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INFESTATION STUDY OF *LIVONECA REDMANII* (ISOPODA, CYMOTHOIDAE) ON *SOLEA SOLEA* IN LAKE QARUN, EGYPT

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Abstract

The study dealt with the infestation of *Livoneca redmanii* (Isopoda, Cymothoidae) on *Solea solea* in Lake Qarun, Egypt. 487 specimens of *S. solea* were examined to extract 99 crustacean parasites. Fish specimens were collected monthly from Eastern and Western regions of Lake Qarun, during the period from January to December, 2016.

The results showed that *S. solea* was infested by *L. redmanii.* The highest infestation recorded was in June b, 38.64 % and the lowest one (10.34 %) in October. The infested fish *S. solea* were mostly females. The highest male infestation was during March (18.37%) and the lowest in April (2.04%).The highest female infestation was during July (22%) and the lowest in August and October (2%). The highest infestation (37.38%) was in mid length group 14cm and the lowest (1.01%) was in large fish at length group 19cm. The highest infestation (43.44 %) was in weight group 30gm and the lowest one (3.07%) was in largest and smallest fishes at weight group 10 & 70gm. The ecto-parasitic Isopods, *L. redmanii* infest gills, ventral side, dorsal side, mouth, head and tail sites on the integument of *S. solea*. The bilateral and/or unilateral infestation per fish was in gills region (73.7%)**.** The main clinical signs in infested *S. solea* were respiratory distress as surface swimming with opened mouth and gill cover. Also, they showed sluggish movement, emaciation, excessive amounts of mucous covering the body surface. Post-mortum examination showed lesions of focal erosion in skin and gills.

Based on the parasitic treatment trails with salinity, the most suitable solution to make control on the parasite blooming was increasing the fresh water flow to adjust the parasite activity and to minimize the optimum condition of blooming.

Key words: Lake Qarun, Infestation, *Livoneca redmanii*, *Solea solea*,

Introduction

Isopods recorded to parasites many species of commercially important fishes worldwide causing significant economic losses to fisheries (Rameshkumar *et al*, 2013), where the incidence and intensity of parasitic isopods exhibit a considerable variation (Grutter, 2003; Cuyas *et al*, 2004).

Isopoda are prospective the leading group of the fish crustacean parasites (Kabata, 1984). They are actually economically significant parasites as they have deleterious effects on cultured fish, such as stunted growth, anemia, and mortalities of fries and fingerlings (Ravi and Rajkumar, 2007; Ravichandran *et al*, 2011). The aquatic environment with its water quality is considered the main factor for the state of health in both cultured and wild fish (Saeed and Shaker, 2008). Salinity is importantly affecting Lake Qarun biota (Khalaf-Allah, 2014).

Lake Qarun constitutes a very important sector in the Egyptian fisheries, for both significant total catch and a large number of economically important species. *Mugil cephalus, M. Capito, M. saliens, Liza aurata, Solea solea* and *Tilapia zillii* were the dominant species in the lake waters. *Dicentrarchus labrax, Sparus aurata, Anguilla anguilla* and *Oreochromis niloticus* are rarely found in commercial catch. The fries of mullets, seabass and seabream were mechanical transported from El-Max Station in Mediterranean Sea to this lake Azab *et al.* (2015). The introducing of fish fry from the Mediterranean Sea and other sources into the lake added other non-commercial species (Khalaf-Allah, 2014). Azab *et al.* (2015) found that small fish were not collected during November in all sites. The disappearance of small fish in Lake Qarun may be due to the heavily abundance of crustacean parasites, which come from the Mediterranean Sea with fish fry caused severe damage to the lake fish stock. The problem in Lake Qarun that prospected in isopod infestation among fishes was noticed by fish loss and marketing problems.

The present study aimed to provide more information about prevalence, infection site, clinical signs and trials to treat *Livoneca redmanii* (Isopoda: Cymothoidae) infesting *Solea solea* at Lake Qarun, Egypt.

