OCCURRENCE OF GNATHIA LARVAE (CRUSTACEA, ISOPODA, GNATHIIDAE) IN THREE LESSEPSIAN FISH SPECIES IN THE SOUTHERN TURKISH COAST OF THE AEGEAN SEA

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Series Historia Naturalis, 30, 2020, 1

UDK 5 Annales, Ser. hist. nat., 30, 2020, 1, pp. 1-130, Koper 2020 ISSN1408-533X

UDK 5

ISSN 1408-533X (Print)
ISSN 2591-1783 (Online)

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Series Historia Naturalis, 30, 2020, 1

KOPER 2020

ISSN 1408-533X (Tiskana izd.)
ISSN 2591-1783 (Spletna izd.)

UDK 5

Letnik 30, leto 2020, številka 1

Izdajatelja/*Editori/Published by:*

Zgodovinsko društvo za južno Primorsko - Koper / *Società storica del Litorale - Capodistria*©
Inštitut IRRIS za raziskave, razvoj in strategije družbe, kulture in okolja / *Institute IRRIS for Research, Development and Strategies of Society, Culture and Environment / Istituto IRRIS di ricerca, sviluppo e strategie della società, cultura e ambiente*©

Sedež uredništva/*Sede della redazione/*
Address of Editorial Board:

Nacionalni inštitut za biologijo, Morska biološka postaja Piran / *Istituto nazionale di biologia, Stazione di biologia marina di Pirano / National Institute of Biology, Marine Biology Station Piran*
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Redakcija te številke je bila zaključena 19. 06. 2020.

Sofinancirajo/*Supporto finanziario/*
Financially supported by: Javna agencija za raziskovalno dejavnost Republike Slovenije (ARRS), Luka Koper in Mestna občina Koper

Annales - Series Historia Naturalis izhaja dvakrat letno.

Naklada/*Tiratura/Circulation:* 300 izvodov/copie/copies

Revija Annales, Series Historia Naturalis je vključena v naslednje podatkovne baze / *La rivista Annales, series Historia Naturalis è inserita nei seguenti data base / Articles appearing in this journal are abstracted and indexed in*: BIOSIS-Zoological Record (UK); Aquatic Sciences and Fisheries Abstracts (ASFA); Elsevier B.V.: SCOPUS (NL); Directory of Open Access Journals (DOAJ).

ANNALES · Ser. hist. nat. · 30 · 2020 · 1

Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istrian and Mediterranean Studies

UDK 5 Letnik 30, Koper 2020, številka 1 ISSN 1408-533X (Print)
ISSN 2591-1783 (Online)

VSEBINA / *INDICE GENERALE / CONTENTS 2020(1)*

received: 2020-04-03 DOI 10.19233/ASHN.2020.11

OCCURRENCE OF *GNATHIA* LARVAE (CRUSTACEA, ISOPODA, GNATHIIDAE) IN THREE LESSEPSIAN FISH SPECIES IN THE SOUTHERN TURKISH COAST OF THE AEGEAN SEA

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ABSTRACT

Gnathia *larvae (praniza) of Gnathiidae (Crustacea, Isopoda) were reported for the first time from the southern Turkish coast of the Aegean Sea, found in the gill filaments of Lessepsian species goldband goatfish* Upeneus moluccensis *(Bleeker, 1855) and Red Sea goatfish* Parupeneus forsskali *(Fourmanoir & Guézé, 1976) (both Perciformes; Mullidae), and in the gill filaments and mouth of redcoat* Sargocentron rubrum *(Forsskål, 1775) (Beryciformes; Holocentridae). The prevalence of* Gnathia *larvae in these fish was 47 %, 63 %, and 58 %, mean intensity 1.3, 1 and 1, respectively. The parasites were observed macroscopically in the gill filaments of the fish, and appeared red as the blood sucked from their hosts completely filled their stomachs. A description of morphological characters of the praniza is also provided.*

Key words: *Gnathia* larvae, Goldband goatfish, Redcoat, Red Sea Goatfish, Lessepsian, Turkey

PRESENZA DI LARVE DI *GNATHIA* (CRUSTACEA, ISOPODA, GNATHIIDAE) IN TRE PESCI LESSEPSIANI LUNGO LA COSTA MERIDIONALE TURCA DEL MAR EGEO

