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Parasites Fauna in Barracuda Fishes in the Western Coast of Libya

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ABSTRACT

Fish parasites are considered as a part of marine biodiversity in worldwide, it is very important to know the native and Non indigenous species in Libyan waters, this study was conducted to investigated fish parasites in the native barracuda fishes. A total of 52 and 50 individuals of S. *viridensis* and *S. sphyraena* respectively, were collected from fishermen in the western coast of Libya. A total of 165 individual of parasites were identified to the species level (except two). The rates of infection in *S. viridensis* and *S. sphyraena*, was 32% and 48% respectively. The highest prevalence of infection was 94.2% and 39.2% for the *Scolex pleuronectis* in both fishes, while the lowest prevalence was 1.96 %, the *Vargula sp.* in *S. sphyraena*. this study in the Mediterranean is very important to provide a contribution to fill the gap of knowledge on the biological and ecological trait of marine fishes.

طفيليات حيوانات في أسماك باراكودا في الساحل الغربي لليبيا

عائشة سيف النصر ، سارة بن زقلام ، محمد شوهدي ، إسماعيل الشقمان

تعتبر طفيليات الأسماك جزءًا من التنوع البيولوجي البحري في جميع أنحاء العالم ، ومن المهم جدًا معرفة الأنواع المحلية وغير المحلية في المياه الليبية ، وقد أجريت هذه الدراسة للتحقق من طفيليات الأسماك في أسماك البراكودا المحلية. تم جمع ما مجموعه 52 و 50 فردا من S. viridensis و S. sphyraenaعلى التوالي من الصيادين في الساحل الغربي لليبيا. تم تحديد ما مجموعه 165 فردًا من الطفيليات على مستوى الأنواع (باستثناء اثنين). كانت معدلات الإصابة في S. viridensis و S. sphyraena 32٪ و48٪ على التوالي. كان أعلى معدل انتشار للعدوى 94.2٪ و 39.2٪ لعدوى Scolex pleuronectisفي كلا السمكتين ، بينما كان أقل انتشار 1.96٪ ، Vargula sp. في S. sphyraena.تعد هذه الدراسة في البحر الأبيض المتوسط مهمة جدًا لتقديم مساهمة في سد فجوة المعرفة حول السمات البيولوجية والإيكولوجية للأسماك البحرية.

INTRODUCTION

Libyan coast has a biodiversity of native and alien fishes, including the Barracuda fishes which belong to the Sphyraenidae family, live in tropical and subtropical waters, it is spread in the Mediterranean, Red Sea, Atlantic, Indian and Pacific Oceans (Carpenter & Niem, 2001). There are four fishes of *Sphyraena* in the Libyan coast, two of them are Native, namely *Sphyraena sphyraena* (Linnaeus, 1758) and *S. viridensis* (Cuvier,1629), while *S. flavicauda* (Rüppelluda, 1838) and *S. chrysotaenia* (Klunzinger, 1884) are considered alien species that have entered the Mediterranean Sea from the Red Sea through the Suez Canal (Golani & Bogorodsky 2010). their habits are probably similar (De Sylva, 1989). They Feeds on cephalopods, crustaceans and fishes, they are caught in commercial quantities by trawl net, purse seine, gill net and trammel nets (El Ganainy *et al.*, 2017).

Sphyraena species serve as hosts for different species of parasites and other pathogens, the effect of parasites does not extend to the mortality of fish population only, but also damage the ecosystem, the food chain, thus it causes a great loss to the economy of fisheries (Lessios, 1988). Parasites have different life cycles that they pass through during their life or parasitism process, some of them need a direct life

cycle, they do not need an intermediate host and infection can spread directly from one fish to another by ingestion of egg, larvae or adult parasites, while the other need a complex indirect life cycle, that they need one or more an intermediate host to complete their life cycle (Yanong, 2002). The marine parasites are considered as a part of these biodiversity, it is very important to identify their taxonomy, source and their epidemiology, some scientists in worldwide used them as a bio-indicator to track the migration of some fish, and others used them as a bio-indicator to detect contamination with heavy metals in marine waters (Yanong, 2002). The Libyan coast is more than a 2000 which supposed to have many answers of unknown questions, Perhaps the parasites that infect fish in the eastern, central and western regions are different, or may be similar as well. for this we need many more studies to get all answers in this area.