Material and Methods

The study area: this work included the South coast of Lake Qarun, Egypt. It is located about 80Km southwest of Cairo between 30°.41778` & 30°.8275` E and latitudes 29°.44194` & 29°.51111` N in the lowest part of El-Fayoum depression (Fig. 1).

A total of 487 of *Solea solea* formed the materials for the present study. Fish specimens were collected monthly from two stations of Lake Qarun, during the period from January to December, 2016. Gill net and encircling net were the main fishing method used to collect the fish. Wherever possible fish were examined fresh or preserved in 10% formalin solution for latter examination. In the laboratory, fish were taxonomically identified (Khalaf-Allah, 2014). Total and standard lengths were measured to the nearest millimeter and recorded. Fish were also weighted to the nearest 0.1 gram and then the following studies were carried out. Crustacean isopod parasite, *Livoneca redmanii* (Fig. 2) were collected from *S. solea* and taxonomically identified (Brusca, 1981).

Infested fish were carefully examined and parasites were removed from different \sites as gills and skin, counted per fish and photographed.

Clinical examination: Fishes were examined for any clinical picture caused by the parasites (Woo, 2006). Infested site was carefully examined to identify its target organ.

Experimental parasite treatment: A total of 30 free male specimens of crustacean isopod parasite, *Livoneca redmanii* with a good condition were obtained from Lake Qarun in July, 2017. Parasites were transported to laboratory of marine invertebrates at Zoology Department, Faculty of Science, Al-Azhar University in a large plastic bag containing about 20L of water and a lot of oxygen. In the laboratory, parasites were acclimatized for a day in well aerated glass tank (100x50x 50cm) before starting the experiment.

Five groups of 5 parasites each were isolated in plastic tank 1L, well aerated and filled with dechlorinated water (pH =7.2±0.50). A graduated salinity concentration was added to the tanks. Exposure was continued for 5 days with concentrations of fresh water, 10, 20, 30, 40g/L. Daily observations for treated groups were done to investigate the dead and life parasites. The dead parasites were removed immediately and recorded.

Results

Monthly prevalence of *Livoneca redmanii* on *S. solea* was 99/487 (20.33%). Of them 97 (97.98%) were infested by one parasite, while other two were double infested. Double infestation was in March and June. Infestation varied between (38.64%) in June & (10.34%) in October. Others were (12.5%) in August and (32.0%) in November (Tab. 1; Fig. 3).

Table 1: Monthly prevalence infestation rate of *Livoneca redmanii* on *Solea solea* at Lake Qarun, year 2016

Months	Number of fish		Infestation type		Infestation percentage
	Examined	Infested	Single	Double	
January	76	12	12		15.79
February	43	6	6		13.75
March	71	12	11	1	16.90
April	19	3	3		15.79
May	30	7	7		23.33
June	44	17	16	1	38.64
July	68	16	16		23.53
August	24	3	3		12.50
September	29	5	5		17.24
October	29	3	3		10.34
November	25	8	8		32.00
December	29	7	7		24.14
Total	487	99	97	2	20.33

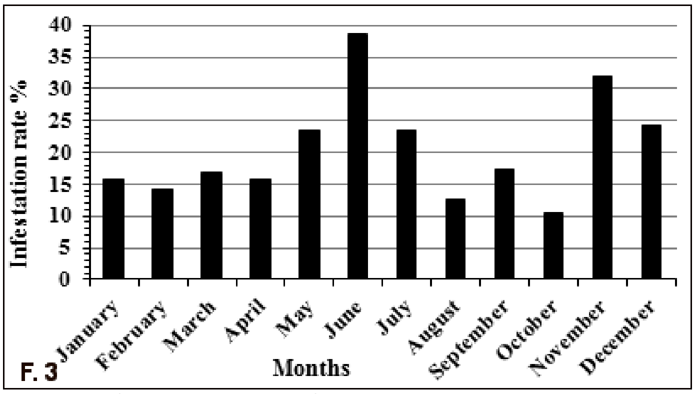

Fig. 3: Monthly prevalence infestation percentages of *Livoneca redmanii* on *Solea solea* at Lake Qarun, year 2016

