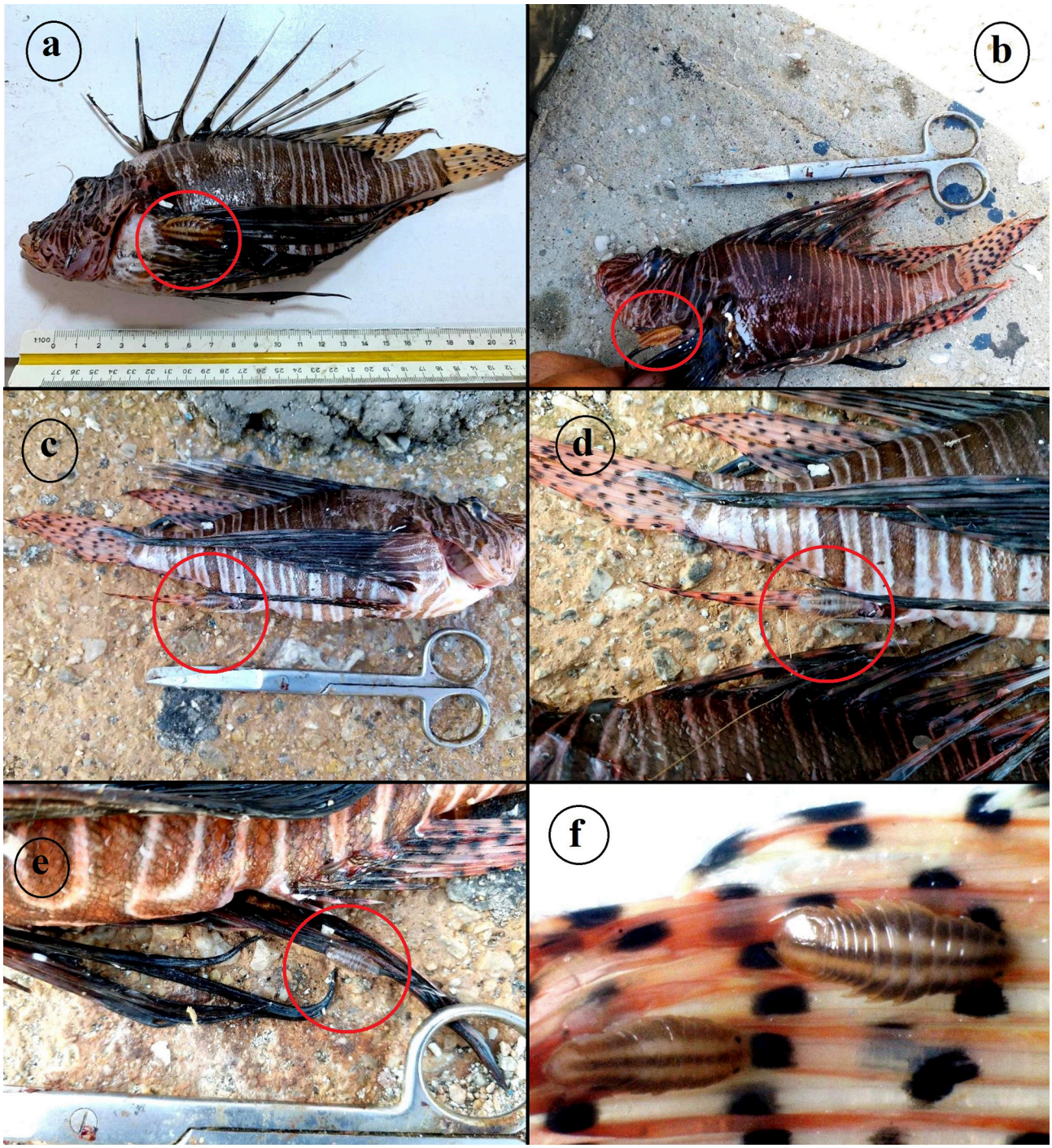

Fig 10. – **A**: *Nerocila bivittata* in the pectoral fin of host from Bodrum (by Sezginer in 2019); **B**: *N. bivittata* in the pectoral fin of host from Kaş (by Öktener in 2019); **C**: *N. milesensis* in the anal fin of host from Kaş (by Öktener in 2019); **D**: *N. milesensis* in the anal fin of host from Kaş (by Öktener in 2019); **E**: *N. bivittata* in the pectoral fin of host from Kaş (by Öktener in 2019); **F**: *N. milesensis* transitional stage in the caudal fin of host from Kaş (by Öktener in 2019).

host species, when the feeding habits of the host species infested with Nerocila are examined.

Bilge *et al*. (2019) analyzed the potential invasiveness of 45 lessepsian marine fish in the South-western coasts of Anatolia (Muğla Region, Turkey) with the Aquatic Species Invasiveness Screening Kit (AS-ISK). They identified the invasive potential of Devil firefish as a high risk with a 45.5 score.

The high invasiveness of the devil firefish reflects its adaptation to the Mediterranean ecological environment after it was first seen in the Mediterranean in 1992. Because the devil firefish is well settled in the Mediterra-

nean, *Nerocila* has the opportunity to parasitize this host species. Considering the lifestyle of devil firefish and the host characteristics parasitized by *Nerocila* as described above, the association between the two species is likely.

Three exotic cymothoids were reported from the Mediterranean Sea. Bariche & Trilles (2008) reported *Ceratothoa collaris*, from the Atlantic Ocean on three fish families, Sparidae, Moronidae, Serranidae in Lebanon. Bariche & Trilles (2006) reported *Anilocra pilchardi* Bariche & Trilles, 2006, a lessepsian species from the Indo-Pacific Ocean on clupeiform fishes, while Trilles & Bariche (2006) reported *Cymothoa indica* Schiödte & Meinert, 1884, a lessepsian species from the Indo-Pacific Ocean, mainly on Sphyraenidae from Lebanon.

There are few studies on the occurrence of native cymothoids on lessepsian fish. *Anilocra physodes* was reported on *Sphyraena chrysotaenia* by Innal *et al*. (2007), on *Pempheris vanicolensis* by Öktener *et al*. (2010) in Turkey, on *Siganus luridus* by Shakman *et al*. (2009) in Libya. *Nerocila bivittata* was found on both *Siganus rivulatus* and *S. luridus* by Shakman *et al*. (2009) in Libya, and on *Pterois miles* by Antoniou *et al*. (2009) in Cyprus.

Parasites are useful for determination of fish stock, study of population dynamics and fishery management (MacKenzie 2002, Mattiucci 2006, Poulin & Kamiya 2015). *Nerocila* on devil firefish may be used as a biological tag to study its geographical distribution in different countries. This is supported by Freeman *et al*. (2017) who suggested that Myxozoan parasites may be used as biological tag in lionfish population studies in the Caribbean Region.

This study brings new information about parasites of invasive fish, especially a host-parasite association that should be monitored in different countries in the future.

ACKNOWLEDGEMENTS. – The authors gratefully acknowledge B Pichet from the Muséum national d'Histoire naturelle, Paris for scanning the literature; the anonymous reviewers and Dr Y Desdevises, Dr E Magnanou, the editors, and Mrs V Arnaud, Editorial Secretary of *Vie et Milieu,* for the valuable, critical and helpful comments and corrections on the manuscript. The first author especially thanks Dr M R Robertson, Marine Scotland Science for scientific help.

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Received on February 14, 2020
Accepted on April 2, 2020
Associated editor: E Magnanou