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Prevalence of parasitic isopods (Cymothoidae and Gnathiidae) on Actinopterygii fishes from the Alexandria coast off the Mediterranean Sea, Egypt

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ABSTRACT

During the year 2021, a total of 2152 Actinopterygii fish represented by eleven fish species were collected from the Egyptian waters of Alexandria. *Livoneca redmanii* Leach 1818, *Anilocra alloceraea* Koelbel 1878, *Ceratothoa oestroides* Rosso, 1827) (family: Cymothoidae), and *Gnathia* sp. (praniza larvae) (family: Gnathiidae) were discovered throughout the research period. The current study aims to provide insight on the distribution of parasitic isopods among infested fish on the Egyptian coast, through associations between parasitic species and their hosts. Two of the four species (*C. oestroides* and *A. alloceraea*) were reported for the first time on the Egyptian coast. Among the six host species, *Gnathia* sp. (praniza larva) has consistently been proven to be the most frequent species. Gills of four host species have been implicated in the discovery of *Livoneca redmanii*. The buccal cavity of *Boops boops* (Linnaeus, 1758) has been gathered to have *Ceratothoa oestroides*. whereas *Anilocra alloceraea* were reported on the outer body of *Sardina pilchardus* (Walbaum, 1792). *L. redmanii* and *Gnathia* sp. which parasitized of *Scomberomorus commerson* (Lacepède, 1800) and *Pomatomus saltatrix* (Linnaeus, 1766) had the greatest prevalence rates across their host species (*P*=27.1% & *P*=17.7%), respectively. The bulk of the host species infection sites is found on the gill macroniche of the hosts, which account for 580 parasitic specimens out of a total of 978 for *Gnathia* sp. *L. redmanii* followed with 162 parasitic individuals out of a total of 174 individuals. Our investigation concluded that the parasites select a particular host to access it secretly, in a situation known as the host's specificity. New hosts that included *L. redmanii* on *P. saltatrix*, *S. commerson*, and *Umbrina cirrosa* (Linnaeus, 1758) have been reported.

INTRODUCTION

Recent years have seen an increase in interest in the parasitic isopod family Cymothoidae Leach, 1814 due to its ecological and commercial importance **(Aneesh, *et al*., 2019, 2021; Hadfield & Smit, 2020).** Members of cymothoid species are protandric hermaphrodites that feed on the blood, flesh, and mucous of several species of freshwater, marine, and estuary fishes, which are easily recognizable, although genera and species are frequently lost and incorrectly categorized **(Aneesh *et al*., 2018; Hadfield & Smit, 2020).** However, as it is challenging to validate or refute previous species reports, a large portion of the present data on the biodiversity, distribution, and host records of this family need further investigation about its authenticity **(Smit *et al.*, 2014).** Despite recent studies **(Hadfield & Smit, 2020),** many cymothoid species still need to be corrected to provide accurate information for future studies on this key group of fish parasites from ecological and commercial perspectives.

The Egyptian parasitic isopod fauna near the Mediterranean is relatively poorly known, and thus far, investigations around this neglected group are still scarce on marine fishes from the Egyptian coasts. In total, 15 species from the family Cymothoidae have been reported from Morocco, 16 species from Algeria, 11 cymothoid species from Tunisia, and seven from Egypt **(see Geba, *et al.*, 2019).** Because cymothoid fauna are common in most marine environments, some cymothoid species, such as *Ceratothoa*, have been linked to significant outbreaks in endemic areas, e.g., the Adriatic Sea and the Aegean Sea. However, it appears that the cymothoids that reside on the fish's surface have fewer particular environmental needs and may thus be found in various positions. Manifestly, such a presumption certainly explains the paucity of information on the location of this group of parasites; most authors explain this simple estimate by positioning the parasites for major subdivisions of the body, e.g., head, trunk, or similar, as reported by **Rameshkumar *et al.* (2016).** On the subject of the nature of isopod parasite infestation in fish, few related papers are accessible in the following references **(Williams & Williams 1994 and Cuyas *et al.*, 2004).** However, marine fishes require more in-depth investigations on the distribution of parasitic **isopods (Rameshkumar, *et al.*, 2013, 2016).** From this vantage point, we were able to pinpoint the presence and distribution of a few parasitic isopod species among the commercially significant fish of the country. Hence, an attempt was made to provide new data on the distribution or prevalence of parasitic isopod species in Actinopterygii fish, which are of great economic importance, as well as to provide data on the host associations of these parasitic species in the Mediterranean of the Egyptian coast.

MATERIAL AND METHODS

The present study is conducted from January to December 2021, 2152, fish specimens belonging to eleven species of Actinopterygii fish were gathered and examined for parasitic isopods. Specimens were collected seasonally along the Alexandria coast of Egypt (Fig. 1). The living parasitic isopods were recovered from the host species in the field, fixed using the techniques described by **Aneesh *et al.*, (2018),** thereafter, preserved in 70% ethanol, and taxonomically identified to species-level using the proper taxonomic key. Fish specimens were delivered right away to the Invertebrate Lab (MiTA in Lab), Faculty of Science, Al-Azhar University for parasitological examination. In Lab, the total and standard length with weight were measured, the fish sex was determined for each fish specimen. Sources of fish taxonomy and host nomenclature were carried out according to Fish-Base **(Froese & Pauly 2021)** and the catalog of fish related to **(Fricke *et al.*, 2021).** The date, fish species, size, parasite micro-niche, and sample location were all documented. Parasitic isopod specimens were examined under a dissecting stereomicroscope (OPTIKA-SFX-33) and light microscopy (06AAGPV4541F1ZO) after being cleaned in lactic acid for two hours. The identification and characterization of parasitic isopod species were performed by using modern classification keys based on morphological features and explained according to the following references **(Hadfield *et al*., 2013; Aneesh 2014).** The host-parasite relationships were analyzed for the sex and size of the hosts. Infestation rates were evaluated using prevalence and mean intensity as defined by **Margolis *et al*., (1982)** and its modification by **Bush *et al*., (1997).**