MATERIALS AND METHODS

A total of 52 and 50 individuals of *S. viridensis* and individuals of *S. sphyraena* respectively, were collected from fishermen in the western coast of Libya during the period from July 2019 to July 2020. (Fig. 1.), then immediately transported to the laboratory of marine biology in the department of Zoology, Faculty of science at the University of Tripoli. Morphometric measurements have been taken; the length near to ± 0.1 mm and weight near to ± 0.1gr were measured, used the traditional method to isolation and identification of the ecto-endo metazoan parasites, by used some laboratory instruments and equipment as forceps, scissor, light and a dissecting microscope connecting with the optical microscopical camera, the parasites examination was carried out according to (Euzet & Trilles, 1960 & Heil, 2009). The semichon'acetocarmine staining technique was used to identify the parasites, (King, 2013 & Radhi *et al*., 2018). Parasitic indicators adopted calculations by (Bush *et al*., 1997).



Fig .1. (A) *Sphyraena viridensis* Linnaeus, 1758 and (B) *Sphyraena sphyraena* Cuvier, 1829 have been collected in the western coast of Libya

RESULTS AND DISCUSSION

The parasites have been found consisted of 7 species of parasites including trematode, cestodes and arthropods. They were collected from various organs (stomach, tissue flukes, gills, eyes and skin) of target barracuda fish in this study as shown in (Fig. 2). The *Scolex pleuronectis* parasites were highest prevalence of infection in the *S. viridensis*, and *S. sphyraena* infection (94.2% and 39.2%) respectively, while the lowest prevalence was for *Vargula* sp. (1.96 %) in *S. sphyraena* respectively as (Table. 1). There were some of the parasites could not able to identify them to species level.

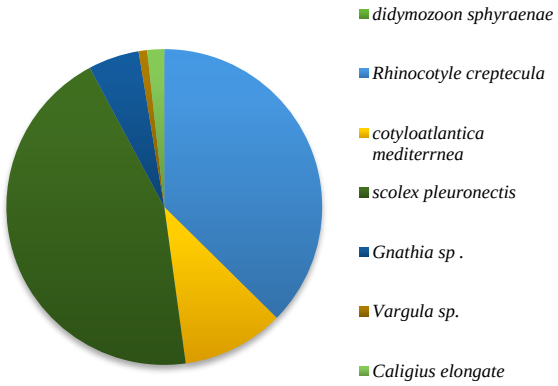


Fig.2. Parasites have been found in the *S. viridensis* and *S. sphyraena* in the western coast of Libya

Table .1. The prevalence, intensity and abundance and the rate of infection have been calculated for parasites found in *S. viridensis* and *S. sphyraena* in the western coast of Libya (P= Prevalence, MI= mean intensity, A=Abundance).

Host	*S. viridensis*			*S. sphyraena*		
No. of sample	52			50		
The rate of infected in each fish sample	32%			48%		
parasites	P %	MI	A	P %	MI	P
didymozoon sphyraenae	13.5	7	0.13	66.7	5.38	0.66
Rhinocotyle creptecula	67.3	2.06	0.67	15.7	1.33	0.15
cotyloatlantica mediterrnea	21.15	1.57	0,.21	19.6	2	0.19
scolex pleuronectis	94.2	8.16	0.94	39.2	1	0.39
Gnathia sp .	3.85	1	0.33	7.84	1.33	0.78
Vargula sp.	-	-	-	1.96	1	0.19
Caligius elongate	-	-	-	3.92	1	0.39

Parasites description: Results of parasites sample shown in (Fig .3): ***Rhinecotyle crepitacula*** Euzet &Trilles, 1960

Host : it found in the *S. viridensis* and *S. sphyraena*.
Location : it was isolated from the gills.
Stage found : Adult stage.
No. of parasites: forty-three (43) of *R. crepitacula* were isolated.

Description: it has the ventral mouth, about 200 x on the ventral midline the genital atrium opening. At the back, there is a slight constriction that separates the body from the haptor, the latter evokes the shape of the spoon whose main axis is parallel to the sagittal axis of the body, the ventral concavity divides into a series of 20 to 29 muscle barriers transversely into two parallel rows of an elongated position. The edge of the haptor from the right or the left of the spoon depending on the individual, is provided with longitudinally lined clamps, front chain, middle chain and posterior chain. Each clamp consists of muscular jaws supported by rigid parts. The chain includes 18 to 22 clips. Depending on the individual, the front jaw presents a segment that forms at the distal end in a T-shape with slightly uneven branches on the midline. This moderate scleritis curves on the proximal side and passes to the posterior jaw where it enlarges and then forms on each side of the medial plane.

Cotyloatlantica Mediterranean Euzet& Trilles, 1960 The origin name for this species is Chauhanea Mediterranea Euzet & Trilles, 1960; Pseudochauhanea Mediterranea (Euzet & Trilles, 1960 & Lebedev, 1969).

Host: it found in the *S. viridensis* and *S. sphyraena*.

Location: it was isolated from the gills.

Stage found: Adult stage.

No. of parasites: Twelve (12) of C. *Mediterranean* were isolated.

