MICROPREDATOR BEHAVIOUR OF *ROCINELA DUMERILII* (ISOPODA, AEGIDAE) ON *TRACHURUS TRACHURUS* IN THE SEA OF MARMARA (TURKEY)

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KEYWORDS: *Rocinela dumerilii*, micropredator, *Trachurus trachurus*, *Elthusa sinuata*, the Sea of Marmara.

ABSTRACT

Rocinela dumerilii (Lucas, 1849) is obtained on the horse mackerel, *Trachurus trachurus* (Linnaeus, 1758) from the Sea of Marmara, in Turkey. This species is a free-living organism from the Aegean Sea of Turkey, the Mediterranean Sea and Atlantic. Its micropredator behaviour is discovered for the first time in this study. *Elthusa sinuata* (Koelbel, 1879) is also collected on the gill cavity of Fries's goby, *Lesueurigobius friesii* (Malm, 1874) in this study. This host is a new record for *Elthusa sinuata*. The morphological characters of *Rocinela dumerilii* species are given by drawings.

RÉSUMÉ: Le comportement microprédateur de *Rocinela dumerilii* (Isopoda, Aegidae) sur le chinchard commun *Trachurus trachurus* dans la Mer de Marmara (Turquie).

Rocinela dumerilii (Lucas, 1849) est collectée sur les exemplaires de chinchard *Trachurus trachurus* (Linnaeus, 1758) en provenant de la Mer de Marmara, en Turquie. Cette espèce est connue en tant que forme de vie libre, de la Mer Egée, en Turquie, de la Mer Méditerranée et de l'Atlantique. Son comportement micro-prédateur a été découvert pour la première fois durant cette étude. *Elthusa sinuata* (Koelbel, 1879) est également collecté de la cavité branchiale du gobie à grandes écailles, *Lesueurigobius friesii* (Malm, 1874) durant cette étude. Cet hôte est un nouveau record pour *Elthusa sinuata*. Les caractères morphologiques de l'espèce de *Rocinela dumerilii* sont indiqués par des dessins.

REZUMAT: Comportamentul microprădător al speciei *Rocinela dumerilii* (Isopoda, Aegidae) pe stavridul atlantic *Trachurus trachurus* în Marea Marmara (Turcia).

Rocinela dumerilii (Lucas, 1849) este colectată de pe exemplare de stavrid atlantic *Trachurus trachurus* (Linnaeus, 1758) din Marea Marmara, Turcia. Această specie este cunoscută ca formă de viață liberă, în Marea Egee, în Turcia, din Marea Mediterană și Atlantic. Comportamentul său microprădător a fost descoperit pentru prima dată în timpul acestui studiu. *Elthusa sinuata* (Koelbel, 1879) a fost, de asemenea, colectată din cavitatea branhială a guvidelui lui Fries, *Lesueurigobius friesii* (Malm, 1874) în timpul acestui studiu. Această gazdă este o nouă semnalare pentru *Elthusa sinuata*. Caracterele morfologice ale speciei *Rocinela dumerilii* sunt indicate prin desene.

INTRODUCTION

Members of the family Aegidae are active predators on hosts such as fish and elasmobranches (Brusca, 1983; Bruce, 2003, 2004). These isopods attack the external surfaces of fish. They were also reported as associated with invertebrates (Brusca, 1983; Bruce, 2003, 2004). They may be named as micropredators or temporary parasites. They may also act as scavengers, consuming dead fish that settle to the benthos. When not feeding, aegids lie on the substratum (Brusca and Iverson, 1985). Aegidae are distributed throughout the world oceans, from the tropics to polar waters (Bruce, 2009). Forty-one species of *Rocinela* are listed by Worms Editorial Board (2019).

There are few association records between aegids, fish, and invertebrates hosts: *Rocinela signata* was reported on the general body surface and gills of hosts such as nurse sharks (Brusca and Iverson, 1985). *R. signata* was reported from *Dasyatis americana*, *D. guttata* (Williams et al., 1994); from few fish species including *Archosargus probatocephalus*, *Balistes vetula*, *Bothus lunatus*, *Calamus calamus*, *Calamus bajonado*, *Calamus penna*, *Caranx* sp., *Dasyatis americana*, *Epinephelus itajara*, *Epinephelus morio*, *Galeocerdo cuvieri*, *Ginglymostoma cirratum*, *Haemulon steindachneri*, *Haemulon flavolineatum*, *Lachnolaimus maximus*, *Lutjanus analis*, *Lutjanus buccanella*, *Lutjanus blackfordi*, *Mycteroperca venenosa*, *Mycteroperca bonaci*, *Orthopristis ruber*, *Raja eglanteria*, *Sparisoma viride*, *Sphyraena barracuda* (Kensley and Schotte, 1989); from *Lutjanus analis*, *Micropogonias furnieri* (Bunkley-Williams and Williams, 1998). *Aega tridens* was reported from *Scomber scomber* (Treasurer, 2001); while *Aega rosacea* from *Epinephelus guaza*, *Mullus barbatus barbatus*, *Squatina squatina* and *Aega deshaysiana* from *Sardina pilchardus* (Ramdane and Trilles, 2008). Garzón-Ferreira (1990) also noted *R. signata* attacking humans in Colombia.