Prevalence of *L. redmanii* on *S. solea*: Infested males were 49(49.49%) with pick in March (18.37%) and lowest in April (2.04%). Others were between (4.08%) in August to November and (16.33%) in January to June. Infested females were 50 (50.51%), very small rate in October (2.0%) to January (8.0%). Picks were in June, July & November (18 %, 22% &12%) respectively (Tab. 2; Fig. 4).

Table 2: Monthly infestation% of *L. redmanii* on male and female *Solea solea* at Lake Qarun, year 2016

Months	No. of infested fish	Infested males		Infested females	
		Number	%	Number	%
January	12	8	16.33	4	8.0
February	6	4	8.16	2	4.0
March	12	9	18.37	3	6.0
April	3	1	2.04	2	4.0
May	7	3	6.12	4	8.0
June	17	8	16.33	9	18.0
July	16	5	10.20	11	22.0
August	3	2	4.08	1	2.0
September	5	2	4.08	3	6.0
October	3	2	4.08	1	2.0
November	8	2	4.08	6	12.0
December	7	3	6.12	4	8.0
Total	99	49		50	

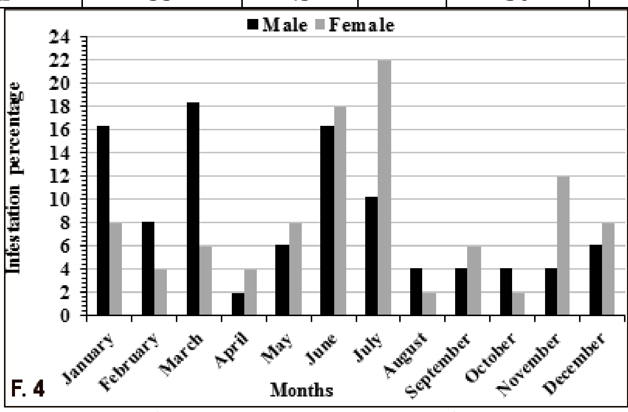

Fig. 4: Monthly prevalence infestation percentage of *Livoneca redmanii* on males and females *Solea solea* at Lake Qarun, year 2016

Prevalence of *L. redmanii,* on *S. solea* as to length and weight: Of 99 infested fish, 75 fish (75.76%) were of middle length ranged from 12-15cm, 19(19.19%) of size over 15cm. The highest infestation was (37.38%) on fish length 14cm and the lowest one (1.01 %) on fish length 19cm. Infestation in others lengths fluctuated between (3.03%) on fish length 17cm and (15.15%) on length 13cm. None was infested with parasite length more than 19cm (Fig. 5). There were 81(81.82%) infested fish with weight ranged between 20 & 40gm, but infested fishes over 50gm was 7 (7.07%). Highest infestation (43.44%) was on fish with weight 30gm and the lowest one was on fish with weight bet- ween 10 & 70gm (3.07%). Infestation on other weights was (4.04%) on weight 60gm and (21.21%) on weight 20gm. None was infested fish over weight of 70gm (Tab. 3; Fig. 6).