Description: The body divided into the cephalic region, trunk, peduncle (present or absent) and opisthaptor, with large numbers of gastrocotyle-like clamps. Total body length is 8 mm, width is 40 - 45µm x (50 - 60µm), Sucker width 0.013 mm, clamps 17 - 19 on Right11 -15 On left, Haptor Width 40 - 45µm x 50 - 60µm, pharynx is sub spherical 0.65-1mm. Paired prohaptoral suckers muscular, usually septate; pharynx small; oesophagus elongate with lateral diverticula; with lateral and/or medial diverticular, extend into opisthaptor. Testes pre-, para-, and post ovarian.

Didyomozoon sphyraenae **Taschenberg, 1879**

Host: it found in the *S. viridensis* and *S. sphyraena*.

Location: it was isolated from the tissue fluke.

Stage found: Adult stage.

No. of parasites: Fifty (50) of *D. sphyraenae* were isolated.

Description: It description depends on the body shape; It consists of two very clear parts. For the male and female genitalia, after oral adhesion; a small pharynx, followed by the oesophagus in the third direction in the front of the head, and then it is divided into two parts of the intestinal caecum that passes to the back of the body and which intersect many times with the male and female reproductive system, the penis is represented elongated, which ends at the base of the head of the common vas deferens, which ends in a small papilla of the genital organs. Some measurements were taken for this parasite based on a total length of 26 mm and width from 1 to 1.7 mm. The excretory system is large, sinuous sac that passes from the posterior region to the anterior third of the body.

Scolex pleuronectis **Müller, 1788**

Host: it found in the *S. viridensis* and *S. sphyraena*.

Location: it was isolated from the stomach.

Stage found: larvae stage (tetraphyllidae).

No. of parasites: Fifty-one (51) of S. *pleuronectis* were isolated.

Description: The identification of this parasite was based on white larva which has five suckers on the scolex, a non-segmented trunk and a body filled with calcareous corpuscles, the elbow surface is large and often divided by a septum, and the scolex contains hardware additions such as pipettes and hooks, the measurements of the studied samples, are as follows: total length 1.665 mm, width 0.498mm the terminal sucker has= had a diameter of 0.141mm lateral sucker diameter is 0.101, total length 2.010 mm, width 0..546mm the terminal sucker has diameter of 0.167mm lateral sucker diameter is 0.123 and total length 1.373 mm, width 0.565mm the terminal sucker has diameter 0.167mm lateral sucker diameter is 0.125, Presumably, Cestoda resembles the pseudophyllidae of the intermediate host in which the procercoid grows, the plerocercoid stages develop in the teleost.

Caligus elongate **Von Nordmann, 1832**

Host: it found in the *S. sphyraena*.

Location: it was isolated from the skin.

Stage found: Adult stage.

No. of parasites: One (2) C. *elongate* were isolated.

Description: it description based on The first and second antennas is clearly observed and separated in a developed anterior plate delineated at the dorsal midline. First antenna proximal segment larger and stronger, sclerotized at junction with cephalothorax. Second antenna subchelate. Basal segment bearing powerful sclerotized round-tipped process projecting posteriorly. Postantennary process consisting of strong, heavily sclerotized claw directed posteriorly. Claw equipped with two bifid sensory setules. Third bifid setule arising near claw Base. Mandible armed with uniform teeth. First maxillas a conical process, with smooth surface and blunt tip Size of palp one-half that of conical process. Second maxilla strongly elongate. It has Maxilliped Sternal furca with trapezoid base and two elongated digitiform processes. First leg with

sclerotized sub rectangular sympod with pinnate seta on ventromedial margin. Smali pyriform endopod with small apical seta. Second leg with strong and wide interpodal bar, third leg fused with powerful interpodal bar and Fourth leg elongate and more sclerotized.

***Vargula* sp. Skogsberg, 1920**

Host: it found in the and *S. sphyraena*.

Location: it was isolated from the skin.

Stage found: Adult stage.

No. of parasites: One (1) *Vargula* sp. were isolated.

Description: It description based on bivalve carapace shell; the smooth part of the body and the shape of the carapace which are oval in lateral view with deep incisur and narrow caudal process; ventral and dorsal margins slightly convex. In fold behind the rostrum with bristles; two pairs of bristles present at inner end of incisur, one pair lateral to selvage, one pair medial to selvage; there is in fold from the middle of ventral margin to anterior end of the caudal process with three double bristles; list in front of caudal process broad with minute processes along the dorsal margin, but appearing smooth at low magnification and with minute medial bristles. Selvage Lamellar is prolonged with smooth outer margin present along anterior and ventral margins. The first antenna has the First joint bare; 2nd joint with spines along the dorsal margin and on the medial surface; the 3rd joint is short with two spinous bristles, one dorsal, one ventral with two spinous, terminal bristles, one ventral, one dorsal; sensory bristle with 12 marginal filaments and bifurcate tip. Second antenna: Protopodite with short spinous medial bristle. Endopodite 3-jointed has 1st joint with five bristles.

