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HOST SELECTIVITY OF *NEROCILA ORBIGNYI* (GUERIN-MENEVILLE, 1832) (ISOPODA, CYMOTHOIDAE) WITH A RECORD OF A NEW HOST FROM THE SEA OF MARMARA (TURKEY)

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KEYWORDS: *Nerocila*, Cymothoidae, host selectivity, *Mugil cephalus*, Sea of Marmara.

ABSTRACT

Nerocila orbignyi (Isopoda, Cymothoidae) is reported for the first time on *Mugil cephalus* Linnaeus, 1758 (Pisces, Mugilidae) from Bandırma Bay (the Sea of Marmara, Turkey) during 2020. This paper aims to present the morphological characters of male of *N. orbignyi* from Turkey. Hosts infested with *N. orbignyi* are commented according to taxonomical status (order, families), ecological behaviours (habitat selections, feeding habits, school-solitary), morphological characters (scale types) according to current records. It may be said that *N. orbignyi* has been reported more frequently on fish belonging to the Perciformes order and Mugilidae and Sparidae families. It may also be said that this parasite selects also the fishes with carnivorous, demersal, schools, and migratory character.

RÉSUMÉ: Sélectivité de l'hôte de *Nerocila orbignyi* (Guerin-Meneville, 1832) (Isopoda, Cymothoidae) avec un enregistrement d'un nouvel hôte de la mer de Marmara (Turquie).

Nerocila orbignyi (Isopoda, Cymothoidae) est signalée pour la première fois sur *Mugil cephalus* Linnaeus, 1758 (Poissons, Mugilidae) sur Bandırma Bay (la mer de Marmara, Turquie) au cours de 2020. L'article vise à présenter les caractères morphologiques du mâle de *N. orbignyi* de Turquie. Les hôtes infestés par *N. orbignyi* sont commentés selon leur statut taxonomique (ordre, familles), leurs comportements écologiques (choix de l'habitat, habitudes alimentaires, leurs caractères morphologiques (types d'échelle) selon les enregistrements actuels. On peut dire que *N. orbignyi* a été signalé plus fréquemment que les poissons appartenant à l'ordre des Perciformes et aux familles des Mugilidae et des Sparidae. On peut également dire que ce parasite sélectionne également les poissons en bancs en bancs et à caractère carnivore, démersal, et migrateur.

REZUMAT: Selectivitatea gazdei *Nerocila orbignyi* (Guerin-Meneville, 1832) (Isopoda, Cymothoidae) cu înregistrarea unei noi gazde din Marea Marmara (Turcia).

Nerocila orbignyi (Isopoda, Cymothoidae) este raportată pentru prima dată pe *Mugil cephalus* Linnaeus, 1758 (Pești, Mugilidae) din Golful Bandırma (Marea Marmara, Turcia) în 2020. Lucrarea își propune să prezinte caracterele morfologice ale masculului de *N. orbignyi* din Turcia. Gazdele infestate cu *N. orbignyi* sunt descrise în funcție de încadrarea taxonomică (ordin, familie), comportamentul ecologic (selecția habitatelor, obiceiurile de hrănire, independența față de banc), caracterele morfologice (tipurile de solzi) conform înregistrărilor actuale. Se poate spune că *N. orbignyi* a fost raportată mai frecvent pe peștii aparținând ordinului Perciformes și familiilor Mugilidae și Sparidae. Se poate spune, de asemenea, că acest parazit selectează și peștii cu caracter carnivor, demersal, social și migrator.

INTRODUCTION

Fish parasites are important groups of biodiversity. Parasites are in balance with host fish in the natural environment. However, parasites can be harmful due to changes in environmental conditions such as intensive stocking, temperature, pH, etc., in fish farms. Fish parasites can even lead to mass mortalities on fish farms (Northcott et al., 1997; Ökterener and Ünal, 2020). Sometimes, parasites can become active for various reasons and cause mass mortalities in natural environments. For example, *Haplosporidium pinnae* Catanese et al., 2018 caused the mass mortality in endangered *Pinna nobilis* (Linnaeus 1758) fan mussels from the Mediterranean Sea (Panarese et al., 2019). It is known that there are 257 fish species from the Sea of Marmara (Bilecenoğlu et al. 2014). However, there are not many studies on parasite diversity in fish.

Cymothoidae (Crustacea) are ectoparasitic isopods especially on the skin, bucal cavity, gill cavity, fins of hosts belonging to different marine, freshwater and brackish teleost fish (Trilles, 1994). Although Cymothoids are typically reported from teleost fish, there are some unusual associations such as sponges (Monod, 1933), jellyfish (Haswell, 1880), crustaceans (Lemos de Castro and Gomes Corrêa, 1982), chondrichthyans (Moreira and Sadowsky, 1978), amphibians (Stadler, 1972), snakes (Saravanakumar et al., 2012). While there are many reports of cymothoids from wild fishes, there are also reports from fish farms and aquaculture systems (Bragoni et al., 1983, 1984; Mladineo, 2002; Horton and Okamura, 2003; Çolak et al., 2018).

The cymothoid diversity of fishes should be more deeply investigated to better understand the biology of them. The present study aims to report a new host record for *Nerocila orbigny* from Turkey. In addition, hosts of *Nerocila orbigny* are examined according to family characteristics, habitat selections, feeding habits.

MATERIAL AND METHODS

109 individuals of *Mugil cephalus* Linnaeus, 1758 were collected by hand fishing rod from Bandırma Bay, the Sea of Marmara of Turkey during 2020. Parasites were fixed in 70% ethanol. Parasites were dissected using a Wild M5 stereo microscope. The dissected parts were mounted on slides in a glycerin-gelatine mounting medium. The appendages were drawn with the aid of a camera lucida (Olympus BH-DA). The photos were taken with the aid of Canon camera (EOS 1100D) attached to the microscope. Measurements were taken in millimeter (mm) with a micrometric program (Pro-way). Scientific names, synonyms were checked with the WoRMS Editorial Board (2020). The information of feeding habits, habitat characteristics of the host were prepared according to Froese and Pauly (2019). Identifications and comparisons of parasites were performed according to Trilles (1975), and Bruce (1987).

RESULTS AND DISCUSSION

Isopoda Latreille, 1817

Cymothoidae Leach, 1818

Nerocila Leach, 1818

Nerocila orbigny (Guérin-Méneville, 1832) (Figs. 1-3)



Figure 1: *Nerocila orbignyi*, male.