Table 3: Infestation % of *L. redmanii* on *S. solea* as to length (cm) and weight (g) at Lake Qarun, year 2016

Length (cm)			Weight (g)		
Size class	Infested fish no.	%	Weight groups	Infested fish no.	%
10			10	3	3.03
11	5	5.05	20	21	21.21
12	11	11.11	30	43	43.44
13	15	15.15	40	17	17.17
14	37	37.38	50	8	8.08
15	12	12.12	60	4	4.04
16	9	9.09	70	3	3.03
17	3	3.03			
18	6	6.06			
19	1	1.01			
Total	99			99	

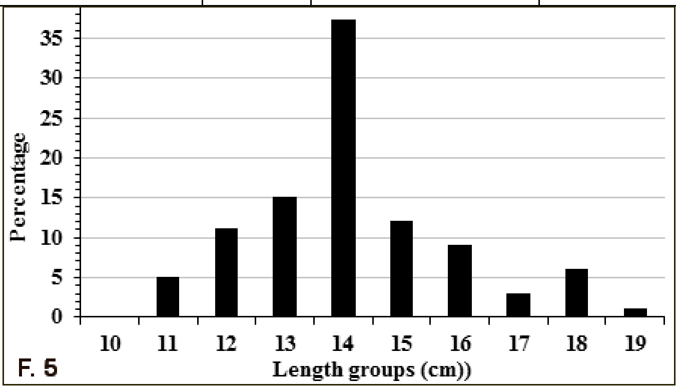

Fig. 5: Infestation percentage of *Livoneca redmanni* on *Solea solea* in relation to their length groups (cm) at Lake Qarun, year 2016

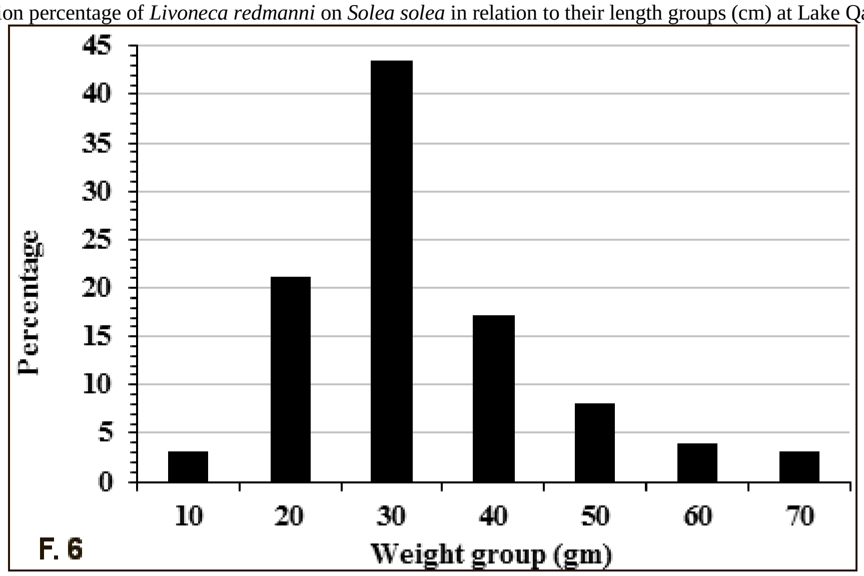

Fig. 6: Infestation percentage of *Livoneca redmanni* on *Solea solea* in relation to their weight groups (g) at Lake Qarun, year 2016

Sites of infection: *S. solea* infested ones were mostly females. Ecto-parasitic Isopods, *Livoneca redmanii* infest gills, ventral side, dorsal side, mouth, head and tail sites on the integument. They were attached with their appendages deeply embedded in fish mus- cles and anchored themselves by their hooks in the terminal appendages (Figs. 7 & 8).

Infestation sites: *L. redmanii* was in gills 73 specimens (73.7%), 11(11.1%) at dorsal side, 6 (6.06%) at ventral side, 4(4.04%) at mouth, 3 (3.03%) at head and 2 (2.02%) at tail region (Fig. 9).