***Gnathia sp.* Leach, 1814**

Host: it found in the S**.** *viridensis* and *S. sphyraena*.

Location: it was isolated from the gills.

Stage found: Larve stage.

No. of parasites: sex (6) of *Gnathia* sp**.** were isolated.

Description gnathic larvae body which is divided into three parts: the cephalosome (including the antennae and the mouthparts), the peraeon with five pairs of peraeopods, the pleon with five pairs of pleopods and the telson with one pair of uropods. The posterior margin of the cephalosome is slightly wider than the anterior one, almost as wide as it is long, presenting few setae on the posterior dorsal region. The lateral margins are straight and parallel. The well-developed compound eyes are oval-shaped and located on the lateral margins of the cephalosome, and the length of the eye is more or less half of the length of the cephalosome. The cephalosome has straight Medio-anterior margins with concave lateral excavations to accommodate the first articles of the antennae. The antennae are straight, antenna 2 being longer than antenna 1. Antenna 1 has three pedunculated articles, the third of which is the largest. The flagellum has four articles, of which article 2 is the largest. Antenna 2 has four pedunculated articles, the fourth of which is the largest. The flagellum has seven articles, of which article 1 is the largest, article 7 ends in three or four simple setae, and few setae exist on the distal end of each article. The labrum is prominent and semicircular, with an apical process. The maxillae are long and thin, exceeding the distal margin of the labrum. The mandibles are stout. The maxilliped is large and cylindrical, with an elongated base. The pereon is larger than the cephalosome and almost twice as long as it is wide. Pereonite 1 is fused with the cephalon, dorsally visible, and has shallow and convex anterior and posterior borders. Ischium, merus, carpus, propodus and dactylus. The base is bigger than the others, with one simple seta.

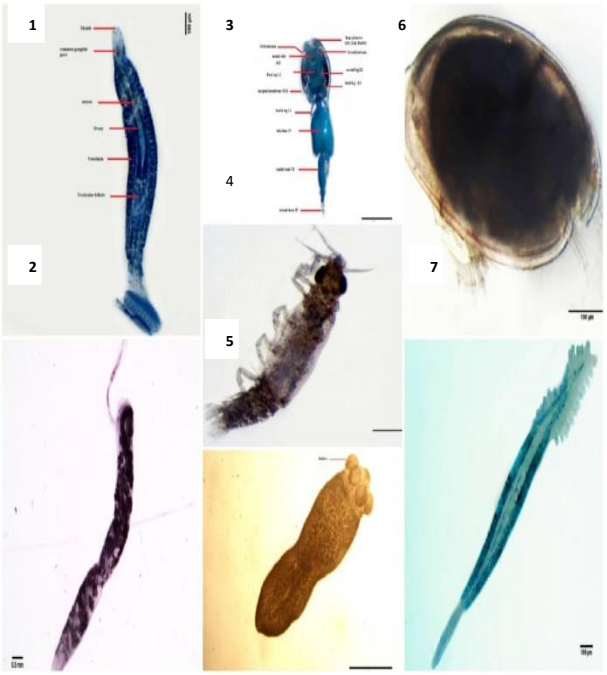


Fig.3.(1) *Rhinocotyle creptecula* (2). *didymozoon sphyraenae* (3) *Caligius elongate* (4) *Gnathia* sp. (5) *Scolex pleuronectis* (6) *Vargula* sp (7) *cotyloatlantica mediterrnea* parasites have been found in Native barracuda fishes in the western coast of Libya.

Parasites efficiently have been shown to be effective indicators of hosts migration, diet, population structure and phylogeny (Williams *et al*., 1994). For about half century, scientists have been used parasites as natural biological tags of fish host populations, this work has expanded to include macro invertebrates and marine mammals (Aznar *et al*., 1995; Oliva and Sanchez, 2005). Several studies have been examined the effects of environmental stress on parasite populations and communities, but few have combined parasitology with other fields of study in an interdisciplinary approach (Marcogliese, 2005).