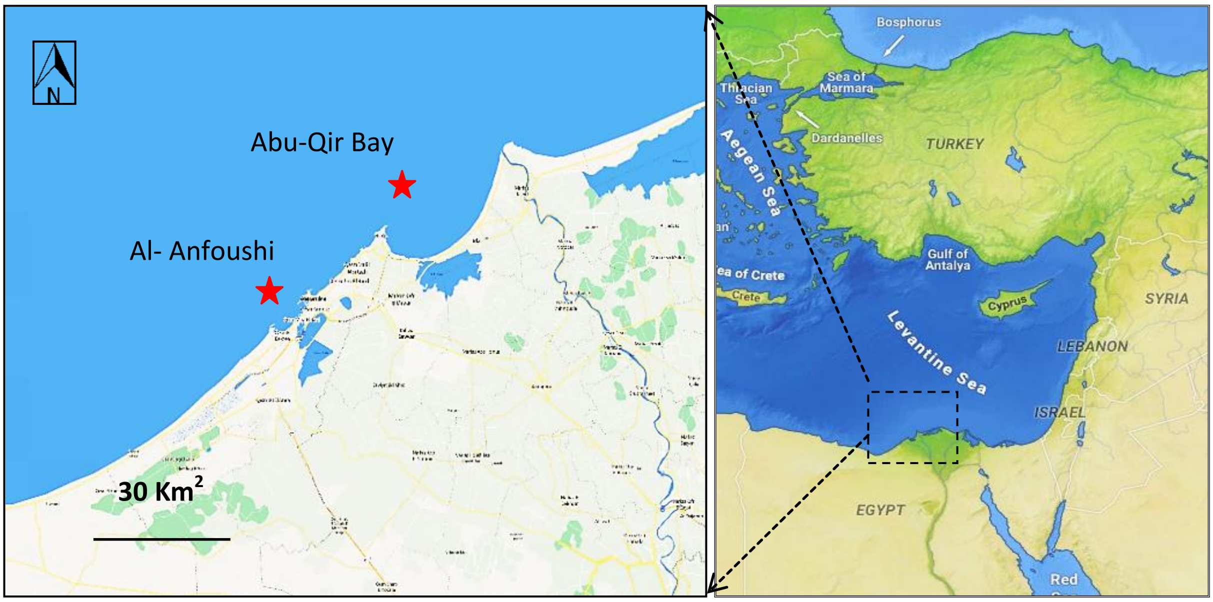

Fig. 1**.** Sampling sites, Abu-Qir Bay and Al-Anfoushi region indicated by red stars.

RESULTS

Throughout the research period, 19 fish species from the Egyptian coast close to Alexandria were gathered and subjected to parasitological analysis. Four parasitic isopod species were discovered from eleven host species. The remaining eight fish species in Table (1) were not infested throughout the collection year. In total, 2152 specimens of Actinopterygii fish were recovered and classified into eleven different fish species across five orders and eight families (Table 1). Four parasitic species representing three genera (*Livoneca*, *Anilocra*, and *Ceratothoa*) of the family Cymothoidae and one genus (*Gnathia*) of the family Gnathiidae that attacked species of Actinopterygii fish were found (Table 2, and Fig. 2).

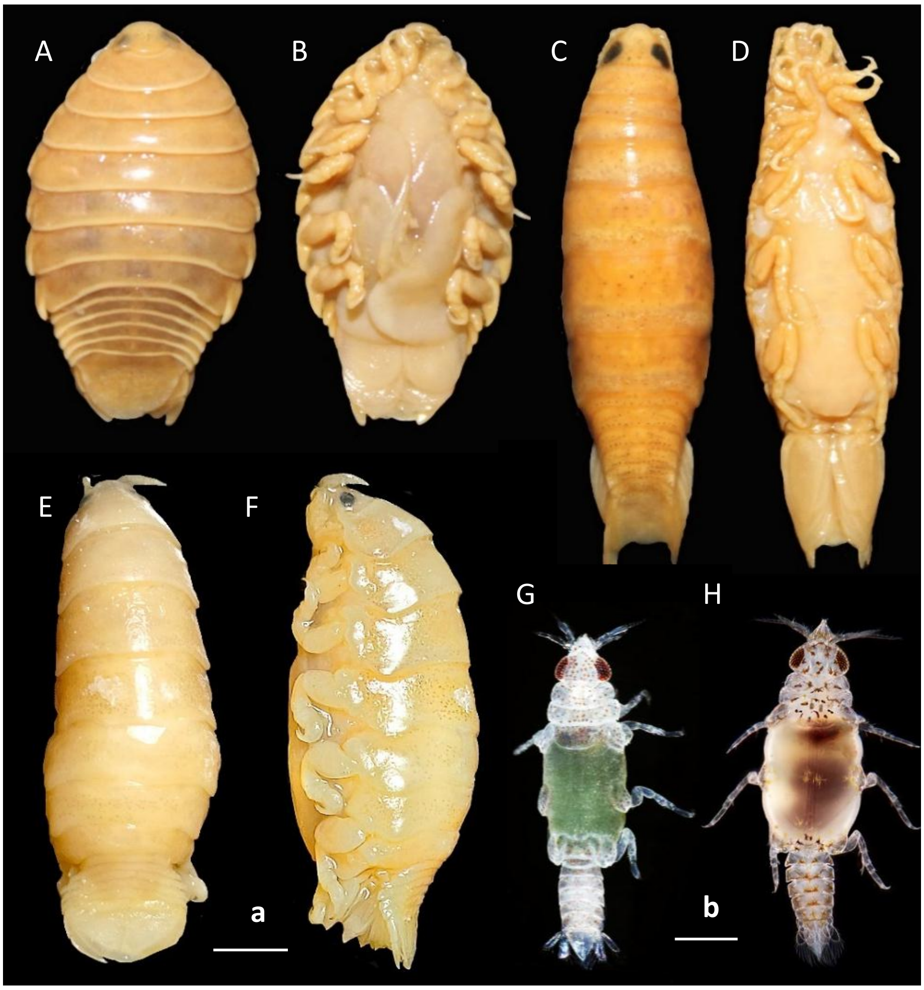

Fig. 2. Parasitic isopod species: (A & B) *Livoneca redmanii*; (C & D) *Anilocra alloceraea*; (E & F) *Ceratothoa oestroides*; and (G & H) *Gnathia* sp. (praniza larva). Scale bar, a= 3.0mm (A – F) and b= 0.5mm.