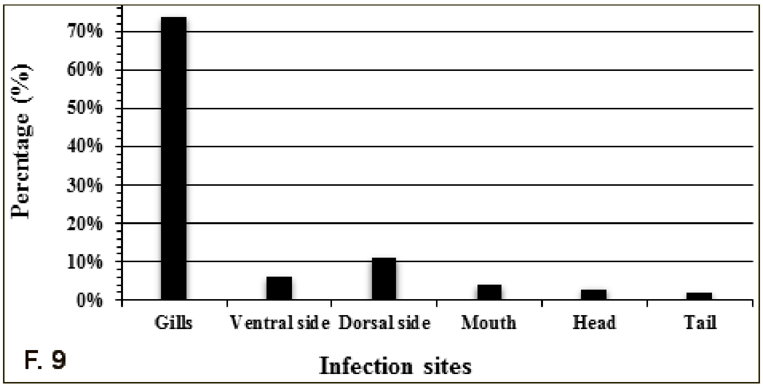

Fig 9: Sites of infestation (%) by *Livoneca redmanii* among *S. solea* at Lake Qarun, year 2016

Clinical signs and post mortum lesions of infested *Solea solea* with *Livoneca redmanii*: The main clinical signs in naturally infested *S. solea* appeared in respiratory distress manifested by surface swimming with opened mouth and gill cover.

Also, some fishes showed sluggish movement, emaciation, excessive amounts of mucous covering the body surface and bulging of the operculum due to the presence of the large sized isopod parasite (Figs. 10 & 11).

The investigation of *S. solea* revealed that either single bilateral and/or double unilateral infestation of their gills per host fish and protrusion of posterior part of the parasite protruded outside the body of the fish (Fig. 12). Examination of post mortem lesions of infested *S. solea* by *L. redmanii* showed that the appearance of focal erosion in skin and gills (Fig., 13).

Parasites treatment: Treatment was applied by a serial gradient of salinity: fresh water, 10, 20, 30 & 40gm/ L. In fresh water aquarium, all *L. redmanii* died after 30 minutes post treatment. In brackish water aquarium (10 ppt.), all *L. redmanii* survived on the first day, on the next day few died one by one but on the third day still 60% survived. In brackish water aquarium (20 ppt.) all parasites survived up to the 4th day, but at the end of experiment only 80% survival. The same results were achieved with the last two salinity treatment (30 &40gm/L). Thus, the most suitable solution to control the parasite blooming was by increasing the fresh water flow in target body of water to stop parasite activity minimizing the optimum condition of blooming.

Table 4: Dead *Livoneca redmanii* treated by different concentrations of salinity, 5 days after exposures

Treatment water	Salinity conc. ppt.	Parasites No.	Time of exposure (days)					Treatment		Survival %
			1	2	3	4	5	Dead	Live	
Fresh water	1	5	5					5	0	0
Brackish water	10	5		1	1			2	3	60
	20	5					1	1	4	80
Salt water	30	5					1	1	4	80
High Salt water	40	5				1		1	4	80

Discussion

Generally, the isopods parasitize many fishes' species worldwide causing significant economic losses (Ravichandran *et al*, 2011). They have been identified to cause deleterious effects on cultured fish, such as stunted growth, anemia, and mortalities of fries and fingerlings (Ravi and Rajkumar, 2007; Rameshkumar *et al*, 2013).

In the present study, *Livoneca redmanii* infested *Solea solea* was 20.30% in Lake Qarun. The percentage was higher than that recorded in Egypt for isopod infestation was 9% from Mediterranean Sea at Port-Said and Matroh Governorates respectively (Abd El Aal and El Ashrum, 2011) and 10.26% (Samn *et al*, 2014) from Mediterranean Sea at Alexandria Governorate. Also, it was higher than (19%) reported by Eissa *et al* (2012) among Mediterranean Sea fishes and lower than that recorded from Suez Canal in Ismailia province (24.4%). Mahmoud *et al* (2016) in Lake Qarun revealed total prevalence of 32.66% with isopod infestation among *Dicentrarchus Labrax*, *Solea vulgaris* and *Tilapia zilli* from Lake Qarun. These variations might be attributed to differences in the study times, climatic conditions, fish species and the geographical distribution of fish hosts and parasites.