SINTESI

Le larve (praniza) di Gnathia *(Crustacea, Isopoda, Gnathiidae) sono state segnalate per la prima volta lungo la costa turca meridionale dell'Egeo, rinvenute nei filamenti branchiali di specie lessepsiane, come la triglia dorata* Upeneus moluccensis *(Bleeker, 1855)* e Parupeneus forsskali *(Fourmanoir & Guézé, 1976) (entrambi Perciformes; Mullidae), e nei filamenti branchiali e nella bocca del pesce armato rosso* Sargocentron rubrum *(Forsskål, 1775) (Beryciformes; Holocentridae). La prevalenza delle larve di* Gnathia *in questi pesci era rispettivamente del 47 %, 63 % e 58 %, con un'intensità media pari a 1,3, 1 e 1. I parassiti sono stati osservati macroscopicamente nei filamenti branchiali dei pesci e sono diventati rossi quando il sangue succhiato ai loro ospiti ha riempito completamente il loro stomaco. Gli autori forniscono anche una descrizione dei caratteri morfologici delle larve.*

Parole chiave: larve di *Gnathia*, triglia dorata, pesce armato rosso, lessepsiani, Turchia

INTRODUCTION

The goldband goatfish, the Red Sea goatfish and the redcoat are known as native to the Indo-Pacific Ocean and Red Sea. After the opening of the Suez Canal, they have been reported as non-indigenous species in the Mediterranean Sea. The goldband goatfish and the redcoat were reported for the first time by Kosswig (1950), and the red sea goatfish by Çınar *et al*. (2006) in the Turkish coast of the Mediterranean Sea . There are several records about these fish species in Turkey: Gücü *et al*. (1994), Taşkavak *et al*. (1998), Kaya *et al*. (1999), Başusta & Erdem (2000), Torcu & Mater (2000), Bilecenoğlu *et al*. (2002), Öğretmen *et al*. (2005), Sangun *et al*. (2007), Gökçe *et al*. (2010), Ergüden & Turan (2013) for the goldband goatfish; Taşkavak *et al*. (1998), Başusta & Erdem (2000), Torcu & Mater (2000), Taşkavak & Bilecenoğlu (2001), Can *et al*. (2002), Öğretmen *et al*. (2005), Kabaklı & Ergüden (2018) for the redcoat; and Yağlıoğlu & Ayaş (2016), Gürlek *et al*. (2016) for the Red Sea goatfish.

The Gnathiidae display sexual dimorphism. Adult forms are free-living organisms found in oscular cavities of sponges, on various substrates, such as galleries in soft sea floor, in coral crevices, or microcliffs of estuaries (Smit & Basson, 2002, Giannetto *et al*., 2003). Larval forms have three stages, with each stage including two forms: praniza and zuphea. Pranizas are known as temporary haematophagous ectoparasites on fish including elasmobranchs and teleosts (Ferreira, 2011). Zupheas are non-feeding benthic dwellers (Hadfield *et al*., 2008; Ferreira, 2011). Pranizas have been reported from the body surface, gill and mouth cavities, and fins of their hosts. A praniza feeds on the blood and tissue fluids of fish; when its gut is filled with the blood of the host, it goes down to the benthos for meal digestion, and later moults into female or male (Tanaka, 2007; Ferreira, 2011).

Several studies have been carried out about pathological and detrimental effects of praniza larvae on their hosts (Paperna & Zwerner, 1976; González *et al*., 2004; Marino *et al*., 2004; Jones & Grutter, 2005). There are also reports of fish deaths caused by praniza infestations from around the world (Paperna & Por, 1977; Paperna & Overstreet, 1981; Mugridge & Stallybrass, 1983; Patarnello *et al*., 1995).

Lessepsian parasites were reported from the Mediterranean (Merella *et al*., 2016; Özak *et al*., 2012; El-Rashidy & Boxshall, 2012), after the occurrence of 18 Lessepsian parasites were recognized by Zenetos *et al*. (2008). In addition to them, the parasitological surveys show that also native parasites were reported from Lessepsian fish (İnnal *et al*., 2007; Shakman *et al*., 2009; Öktener *et al*., 2010; Boussellaa *et al*., 2016; Merella *et al*., 2016; Bakopoulos *et al*., 2017).

These isopods have previously been reported from host species belonging to different fish families native to Turkey (Akmırza, 2000; Akmırza, 2001; Genç *et al*., 2003; Kırkım *et al*., 2008; Alaş *et al*., 2009). Although the mentioned three Lessepsian fish species have colonized the Mediterranean coasts, the parasites associated with them have not been investigated in detail in Turkey. The present study reports the occurrence of new hosts of praniza of *Gnathia* sp in Turkey, complete with morphological characters.