1. Annual prevalence of investigated isopod species

Throughout the research period, *Livoneca redmanii* Leach, 1818; *Anilocra alloceraea* (Koelbel, 1878); *Ceratothoa oestroides* (Risso, 1827), and *Gnathia* sp. (praniza larva) were discovered from 346 distinct host specimens (Tab. 3, and Fig. 2). *Sardina pilchardus*, the host species, had occasional penetrations of *A. alloceraea* on its body surface; the *Boops boops* buccal cavity yielded the discovery of *C. oestroides*, whereas various host species, including *Dicentrarchus labrax, Mugil cephalus, Pomatomus saltatrix, Scomberornorus commerson,* and *Umbrina cirrosa*, were discovered to accommodate *L. redmanii* parasitic species; additionally, *Dicentrarchus labrax, Mugil cephalus, Sparus aurata, Mullus surmuletus*, *Lithognathus mormyrus,* and *Pagellus erythrinus* were found to have parasitic *Gnathia* sp. (Figs., 4, 5, and 6). The annual distribution of parasitic isopods was determined according to the seasons. A total of 346 host specimens were investigated as a result of our research, which constituted 54.8% of host females and 45.2% of host males. These host species were found to carry 1295 isopod parasites, corresponding to an overall prevalence of 16.1%. Female and male host species alike had the same infestation rate (*P*=16.1%)

(*P*=16.0%). Seasonal prevalence exhibited noticeable year-round changes. The summer season saw the highest infestation rate (*P*=19.6%), while the autumn saw the lowest (*P*=12.8%). The mean intensity varied from 3.4 at its lowest point in the summer to 4.4 at its highest point in the winter. Regarding the sex of the host, male predominance was highest in the summer (*P*=20.2%) and lowest (*P*=13.3%) in the spring. In female hosts, the frequency peaked in the winter at 20.5% and peaked in the fall at 12.3%. For male hosts during spring and for female hosts during winter, greater intensities (4.9 and 3.8) were noted (Table 2). Some clarifications on the distribution and attachment mode of the cymothoid and gnathiid species were addressed in relation to host species (Table 3) as follows.

2. Parasitological indices of parasitic isopod

A total of 1295 individuals of parasitic isopod species were collected throughout this survey. Of these, 174 *Livoneca redmanii* individuals were gathered from five distinct host species: *Dicentrarchus labrax*, *Mugil cephalus*, *Pomatomus saltatrix Scomberomorus commerson*, and *Umbrina cirrosa*. This isopod exhibits a higher prevalence on host species, *S. commerson* (*P*=27.1%), compared with its distribution on other host species, *M. cephalus* (*P*=3.0%), and *P. saltatrix* (*P*=8.8%) (Table 3). *Livoneca redmanii* are often discovered on host fish gills and cause negative effects on their hosts. A few individuals of *Livoneca redmanii* were observed attached to the host's trunk. They were discovered to be fixed to the host by hook-like projections on the first three pereopods, first maxillae, and mandibles. The body was always pointed toward the fish's front end when it was in the connected position. In other instances, numerous *L. redmanii* individuals were discovered from the gills on the same host, e.g., *U. cirrosa* (Fig. 4C), and these infections resulted in exceedingly serious side effects because of the known frequency or quantity of infections. However, *L. redmanii* has fewer microniches on their hosts, normally seen attached on/between the gill filaments (162 individuals), and the majority of them were obtained from the fish host of *S. commerson* (83 individuals) or the outer body surface (12 individuals) of their hosts.

Sardina pilchardus, the host species, revealed the presence of 139 individuals of *Anilocra alloceraea* on its outer body surface. According to parasitic distribution, the prevalence of this parasite was rather high (*P*=23.0%), constituting 24.1% of the female host population and 21.6% of the male host population. Infections on the gill filaments themselves, on the outer or inner of the operculum, or anywhere else along the circumference of the gill zone were considered to fall under the definition of "gills", as shown in Fig. 5C. The presence of *A. alloceraea* within the gill filaments may have been entirely accidental, as no internal infection was observed on the gill filaments in the presence of the parasites, with the exception of one specimen that was too fragile to readily identify infections with it. However, the majority of *A. alloceraea* individuals were found on its ventral surfaces, particularly between the pectoral fins under the operculum (76 parasitic individuals) and were distributed close to the gill zonation (50 individuals). In certain instances, there were two or more individuals on the same host, as shown in Fig 5A.

Table. 1. A list of taxonomy for Actinopterygii fish species with reference to their numbers that were gathered throughout the research period.

Order	Family	Species	No	Inf	Un-Inf
Perciformes	Moronidae	*Dicentrarchus labrax* (Linnaeus, 1758)	234	+	
	Sparidae	*Sparus aurata* (Linnaeus, 1758)	211	+	
		Boops boops (Linnaeus, 1758)	119	+	
		Lithognathus mormyrus (Linnaeus, 1758)	84	+	
		Pagrus pagrus (Linnaeus, 1758)	96		+
		Diplodus sargus Linnaeus, 1758	126		+
	Sphyraenidae	*Sphyraena viridensis* Cuvier, 1829	36		+
	Serranidae	*Epinephelus alexandrines* (Valenciennes, 1828)	16		+
	Siganidae	*Siganus rivulatus* Forsskål & Niebuhr, 1775	62		+
Clupeiformes	Clupeidae	*Sardina pilchardus* (Walbaum, 1792)	357	+	
	Mullidae	*Mullus surmuletus* (Linnaeus, 1758)	168	+	
		Pagellus erythrinus (Linnaeus, 1758)	164	+	
	Pomatomidae	*Pomatomus saltatrix* (Linnaeus, 1766)	160	+	
Acanthuriformes	Sciaenidae	*Umbrina cirrose* (Linnaeus, 1758)	145	+	
		Argyrosomus regius Asso, 1801	48		+
Mugiliformes	Mugilidae	*Mugil cephalus* Linnaeus, 1758	231	+	
Scombriformes	Scombridae	*Scomberomorus* commerson (Lacepède, 1800)	210	+	
Aulopiformes	Synodontidae	*Saurida undosquamis* (J. Richardson, 1848)	98		+
Beloniformes	Hemiramphidae	*Hemiramphus far* (Forsskål, 1775)	123		+

