Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 25(1): 865 – 884 (2021)
www.ejabf.journals.ekb.eg

Biodiversity and Efficiency of fish helminthes parasites as a possible bioindicator of water quality in Jazan coastal area, Saudi Arabia

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ARTICLE INFO

Article History:
Received: Aug. 20, 2020
Accepted: Jan. 28, 2021
Online: Feb. 28, 2021

Keywords:
helminth parasites,
prevalence,
abundance,
water criteria,
biodiversity,
bioindicator

ABSTRACT

The present study was presented to assess a database about the helminthes parasites species infested marine fish in Jazan coastal area. Thus, the following sites were selected; Jazan Fishing site, Jazan coast near Aramco Company and the coastal area near the sewage treatment station. The Emperor fish *Lethrinus* sp., Rabbitfish *Siganus rivulatus*, Greasy grouper *Epinephelus tauvina*, and the marine fish *Carangoides orthogrammus* were investigated. Water criteria; pH, dissolved oxygen and conductivity were determined for the selected sites. Four trematodes, two nematodes, one acanthocephalan species were detected. Larval stages of trematode, cestode, nematode and acanthocephalan were isolated. A high prevalence of infection was recorded for trematode and nematode parasites in *Epinephelus tauvina*, *Lethrinus nebulosus*, and *Siganus rivulatus*. No significant effect was shown for body weight or sex on the abundance of helminthes parasites. Shannon-Wiener diversity index studies demonstrated the highest diversity of helminthes parasites for the fishing areas and lowest helminthes diversity infected *Siganus rivulatus* collected from the coastal area near sewage treatment station or Aramco Company. Regression analysis data showed high significant relationship between pH and conductivity on the abundance of trematode, nematode and acanthocephalans and between the dissolved oxygen concentration and the abundance of nematode and acanthocephalans at the three examined sites. Data were discussed to assess the efficiency of helminthes parasites as bioindicator for water quality in the Jazan marine ecosystem.

INTRODUCTION

Jazan region as a distinct part of the red sea coastline is familiar with the diversity of marine organisms including marine fish. In this research, three sites were selected to study the infection of existing marine fish with intestinal helminth parasites and to investigate the effect of water quality changes on the helminthes parasitism.

Fish fauna comprises more than 31,400 species **(Froese & Pauly, 2010)**, about half of them (14,970 species) live in marine waters. Because of the long-term stability of marine ecosystems, fish parasite diversity per host is higher than in freshwater **(Palm, 2011)**. As much as 30,000 helminth species were defined as parasites of fish **(Williams & Jones, 1994; Shahat *et al.*, 2011)**. The recorded parasites of eels, *Anguilla anguilla* and *A.rostrata* were up to 27 different parasite species that have been determined from the respective collectives around the world **(Kennedy, 1995; Sures *et al.*, 1999a).**

Helminth parasites biodiversity is a worthy scientific approach explains the interactions between parasites and pollutants in the environment. Helminth parasites, especially intestinal ones (digenean trematodes, cestodes, nematodes and acanthocephalans) were employed as biological indicators for environmental contamination **(Gotar *et al.*, 2013; Sures *et al.*, 2017)**. Parasitic species represent large number of living organisms. Moreover, parasitic species have complex life cycles with different stages that require different growth conditions, thereby increasing the number of potential indicators. Many parasitic species have free living transmission stages that are sensitive to environmental changes. The pronounced decrease in the intensity of infection serves as an early warning sign for environmental changes. In case of ectoparasitic species, the number of ectoparasites increases as a response to unfavorable environmental conditions **(Mackenzie, 1999).**

Efforts to use parasites as indicators of marine pollution are dependent on the pathology resulted from parasitic infections. It is moreover, a function of parasites sensitivity to exposed pollutants **(McVica, 1986)**. Intestinal helminth parasites of fish were successfully investigated as potential bioindicators for heavy metal contamination in aquatic habitats **(AbdAllah, 2017; AbdAllah & Haroun, 2019)**. Parasites biodiversity constitutes an important element of the animals' biodiversity in different ecosystems **(Hoberg, 1997; Brusca & Brusca, 2003)**. Despite of the negative effects of some parasites to their hosts, they could be employed as sentinel organisms or mirror of the changes in the aquatic habitats. Fish parasites have been investigated for the possible use to assess pollution **(Sures *et al.*, 1994; Sures, 2006)**, global climate change **(Brooks & Hoberg, 2007)** and anthropogenic impacts or general ecosystem health **(Marcogliese, 2005)**.

Several studies have demonstrated and highlighted the accumulation potential of different parasite taxa and identified them as useful sentinels for chemical pollution. In comparison to established free living accumulation indicators, parasites are often able to take up chemicals (e.g. metals) at much higher levels **(Sures, 2004; Shahat *et al.*, 2011)**. Thus, they can bioconcentrate pollutants that are present in very low concentrations in the environment and make them detectable and quantifiable using conventional analytical techniques. Furthermore, some parasites were found to tolerate very high pollutant burdens **(Shahat *et al,* 2011; Sures, 2017)**.