Cymothoid isopods generally have a bimodal life cycle, in February and August (Aneesh *et al*, 2013). Female parasites with eggs were reported in February and August in the present study. The highest intensity and variety of parasites were detected in summer, whereas the lowest were in winter. These parasites usually prefer the coastal area, while fish migrate to deeper waters in the winter season due to changes of water temperatures (Er and Kayis, 2015).

In the present study, the highest infestation of *L. redmanii* (38.60%) on *S. solea* was in June and the lowest in October (10.30%). This result agreed with El-Seify *et al* (2011) who reported that the highest seasonal prevalence of crustaceans among *Oreochromis niloticus* was in summer, then spring followed by autumn and finally in winter. Eissa *et al* (2012) recorded the summer showed the highest infestation (19%), followed by autumn (17%), then spring (7%) and the lowest was (4%) in winter. Noor El-Deen *et al* (2013) found that the highest infestation percentage of *Nerocila orbignyi* in European seabass was recorded during summer and spring seasons, while infestation was disappeared during autumn and winter seasons. Samn *et al* (2014) mentioned that the highest infestation percentage of *Nerocila bivittata* was recorded in summer (10.26%) and the lowest (2.70%) was in spring. Abdel-Latif (2016) found that the greatest occurrence of *Nerocila* was in summer, followed by winter. Mahmoud *et al* (2017) in Lake Qarun recorded the highest infestation rate in the summer (73%), while the lowest was in winter (28%).

In the present study, concerning sex, the infestation percentages of *L. redmanii* were increased in females (23.50%) than males (17.90%) in *S. solea*. It may be due to slow movement of females too easy to be infested by parasites. Samn *et al* (2014) noticed that *Nerocila bivittata* infest mostly females of *Lithognathus mormyrus* from Abu Qir Bay, Alexandria, Egypt.

In the present study, concerning with length groups, the highest infestation rate of *L. redmanii* on *S. solea* was recorded in medium size towards the large size fish. Concerning with the weight groups, the highest infestation rate was recorded in small weight towards the medium weight of fish. The relation between fish body weights, lengths and infestation rate was significant for infested fish. These findings agreed with Eissa *et al* (2012). They concluded that the infestation rate was increased with increasing in length and weight of infested fish. The lowest infestation occurred in large fish, which might be due to *S. solea* buried in the sediment during day time and become more active at night (Bishai and Kirollus, 1987).

Crustacean ecto-parasites on marine fish are diverse. Many species of fish are infested by cymothoids. They are blood-feeding; several species settle in the buccal cavity of fish, others live in the gill chamber or on the body surface including the fins. Their life cycle involves only one host (Holoxenic cycle) (Ramdane *et al*, 2007). In the present study, the ecto-parasitic isopods, *L. redmanii* infest gills, ventral side, dorsal side, mouth, head and tail sites on the integument of *S. solea*.

The position of attachment in ventral, dorsal, and tail sites might depend on the host's body movement. Fish swimming is undulatory movements of their body and/or their paired and unpaired fins. In undulatory swimming, a backward travelling wave is gene-percentage by the sequential activation of the segmental myotomes from head to tail (Altringham and Ellerby, 1999; Samn *et al*, 2014). The cause of attachment at this position may be due to easier attachment at this site by the parasite or due to easier shedding of the parasite from other areas by the host (Printrakoon and Purivirojkul, 2011).

Examination of the infested fish revealed that the intensity of infestation in *S. solea* was one or two per hosted fish in gills region or attached on the skin and slight protrusion of gill cover (operculum), atrophy and hemorrhage at site of attachment. These may be attributed to the low respired oxygen of destructed gill epithelium which caused by feeding activity, attachment, fixation and locomotion of crustaceans. These results agreed with Eissa *et al* (2012) in Suez Canal at Ismailia, and with Kayiş and Ceylan (2011) in Pazar coast, Black Sea, Turkey. They found a female *Nerocila orbignyi* between the operculum and pectoral fin of *S. solea*.