In the current study the community consisted of 165 individuals of parasites distributed in three trematodes, one cestodes and three arthropods. *Didymozoid sphyraena* one of the trematodes has been found in the tissue flukes of the *s. viridensis* and *s. sphyraena* from the western coast of Libya in the 2021. Where, the first report of *D. sphyraena* was in the last quarter of 1960 in January 1961; found under the oral mucosa of barracuda fish in India (Madhavi, 1982). *D. sphyraena* have specificity to Barracuda fish, which exhibit a high affinity for didyzmoon infections (Yamaguti, 1959; Madhavi, 1982 and Hussein *et al*., 1985) *D. sphyraena* was described in tropical and subtropical waters in the western Pacific and the Mediterranean (Yamaguti, 1959), it is abundant and diverse (Ching and Madhavi, 1999). And also, the *C. mediterranea* and *R. crepitacula* trematode monogenea parasites were collected from gills of the *S. viridensis* and *S. sphyraena*. *C. mediterranea* have other synonymes, Chauhanea Mediterranea (Euzet and Trilles, 1960); Pseudochauhanea Mediterranea (Euzet & Trilles, 1960), Both are distributed in the central and northwest of the Mediterranean (Lebedev, 1969). *S. pleuronectis*, found in this study, is widespread that found in *Engraulis encrasicolus, Gadus capellanus, Mullus barbatus, Scorpaena scrofa, Spicara smaris, Trachinus draco, Trachurus mediterraneus* and *Trachurus trachovaurus* (Naidenovan and Mordvinova, 1997) proven Mediterranean; in *Solea solea* by (Keser *et al*., 2007) from *Dardanellen strasse*; in *Pleuronectes flesus* by (Oguz, 1989); in *Anguilla anguilla* by (Altunel, 1989) in the *Ekinli lagoon*; and in *Gobius niger*, *Gobius cobitis*, Merluccius merluccius, Eutrigla gurnardus, Solea vulgaris and in Scorpaena scrofa by (Oguz, 1995) and in *Boops boops*, *Solea nasuta*, *Spondyliosoma cantharus*, *Ophidium barbatum*, *smaris smaris* and *Scomber japmironicus* from (Akmirza, 2002) in the Aegean Sea. *Scolex pleuronectis* was also found in *Belone belone* euxini and *Trachurus mediterraneus* (Polyakova, 2009); in *Liza aurata, Liza saliens* and *Mugil cephalus* by (Dmitrieva & Gaevskaya, 2001) and in *Odontogadus merlangus* euxinus, *Ophidion rochei*, *Sarda sarda* and *Trachurus mediterraneus* (Dimitrieva, 1989) in the Black Sea. Most records of these parasites presence as members of assemblages in different host species but do not indicate host-parasite interactions. To explain the effect of *S. pleuronectis* in the fitness of marine fishes is very difficult; because it's affecting the viscera, skeletal musculature and peritoneal cavity of fish are in the majority metacercariae larval stage (MacKenzie, 1985; Borucinska and Caira, 1993; Williams & Jones, 1994). Its mature in the stomach or spiral valve of elasmobranchs, in both taxa known as low specificity in the teleost intermediate hosts (Khalil *et al*., 1994; Palm and Caira, 2008). *Gnathia* sp. Larvae belong to the family Gnathidae have been collected from native and invasive barracuda fishes where the parasite was only at the Prnizan stage. Gnathiid isopods are unique protelic parasites of fishes, where only the juvenile stages are parasitic and feed on host blood, lymph or mucus, while adults are free-living, non-feeding benthic organisms (Smit & Davies, 2004). These marine isopods are worldwide distributed and have been ranged from the Antarctic to the Arctic, but mostly in warm (tropical) areas where they have been reported. It is very common in the Mediterranean and Libyan coast, presence in their hosts (commercial fishes and crustaceans), as well as causing lesions that would represent access to viruses and bacterial infection (Grutter, 1994). In addition to the above locations, they have also been detected in the diet of fish from Portugal, Brazil, aquariums in the United Kingdom, Spain, Puerto Rico, Bahamas and Panama (Grutter *et al*., 2002). Hence, it is important to understand the ecology of the Gnathid in order to understand the cleaning behavior, Prnizia are often found on fish that feed on fish parasites at the larval stage, then return to the benthos to digest their blood meal and molt to develop to the next stage (Monod, 1926). They have 3 larval stages; however, the adults do not eat or reproduce in benthos (Monod, 1926; Wagele, 1987; Grutter & Poulin 1998; Sikkel *et al*., 2000; Arnal & Morand, 2001). *C. elongatus* known as sea lice, it was discovered by Müller (1785). *Caligus* sp. reported as worldwide (Hemmingsen *et al*., 2020), more common in L. salmonis on farmed Atlantic salmon in the Bay of Fundy in the Northwest Atlantic (Hogans and Trudeau, 1989). In this study, *C. elongatus* was obtained from native fish, which directly damage the hosts through their attachment and feeding activities. These copepods can affect the growth rate, fertility and survival of their hosts (Tully, 1989). *C. elongatus* feeds on the mucus, tissue and blood of the host, making them potential vectors and carriers for numerous pathogens among fish (Cusack & Cone, 1986; Gustafson *et al*., 2005). As already mentioned, copepods, *C. elongatus*, can be involved in the spread of photobacteriosis infections; it has a very low specificity, so that it has been described in more than 80 fishes and whales (Kabata, 1994; Kabata, 1979 &Agusti-Ridaura *et al*., 2019). The life cycle of C. *elongatus* is direct and does not require an intermediate host and comprises two free-swimming nauplius stages distributed in plankton, followed by an infectious stage (Kilburn *et al*., 2010). *Vargula sp*. were collected from gills of the *S. sphyraena* in the present study, which is marine ostracods belong to the family Cyprinidae, including the genus *Vargula* sp. (Morin and Bermingham, 1980; Cohen and Morin, 1986). Ostracoda is carried by wind and fishes; this maybe the main factor behind the worldwide spread of marine Ostracoda (Kornicer and Sohn,1971), instead, the large size of larvae and adults may limit their distribution due to the less susceptibility to wind transport, thus, possibly reducing the Ostracoda migration (Kornicer and Sohn,1971). The life cycle of *Vargula* sp. represent ostracode, that uses bioluminescence for courtship, it is a unique mating system with bioluminescent courtship to displays is associated with variation in basic life history characteristic (Gerrish and Morin, 2008).