The *Elthusa* members are observed in the branchial cavities of hosts. 35 species belonging to this genus are listed by Worms Editorial Board (2019). It is recorded from the Indo-West Pacific, Eastern Pacific, the Atlantic, and the Mediterranean (van der Wal et al., 2019). *Elthusa sinuata* (Koelbel, 1879) is known from the Mediterranean Sea red bandfish.

Although species of *Rocinela* from Mediterranean has been reported by several researchers many times, the morphology of females and males of this genus in the Mediterranean has not been investigated. Specific key is necessary to identify the species belonging *Rocinela* genus for Mediterranean Sea.

The aim of this study is to provide a tool for taxonomists for future use. The present study contributes the presence of micropredator behavior of *R. dumerilii* on host fish and also to the knowledge of the host diversity of *Elthusa sinuata*.

MATERIAL AND METHODS

Trachurus trachurus (Linnaeus, 1758) (Fig. 1) (Perciformes, Carangidae) and *Lesueurigobius friesii* (Malm, 1874) (Fig. 2) (Perciformes, Gobiidae) were caught by trawling net in Marmara Sea, Turkey, on July 2017. Collected isopod samples were fixed in 70% ethanol. Some specimens were dissected with the use of a Wild M5 stereo microscope. The appendages were drawn with the aid of a camera lucida (Olympus BH-DA). Drawings were transfered to digital media via scanner. The photos were taken with a Canon EOS 1100D camera attached to a microscope. Measurements (in μm) were obtained using a program (Pro-way). Identifications and comparisons were performed according to Schiodte and Meinert (1879), Kussakin (1979), Monod (1923) for *R. dumerilii* and Trilles (1976), Öktener et al. (2018) for *Elthusa sinuata*. The scientific names, synonyms of parasite, and host were checked with Worms Editorial Board (2019), and Froese and Pauly (2019).

Figure 1: *Trachurus trachurus*
(Linnaeus, 1758).

Figure 2: *Elthusa sinuata* in the gill cavity
of *Lesueurigobius friesii* (Malm, 1874)
(partialy dissected).

RESULTS AND DISCUSSION

Order Isopoda Latreille, 1817
Suborder Cymothoida Wagele, 1989
Superfamily Cymothooidea Leach, 1814
Family Aegidae White, 1850
Genus *Rocinela* Leach, 1818
Rocinela dumerilii (Lucas, 1849) (Figs. 3-9)
Synonmyies *Acherusia dumerilii* Lucas, 1849; *Acherusia complanata* Grube, 1864

Rocinela dumerilii Lucas, 1849: Schiodte and Meinert, 1879; Richardson, 1898; Norman, 1904; Richardson, 1905; Norman and Scott, 1906; Monod, 1923; Duncan, 1956; Menzies and Glynn, 1968; Schultz, 1969; Kensley, 1978; Kussakin, 1979; Howson and Picton, 1997; Junoy and Castelló, 2003; Alves et al., 2006; Kırkım et al., 2006; Mansour et al., 2011; Bakır et al., 2014; Bedini et al., 2015; Sampaio et al., 2016; Ortiz and Lalana, 2018.

Figure 3: *Rocinela dumerilii* (Lucas, 1849).

Host: The Atlantic horse mackerel, *Trachurus trachurus* (Linnaeus, 1758).
Infestation site: body surface. Infestation tissue: skin.
Sampling stations: 40°31'N-28°12'E; 40°33'N-27°52'E; 40°26'N-27°36'E.

Description. Body (14.9, 15.3, 16.9 mm) 2.4-2.6 times as long as max. width, widest at pereonite four, lateral margins subparallel. Eyes not united, separated by 9-10% width of head; each eye made up of ~13 transverse rows of ommatidia, each row with ~nine ommatidia; black eyes. Pleon with pleonite one largely concealed by pereonite seven, or visible in dorsal view; pleonite four with posterolateral margins extending beyond posterior margin of pleonite five; pleonite five with posterolateral angles acute. Pleotelson 0.8 times as long as anterior width.

Antennule peduncle article three, 0.7 times as long as combined lengths of articles one and two, 2.3 times as long as wide; flagellum with six articles, not extending to anterior of pereonite one. Antenna peduncle article three, three times as long as article two, 1.1 times as long as wide; article four 4, 1.3 times as long as article three, 1.5 times as long as wide, inferior margin with one simple seta; article five, 1.4 times as long as article four, 2.4 times as long as wide, inferior margin with one seta, anterodistal angle with cluster of three short simple setae; flagellum with 15 articles, extending to posterior of pereonite one.

Mandible molar process is a flat lobe; palp article two with seven short marginal distolateral setae and two long distolateral setae; palp article three with 16 setae. Maxillule with six RS/robust spine (one large, five slender, without serrate). Maxilla mesial lobe with two RS; lateral lobe with two RS. Maxilliped palp article one distomesial angle with three RS (with thin one seta betwen two large setae); article two with three hooked RS (with one thin and two large setae); article three with one hooked RS (article three fused to article two).