Furthermore, only three of the 119 fish specimens of *Boobs boops* that were investigated had four Ceratothoa oestroides individuals, which had a significantly low distribution (*P*=1.3%). Since C. oestroides only lived in the host fish's buccal cavity, their location is quite particular. During the study period, only four individuals of *C. oestroides* were recorded throughout the year (Tables 3, and 4). Three of the individuals were captured in a posture facing the mouth opening, and a fourth specimen protruded from the mouth.

Multiple host species, including *D. labrax*, *Sparus aurata*, *Mullus surmuletus Lithognathus mormyrus*, *Pagellus erythrinus*, *M. cephalus*, and *Gnathia* sp. (praniza larva), were also discovered. *P. erythrinus* had the highest prevalence of this isopod parasite (*P*=17.7%), whereas *D. labrax* had the lowest prevalence (*P*=8.1%) (Table 3). The top-ranking and most prevalent parasite was *Gnathia* sp. (praniza larva), which took up residence in a number of microniches on its hosts (580 individuals on gills, 304 individuals in the buccal cavity and mouth); the remainder were gathered from various areas of the body's surface, particularly the frontal region, which includes the head, the upper and lower pectoral fins, the region between the pectoral and pelvic fins, and the area under the dorsal fin. The majority of these parasite individuals were discovered on the gills of the fish hosts *S. aurata* (132 individuals), *P. erythrinus* (128 individuals), and *M. cephalus* (133 individuals) (Table 4).

Table 2. Seasonal variation in the prevalence of parasitic isopods according to the fish sex.

Season	**Total**			**Female fish**			**Male fish**		
	NEF	NIF	NCP	NEF	NIF	NCP	NEF	NIF	NCP
		P (%)	MI		*P* (%)	MI		*P* (%)	MI
Winter	410	77 (18.8)	337 (4.4)	219	45 (20.5)	220 (4.9)	191	32 (16.8)	117 (3.7)
Spring	589	77 (13.1)	297 (3.9)	325	42 (12.9)	165 (3.9)	264	35 (13.3)	132 (3.8)
Summer	654	128 (19.6)	438 (3.4)	367	70 (19.1)	232 (3.3)	287	58 (20.2)	206 (3.6)
Autumn	499	64 (12.8)	223 (3.5)	268	33 (12.3)	112 (3.4)	231	31 913.4)	111 (3.6)
Total	**2152**	**346 (16.1)**	**1295 (3.7)**	**1179**	**190 (16.1)**	**729 (3.8)**	**973**	**156 (16.0)**	**566 (3.6)**

***NEF** = No. of Examined fish;* ***NIF** = No. of Infested fish;* ***NCP** = No. of collected parasites;* ***MI**= Mean Intensity and* ***P (%)** = Prevalence*

The prevalence of isopod parasites in relation to the sex of hosts was calculated according to the different fish hosts. In male fishes, the highest prevalence (23.5%) was observed for *L. redmanii* on *S. commerson* and the lowest (2.9%) for the same parasite species on the host *Mugil cephalus*. In female fishes, the prevalence was maximum (30.4%) for *L. redmanii* on *S. commerson* and the minimum (1.4) for *L. redmanii* on all its fish hosts (Table 3). The mean intensity of isopod species was low and did not exceed 1.7 for *L. redmanii*, *Anilocra alloceraea* and *Ceratothoa oestroides* on most fish hosts. However, for *Gnathia* sp., the mean intensity was markedly high, ranging between 4.2 and 9.0 on the fish hosts *D. labrax* and *M. cephalus*, respectively (Tab. 3).

According to field observations of the researched hosts (Figs. 4, 5, and 6), the principal clinical symptoms of infested fish species were sluggish movement, swimming near the water's surface, debilitation with abundant mucus and becoming food intolerant, as well as rubbing against hard objects. Additionally, fish that were infected with parasitic isopods displayed increased opercular movement and gathered around air sources. Some fish gathered on the water's surface, while others gathered along the beach, particularly in the intertidal zone. Below is a list of some of these indicators that were seen throughout the inquiry period, including the lack of escape reflex, emaciation, degenerative and hyperplastic alterations in the skin, and the scale of the body surface.

Table 3. Parasitological indices of parasitic isopod on their hosts in relation to the sex of hosts.