MATERIAL AND METHODS

Redcoat, *Sargocentron rubrum* (Forsskål, 1775) (Beryciformes; Holocentridae) (n = 63), goldband goatfish, *Upeneus moluccensis* (Bleeker, 1855) (Perciformes; Mullidae) (n = 42) from Fethiye Bay (16°17′ N 120°12′ E) and Red Sea goatfish, *Parupeneus forsskali* (Fourmanoir & Guézé, 1976) (Perciformes; Mullidae) (n = 48) from Datça Bay (16°17′ N 120° 12′ E) were caught by gill nets in the Aegean Sea, Turkey in July 2019. The collected parasite samples were fixed in 70% ethanol. Some of the praniza were put in lactic acid for clearing for a minimum of 24 h. The praniza were dissected out in lactic acid between slide and cover slip using Wild M5 and Leica M140 stereo microscopes. All drawings were made with the aid of a drawing tube (Olympus BH-DA) attached to the compound microscope. Measurements are given in millimeters. Identifications and comparisons were performed according to Smit & Basson (2002), Giannetto *et al*. (2003), Hadfield *et al*. (2008) and Ferreira (2011). Scientific names and synonyms of parasites were checked in WoRMS Editorial Board (2020), and fish hosts described according to Froese & Pauly (2019).

RESULTS

Order Isopoda Latreille, 1817
Suborder Cymothoida Wägele, 1989
Superfamily Cymothooidea Leach, 1814
Family Gnathiidae Leach, 1814
Genus *Gnathia* Leach, 1814 (Figs. 1-8, Tab. 1)

Tab. 1: Infestation information concerning praniza.
Tab. 1: Podatki o okužbi s pranico.

Hosts	Prevalence (%)	Mean Intensity	Infestation site
Parupeneus forsskali	63	1	the gill filaments
Upeneus moluccensis	47	1.3	the gill filaments
Sargocentron rubrum	58	1	the gill filaments, mouth cavity

Fig. 1: Praniza of gnathiid isopod. Scale bar: 0.5 mm.
Sl. 1: Ličinka pranica raka enakonožca iz rodu *Gnathia*. ***Merilo: 0,5 mm.***

The trunk colour of the larvae was reddish in appearance as their bodies were filled with the blood of the host. In addition, excess mucus was observed in the gill filaments of the hosts. Infestation information of the praniza is provided in Table 1.

Description of praniza larva (Figs. 1-8): Total body length of praniza larvae is 1.93-2.52 mm, body width 0.61-0.67 mm (n=25). Cephalosome sub-circular and conical-shaped. Posterior margin straight and slightly wider than anterior margin. Cephalon slightly wider than long. Lateral margins slightly convex and parallel. Eyes oval-shaped, large, well developed on lateral margins of cephalosome. Length of eyes is two-thirds of the length of cephalosome. Many melanospots randomly covering dorsal surface of cephalosome. Antenna longer than antennule. Antennule (Fig. 2a) with three peduncle articles, third article longest. Flagellum with four articles, article 2 longest. Both articles 2 and 3 with one and two simple setae; article 4 with one aesthetic seta and five setae. Antenna (Fig. 2b) with four peduncle articles; fourth article longest. Lateral margins of articles 2-4 denticulated. Flagellum with seven articles; article 1 slightly longer. Article 7 with four long setae on distal tip; each article with 1-5 setae on distal end. Mandible (Fig. 2d) stout with swollen basis; distal tip styliform with 12 backwardly directed teeth on its inner margin. Maxillule (Fig. 2e) long and styliform; with eight small teeth on distal inner margin. Maxilla not visible. Maxilliped (Fig. 2c) large, cylindrical, composed of basis and three articled palps. Basis with a long seta and style-like endite. Article 1 with 10 teeth, article 2 with four setae, article 3 with three setae. Gnathopods (Fig. 2f) smaller than pereopods, with seven articles; basis and coxa without pectinate or seta; basis, ischium, merus, carpus, propodus with pectinate scales on inner margins; ischium, merus, carpus, propodus with one seta; dactylus hook-like with a small tooth on medium. Merus the largest article, carpus the smallest article. Paragnath (Fig. 2g) three-segmented, basal segment bears one seta.