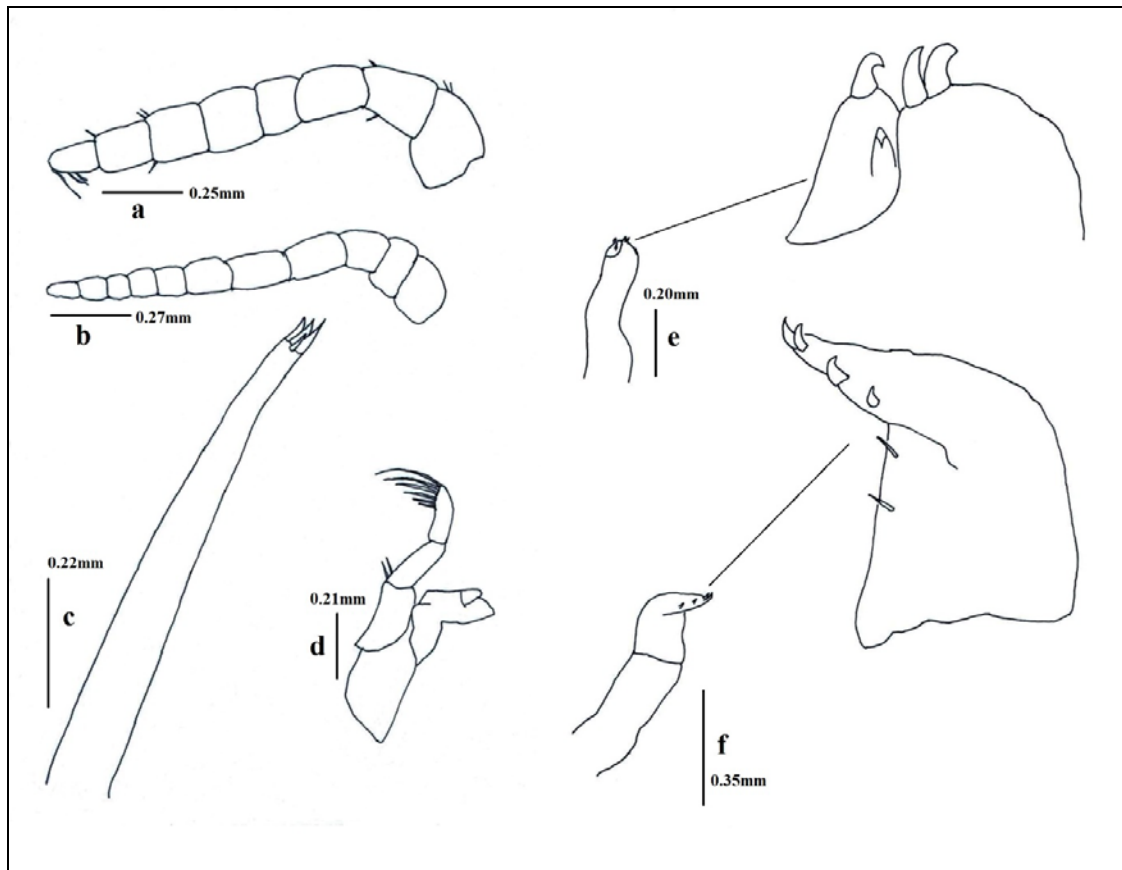


Figure 2: a) antennula, b) antenna, c) maxillula, d) mandible, e) maxilla, f) maxilliped.

Number of examined fish 109; number of infested fish eight; prevalence 7.33%; mean intensity 1; infestation site on host on ventral and pectoral fins.

Male morphological characteristics: body length varies from 6.8 to 9.5 mm. Cephalon 0.5 times longer than wide, visible from dorsal view. Body three times as long as greatest width. Pereon longest at pereonite 1, shortest at pereonite 4. Pereon widest at pereonite 5, most narrow at pereonite 1. Eyes big, facets distinct, 0.2 times width of head. Coxal plates of pereonites not visible in dorsal view. All pleonites visible in dorsal view. Pleon longest at pereonite 5, shortest at pereonite 1. Pleon widest at pereonite 1, most narrow at pereonite 5. Pleon 1 and 2 not overlapped by pereonite 7. Pleotelson 0.85 times as long as anterior width. Pleotelson not wider than pereonite 7 and pleonite 5. Pleotelson longer than width. Antennula (Fig. 2a) comprising eight articles; extending to posterior margin of eye. Antenna (Fig. 2.b) comprising 11 articles, extending to anterior margin of pereonite 1. Antenna slightly longer than antennula. Mandibular process (Fig. 2d) without simple setae. Third article of mandible palp slightly shorter than others, article 3 with six setae; article 2 with two setae on lateral margin. Maxillula (Fig. 2c) with four terminal setae, one long, one short, two setae similar in length. Maxilla (Fig. 2e) mesial lobe with two robust setae, lateral lobe with two recurved setae. Maxilliped (Fig. 2f) comprising three articles, article 3 with 4 recurved robust setae.

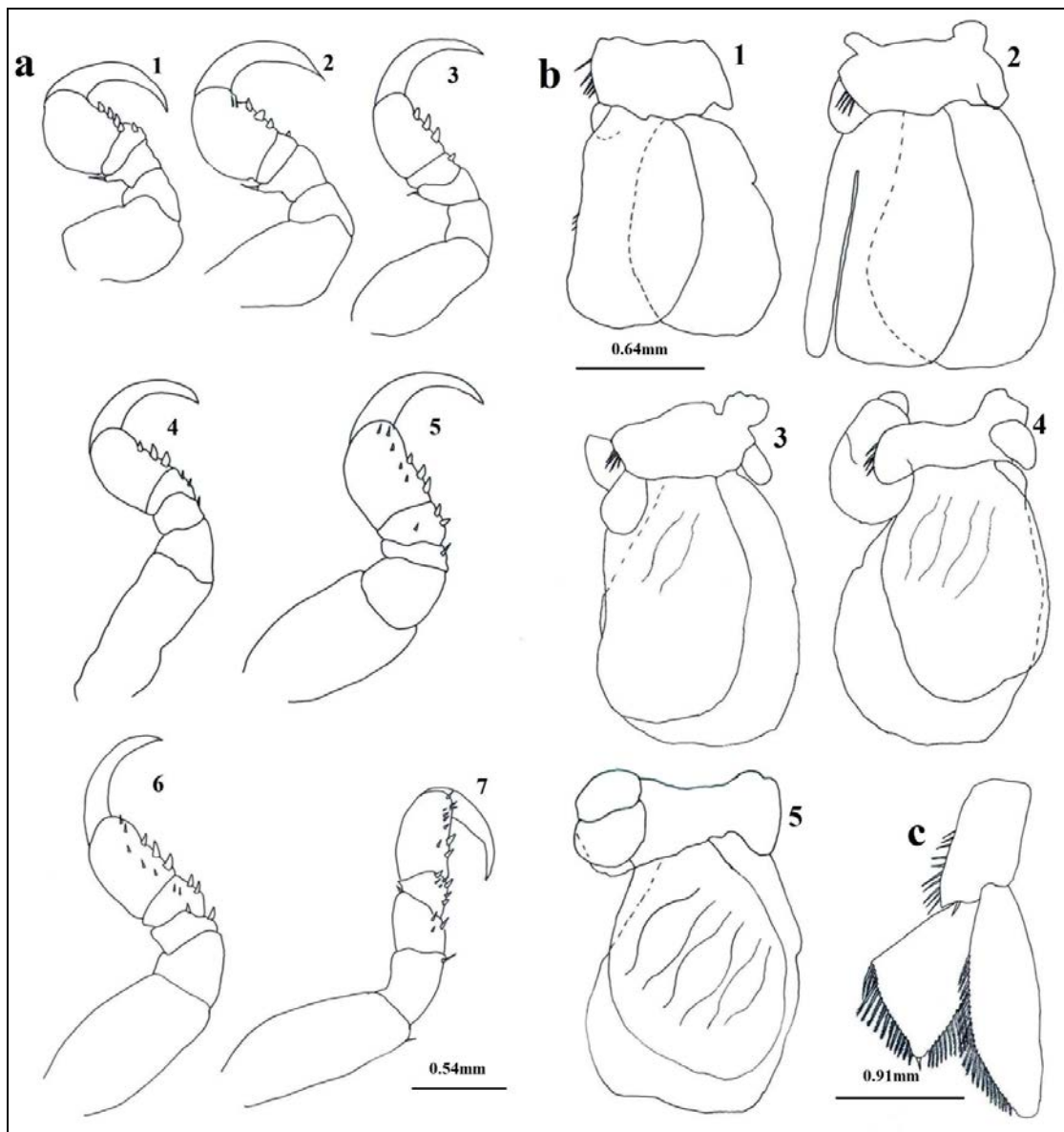


Figure 3: a) Pereopods 1-7, b) pleopods 1-5, c) uropod.