Pereopod one basis 2.3 times as long as greatest width; ischium three times as long as basis, inferior margin with zero RS and inferrodistal angle with two spines, superior distal margin with one seta; ischium superior distal angle with two setae and inferodistal angle with one seta; merus inferior margin with four RS and one small spine, superior distal angle with three setae; carpus 0.7 as long as merus, inferior margin with one RS (minute); propodus 1.2 times as long as proximal width, propodal palm with blade, propodal blade 0.6 times as wide as palm, inferior margin with four RS; dactylus 1.2 times as long as propodus. Pereopods two and three similar to pereopod one (but RS on merus longer). Pereopods six and seven similar.

Pereopod seven basis 2.9 times as long as greatest width, inferior margins with 10 palmate setae; ischium 0.8 as long as basis, inferior margin with four RS, superior distal angle with three RS, inferior distal angle with four RS; merus 0.5 times as long as ischium, 2.1 times as long as wide, inferior margin with one RS, superior distal angle with five RS, inferior distal angle with four RS; carpus 0.6 as long as ischium, 2.5 times as long as wide, inferior margin with two RS, superior distal angle with eight RS (two setae), inferior distal angle with six RS; propodus 0.5 long as ischium, 4.0 long as wide, inferior margin with three RS, superior distal angle with two long and two short setae and one palme seta, inferior distal angle with two RS.

Pleopod one exopod 1.9 times as long as wide, with PMS/plumose seta on right lateral margin, with PMS on two-thirds of left lateral margin; mesial margin weakly convex, with PMS; endopod 2.2 times as long as wide, lateral margin weakly concave, with PMS on two-third of left margin, without PMS on right margin; mesial margin with PMS; peduncle mesial margin with five-six coupling hooks. Pleopods two-four peduncle mesial margin with five-six coupling hooks, lateral margin with PMS. Uropod peduncle ventrolateral margin with two RS and five-seven PMS, posterior lobe half long as endopod. Exopod rami not extending to pleotelson apex. Endopod lateral margin convex, lateral margin with five RS, mesial margin distally rounded, with five RS. Exopod not extending to endopod end, 3.2 times long as maximum width; lateral margin convex, with eight RS; mesial margin straight, distally convex, with zero RS; distal margin with indistinct apex.