Pereopods (Fig. 3) 1-2 similar in size; pereopods gradually increasing from 1 to 5, pereopod 1 being

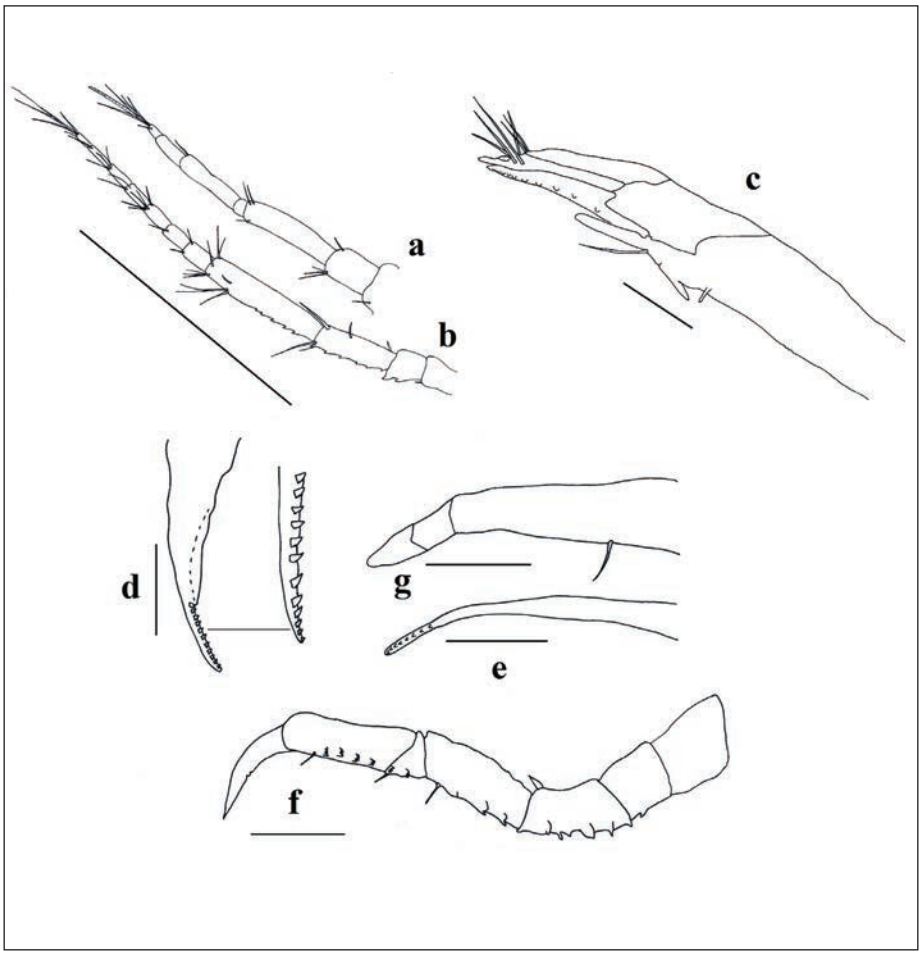

Fig. 2: a. Antennule, b. Antenna, c. Maxilliped, d. Mandible, e. Maxillule, f. Gnathopod, g. Paragnath. Scale bar a & b: 0.38 mm, c & g: 0.05 mm, d: 0.07 mm, e: 0.08 mm and f: 0.09 mm.
Sl. 2: a. antenula, b. antena, c. maksiliped, d. mandibula, e. maksilula, f. gnatopod, g. paragnat. Merilo a & b: 0,38 mm, c & g: 0,05 mm, d: 0,07 mm, e: 0,08 mm in f: 0,09 mm.

the shortest, pereopod 5 the longest. The length of the basis of pereopod 2 about 4 times the width, basis with three simple setae anteriorly, a single simple seta posteriorly, ischium 0.6 times as long as basis, three setae anteriorly, two setae posteriorly, merus 0.6 times as long as ischium, with anterior bulbous protrusion, two simple setae and a single feather-like seta on bulbous protrusion, two setae on posterior margin, carpus 1.2 times as long as merus, four simple setae on posterior margin, propodus 1.2 times as long as carpus, two simple setae on anterodistal margin, two robust setae and a single seta on posterior margin, dactylus 0.6 times as long as propodus, two setae on posterior side and two setae on median side. Posterior margin on propodus of pereopod 1 denticulated; pereopod 2 non-denticulated; posterior margin of propodus, carpus, merus, ischium of pereopod 3 denticulated; posterior margin of propodus, carpus, merus of pereopods 4-5 denticulated.