Pereopods 1-3 (Fig. 3a) similar in size, slightly smaller than pereopods 4-7. Three big spines on posterior margin of propodus of pereopods 2-6; four spines on posterior margin of propodus of pereopod 1; two spines on posterior margin of propodus of pereopods 7. Besides, five spines on medial side of propodus of pereopods 5-6; eight spines with pereopod 7. One big spine on posterior margin of carpus of pereopods 1-3; two big spines on posterior margin of carpus of pereopods 4-6; five big spines posterior margin of carpus of pereopod 7. Small spines on medial side of carpus of pereopod 5-7. One spine of posterior margin of merus of pereopods 4-5; two spines posterior margin of merus of pereopods 6-7. Besides, one spine on anterior margin of merus of pereopods 1-3, 7. One spine on posterior margin of ischium and

basis of pereopod 7. Pleopods (Fig. 3b) slightly decreasing in length. Pleopod 2 appendix masculina the same length as length of endopod. Peduncles of pleopods 1-4 with coupling hooks. Pleopod 1 exopod 1.4 times as long as wide, lateral and mesial margin slightly rounded, distally broadly rounded; endopod 1.6 times as long as wide, lateral margin straight, distally broadly rounded, mesial margin rounded; peduncle 1.8 times as wide as long. Exopod of uropod (Fig. 3c) longer than endopod; endopod extending beyond pleotelson posterior margin.

Eight genus belonging to the family Cymothoidae (Crustacea, Isopoda) were reported from the Mediterranean such as *Anilocra*, *Ceratothoa*, *Elthusa*, *Emetha*, *Idusa*, *Livoneca*, *Mothocya*, and *Nerocila* (Trilles, 1997; Castello et al., 2020). Forty-two species were listed by The World Register of Marine Species (WoRMS, 2020) in the genus *Nerocila*. Four species (*Nerocila acuminata*, *Nerocila bivittata*, *Nerocila orbignyi*, and *Nerocila milesensis*) were reported from Turkish waters (Öktener and Trilles, 2004; Er and Kayış, 2015; Öktener et al., 2020).

Nerocila orbignyi is a parasite frequently reported from the body surfaces and fins of fish. It has been reported from North Atlantic Ocean, Mediterranean Sea, Adriatic Sea (Trilles 1994). It is associated with Actinopterygii and Elasmobranchii (Tab. 1).

Table 1: The hosts of *Nerocila orbignyi* with synonyms.

Nerocila orbignyi (Guérin-Méneville, 1832) with synonyms	Host fish species (synonyms)	Order, family of host	Locality	References
	<i>Chimaera</i> sp.	Chimaeriformes, Chimaeridae.	Warrnambool, Victoria	Hale (1926)
	<i>Callorhinchus milii</i>	Chimaeriformes, Callorhinchidae.	Tasmania, off Storm Bay	Hale (1940)
	<i>Chelon auratus</i> (syn. <i>Mugil auratus</i>)	Mugiliformes, Mugilidae.	Thau and Vic-Mireval ponds, and Lake Patria in Italy	Trilles (1961, 1962, 1964a, b, 1968)
	<i>Mugil cephalus</i>	Mugiliformes, Mugilidae.	Thau and Vic-Mireval ponds, and Lake Patria in Italy	Trilles (1961, 1962, 1964a, b, 1968)
	<i>Chelon ramada</i> (syn. <i>Mugil capito</i>)	Mugiliformes, Mugilidae.	Thau and Vic-Mireval ponds, and Lake Patria in Italy	Trilles (1962, 1964a, b, 1968)
	<i>Chelon labrosus</i> (syn. <i>Mugil chelo</i>)	Mugiliformes, Mugilidae.	Thau and Vic-Mireval ponds, and Lake Patria in Italy	Trilles (1962, 1964a, b, 1968)
	<i>Dicentrarchus labrax</i> (syn. <i>Labrax lupus</i>)	Perciformes, Moronidae.	Thau and Vic-Mireval ponds, and Lake Patria in Italy	Trilles (1962, 1964a, b, 1968)

Table 1 (continued): The hosts of *Nerocila orbignyi* with synonyms.

	Host fish species (synonyms)	Order, family of host	Locality	References
Nerocila orbignyi (Guérin-Méneville, 1832) with synonyms	<i>Platichthys flesus</i> (syn. <i>Pleuronectes flesus</i> , <i>Flesus passer</i>)	Pleuronectiformes, Pleuronectidae.	Thau and Vic-Mireval ponds, and Lake Patria in Italy	Trilles (1962, 1964a, b, 1968)
	<i>Oreochromis spilurus</i> (syn. <i>Tilapia galilea</i>)	Perciformes, Cichlidae.	Brackish lake in Egypt	Wunder (1962)
	<i>Salmo trutta</i>	Salmoniformes, Salmonidae.	–	Scott (1964)
	<i>Syphonostomes</i>	–	–	Fain-Maurel (1966)
	<i>Mugilidae</i>	Mugiliformes, Mugilidae.	–	Fain-Maurel (1966)
	<i>Argyrozona argyrozona</i>	Perciformes, Sparidae.	Table, False, Algoa, Senegal, North Africa	Kensley (1978)
	<i>Pterogymnus laniarius</i>	Perciformes, Sparidae.	Table, False, Algoa, Senegal, North Africa	Kensley (1978)
	<i>Rhabdosargus globiceps</i>	Perciformes, Sparidae.	Table, False, Algoa, Senegal, North Africa	Kensley (1978)
	<i>Synaptura</i> sp.	Pleuronectiformes, Soleidae.	Table, False, Algoa, Senegal, North Africa	Kensley (1978)
	<i>Thyrsites atun</i>	Perciformes, Gempylidae.	Table, False, Algoa, Senegal, N. Africa	Kensley (1978)
	<i>Chelon auratus</i> (syn. <i>Mugil auratus</i>)	Mugiliformes, Mugilidae.	Gulf of Marseille	Berner (1969)
	<i>Chelon ramada</i> (syn. <i>Mugil capito</i>)	Mugiliformes, Mugilidae.	Gulf of Marseille	Berner (1969)
	<i>Chelon labrosus</i> (syn. <i>Mugil chelo</i>)	Mugiliformes, Mugilidae.	Gulf of Marseille	Berner (1969)
	<i>Rhombosolea plebeia</i>	Pleuronectiformes, Rhombosoleidae.	the Avon heathcote estuary	Webb (1973)
	<i>Rhombosolea leporina</i>	Pleuronectiformes, Rhombosoleidae.	the Avon heathcote estuary	Webb (1973)
	<i>Chelon auratus</i> (syn. <i>Mugil auratus</i>)	Mugiliformes, Mugilidae.	Tunis Lake, Tunisia	Trilles and Raibaut (1973)
	<i>Mugil cephalus</i>	Mugiliformes, Mugilidae.	Gulf of Tunis	Trilles and Raibaut (1973)
	<i>Chelon ramada</i> (syn. <i>Mugil capito</i>)	Mugiliformes, Mugilidae.	Ichkeul Lake, Tunisia	Trilles and Raibaut (1973)

Table 1 (continued): The hosts of *Nerocila orbignyi* with synonyms.