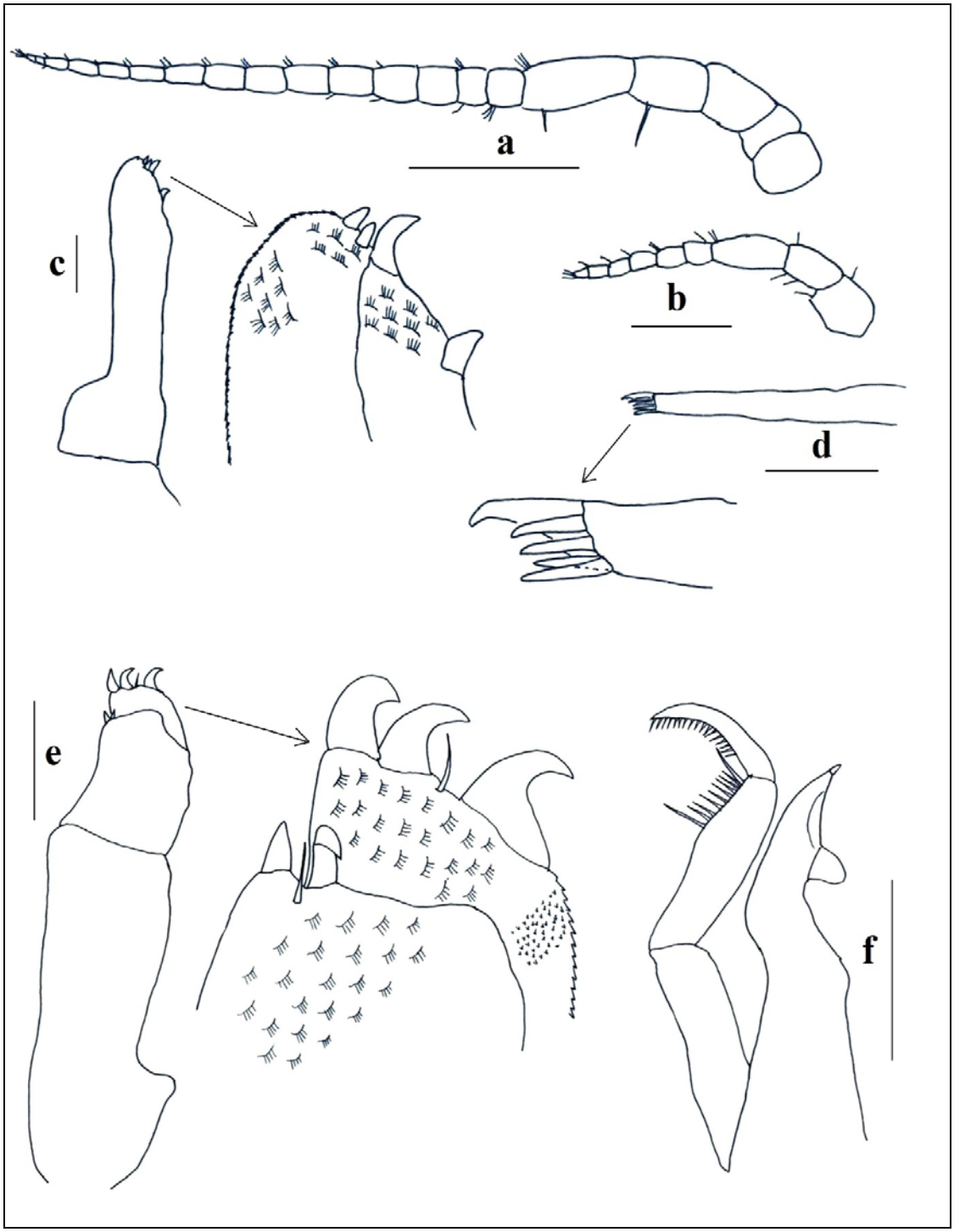

Figure 4: *Rocinela dumerilii* a. antenna (1.31 mm), b. antennule (0.8 mm), c. maxilla (0.16 mm), d. maxillule (0.37 mm), e. maxilliped (0.37 mm), f. mandible (0.57 mm).

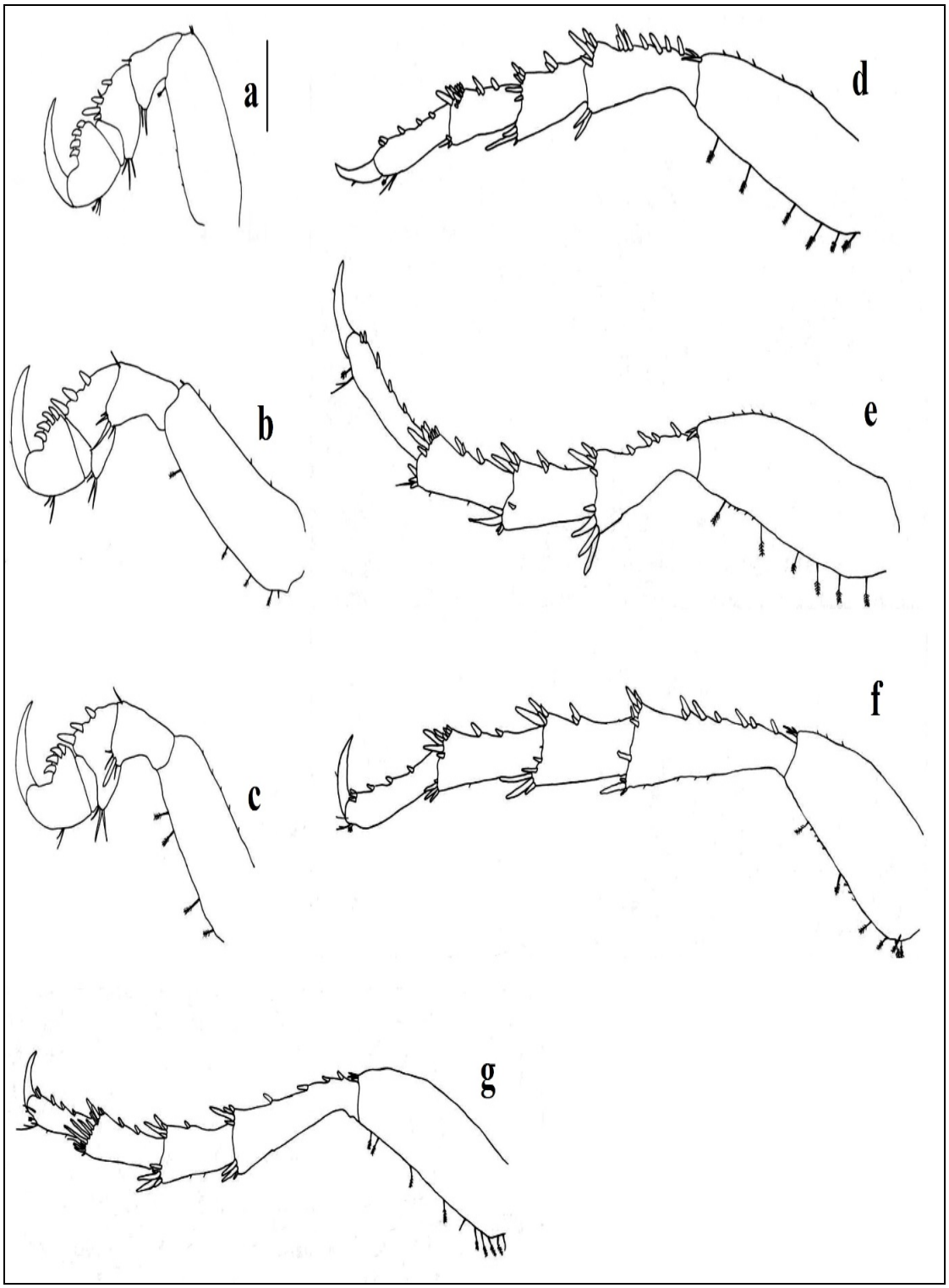

Figure 5: *Rocinela dumerilii* (a-g),
Pereopods 1-7 (0.66 mm).