Fish hosts	**Parasitic isopods**	**Total**			**Female host fish**			**Male host fish**		
		NEF	NIF P (%)	NCP MI	NEF	NIF P (%)	NCP MI	NEF	NIF P (%)	NCP MI
Dicentrarchus labrax	*Livoneca redmanii*	234	23 (9.8)	30 (1.3)	134	14 (10.4)	20 (1.4)	100	9 (9.0)	10 (1.1)
	Gnathia sp		19 (8.1)	80 (4.2)		11 (8.2)	45 (4.1)		8 (8.0)	35 (4.4)
Mugil cephalus	*Livoneca redmanii*	231	7 (3.0)	8 (1.1)	128	4 (3.1)	5 (1.3)	103	3 (2.9)	3 (1.0)
	Gnathia sp		29 (12.6)	262 (9.0)		15 (11.5)	176 (11.7)		14 (13.6)	86 (6.1)
Pomatomus saltatrix	*Livoneca redmanii*	160	14 (8.8)	18 (1.3)	93	10 (10.8)	14 (1.4)	67	4 (6.0)	4 (1.0)
Scomberornorus commerson		210	57 (27.1)	95 (1.7)	112	34 (30.4)	57 (1.7)	98	23 (23.5)	38 (1.7)
Umbrina cirrosa		145	17 (11.7)	23 (1.4)	78	7 (9.0)	10 (1.4)	67	10 (14.9)	13 (1.3)
Sparus aurata	*Gnathia sp*	211	29 (13.7)	222 (7.7)	107	15 (14.0)	124 (8.3)	104	14 (13.5)	98 (7.0)
Mullus surmuletus		168	15 (8.9)	73 (4.9)	92	9 (9.8)	44 (4.9)	76	6 (7.9)	29 (4.8)
Lithognthus mormyrus		153	22 (14.4)	134 (6.1)	84	11 (13.1)	65 (5.9)	69	11 (15.9)	69 (6.3)
Pagellus erythrinus		164	29 (17.7)	207 (7.1)	85	12 (14.1)	90 (7.5)	79	17 (21.5)	117 (6.9)
Sardina pilchardus	*Anilocra allocerаea*	357	82 (23.0)	139 (1.7)	195	47 (24.1)	78 (1.7)	162	35 (21.6)	61 (1.7)
Boops boops	*Ceratothoa oestriodes*	119	3 (2.5)	4 (1.3)	71	1 (1.4)	1 (1.4)	48	2 (4.2)	3 (1.5)
Total		2152	346 (16.1)	1295 (3.7)	1179	190 (16.1)	729 (3.8)	973	156 (16.0)	566 (3.6)

***NEF**= No. of Examined fish; **NIF**= No. of Infested fish; **NCP**= No. of collected parasites; **MI**= Mean Intensity and **P (%)** = Prevalence.*

Table 4. Attachment sites (micro-niche) of parasitic isopods on host species.

Parasitic sp.	**Host species**	**Micro-niche**					
		Gills	*BCM*	*D. side*	*V. side*	*Tail*	*Head*
Anilocra alloceraea	*S. pilchardus*	50	-	5	76	6	2
Ceratothoa oestriodes	*B. boops*	-	4	-	-	-	-
Livoneca redmanii	*D. labrax*	30	-	-	-	-	-
	M. cephalus	8	-	-	-	-	-
	P. saltatrix	18	-	-	-	-	-
	S. commerson	83	-	7	5	-	-
	U. cirrosa	23	-	-	-	-	-
	Total	162	-	7	5	-	-
Gnathia sp. (praniza larva)	*D. labrax*	58	15	-	3	-	4
	S. aurata	132	75	3	1	-	11
	M. surmuletus	49	20	3	1	-	-
	L. mormyrus	80	46	2	-	-	6
	P. erythrinus	128	64	-	2	-	13
	M. cephalus	133	84	10	16	5	14
	Total	580	304	18	23	5	48
Total		**792**	**308**	**20**	**104**	**11**	**50**

BCM=*Buccal cavity and Mouth.* ***D***=*Dorsal side.* ***V***=*Ventral side.*

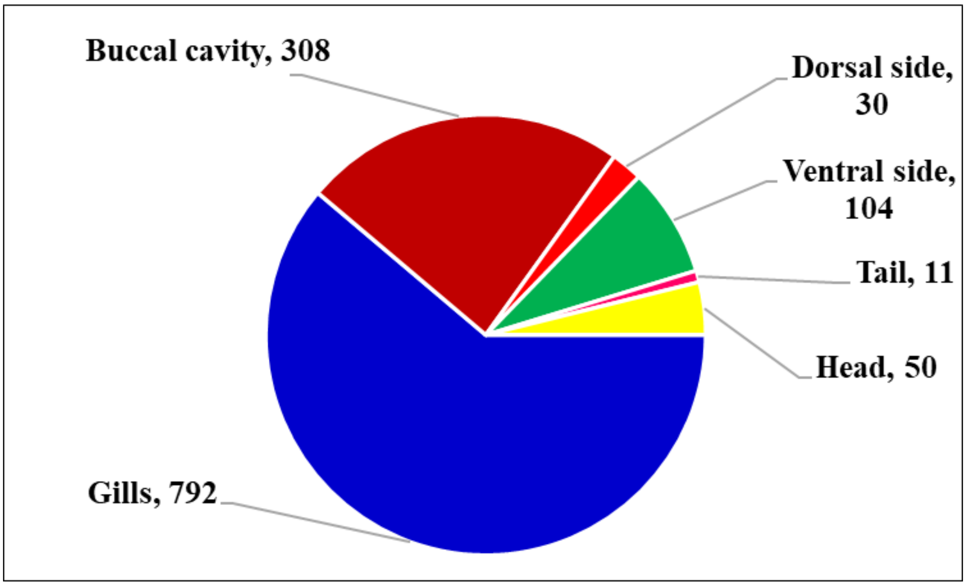

Fig. 3. Attachment sites (micro-niches) of parasitic isopods on Actinopterygii fish.