	Host fish species (synonyms)	Order, family of host	Locality	References
Nerocila orbignyi (Guérin-Méneville, 1832) with synonyms	<i>Chelon labrosus</i> (syn. <i>Mugil labrosus</i>)	Mugiliformes, Mugilidae.	Tunis Lake, Tunisia	Trilles and Raibaut (1973)
	<i>Alosa fallax</i>	Clupeiformes, Clupeidae.	Tunisia	Trilles and Raibaut (1973)
	<i>Alosa fallax</i> (syn. <i>Alosa fallax nilotica</i>)	Clupeiformes, Clupeidae.	Tunisia	Trilles and Raibaut (1973)
	<i>Chelon auratus</i> (syn. <i>Mugil auratus</i>)	Mugiliformes, Mugilidae.	Royan (lower Charante), Gulf of Gascogne	Trilles (1975)
	<i>Mugil cephalus</i>	Mugiliformes, Mugilidae.	Royan (lower Charante), Gulf of Gascogne	Trilles (1975)
	<i>Chelon ramada</i> (syn. <i>Mugil capito</i>)	Mugiliformes, Mugilidae.	Royan (lower Charante), Gulf of Gascogne	Trilles (1975)
	<i>Chelon labrosus</i> (syn. <i>Mugil chelo</i>)	Mugiliformes, Mugilidae.	Royan (Charante), Gulf of Gascogne	Trilles (1975)
	<i>Platichthys flesus</i> (syn. <i>Pleuronectes flesus</i> , <i>Flesus passer</i>)	Pleuronectiformes, Pleuronectidae.	Royan (lower Charante), Gulf of Gascogne	Trilles (1975)
	<i>Dicentrarchus labrax</i> (syn. <i>Labrax lupus</i>)	Perciformes, Moronidae.	Royan (lower Charante), Gulf of Gascogne	Trilles (1975)
	<i>Halobatrachus didactylus</i> (syn. <i>Batrachoides didactylus</i>)	Batrachoidiformes, Batrachoididae.	Temara-isthme, Rabat, Morocco	Dollfus and Trilles (1976)
	<i>Solea senegalensis</i>	Pleuronectiformes, Soleidae.	Rabat, Morocco	Dollfus and Trilles (1976)
	<i>Dicentrarchus labrax</i>	Perciformes, Moronidae.	the pond Diana (Corsica)	Bragoni et al. (1983)
	<i>Dicentrarchus labrax</i>	Perciformes, Moronidae.	the pond Diana (Corsica)	Bragoni et al. (1984)
	<i>Pleuronectidae and Soleidae</i>	Pleuronectiformes.		Rokicki (1985)
	<i>Chelon saliens</i> (syn. <i>Liza saliens</i>)	Mugiliformes, Mugilidae.	Montenegro	Trilles et al. (1989)
<i>Chelon auratus</i> (syn. <i>Liza aurata</i>)	Mugiliformes, Mugilidae.	Montenegro	Trilles et al. (1989)	

Table 1 (continued): The hosts of *Nerocila orbigny* with synonyms.

Host fish species (synonyms)	Order, family of host	Locality	References
<i>Chelon ramada</i> (syn. <i>Liza ramada</i>)	Mugiliformes, Mugilidae.	Montenegro	Trilles et al. (1989)
<i>Chelon labrosus</i>	Mugiliformes, Mugilidae.	Montenegro	Trilles et al. (1989)
<i>Lophius budegassa</i>	Lophiiformes, Lophiidae.	Montenegro	Trilles et al. (1989)
<i>Belone belone</i>	Beloniformes, Belonidae.	Courtmascsherry Bay	Dorman and Holmes (1991)
<i>Prionotus</i> sp.	Scorpaeniformes, Triglidae.	Amazonas, Brazil	Thatcher (1995)
<i>Merlangius merlangus</i>	Gadiformes, Gadidae.	The Severn Estuary, Bristol Channel	Potter et al. (1989) (1988)
<i>Chelon ramada</i> (syn. <i>Liza ramada</i>)	Mugiliformes, Mugilidae.	Ghar El Melh, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Chelon saliens</i> (syn. <i>Liza saliens</i>)	Mugiliformes, Mugilidae.	Bizerte, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Chelon auratus</i> (syn. <i>Liza aurata</i>)	Mugiliformes, Mugilidae.	Ghar El Melh, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Chelon labrosus</i>	Mugiliformes, Mugilidae.	Sfax, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Dicentrarchus labrax</i>	Perciformes, Moronidae.	Ghar El Melh, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Solea solea</i>	Pleuronectiformes, Soleidae.	Sfax, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Serranus scriba</i>	Perciformes, Serranidae.	Sfax, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Diplodus annularis</i>	Perciformes, Sparidae.	Sfax, Tunisia	Charfi-Cheikhrouha et al. (2000)
<i>Arripis trutta</i>	Perciformes, Arripidae.	New Zealand	Hine et al. (2000)
<i>Dicentrarchus labrax</i>	Perciformes, Moronidae.	Aegean Sea, Turkey	Horton and Okamura (2001)
<i>Chelon auratus</i> (syn. <i>Liza aurata</i>)	Mugiliformes, Mugilidae.	Mistras Lagoon, Sardinia	Merella and Garippa (2001)
<i>Seriola dumerili</i>	Perciformes, Carangidae.	Mazarrón (Murcia)	Montero (2001)
<i>Chelon auratus</i> (syn. <i>Liza aurata</i>)	Mugiliformes, Mugilidae.	Black Sea	Öktener and Trilles (2004)
<i>Halobatrachus didactylus</i>	Batrachoidiformes, Batrachoididae.	Portuguese coast Guadiana, Tagus, Sado, Olhaõ and Tavira coastal areas	Marques et al. (2005)

Nerocila orbigny (Guérin-Méneville, 1832) with synonyms

Table 1 (continued): The hosts of *Nerocila orbignyi* with synonyms.