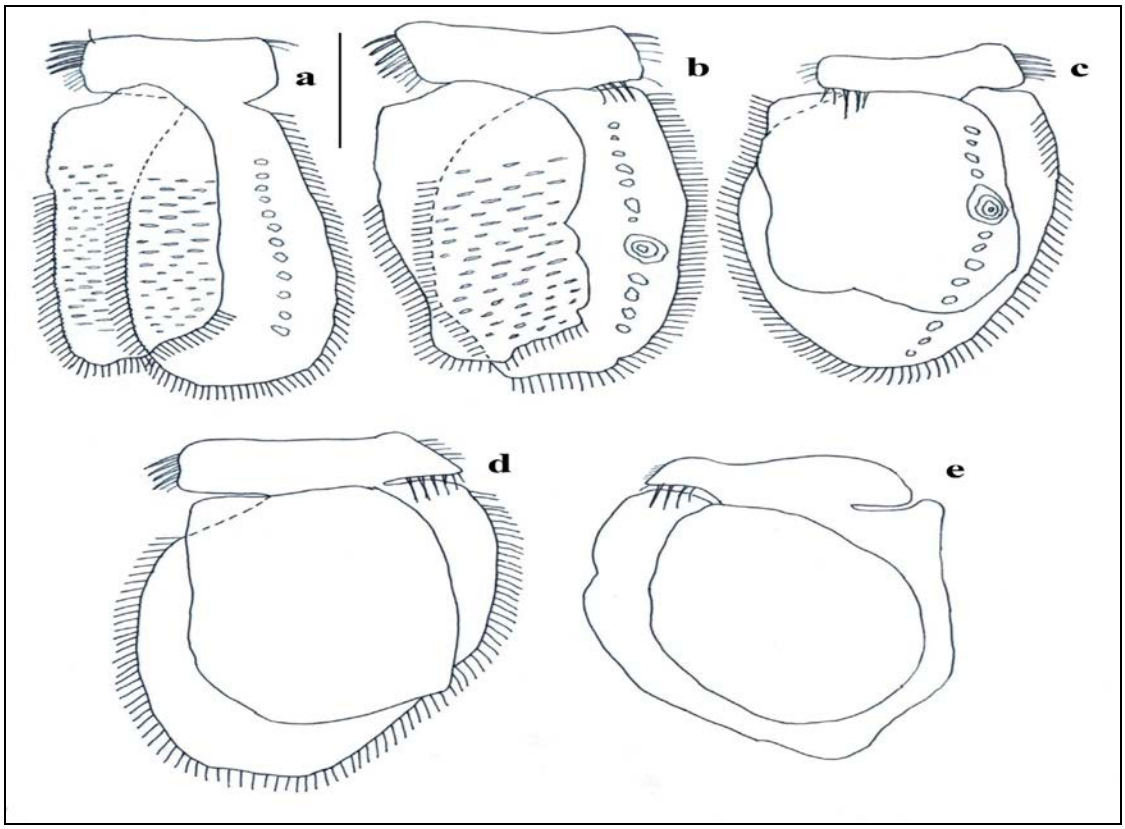

Figure 6: *Rocinela dumerilii* (a-e), Pleopods 1-5 (1.21 mm).

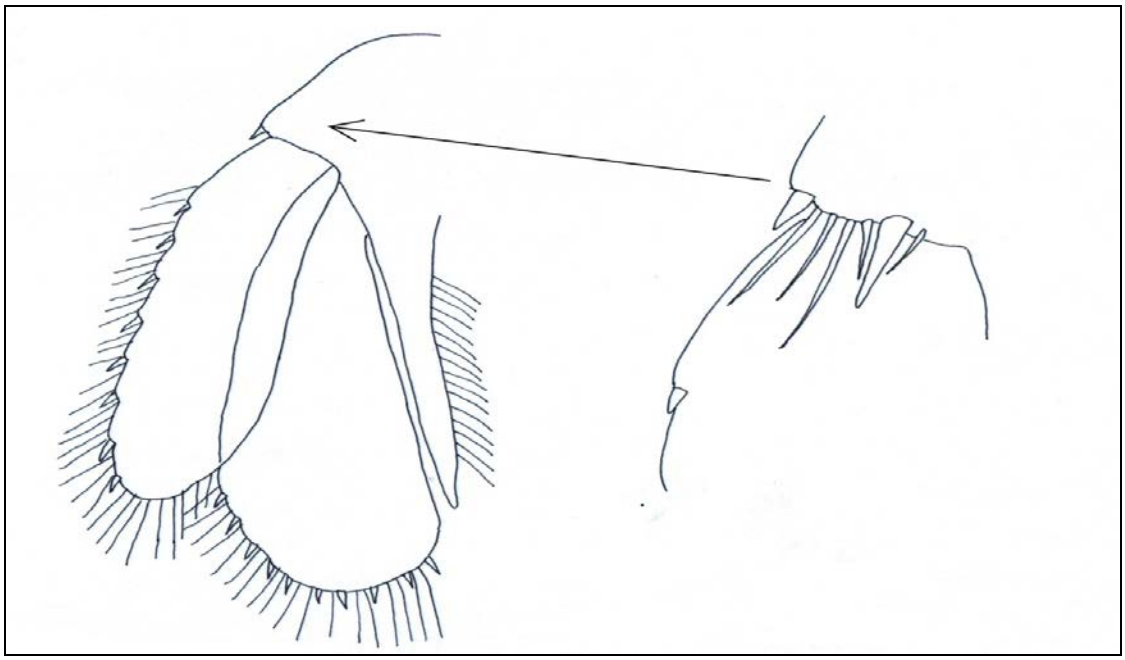

Figure 7: *Rocinela dumerilii*, Uropod and apex of exopod.