Generally, parasites recorded in the Mediterranean are higher than in the Red Sea/Indo-Pacific region (Mele *et al*., 2012) New parasites also appeared with high levels of infection for example; in this study, gnathiid were recorded in all fishes, the alien parasites must have converted to barracuda fishes after their migration; other parasites have been described in both the Mediterranean and the natural range but their short lifespan indicates that they were acquired in the newly invaded habitat (Mackenzie & Abaunza, 2014). Parasites can also slow the movement abilities of fish (Wagner *et al*., 2008 & Binning *et al*., 2013). an ecological and physiological combination and behavioural factors may influence different stages (Arndt & Schembri, 2015).

CONCLUSION

Carried out, seven parasite species with total of 165 individuals have been found in the fish samples, the highest prevalence of infection was *Scolex pleuronectis* and lowest prevalence was for *Caligus elongatus* and *vargula* sp., some parasites could not be classified to the species level. The present study has contributed to filling the gap of knowledge about the biological and ecological traits on these fishes, moreover, should help to increase the knowledge on the effect of the alien species. Furthermore, it is required to collect more data on the parasites of alien fishes through examining the Mediterranean juvenile fishes and investigating whether the possible intermediate hosts of the natural indo-pacific parasites may or may not be found in the Mediterranean Sea.

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REFERENCES

Arndt, E., & Schembri, P. J. (2015). Common traits associated with establishment and spread of Lessepsian fishes in the Mediterranean Sea. *Marine Biology*, *162*(10), 2141-2153.

Aguirre-Macedo, M. L., Scholz, T., Gonzalez-Solis, D. A. V. I. D., Vidal-Martinez, V. M., PosEL, P. E. T. R., Arjona-Torres, G., ... & Dumailo, S. (2001). Larval helminths parasitizing freshwater fishes from the Atlantic coast of Nicaragua. Comparative Parasitology, 68(1), 42-51.

Akmirza A (2002) Gökçeada civarındaki balıklarda görülen akantosefal ve sestod parazitleri. Türkiye Parazitol Derg 26: 93–98 (in Turkish).

Agusti-Ridaura, C., Hamre, L. A., Espedal, P. G., Øines, Ø., Horsberg, T. E., & Kaur, K. (2019) First report on sensitivity of Caligus elongatus towards anti-louse chemicals and identification of mitochondrial cytochrome C oxidase I genotypes. *Aquaculture*, *507*, 190-195.

Altunel FN (1989) Karacabey Çiftliği (Ekinli) Gölü'ndeki Yılan Balıklarının (Anguilla anguilla L. 1758)'nın Parazit Faunası Üzerine Araştırmalar. Thesis, Uludağ University, Bursa, Turkey (in Turkish).

Aznar, F. J., Raga, J. A., Corcuera, J., & Monzón, F. (1995) Helminths as biological tags for franciscana (Pontoporia blainvillei)(Cetacea, Pontoporiidae) in Argentinian and Uruguayan waters. *Mammalia*, *59*(3), 427-436.

Binning, S. A., Roche, D. G., & Layton, C. (2013). Ectoparasites increase swimming costs in a coral reef fish. *Biology Letters*, *9*(1), 20120927.

Bush, A. O., Lafferty, K. D., Lotz, J. M., & Shostak, A. W. (1997). Parasitology meets ecology on its own terms: Margolis et al. revisited. *The Journal of parasitology*, 575-583.