Host fish species (synonyms)	Order, family of host	Locality	References
<i>Mugil cephalus</i>	Mugiliformes, Mugilidae.	Béjaïa, Soummam Oued, Algeria	Ramdane et al. (2007)
<i>Symphodus tinca</i> (<i>Crenilabrus pavo</i>)	Perciformes, Labridae.	Gulf of Béjaïa, Algeria	Ramdane et al. (2007)
<i>Symphodus tinca</i> (<i>Crenilabrus pavo</i>)	Perciformes, Labridae.	Gulf of Jijel, Algeria	Ramdane et al. (2007)
<i>Trigla lyra</i>	Scorpaeniformes, Triglidae.	Gulf of Béjaïa, Algeria	Ramdane et al. (2007)
<i>Platichthys flesus</i>	Pleuronectiformes, Pleuronectidae.	North-Central Portuguese Coast	Cavaleiro and Santos (2007)
<i>Scorpaena porcus</i>	Scorpaeniformes, Scorpaenidae.	Adriatic Sea	Ferri et al. (2008)
<i>Monochirus hispidus</i>	Pleuronectiformes, Soleidae.	Northeast Atlantic	Marques et al. (2009)
<i>Solea solea</i>	Pleuronectiformes, Soleidae.	Pazar Coast, Turkey, Black Sea	Kayış and Ceylan (2011)
<i>Chelidonichthys capensis</i>	Scorpaeniformes, Triglidae.	South Africa	Hadfield et al. (2013)
<i>Moolgarda seheli</i>	Mugiliformes, Mugilidae.	Red Sea, Yemen	Al-Zubaidy and Mhaisen (2013)
<i>Chelon auratus</i> (syn. <i>Liza aurata</i>)	Mugiliformes, Mugilidae.	Red Sea, Yemen	Al-Zubaidy and Mhaisen (2013)
<i>Serranus cabrilla</i>	Perciformes, Serranidae.	Samandağ, Turkey, Mediterranean	Özcan et al. (2015)
<i>Belone belone</i> (syn. <i>Belone b. gracilis</i>)	Beloniformes, Belonidae.	Tunisia	Châari et al. (2015)
<i>Chelon ramada</i> (syn. <i>Mugil capito</i>)	Mugiliformes, Mugilidae.	Qaroun Lake, Egypt	Shaheen et al. (2017)
<i>Solea solea</i>	Pleuronectiformes, Soleidae.	Qaroun Lake, Egypt	Shaheen et al. (2017)
<i>Coptodon zillii</i> (syn. <i>Tilapia zilli</i>)	Perciformes, Cichlidae.	Qaroun Lake, Egypt	Shaheen et al. (2017)
<i>Chelon ramada</i> (syn. <i>Mugil capito</i>)	Mugiliformes, Mugilidae.	Qaroun Lake, Egypt	Mahmoud et al. (2017)
<i>Liza carinata</i>	Mugiliformes, Mugilidae.	Qaroun Lake, Egypt	Mahmoud et al. (2017)
<i>Coptodon zillii</i> (syn. <i>Tilapia zilli</i>)	Perciformes, Cichlidae.	Qaroun Lake, Egypt	Mahmoud et al. (2017)
<i>Scomber scombrus</i>	Perciformes, Scombridae.	Swanage, UK waters	Horton and Baillie (2019)
<i>Clupea harengus</i>	Clupeiformes, Clupeidae.	Southampton, UK waters	Horton and Baillie (2019)
<i>Chelon labrosus</i>	Mugiliformes, Mugilidae.	Newlyn harbour, UK waters	Horton and Baillie (2019)

Nerocila orbignyi (Guérin-Méneville, 1832) with synonyms

Table 1 (continued): The hosts of *Nerocila orbignyi* with synonyms.

	Host fish species (synonyms)	Order, family of host	Locality	References
Nerocila orbignyi (Guérin-Méneville, 1832) with synonyms	<i>Solea solea</i>	Pleuronectiformes, Soleidae.	Sinop, Turkey, Black Sea	Güven and Öztürk (2019)
	<i>Salmo salar</i>	Salmoniformes, Salmonidae.	Tasmania, Australia	González et al. (2019)
	<i>Callorhynchus milii</i>	Chimaeriformes, Callorhynchidae.	Bass Strait, Nutgrove Beach, Derwent Estuary	Bruce (1987)
	<i>Pseudocaranx dentex</i>	Perciformes, Carangidae.	Southern Western Australia, Walpole	Bruce (1987)
	<i>Dactyloptena orientalis</i>	Scorpaeniformes, Dactylopteridae.	South Coast, Tasmania	Bruce (1987)
	<i>Girella tricuspidata</i>	Perciformes, Girellidae.	Lake Illawarra, New South Wales, Australia	Bruce (1987)
	<i>Mola mola</i>	Tetraodontiformes, Molidae.	Off New South Wales, Australia	Bruce (1987)
	<i>Mugillidae</i> sp.	Mugiliformes, Mugilidae.	Port Hacking, New S. Wales, Australia	Bruce (1987)
	<i>Platycephalidae</i> sp.	Scorpaeniformes, Platycephalidae.	Victoria	Bruce (1987)
	<i>Pomatomus saltatrix</i>	Perciformes, Pomatomidae.	Nornalup, Western Australia	Bruce (1987)
	<i>Sillago bassensis</i>	Perciformes, Sillaginidae.	Frederick Henry Bay, Storm Bay, Tasmania	Bruce (1987)
	<i>Acanthopagrus butcheri</i>	Perciformes, Sparidae.	The Coorong, South Australia	Bruce (1987)
	<i>Pagrus auratus</i> (syn. <i>Chrysophrys auratus</i> , <i>Pagrosomus auritus</i>)	Perciformes, Sparidae.	Sydney, New South Wales, Palm Beach, Broken Bay, Little Jerusalem Bay, Hawkesbury River	Bruce (1987)
	<i>Chelidonichthys kumu</i>	Scorpaeniformes, Triglidae.	Southern Western Australia, Walpole	Bruce (1987)
	<i>Mugil cephalus</i>	Mugiliformes, Mugilidae.	Israel	Paperna and Overstreet (1981)
	<i>Dicentrarchus labrax</i>	Perciformes, Moronidae.	Black Sea	Kayış et al. (2017)
	<i>Chelon auratus</i> (syn. <i>Liza aurata</i>)	Mugiliformes, Mugilidae.	Black Sea	Kayış et al. (2017)
	<i>Serranus cabrilla</i>	Perciformes, Serranidae.	Black Sea	Kayış et al. (2017)
<i>Solea solea</i>	Pleuronectiformes, Soleidae.	Black Sea	Kayış et al. (2017)	

Table 1 (continued): The hosts of *Nerocila orbignyi* with synonyms.