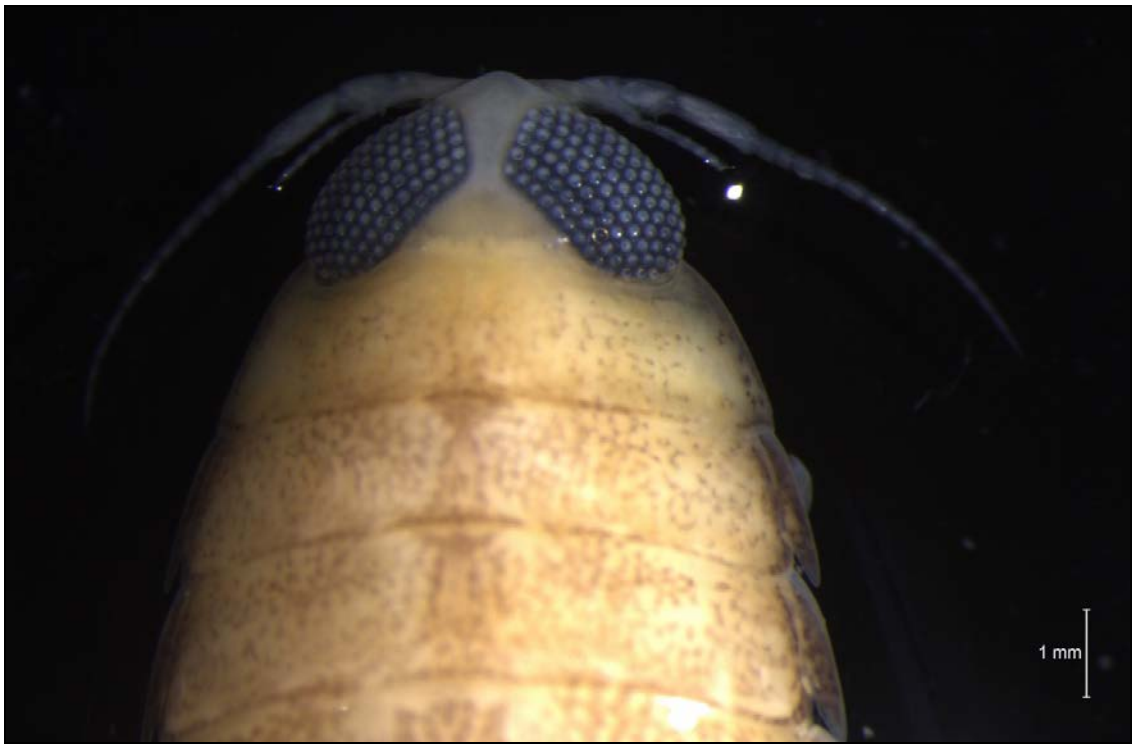

Figure 8: *Rocinela dumerilii*, head.

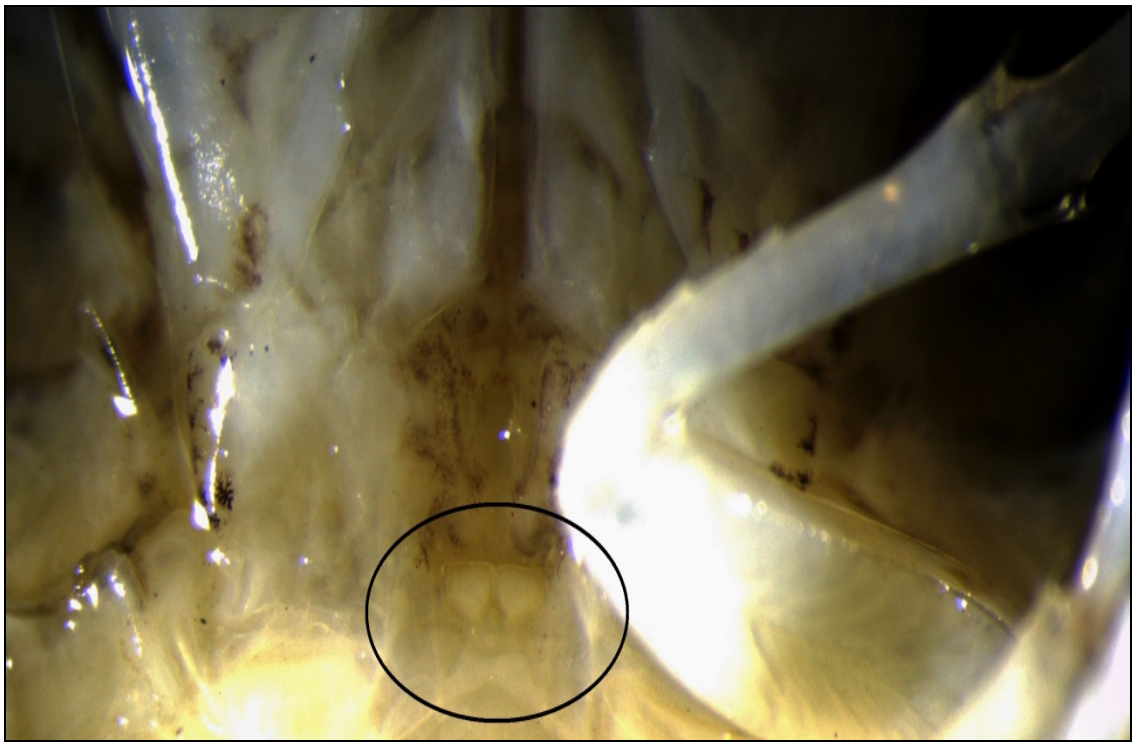

Figure 9: *Rocinela dumerilii*, penes.