Pleopods (Fig. 4a) biramous and fan-shaped; endopod larger than exopod in each pleopod. Endopod of pleopod 1 with two articles and bearing 11 plumose setae, exopod with 10 plumose setae. Pleopods 2-3 with 8 plumose setae on endopod and 9 plumose setae on exopod. Pleopod 5 with 7 plumose setae on endopod and 8 plumose setae on exopod. Peduncles of pleopods with two coupling hooks on inner margin, a single seta on inner margin. Endopod (Fig. 4b) larger than exopod. Endopod slightly extending beyond tip of pleotelson. Endopod and exopod with 9 plumose setae. Outer and inner margins of exopod and endopod with short hair-like setae. Uropodal basis with two simple setae.

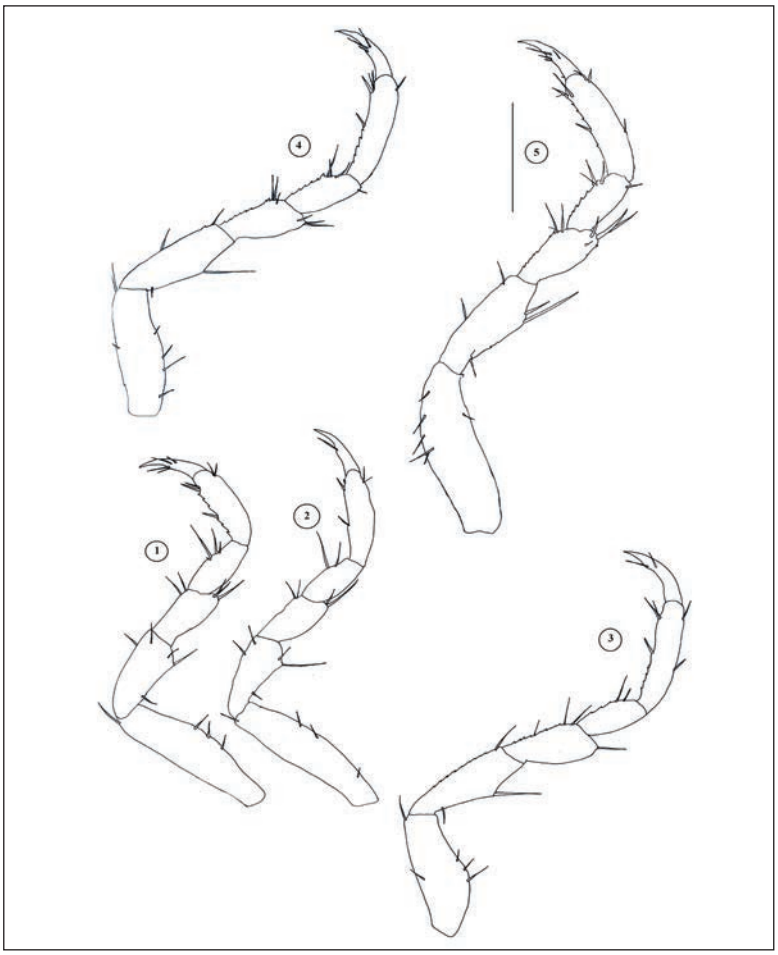

Fig. 3: Pereopods 1-5 of praniza. Scale bar: 0.32 mm.
Sl. 3: Pereiopodi od 1 do 5 pri ličinki pranici. Merilo: 0,32 mm.

DISCUSSION

The fish diversity of Turkish coasts was reviewed by Bilecenoğlu *et al*. (2014), who identified 512 species. Marine fish fauna of Turkey has changed considerably with the arrival of alien species of Indo-Pacific and Atlantic origin through the Suez Canal, Gibraltar, due to climate change, and through ballast water (Oral, 2010; Turan *et al*., 2018). Turan *et al*. (2018) counted 101 non-indigenous fish species reported in Turkish marine waters, including 73 species of Indo-Pacific origin, 22 species of Atlantic origin and 6 species of unknown origin.

The examination of the three Lessepsian fish carried out in this study mainly concerned their length-weight relationships, ecology, and population dynamics in Turkey to date. Although these Lessepsian fishes have been colonizing the Mediterranean coasts since the opening of the Suez Canal in 1869, the parasites associated with them have only been scarcely investigated in the Mediterranean.

Taxonomy of the gnathiid is generally based on the morphology of the free-living male, thus the identification of the morphology of gnathiid larvae is not possible (Smit & Basson, 2002; Hadfield *et al*., 2008; Ferreira, 2011). Hence, the gnathiid larvae in this study could not be identified at species level. There is no previous study providing the description of gnathiid larvae in Turkey. This study is the first report on parasites found in three Lessepsian fish from the Mediterranean Sea.