	Host Fish Species (synonyms)	Order, Family of Host	Locality	References
Synonym as <i>Nerocila maculata</i> H. Milne Edwards, 1840	Unknown	Unknown	Castellon, Spain	Balcells (1953)
	<i>Raja</i> sp.	Rajiformes, Rajidae	the Croisic vicinity, France	Trilles (1975)
	<i>Trisopterus capelanus</i> (syn. <i>Gadus capelanus</i>)	Gadiformes, Gadidae	Algeria	Dollfus and Trilles (1976)
	Unknown	Unknown	Province de Bou Haroun, Algeria	Dollfus and Trilles (1976)
	<i>Rostroraja alba</i> (syn. <i>Raja alba</i>)	Rajiformes, Rajidae	Casablanca, Morocco	Dollfus and Trilles (1976)
	Unknown	Unknown	Turkey, Spain, Yougoslavie	Trilles (1977)
	<i>Raja clavata</i>	Rajiformes, Rajidae	Yougoslavie	Trilles (1977)
	<i>Chelon labrosus</i> (syn. <i>Crenimugil labrosus</i>)	Mugiliformes, Mugilidae	The Island of Texel	Trilles (1977)
	Unknown	Unknown	Naples, Genova	Trilles (1977)
	<i>Chelon labrosus</i> (syn. <i>Crenimugil labrosus</i>)	Mugiliformes, Mugilidae	Wadden Sea	Holthuis (1978)
	<i>Chelon labrosus</i> (syn. <i>Crenimugil labrosus</i>)	Mugiliformes, Mugilidae	The Island of Texel	Adema and Huwae (1982)
	<i>Trisopterus minutus</i>	Gadiformes, Gadidae	Montenegro	Trilles et al. (1989)
	<i>Trachinus draco</i>	Perciformes, Trachinidae	Montenegro	Trilles et al. (1989)
	<i>Pagellus acarne</i>	Perciformes, Sparidae	Gulf of Béjaïa, Algeria	Ramdane et al. (2007)

The host fish of *Nerocila orbignyi* are examined according to their order; 22 (38%) of 58 host species belong to Perciformes; 14 species (14%) to Mugiliformes and Pleuronectiformes; 22 species (38%) to different fish families (Fig. 4).

According to their families, the parasite appears to be more frequently reported from two families; Mugilidae and Sparidae with seven species (Fig. 5).

According to habitat selections; 24 (42%) of 58 host fish species are demersal; 15 species (26%) are benthopelagic, seven species (12%) are pelagic-neritic, six species (10%) are reef-associated, three species (5%) are bathydemersal, three species (5%) are pelagic-oceanic (Fig. 6). It seems that *Nerocila orbignyi* clearly prefers demersal fish than pelagic fish. Luque et al. (2010) and Brusca (1981) verified the occurrence of higher parasite species on demersal fishes in their studies.

According to feeding habits; 44 species (76%) of 58 host fish species are carnivorous; 12 species (21%) are omnivorous; two species (3%) are herbivorous (Fig. 7). *Nerocila orbignyi* appears to prefer carnivorous fish rather than omnivorous and herbivorous fish.

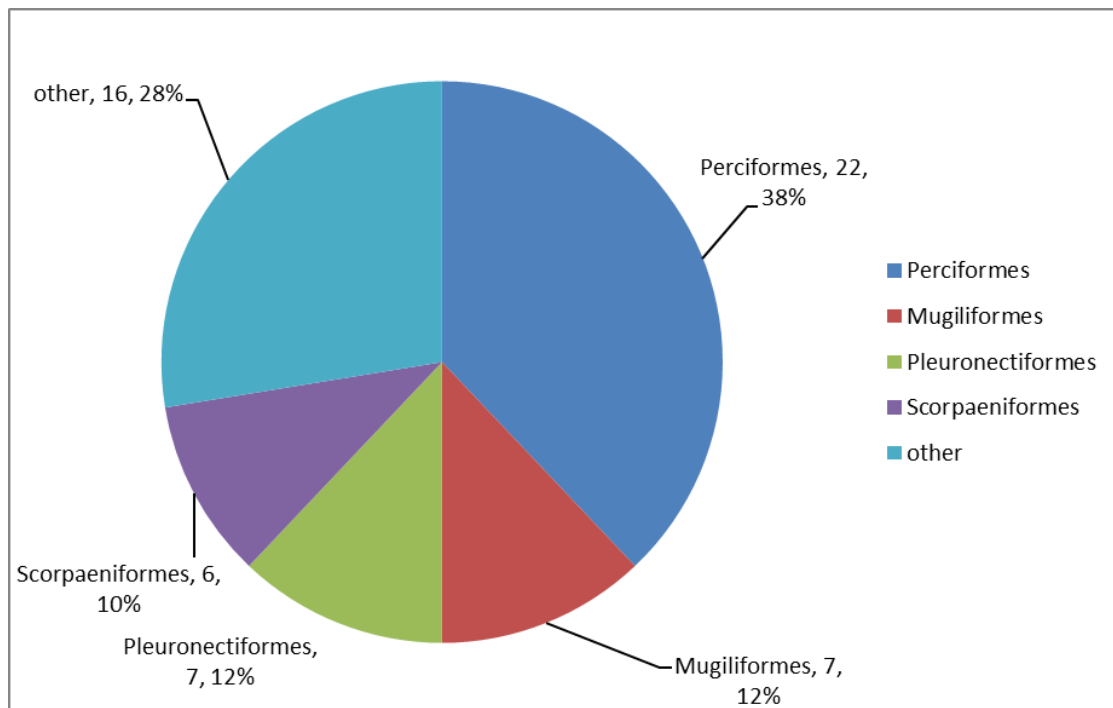


Figure 4: The host reported with *Nerocila orbignyi* according to their order.

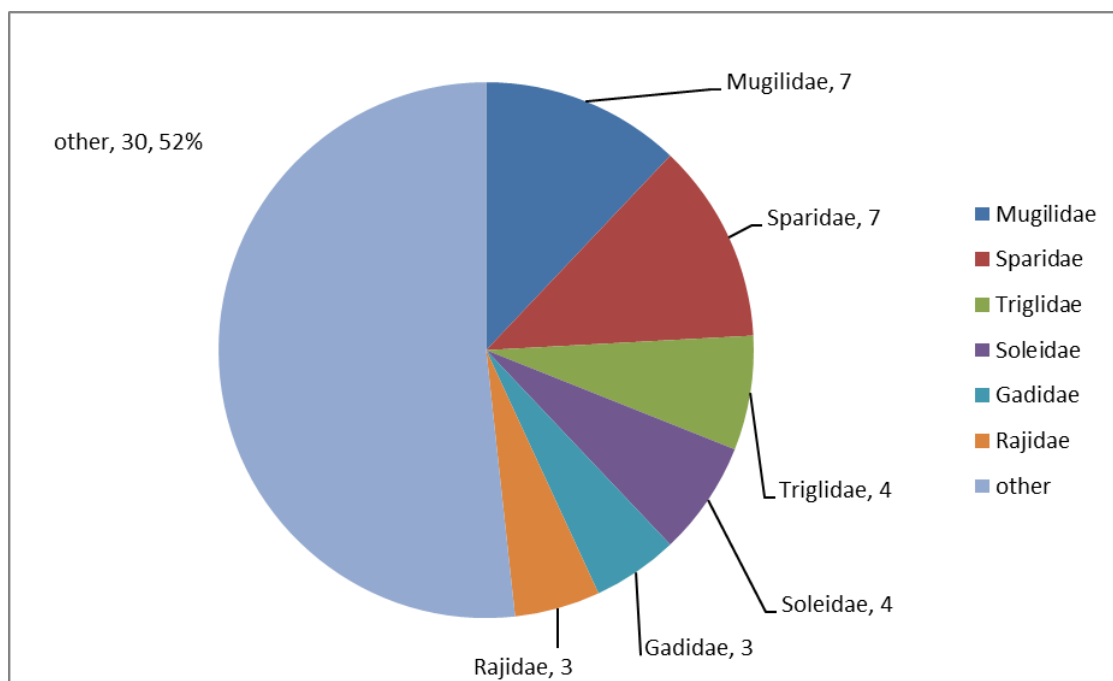


Figure 5: The host reported with *Nerocila orbignyi* according to their family.