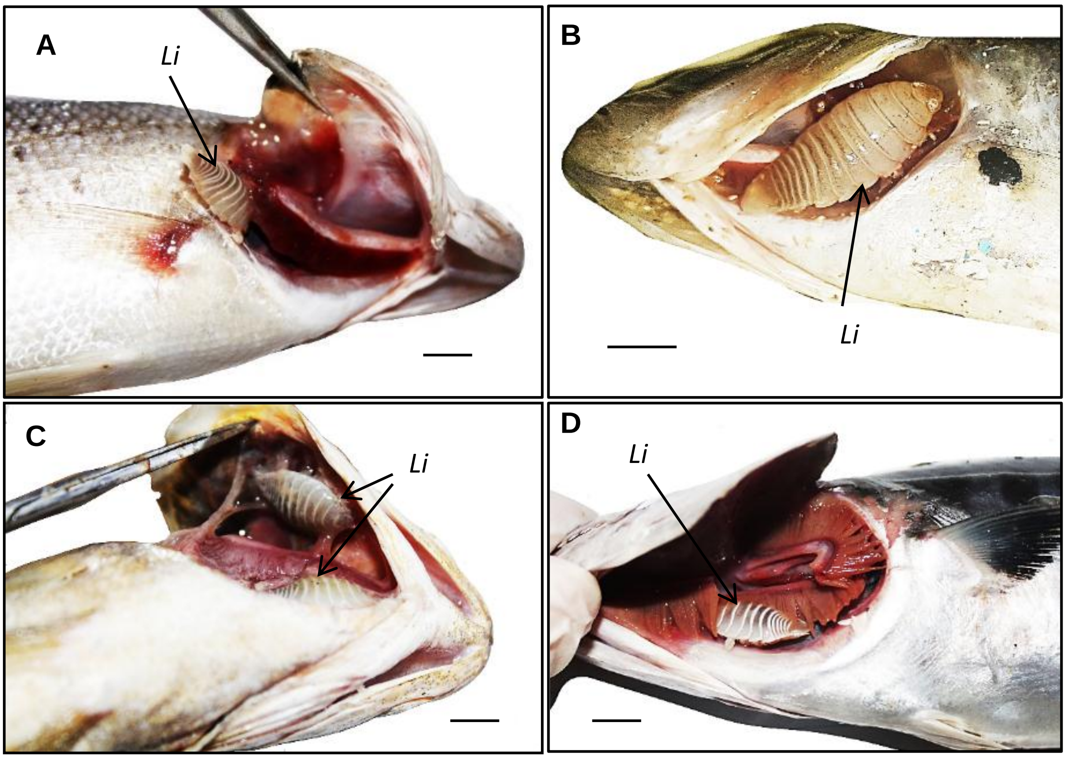

Fig. 4. *Livoneca redmanii* on their host gills. A) *D. labrax*, B) *M. cephalus*, C) *U. cirrosa*, and D) *S. commerson*. Scale bar for host species= 1cm.

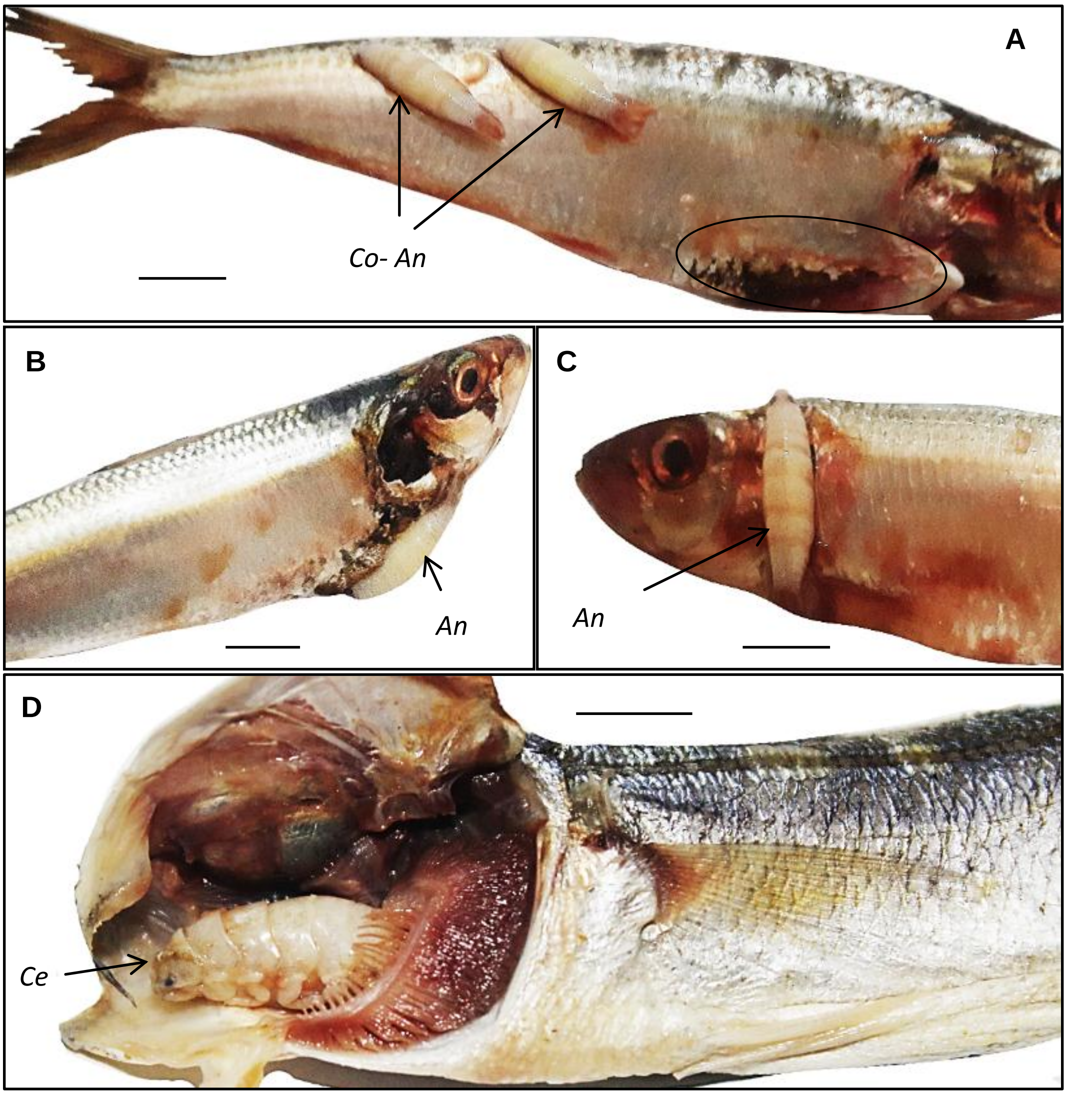

Fig. 5. *Anilocra alloceraea* in several macro-niche of *S. pilchardus* (A – C); and *Ceratothoa oestroides* on the host buccal cavity of *B. boops*. Scale bar for host species= 1cm.