To date, members belonging to the Gnathiidae have been reported in twenty-eight fish species in the Sea of Marmara, Black Sea, Aegean Sea and Mediterranean coasts of Turkey (Tab. 2). Table 2 provides a general idea about the hosts of Gnathia larvae. Host fish parasitized by Gnathiidae are interpreted according to the feeding type, habitat preference, and family.

There are only a few reports concerning praniza found in members belonging to the Actinopterygii in Turkey. Nunomura and Honma (2004), and Ota

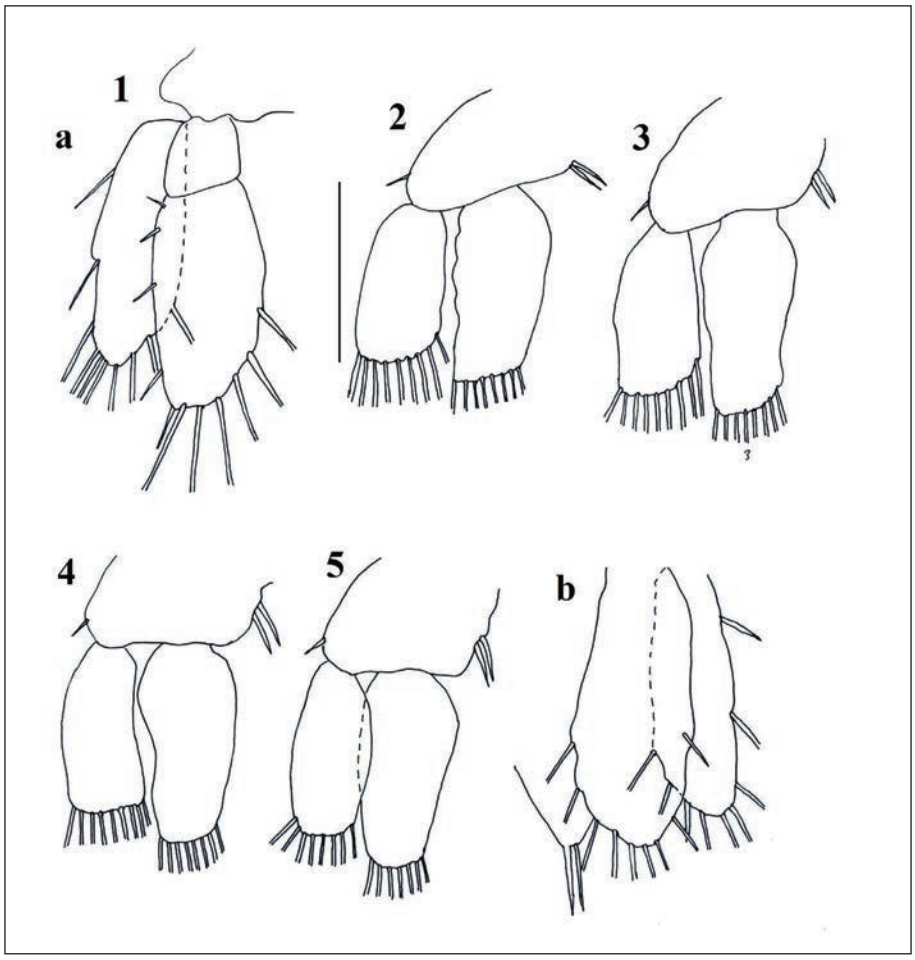

Fig. 4: a. Pleopods 1-5 (0.13 mm), b. uropod. Scale bar: 0.13 mm.
Sl. 4: a. Pleopodi 1-5 (0,13 mm), b. uropod. Merilo: 0,13 mm.

(2015) reported of praniza in elasmobranchs. On the other hand, Mhaisen *et al*. (2018) counted 18 marine fish species (10 bony fishes + 8 cartilaginous fishes) as hosts of *Gnathia* sp. in Iraq. There is no record of praniza in Elasmobranchii in Turkey. Gnathiids are mainly reported in fish belonging to the Sparidae and the Serranidae of the Perciformes in light of the studies carried out in Turkey. Based on the habitat types of the host species, the praniza also seem to display a preference for demersal fish, including reef-associated and benthopelagic, over pelagic fish. When the feeding habits of the host species infested with praniza are examined, it may be said that praniza larvae prefer carnivorous to omnivorous or herbivorous fishes.