Remarks. Fourty-one species belonging to *Rocinela* genus are listed by Worms Editorial Board (2019). The monographs, detailed descriptions, and revision studies concerning *Rocinela* genus have been published mostly on the Australia, New Zealand, and Pacific Ocean (Bruce, 1983; 2009; Brusca, 1983; Brusca and France, 1992).

The historic literature about the species of *Rocinela* in the Mediterranean Sea lack modern or detailed descriptions (Schioedte and Meinert, 1879; Kussakin, 1979; Sars, 1899). Three species belonging to *Rocinela* genus were reported such as *Rocinela ophthalmica* Milne Edwards, 1840, *Rocinela dumerilii* (Lucas, 1849), and *Rocinela danmoniensis* Leach, 1818 from the Mediterranean Sea.

Although there are no detailed descriptions currently available to compare the morphological characters of *R. dumerili* and *R. danmoniensis*, some morphological characters such as the setation on propodus of pereopods and the distance between eyes were compared in this study. *R. dumerilii* species is very closely similar to *R. Danmoniensis* species. The main point of difference is that in *R. danmoniensis* the eyes are closer together and may even touch other (Schiodte and Meinert, 1879; Norman, 1904; Richardson, 1905; Norman and Scott, 1906; Schultz, 1969; Kussakin, 1979; Kırkım et al., 2006). The eyes on *Rocinela* samples in this study are separated by about 9-10% width of head. The propodus of the pereopod two bears four setae in female and male of *R. dumerilii*, but two setae in the propodus of the pereopod one of pullus primus of *R. danmoniensis* according to Schiodte and Meinert (1879). The setation of propodus in this study is consistent with *R. dumerilii*. The morphological extremities of mouth-parts of specimens found in this study have been compared to the findings presented by Monod (1923). The morphology of specimens collected in this study is consistent with the literature concerning *R. dumerilii* (Schiodte and Meinert 1879; Monod, 1923; Kussakin, 1979).

There are several association records between isopods belonging *Rocinela* genus and fish around the world (Novotny and Mahnken, 1971; Brusca and Iverson, 1985; Kensley and Schotte, 1989; Garzón-Ferreira, 1990; Williams et al., 1994; Wing and Moles, 1995; Bunkley-Williams and Williams, 1998; De Lima et al., 2005). Regarding the Mediterranean Sea, there were micropredator reports of *R. danmoniensis* from fish as host. *R. danmoniensis* was reported on Atlantic cod, *Gadus morhua* (Gadidae) (Schiodte and Meinert, 1879) and Blackspot seabream, *Pagellus bogaraveo* (Sparidae) (Hermida et al., 2013). Sars (1899) mentioned that it is more generally found clinging to the skin of fish of various kinds, for instance the common cod, the haddock, the ling, etc. Stephensen (1948) indicated the occurrence of its parasitism on Gadidae such as cod, haddock and lange.

There were some reports of *Rocinela dumerilii* surviving as free-living organisms and from the digested stomach content of some marine organisms. Bedini et al. (2015) reported this species among macroinvertebrate assemblages within a *Posidonia oceanica* meadow. Sampaio et al. (2016) recorded it at 48 meters depth of the Portuguese continental shelf. Alves et al. (2006) recorded it in stomach contents of *Sepia officinalis* Linnaeus, 1758 (Mollusca, Cephalopoda) off the south coast of Portugal, while this species was also reported among the food of grey seals, *Halichoerus grypus* (Fabricius, 1791) (Chordata, Mammalia) from the Isle of Man by Duncan (1956), and as food of the Almaco Jack, *Seriola rivoliana* Valenciennes, 1833 (Chordata, Actinopterygii) in Tunisian marine waters by Mansour et al. (2011).

R. dumerilii was collected on the *Trachurus trachurus* body in this study. *Trachurus trachurus* (Linnaeus, 1758) (Perciformes; Carangidae) is pelagic-neritic and oceanodromus fish with commercial value. It is one of the most important pelagic fish of purse seine and trawling fishery (Froese and Pauly, 2019). The total amount of european hake has been decreasing about 22.200 tones in 2000 to 12.985 tones for 2017 in Turkey (TUIK, 2018).