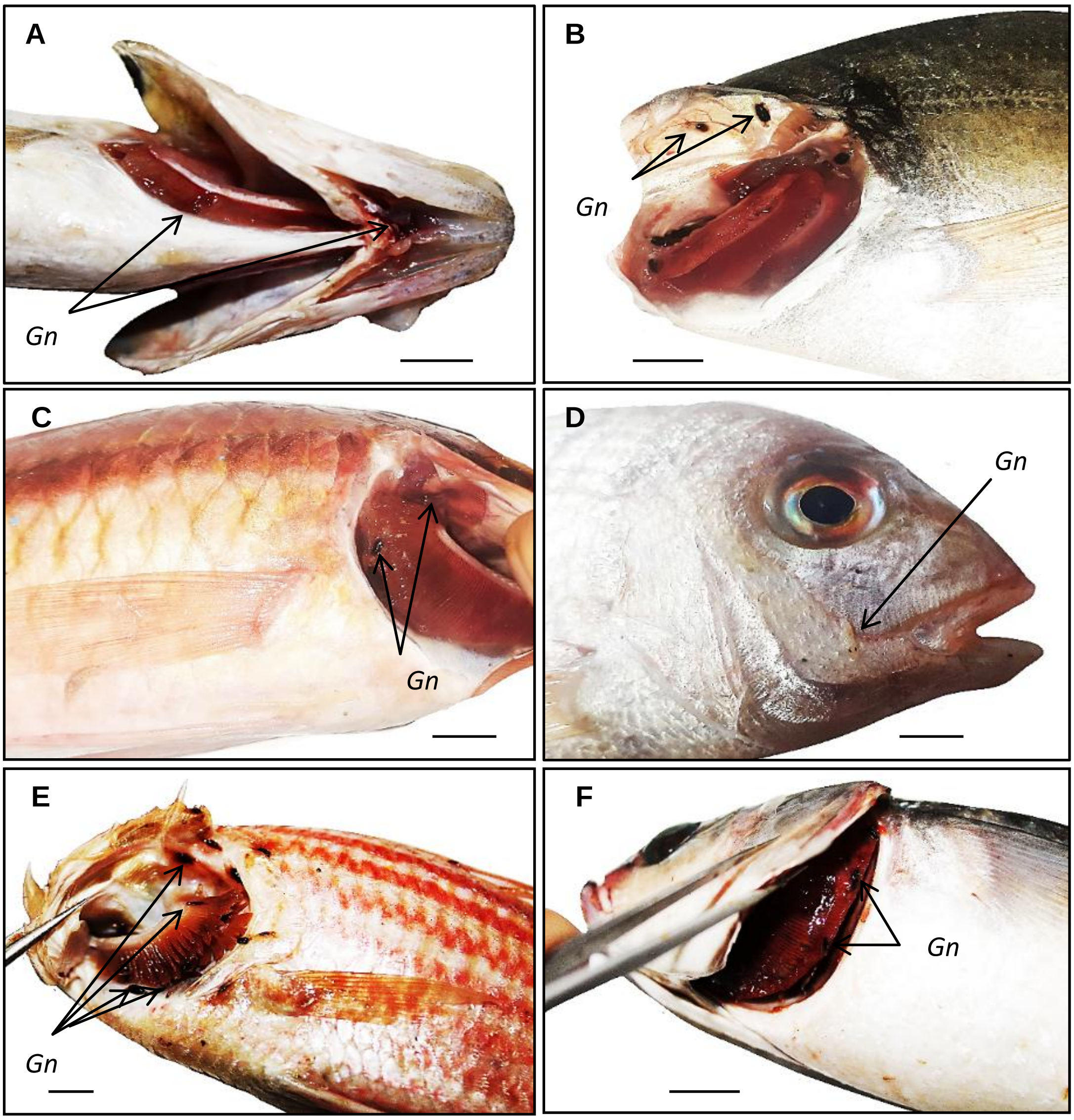

Fig. 6. *Gnathia* sp. (praniza larva) on their host species. A) *D. labrax*, B) *S. aurata*, C) *M. surmuletus*, D) *L. mormyrus*, E) *P. erythrinus* and F) *M. cephalus*. Scale bar for host species=2cm

DISCUSSION

Numerous fish species are parasitized by cymothoid isopods in a variety of habitats, which causes significant economic losses **(Ravichandran *et al.*, 2011; Khalaf-Allah & Yousef, 2019).** Eight out of the 19 fish species we examined in our survey were not parasitized by any isopods, while four different isopods parasitized eleven of the host species. The current study documents the presence of four species of parasitic isopods that feed on commercially significant marine fishes off the coast of Alexandria, Egypt; three of these species are in the family Cymothoidae, and one is in Gnathiidae. *Anilocra alloceraea* and *Ceratothoa oestroides* were recorded for the first time, and each parasitized just one host species; *Livoneca redmanii* and *Gnathia* sp. (praniza larva) were discovered on several distinct host species.

Livoneca redmanii has been misidentified several times by researchers in Egypt after being found in Lake Qarun, the Suez Canal, and the Mediterranean Sea **(see Geba, *et al.*, 2019).** Five distinct fish species were parasitized by *L. redmanii* in the current investigation, and the prevalence rates for the examined hosts varied from 3.0% for the fish host *Mugil cephalus* to 27.10% for the fish host *Scomberomorus commerson*. The analysis of diversity indices revealed that the researched fish species had a high diversity and a moderate prevalence rate. Additionally, these cymothoid species favor gill location above other microniches. These results are commensurate with the findings given by **Samn *et al.*, (2014)** for some Sparidae fish species infected by *Nerocila bivittata* (Risso, 1816) in the Mediterranean, **Khalaf-Allah & Yousef (2019)** for *L. redmanii* on *Solea solea* (Linnaeus, 1758) from Lake Qarun and **Hellal & Yousef (2018)** for *L. redmanii* on *Mugil cephalus* Linnaeus, 1758 from the same lake. Additionally, **Mahmoud *et al.*, (2019)** examined certain Mugilidae fish from the Mediterranean that have *L. redmanii* infection. Different parasite species exhibit host and environment selection (microniches) to varying degrees. The morphological and physiological factors that affect an isopod's choice of location are still unknown for the vast majority of species **(Kabata, 1981; Youssef *et al.*, 2018).** The results of the current investigation indicated that the majority of parasites were attached to the fish's gill, seldom to the fish's body surface.