In the present study, the clinical examination of most infested fish, *S. solea* with *L. redmanii* showed some slight abnormalities as represented as respiratory manifestation, sluggish movement, some aggregated on the surface and accumulated at the mouth of agriculture drains and fresh water inlet of the pond. Also, fishes showed emaciation, excessive amounts of mucous covering the body surface and some fishes have scale sloughing. These results agreed with Noor El-Deen *et al.* (2013) at Kafr El Sheikh Governorate fish farms and Abdel-Mawla *et al* (2015) at Red Sea at Suez Canal. Excessive mucous secretion is used to dilute the irritation and act as a defense mechanism against infestation (Yambot and Lopez, 1997).

In the present study, postmortem showed that most infested *S. solea* with *L. redmanii* with mucus producing cells, ulcer and erosion in the gills. Their skin developed ulcers, scale less and discoloration. These results agreed with Eissa (2004) and Noor El-Deen *et al.* (2013).

In the present study, the gills of *S. solea* were highly infested (73.7%) with *L. redmanii*, which consume on gill tissues. This result agreed with Manera and Dezfuli (2003). Adult isopods are hematophagus causing anemia (Ravi and Rajkumar, 2007). Consequently, the respiratory surface were seriously reduced by gills atrophy (Horton and Okamura, 2001; Mladineo, 2003; Toksen *et al*, 2008; Kayiş and Ceylan, 2011). Like most isopods, cymothoids feeds on the host blood, but also consume the mucus, epithelium and subcutaneous tissues (Ramdane *et al*, 2007). This fact was reported in the present study.

Mahmoud *et al* (2017) reported that treatment of crustacean parasites especially isopods was a complicated process and chemical agents is illogical and difficult to use with huge infestation in large water basin as in Lake Qarun.

Conclusion

No doubt, fish contribute much as one of the main sources of protein for human consumption. The outcome results showed fresh water considered the best and effective to eliminate the cymothoid isopod, *L. redmanii* infest fish in Qarun Lake. This is no practical. So, to find out a biological means to control this pest and to safe fish is more feasible.

Recommendations

1. Reduction of the lake salinity, since the low salinity water kill *L. redmanii.* The effectiveness of the fresh water might be due to osmotic concentration. The parasites numbers in the Lake eastern region (low salinity) was lower than in western region (high salinity); infested fish aggregated on the water surface and accumulated at the agricultural mouths drains with fresh water to get rid of them.
2. Cymothoid isopod, *L. redmanii* is holoxenic, and dies with its host death. This might

by achieved by stopping adding of any fries of the hosted fishes on the long run. Then after, the lake could be re-aquaculture by the non-infested fry and fingerling of fishes.

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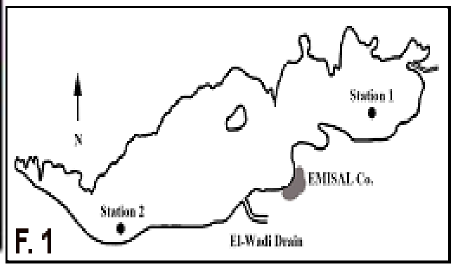
Explanation of figures

Fig. 1: Map of Lake Qarun showing study area, 0---1Cm = 5 Km. Fig. 2: *Livoneca redmanii* A, male dorsal view; B, male ventral view; C, female dorsal view and D, female ventral view

Fig. 7: *S. solea* infested gills, Fig. 8: *S. solea* infested skin. Fig.10: *S. solea* infested gill region extended to operculum, Fig. 11: Infested *S. solea* emaciation with mucous covering its body, Fig. 12: *S. solea* with infested gill, poster part of one protruded outside, Fig. 13: Infested *S. solea* with focal erosion on gills and skin.