The praniza larvae in this study were reported from Lessepsian fishes *U. moluccensis*, *P. forsskali* and *S. rubrum*. The fact that these fish are of demersal character in view of their habitat, and carnivorous by feeding habit, presents them as possible hosts of Gnathiidae praniza larvae.

Bilge *et al*. (2019) analysed the potential invasiveness of 45 Lessepsian marine fishes in the southwestern coasts of Anatolia (Muğla region, Turkey) using the Aquatic Species Invasiveness Screening Kit (AS-ISK). They categorised *Upeneus moluccensis* and *Sargocentron rubrum* as high-risk species, and *Parupeneus forsskali* as a medium-risk species according to both thresholds. After these Lessepsian fishes were first seen in the Mediterranean Sea in 1950, their high-risk potential invasiveness values show that they adapted very well to the Marmara Sea. The fact that these fishes are well settled in the Mediterranean contributes to them being potential hosts of gnathiid praniza.

Although the Gnathiidae are treated as native parasites in this study, it is not known whether this parasite species is invasive. It has been reported from these hosts in the Indian Ocean as well. Chelladurai & Subbulakshmi (2017) reported of gnathiid praniza on *Parupeneus indicus* with a 93.7% prevalence, and *Sargocentron rubrum* with a 63.6% prevalence

Fig. 5: Red Sea goatfish, *Parupeneus forsskali* ***(Fourmanoir & Guézé, 1976), redcoat,*** *Sargocentron rubrum* ***(Forsskål, 1775), goldband goatfish,*** *Upeneus moluccensis* ***(Bleeker, 1855) (top to bottom).***
Sl. 5: *Parupeneus forsskali* ***(Fourmanoir & Guézé, 1976),*** *Sargocentron rubrum* ***(Forsskål, 1775),*** *Upeneus moluccensis* ***(Bleeker, 1855) (od zgoraj navzdol).***

Fig. 6: Praniza on mouth base of redcoat.
Sl. 6: Pranica na ustih veveričevke.

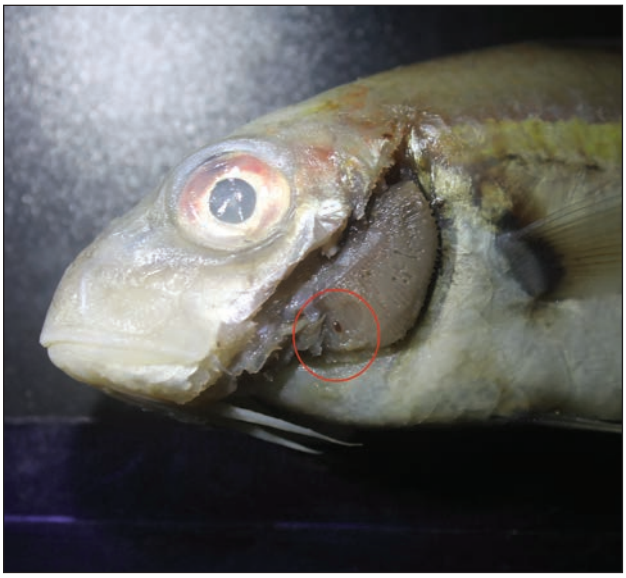

Fig. 7: Praniza on gill filaments of goldband goatfish.
Sl. 7: Pranica na škržnih filamentih vrste *Upeneus moluccensis.*

Fig. 8: Praniza on gill filaments of goldband goatfish.
Sl. 8: Pranica na škržnih filamentih vrste *Upeneus moluccensis.*

Tab. 2: Reports of gnathiid isopods on fish from Turkey.
Tab. 2: Poročanja o rakih enakonožcih na ribah iz Turčije.