Sardina pilchardus was infected with *Anilocra alloceraea* at a high prevalence rate (*P*=23.0%), with the ventral body surface location of the host being the primary microniches for infection (54.7% of all individuals). **Bariche & Trilles (2006),** *S. pilchardus,* which was obtained from an offshore area of Lebanon in the Mediterranean Sea, was heavily parasitized by *A. pilchardi*. According to **Bariche & Trilles (2006), Welicky *et al.*, (2017), and Fujita *et al.*, (2021),** the genus *Anilocra* is more frequently found on the body surface than on the fins or in the mouth, which was also noted in the current study. The most prevalent species of tropical fish on the coast of Alexandria is *S. pilchardus*, which is also a strong swimmer and fast-growing epipelagic. *A. alloceraea* abundance among its constituents was probably due to the species' extensive occurrence in varied environments. Therefore, host specificity and the geographic location of the host may both have a role in the high frequency or abundance of *A. alloceraea* on *S. pilchardus*. As a result, our study supports the conclusions of **Welicky *et al.*, (2017), Hure & Mustas (2020), and Fujita *et al.*, (2021).** In the buccal cavity of the host fish *Boobs boops*, four individuals of Ceratothoa oestroides were discovered (*P*=2.5%), suggesting that it may merely be a less frequent species in this host at that site. Considering that there are only 25 recognized *Ceratothoa* species and that they are only present in eight of the world's twelve nautical biogeographical zones, as reported by **Hadfield & Smit (2020),** this behavior and rarity of *Ceratothoa* species may be reflected in the declining prevalence rates among their examined host species.

Gnathia sp. (praniza larvae) are a common ectoparasite of elasmobranchs and teleost fishes **(Genc *et al.*, 2005, Gonzalez & Moreno 2005; Nagel & Grutter 2007).** They are blood-feeding isopod larvae found on various sites of their hosts, causing severe lesions **(Davies 1981).** In addition, these parasites have low host specificity and worldwide distribution in different habitats, including the Mediterranean Sea **(Papoutsoglou 1975; Ayari 2004; Koukouras 2010).** Previously, they have been reported in many areas around the world **(see Tanaka 2004; Shimomura & Tanaka 2008; Hadfield & Smit 2008).** In the present study, *Gnathia* sp. (praniza larva) was reported from six fish species and showed the highest parasite abundance among the investigated hosts. This parasite prefers members of Sparidae as hosts and has a higher prevalence on *Pagellus erythrinus* (*P*=17.7%) and *Lithognathus mormyrus* (*P*=14.4%). Our investigation using a few indices revealed that the analyzed hosts had a high frequency and quantity of *Gnathia* sp. In fact, this analysis concurs with that made by **Grutter (1994); Chambers & Sikkel (2002).** Although some articles have proven the opposite, **Honma *et al.*, (1991) and Martens & Moens (1995)** revealed that *Gnathia* sp. seldom injures the hosts they feed on **(Paperna *et al.*, 1984; Honma & Chiba 1991).** It is probable that what the first stated is compatible with our findings. *Gnathia* sp. is widely distributed over many hosts, and the severity of the varied sicknesses in the various regions of the host's body produces significant harm among the afflicted fish.

The host species of the fish that are most frequently sought after are abundant and widespread around the coast of Alexandria, although there are also fewer common species. The most common species in our study were *Dicentrarchus labrax* and *Mugil cephalus*, allowing us to analyze 234 and 231 specimens of each in only one year. These two species have the highest richness among the species assessed along the Alexandrian coast, with two parasitoids appearing. These findings agree with those made public by **Youssef *et al.*, (2018) and Raibaut *et al.*, (1998).** Therefore, parasite prevalence rates and main intensity among the individuals of these host species may be influenced by population richness. The current study sought to provide light on the distribution of parasitic isopods among infested fish in Egyptian habitats and concluded that some parasitic isopod species may be predicted to be present on specific hosts but not others. This impression can be explained by the fact that parasites favor and are drawn to a particular host, and this coexistence or dependency between parasite animals and their hosts might result from environmental changes. In light of an awareness of the link between the parasite and its host, this view also clarifies a few ideas relating to biodiversity. As certain environmental variables overlap with other determinants, such as population density or geographic distribution, they may also have an impact on the frequency and severity of infections.

CONCLUSION

Aspects of several cymothoid species' distribution and prevalence in the Egyptian waters were discussed in the study. These aspects are crucial for identifying their host species, which increases their variety and geographic distribution. The gills of Actinopterygii fish captured off the Egyptian Mediterranean coast suffered serious damage as a result of the isolation of cymothoid species as obligatory parasites on their hosts. Understanding this behaviour is essential to comprehending the problem of biodiversity, particularly in areas where parasitic crustaceans are few. By performing more study to comprehend other concerns, such as those linked to the taxonomic aspects and the egregious issues experienced by these parasitic species, this report assures that researchers are going forward in their efforts to improve the use of these parasites.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could influence the work presented in this paper.

Conflict of interest

I, as the corresponding author, declare, on behalf of all authors of the paper, that no financial conflict of interest exists concerning the work described.

Ethical approval

The specimen is not under the listed category of experimental animals, which requires ethical approval.

Sampling and field studies

All necessary permits for sampling and observational field studies were obtained by the authors from the competent authorities.

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