Carpenter, K. E., & Niem, V. H. (2001). FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine mammals. FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine mammals.

Ching, H. L., & Madhavi, R. (1999). Lobatocystis euthynni sp. n.(Digenea: Didymozoidae) from mackerel tuna (Euthynnus affinis) from Sulawesi Island, Indonesia. JOURNAL-HELMINTHOLOGICAL SOCIETY WASHINGTON, 66, 25-27.

Cusack, R., & Cone, D. K. (1986). A review of parasites as vectors of viral and bacterial diseases of fish. Journal of Fish Diseases, 9(2), 169-171.

De Sylva, (1981).Fish habitats in dade county , Florida .in metro Dade county ArtificialReef workshop,Rosenstial Schoolof Marine and Atmospheric Sciense, Miami,Florida ,, 14 junuray1981,10 pp.,16figs.In press.

Dimitrov GI (1989). Investigations of the helminths of fishes of the Bulgarian Black Sea Coast. PhD, Bulgarian Academy of Sciences, Sofia, Bulgaria.

Dmitrieva .E.V., Gaevskaya . A.V .(2001). Parasitological aspects of mugilids mariculture and of their introduction into the Sea of Azov and the Black Sea. Ekologiya Moriya 55: 73–78.

ElGanainy, A., Amin, A., Ali, A., & Osman, H. (2017). Age and growth of two barracuda species Sphyraena chrysotaenia and S. flavicauda (family: Sphyraenidae) from the Gulf of Suez, Egypt. *The Egyptian Journal of Aquatic Research*, *43*(1), 75-81.

Euzet, L., & Trilles, J. P. (1960). Octolabea turchinii ag, n. sp.(Plectanocotylidae) un monogène nouveau, parasite de Peristhedion cataphractum (L.). Annales de parasitologie humaine et comparee, 35(4), 504-508.

Golani, D., & Bogorodsky, S. V. (2010). The fishes of the Red Sea—reappraisal and updated checklist. Zootaxa, 2463(1), 1-135.

Gerrish, G. A., & Morin, J. G. (2008). Life cycle of a bioluminescent marine ostracode, Vargula annecohenae (Myodocopida: Cypridinidae). *Journal of Crustacean Biology*, *28*(4), 669-674.

Grutter, A. S. (1994). Spatial and temporal variations of the ectoparasites of seven reef fish species from Lizard Island and Heron Island, Australia. *Marine Ecology Progress Series*, *115*, 21-30.

Grutter, A. S., & Poulin, R. (1998). Intraspecific and interspecific relationships between host size and the abundance of parasitic larval gnathiid isopods on coral reef fishes. *Marine Ecology Progress Series*, *164*, 263-271.

Grutter, A. S., Deveney, M. R., Whittington, I. D., & Lester, R. J. G. (2002). The effect of the cleaner fish Labroides dimidiatus on the capsalid monogenean Benedenia lolo parasite of the labrid fish Hemigymnus melapterus. *Journal of Fish Biology*, *61*(5), 1098-1108.

Heil, N., (2009). National Wild Fish Health Survey – Laboratory Procedure Manual, fifth ed. US Fish and Wildlife Service, Warm Springs.

Hile, R. (1936). Age and growth of the cisco, Leucichthys artedi (Le Sueur), in the lakes of the northeastern highlands, Wisconsin.

Hogans, W. E., & Trudeau, D. J. (1989). Preliminary studies on the biology of sea lice, Caligus elongatus, Caligus curtus and Lepeophtheirus salmonis (Copepoda: Caligoida) parasitic on cage-cultured salmonids in the lower Bay of Fundy. Canadian Technical Report of Fisheries and Aquatic Sciences, (1715).

Horberg E.P. (2005) . Coevolution in marine systems . In : Rhode K(ed) marine parasitology . CABI Puplishing , Wallingford ,pp327-339.

Hussain, S. A., Rao, H., & Shyamasundan, K. (1985). On digenetic trematodes of the family Didymozoidae Poche, 1907 from fishes of Waltair Coast Bay of Bengal. Rivista di Parassitologia, 2, 91-97.

Khalil L.F., Jones A., Bray R.A. (1994). Keys to the Cestode Parasitesof Vertebrates. CAB International, Wallingford, 751 pp.

Kilburn, R., Bricknell, I. R., Cook, P., Pert, C. C., Dunn, J., & Matejusova, I. (2010). Design and application of a portable, automated plankton sampler for the capture of the parasitic copepods Lepeophtheirus salmonis (Krøyer 1837) and Caligus elongatus (Von Nordmann 1832). Journal of plankton research, 32(6), 967-970.