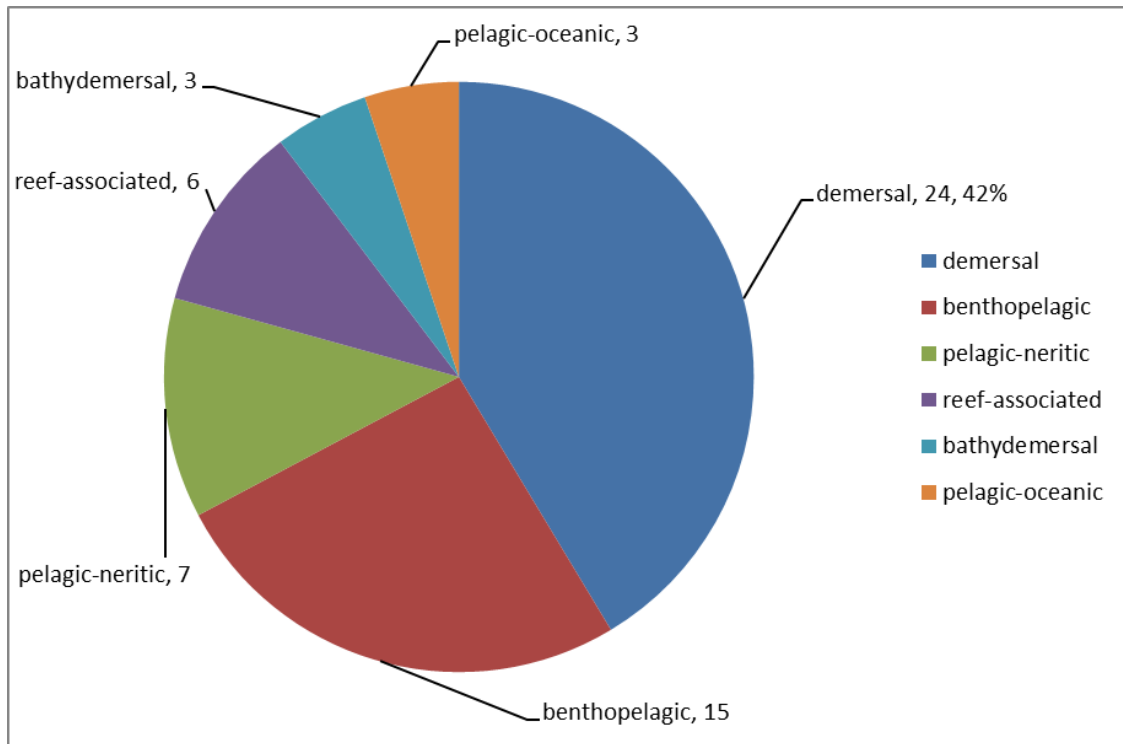


Figure 6: The host reported with *Nerocila orbigny* according to habitat selections.

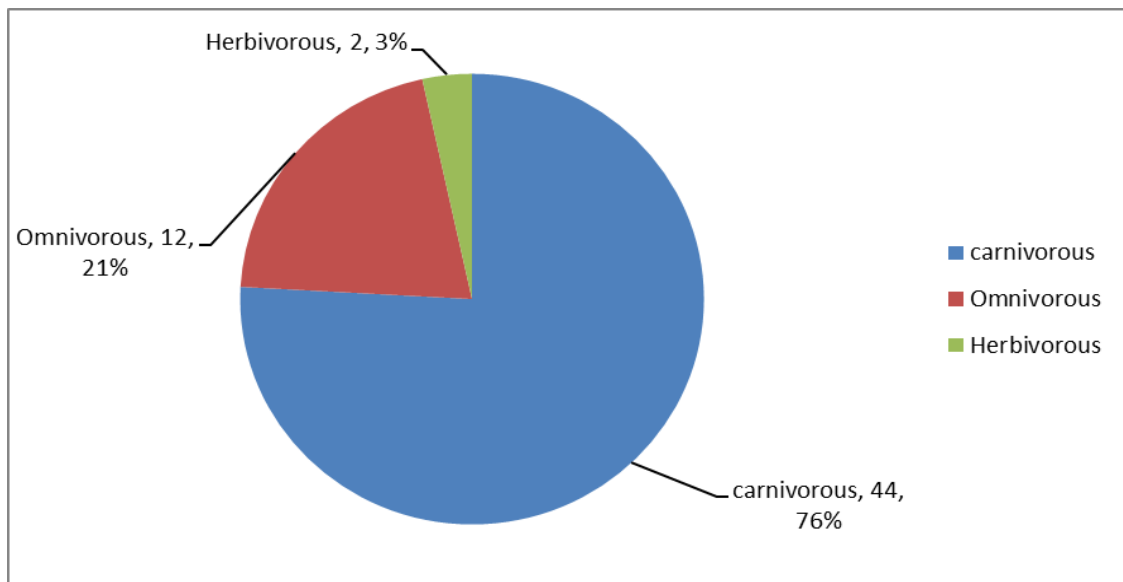


Figure 7: The host reported with *Nerocila orbigny* according to feeding habits.

According to their solitary/schools; 33 (57%) of 58 host fish species are schooling, 25 species (43%) are solitary (Fig. 8). Although there is not much difference, it may be argued that *Nerocila orbigny* is reported more frequently than fish that form a school. Luque et al. (2014) indicated that fish parasites prefer fish that form more schools than solitary fish especially ectoparasites. Brusca (1981) determined preferred hosts of *Nerocila acuminata* are schooling fishes.

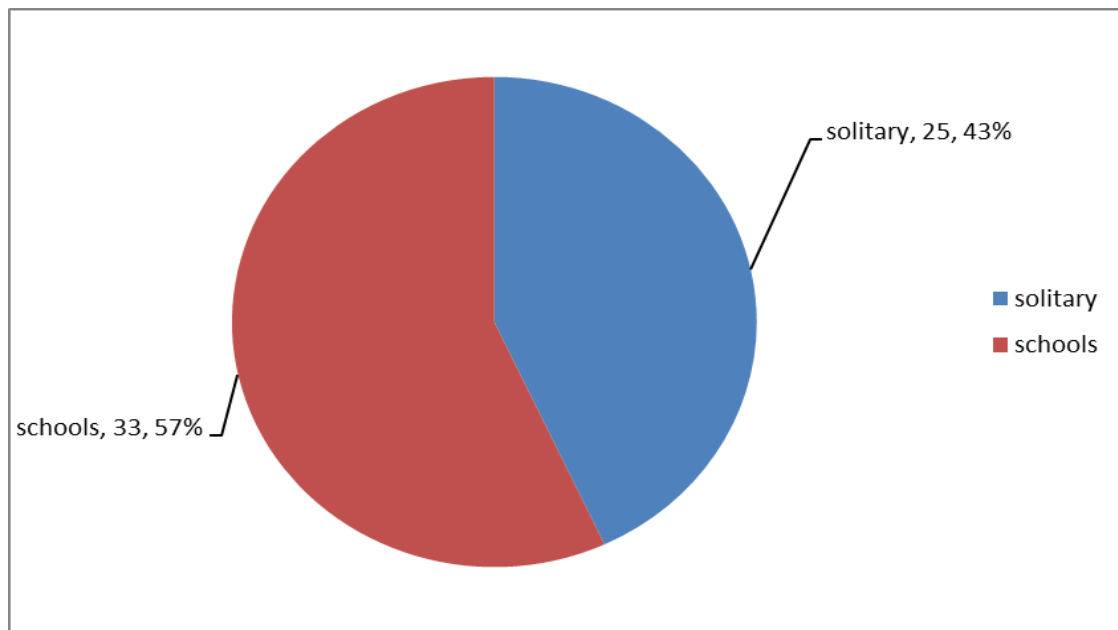


Figure 8: The host reported with *Nerocila orbigny* according to solitary/schools.