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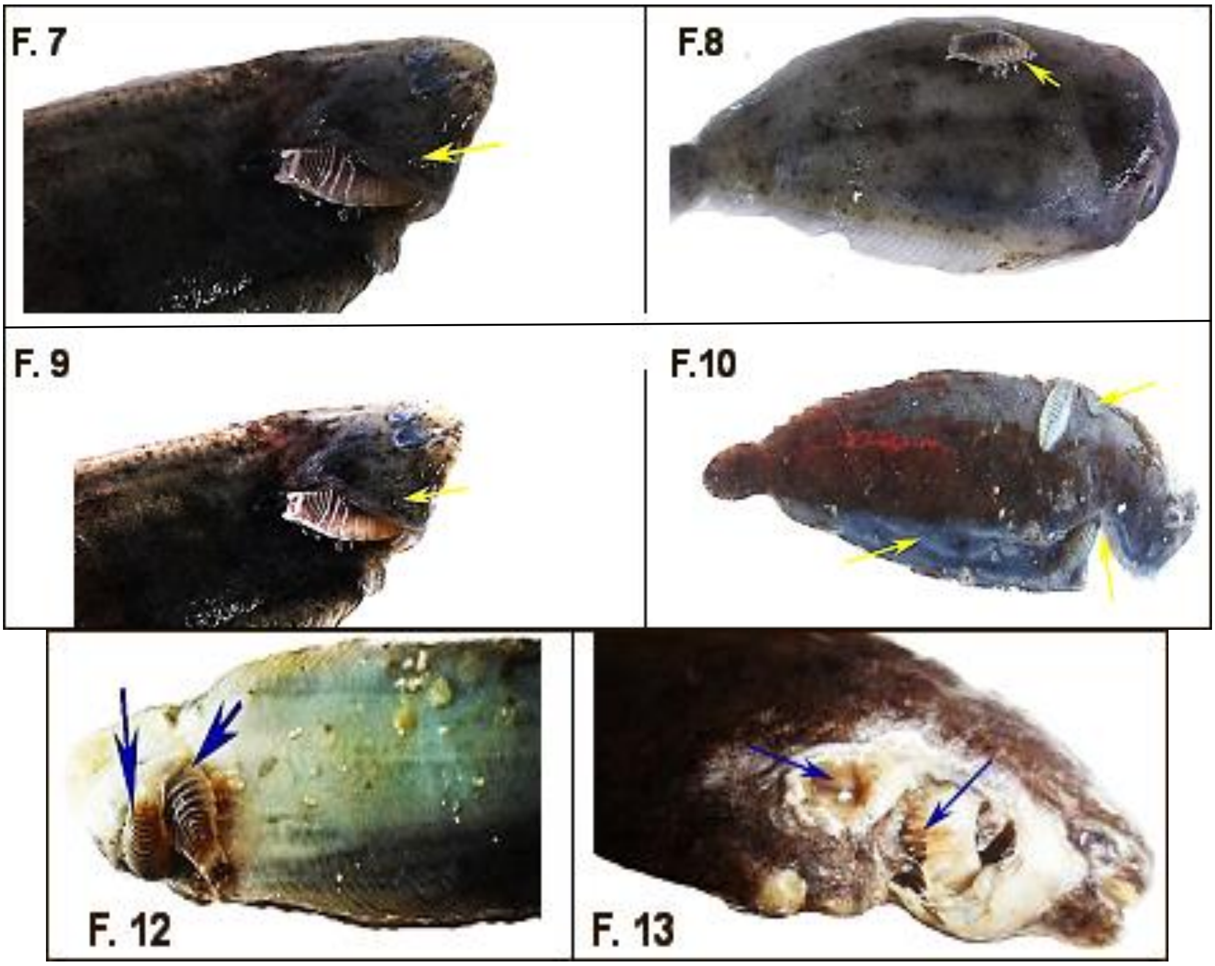
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