KORNICKER, L.S., AND I.G. SOHN. (1971). Viability of ostracod eggs egested by fish and effect of digestive fluids on ostracod shell—ecologic and paleontologic implications. Bulletin, Centre de Recherches de Pau (SNPA 5 supplement):207–237.

Keser, R., Bray, R. A., Oguz, M. C., Çelen, S., Erdoğan, S., Doğuturk, S., ... & Marti, B. (2007). Helminth parasites of digestive tract of some teleost fish caught in the Dardanelles at Çanakkale, Turkey. Helminthologia, 44(4), 217-221.

King, M. (2013). Fisheries biology, assessment and management. John Wiley & Sons.

Lebedev, B. I., (1969). Basic regularities in the distribution of monogeneans and trematodes of marine fishes in the world ocean (Russ.) — Zool. Zh.*48*, 41–50.

Lessios H.A. (1988). Mass mortality of Diadema antillarum in the Caribbean: what have we learned? Ann Rev Ecol Syst 19: 371-393.

Madhavi, R. (1982). Didymozoid trematodes (including new genera and species) from marine fishes of the Waltair coast, Bay of Bengal.Systematic Parasitology,4, 99–124.

Mele, S., Macías, D., Gómez-Vives, M. J., Garippa, G., Alemany, F., & Merella, P. (2012). Metazoan parasites on the gills of the skipjack tuna Katsuwonus pelamis (Osteichthyes: Scombridae) from the Alboran Sea (western Mediterranean Sea). Diseases of aquatic organisms, 97(3), 219-225.

MacKenzie, K., & Abaunza, P. (2014). Parasites as biological tags. In Stock Identification Methods (pp. 185-203). Academic Press.

Marcogliese, D. J. (2005). Parasites of the superorganism: are they indicators of ecosystem health?. *International journal for parasitology*, *35*(7), 705-716.

Monod, T. (1926). Les Gnathiidae. Essai monographique (morphologie, biologie,

systématique). *Mémoires de la Société des Sciences naturelles du Maroc*, *13*, 1-668.

Naidenova NN, Mordvinova TN (1997). Helminth fauna of Mediterranean Sea fish upon the data of IBSS's expeditions (1959-1973). Ekologiya Morya Kiev 46: 69–74 (in Russian).

Oğuz. M.C. (1989). Ekinli Lagünü'ndeki Pisi Balıklarının (*Pleuronectes flesus luscus* L.) Parazit Faunası. MSc, Uludağ University, Bursa, Turkey (in Turkish).

Oğuz. M.C. (1995). Mudanya Kıyılarındaki Bazı Teleost Balıklarda Rastlanılan Helmintler. PhD, Uludağ University, Bursa, Turkey (in Turkish).

Oliva, M. E., & Sánchez, M. F. (2005). Metazoan parasites and commensals of the northern Chilean scallop Argopecten purpuratus (Lamarck, 1819) as tools for stock identification. *Fisheries Research*, *71*(1), 71-77.

Polyakova .T.A. (2009). Fauna of cestodes in fishes from Kerch Channel (Naberejnoe). Ekologiya Morya 77: 52–56.

Radhi, A. M., Fazlinda, M. F. N., Amal, M. N. A. & Rohasliney, H. (2018). A review of length-weight relationships of freshwater fishes in Malaysia. Transylvanian Review of Systematical and Ecological Research, 20(1): 55-68.

Smit, N. J., & Davies, A. J. (2004). The curious life-style of the parasitic stages of gnathiid isopods. *Advances in parasitology*, *58*, 289-391.

Tully, O. (1989). The succession of generations and growth of the caligid copepods Caligus elongatus and Lepeophtheirus salmonis parasitising farmed Atlantic salmon smolts (Salmo salar L.). Journal of the Marine Biological Association of the United Kingdom, 69(2), 279-287.

Wagner, G. N., Fast, M. D., & Johnson, S. C. (2008). Physiology and immunology of Lepeophtheirus salmonis infections of *salmonids*. *Trends in parasitology*, *24*(4), 176-183.

Wägele, J. W. (1987). Description of the postembryonal stages of the Antarctic fish parasite *Gnathia calva Vanhöffen* (Crustacea: Isopoda) and synonymy with Heterognathia Amar & Roman. Polar Biology, 7(2), 77-92.

Williams, H. H., Jones, A., & Crompton, D. W. T. (1994). *Parasitic worms of fish* (No. 04; SH175, W5.). London: Taylor & Francis.

Yamaguti .S.(1959). Systema Helminthum. Vol n. The Cestodes of Vert brates . New Y ork : Interscience Publishers , 1959: 860 pp.

Yanong, R. P. (2002). Nematode parasites of animals and Humans. Fishes & Aquatic Science [SFRC], Florida.