There is no report regarding micropredations of *R. dumerilii* on fish or other marine organisms according to the available literature. When the interrelationships between members of Carangidae as host and Aegidae as micropredator were examined, the occurrence of some records in the literature is supportive of our finding micropredator behaviour of *R. dumerilii* being also aegid on the atlantic horse mackerel in this study. Bruce (2009) found *Aegapheles alazon* species from the yellowtail horse mackerel, *Trachurus novaezelandiae* Richardson, 1843, belonging to Carangidae family in New Zealand. *R. signata* was reported on *Caranx crysos* (Mitchill, 1815) (Carangidae) and *Oligoplites saliens* (Bloch, 1793) (Carangidae) from Bahia by Carvalho-Souza et al. (2009), while it was reported on *Chloroscombrus chrysurus* (Linnaeus, 1766) (Carangidae) from Rio Grande do Norte by Lima et al. (2011); on *Caranx* sp. from Jamaica; Carrie Bow Cay and Blue Ground Range, in Belize by Kensley and Schotte (1989).

Mansour et al. (2011) found that *Rocinela dumerilii* from the stomach content of almaco jack, *Seriola rivoliana,* being carangid fish in Tunisian marine waters. Torcu Koç and Erdoğan (2019) and Bayhan et al. (2013) indicated that crustaceans were the dominant food category of atlantic horse mackerel. It is our opinion that Atlantic horse mackerel, being a migratory and carnivorous fish species, may have interacted with these isopods during their feeding activities during migrations.

Stepien and Brusca (1985) reported that fish were attacked by members of demersal crustacean assemblage such as luminent ostracod, *Vargula tsujii*, and the isopod *Cirolana diminuta* during their night diving observations while studying the case of death of adult fish in large cages on the seafloor off of the Southern California coast. They summarized the relationships and interactions between nocturnal migrating zooplankton and fish throughout the world.

Nocturnal migrating zooplankton assemblages consist of crustaceans including copepods, ostracods, amphipods, isopods, mysids, cumaceans, decapod larvae, and shrimps. These zooplankton assemblages pose a predation risk for migrating fish in comparison with non-migrating fish. Most nocturnally-active reef fish feed primarily on these migrating forms (Stepien and Brusca, 1985).

Stepien and Brusca (1985) indicated that ostracods are more attracted to chemicals released by healthy, sexually mature fish in comparison to juvenile fish. The chemicals from fish injured by ostracods may serve to attract amphipods and isopods. They observed that both ostracods and isopods often invaded the gills, entered the body cavity, and consumed the fish' gonads and liver. Stepien and Brusca (1985) also discussed that whether anecdotally reported these attacks occurred on live, dying or already-dead fish in the Pacific Ocean, off the coasts of Japan and the Arctic. This may be a possible reason, needed to be studied, for these attacks as the chemicals released from wounds being on fish after caught in the gill net attract isopods and amphipods. It is implied that the phenomenon about attack behaviour may be common in most coastal areas in the world. This attack behaviour was also observed by Turkish commercial fishermen many times during our research surveys.

Family Cymothoidae Leach, 1814

Elthusa Schioedte and Meinert, 1884

Elthusa sinuata (Koelbel, 1879) (Fig. 8)

Synonyms: *Livoneca mediterranea* Heller, 1868; *Livoneca sinuata* Koelbel, 1879; *Livoneca sinuata* Brian, 1912.

Figure 8: *Elthusa sinuata* (1 mm).

Host: the Fries's goby, *Lesueurigobius friesii*.

Infestation area, gill cavity. Examined fish, 70. Infested fish, five. Prevalence, 7.12%. Mean intensity, one.

Sampling stations: 40°31'N-28°12'E; 40°33'N-27°52'E; 40°33'N-27°41'E; 40°26'N-27°36'E.

Elthusa sinuata (syn. *Livoneca sinuata*) was described on the red bandfish, *Cepola macrophthalma* (syn. *Cepolae rubescentis*) from Sicilia by Koelbel (1879). It was reported from North-West Africa, United Kingdom, Mediterranean and Adriatic seas, Spain, France, Algeria, Tunisia, Italy, Yugoslavia, Montenegro, Turkey (van der Wal et al., 2019).

This parasitic isopod has been collected on hosts from several fish species as *Cepola macrophthalma* (Cepolidae), Pleuronectes sp. (Pleuronectidae), *Raja miraletus* (Rajidae), *Boops boops* (Sparidae), *Gobius* sp. (Gobidae), *Brama brama* (Bramidae), *Lepidopus caudatus* (Trichiuridae), *Trichiurus lepturus* (Trichiuridae), *Raja clavata* (Rajidae), and *Argentina sphyraena* (Argentinidae). It was also recorded from two cephalopod species *Sepiola ligulata* and *Loligo vulgaris* except of fish (Öktener et al., 2018; van der Wal et al., 2019).

Although no comment can be made about the host selectivity of *Elthusa sinuata*, six of the ten parasitized species belong to Perciformes. Most of host species exhibit demersal character and carnivorous feeding behaviour. This parasite is found on the gill cavity of Fries's goby, *Lesueurigobius friesii* in this study. This new host species also exhibits demersal character and carnivore feeding behaviour. The characters of this gobiid are similar to the characters of other hosts. This is consistent with findings in *Gobius* sp. reported by Dollfus and Trilles (1976).

CONCLUSIONS

Members of Aegidae are known for their behavior as micropredators or temporary parasites. Although species of these micropredators from Mediterranean have been reported by several researchers many times, information about the biology, life cycles, and interactions and relationships with other organisms of these micropredators are limited. The aim of this study is to contribute scientific information regarding the aforementioned unknown areas about these micropredators.

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