Gnathiid Species	Host	Locality	Record
Praniza larvae	*Diplodus annularis*	Aegean Sea	Akmırza (2000)
Praniza larvae	*Diplodus vulgaris*	Aegean Sea	Akmırza (2000)
Praniza larvae	*Diplodus sargus*	Aegean Sea	Akmırza (2000)
Praniza larvae	*Dentex dentex*	Aegean Sea	Akmırza (2000)
Praniza larvae	*Lithognathus mormyrus*	Aegean Sea	Akmırza (2000)
Praniza larvae	*Pagrus pagrus*	Aegean Sea	Akmırza (2000)
Praniza larvae	*Diplodus annularis*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Diplodus vulgaris*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Symphodus tinca*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Scorpaena porcus*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Scorpaena scrofa*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Gaidropsarus mediterraneus*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Umbrina cirrosa*	Aegean Sea	Akmırza (2001)
Praniza larvae	*Epinephelus aeneus*	Mediterranean Sea	Genç *et al.* (2003)
Praniza larvae	*Epinephelus marginatus*	Mediterranean Sea	Genç (2007)
Praniza larvae	*Ephinephelus costae*	Mediterranean Sea	Erol (2007)
Praniza larvae	*Mullus surmuletus*	Black Sea	Alaş *et al.* (2009)
Praniza larvae	*Scorpaena scrofa*	the Sea of Marmara	Alaş *et al.* (2009)
Praniza larvae	*Serranus cabrilla*	the Sea of Marmara, Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Mugil cephalus*	Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Gaidropsarus mediterraneus*	Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Trachurus mediterraneus*	Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Sarpa salpa*	Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Diplodus vulgaris*	Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Sciaena umbra*	Aegean Sea	Alaş *et al.* (2009)
Praniza larvae	*Pagellus erythrinus*	the Sea of Marmara	Alaş *et al.* (2009)
Praniza larvae	*Diplodus annularis*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Diplodus vulgaris*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Lithognathus mormyrus*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Spicara maena*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Pagellus erythrinus*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Coris julis*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Scorpaena scrofa*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Stephanolepis diaspros*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Sparus aurata*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Dicentrarchus labrax*	Aegean Sea	Akmırza (2010)
Praniza larvae	*Conger conger*	Aegean Sea	Akmırza (2012)
Praniza larvae	*Dentex macrophthalmus*	Aegean Sea	Düşen *et al.* (2016)
Paragnathia formica (Hesse,1864)	*Mugil cephalus*	Aegean Sea	Kırkım *et al.* (2008)
Paragnathia formica (Hesse,1864)	*Pagellus erythrinus*	Aegean Sea	Kırkım *et al.* (2008)
Paragnathia formica (Hesse,1864)	*Mugil cephalus*	Mediterranean Sea	Taşkın (2013)

from the southeastern coast of India, Gulf of Mannar. Paperna & Por (1977) reported *Gnathia piscivora* in mullets in Israel. Tuan *et al*. (2015) reported Gnathia sp with a 26.92% prevalence on *Parupeneus multifasciatus* and a 57.14% prevalence on *P. heptacanthus* in Vietnam. Rückert *et al*. (2009) reported of *Gnathia* sp with a 10% prevalence on *Upeneus moluccensis* in Lampung Bay, Indonesia.

Fish parasites have been used to discriminate fish stock in population studies (Avdeev, 1992; MacKenzie & Abaunza, 1998; MacKenzie, 2002; Catalano *et al*., 2014; Poulin & Kamiya, 2015) and in other fields of study, e.g., as pollution indicators (MacKenzie *et al*., 1995; MacKenzie, 1999; Palm & Dobberstein, 1999; Williams & MacKenzie, 2003) since the 1950s.

ACKNOWLEDGEMENTS

The authors wish to thank Msc. Murat Keleş for correcting the grammar of the manuscript.

POJAVLJANJE LIČINK VRSTE IZ RODU *GNATHIA* (CRUSTACEA, ISOPODA, GNATHIIDAE) PRI TREH LESEPSKIH SELIVKAH V JUŽNIH TURŠKIH VODAH EGEJSKEGA MORJA

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POVZETEK

Avtorji poročajo o prvem pojavljanju ličink (pranica) vrst iz rodu Gnathia *(Crustacea, Isopoda) iz južnih turških voda Egejskega morja, najdenih na filamentih lesepskih bradačev* Upeneus moluccensis *(Bleeker, 1855) in* Parupeneus forsskali *(Fourmanoir & Guézé, 1976) (oba Perciformes; Mullidae) ter na škržnih filamentih veveričevke* Sargocentron rubrum *(Forsskål, 1775) (Beryciformes; Holocentridae). Pojavljanje ličink iz rodu* Gnathia *pri teh ribah je bilo 47 %, 63 %, in 58 %, povprečna intenzivnost pa 1.3, 1 in 1. Zajedavci so bili opaženi na škržnih filamentih in so bili rdeče barve, saj so s krvjo gostitelja povsem zapolnili želodec. Avtorja podajata tudi popis morfoloških znakov pranice.*

Ključne besede: ličinke iz rodu *Gnathia*, *Upeneus moluccensis*, *Parupeneus forsskali*, *Sargocentron rubrum*, lesepske selivke, Turčija

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