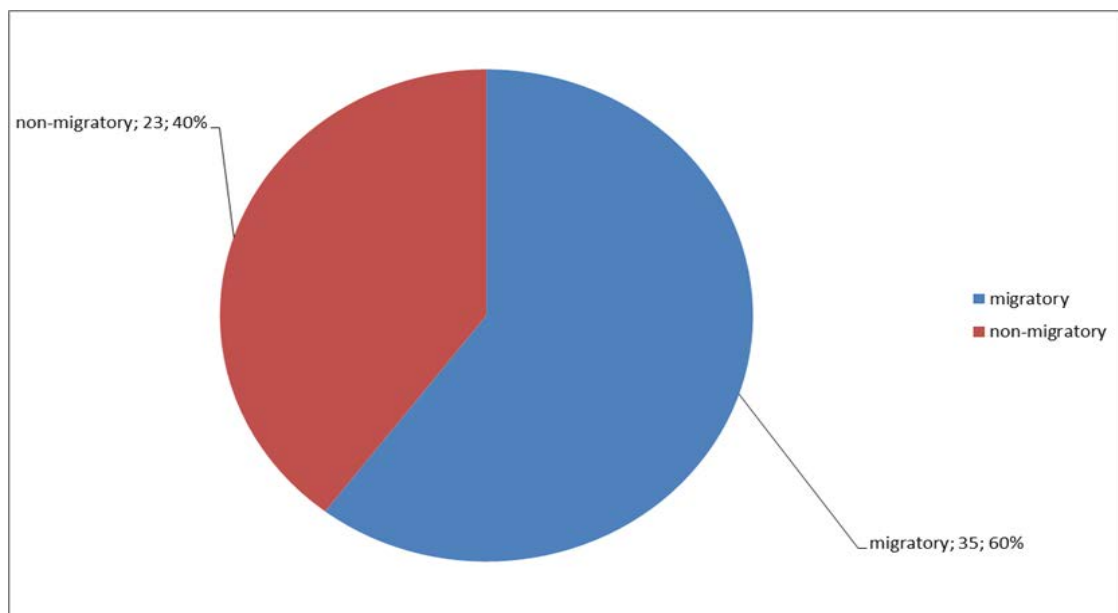


Figure 9: The host reported with *Nerocila orbigny* according to migratory/non-migratory.

According to migratory/non-migratory; 35 species (60%) of 58 host fish species are migratory; 23 species (40%) to non-migratory. (Fig. 9). Fryer (1966) and Welicky and Sikkell (2015) founded that diurnal movements and nocturnal migrations of fish has an important role for the most settlement of parasite.

According to their scale types; 27 (46%) of 58 host fish species are cycloid; 26 species (45%) ctenoid; five species (9%) with placoid (Fig. 10).

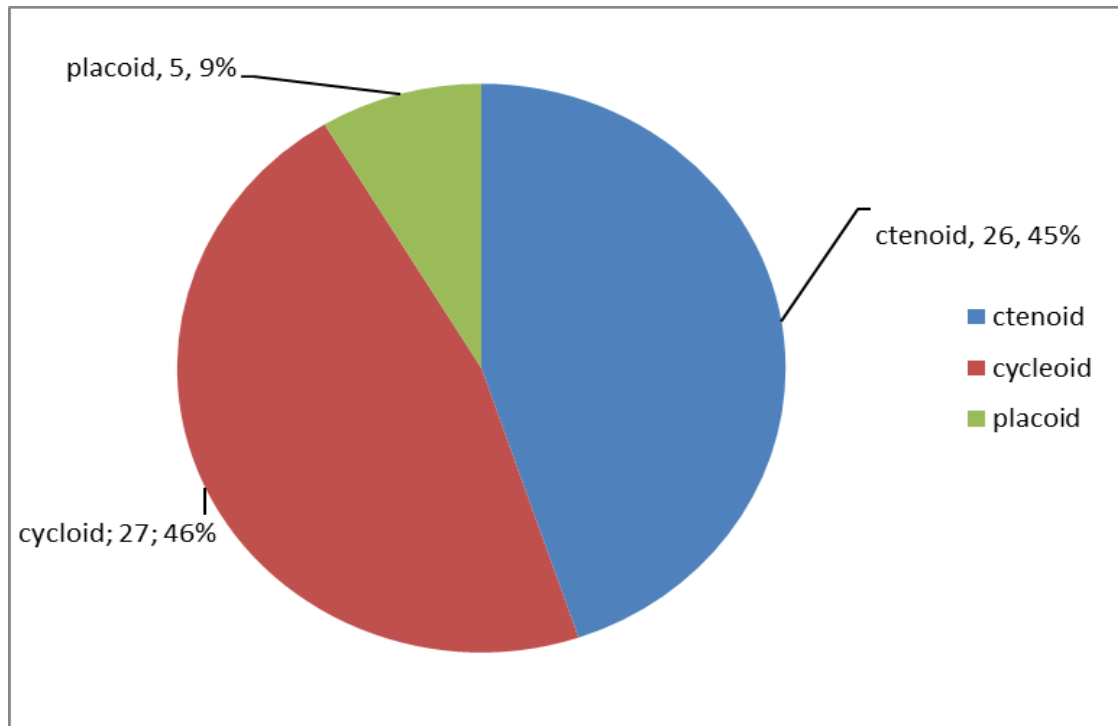


Figure 10: The host reported with *Nerocila orbignyi* according to scale type.

It may be said that *Nerocila orbignyi* has been reported more frequently than fish belonging to the Perciformes order and Mugilidae and Sparidae families. It may also be said that this parasite selects also the fishes with carnivorous, demersal, schools, and migratory character.

CONCLUSIONS

Cymothoids are an important group of parasites reported in fish. *Nerocila* is also a highly reported genus among Cymothoidae. It is a genus that is reported only from the body surface and fins in fish. Articles about cymothoid parasites are mostly in the form of reports and not much information is given about their morphology. The aim of this study is to give the updated morphology of *Nerocila orbignyi* and to provide comparison opportunities for those working on this subject. In addition, there is not much work on the host and host properties of cymothoid parasites. In this article, it is aimed to examine the host selectivity by mentioning both the morphology and ecology of the hosts of *Nerocila orbignyi*.

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