The present study aimed to establish a database about helminth parasites infesting the marine fish Emperor fish *Lethrinus nebulosus*, rabbitfish *Siganus* sp., Carangidae fish *Carangoides orthogrammus* and Greasy grouper *Epinephelus tauvina*. Moreover, the current study determined the prevalence of infestation, abundance and the intensity of infection with helminth parasites at each study site and to calculate the percentage of single, double and triple infection. Regression analysis of the relationship between water criteria and intensity of helminth infection at different studied sites was investigated.

MATERIALS AND METHODS

Sampling and sample preparation

A total number of 176 fish specimens of *Lethrinus nebulosus* fish, *Lethrinus* sp., *Epinephelus tauvina* fish, *Siganus rivulatus* fish and Carangidae fish *Carangoides orthogrammus* was collected during September- December 2019 from three different sites; the coastal area close to the sewage treatment station, the coastal region near Aramco Company (Petromin) in addition to the Jazan fishing site (Fig. 1).

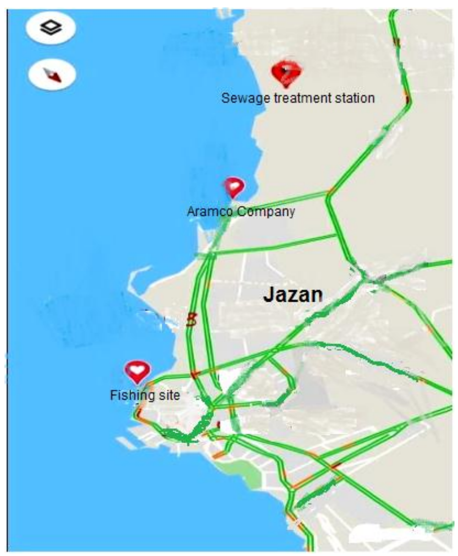

Fig. 1. A map showing the study sites

The collected fishes were brought to the laboratory for detailed investigations. Their lengths, width and sex were recorded. The fish specimens were weighed to the nearest 0.005 gm using electronic digital balance. The fish were dissected, their guts were cut out, and the intestine was put in a petri dish, split longitudinally, washed several times with 0.75% saline solution, and then examined by Zeiss microscope searching for helminth parasites. The number of male and female fish infected with the intestinal helminth parasites was determined. Unstained helminth parasites were fixed in 70% ethyl alcohol, stained with Acetic Acid Alum Carmine, cleared in xylene and mounted in Canada Balsam. Nematodes were fixed in 70% ethyl alcohol and cleared in lactophenol.

The types and species of helminth parasites were identified according to **(Saoud *et al*.; 1987; Bray *et al*., 2002; Nachev, 2010)** and their number was counted.

Water samples were collected from all the investigated places specified for the study. Investigated water criteria were pH level, oxygen concentration and conductivity. The three studied areas were compared for water criteria, prevalence, intensity and abundance of helminth parasites in investigated fish species.

Prevalence and abundance of helminth parasites

The number of male and female infected fish of all investigated fish species was counted. Prevalence, abundance and mean intensity of infection were calculated according to Margolis *et al.* (1982)**.**

$$\textbf{Parasite prevalence} = \frac{\text{Number of infected fish}}{\text{Total number of examined fish}} \times 100$$

$$\textbf{Parasite abundance} = \frac{\text{Number of parasites}}{\text{Total number of examined fish}}$$

$$\textbf{Mean intensity} = \frac{\text{Number of parasites}}{\text{Total number of infected host}}$$

Calculated values were compared for the three investigated regions to find out the places that were most susceptible to infection with helminth parasites and the places less susceptible to infection. Single, double and triple infection were determined for all studied fish species.

Statistical analysis

Regression analysis was determined to estimate the relationship between water criteria and parasite abundance of different helminth species. In addition, the correlation relationship between body weight of fish and abundance of intestinal helminth parasites was examined. The effect of sex on the prevalence, abundance and intensity of helminth parasites was investigated using Duncan's test for of comparison of means.

Species richness

Total number of helminth parasite species noted at each studied site was recorded as species richness **(Tumisto, 2010)**.

Shannon-Weiner diversity index

The biodiversity of helminth parasite infestation was examined for marine fish inhabited Jazan fish site, coastal area near sewage waste station and coastal area close to

Aramco Company. The formula adopted by **Shannon (1951)** was used to calculate biodiversity of helminth parasites.

$$H' = -\sum_{I=1}^{n} pi \log pi$$

Where i is the abundance of helminth species, pi is the relative abundance (percentage composition) of each isolated helminth species.

RESULTS

1. Water criteria

Highest pH value was recorded for the fishing site (7.39) while the lowest was for coastal site close to Aramco station (6.88). Highest value of the dissolved oxygen was for the coastal site closed to Aramco station (19.1 mg/l). The lowest value was for the coastal site close to sewage station (14.2 mg/l). Highest conductivity value was for the coastal area close to Aramco station (74.9 mg/l). The lowest value (66.1 mg/l) was for the fishing site (Table 1).

Table 1. Water criteria Recorded at the selected study sites

Water criteria	**Fishing site**	**Sewage station**	**Aramco**
pH	**7.39**	**7.33**	**6.88**
Dissolved oxygen (mg/l)	**16.1**	**14.2**	**19.1**
Conductivity(mg/l)	**66.1**	**68.7**	**74.9**

Prevalence, abundance and intensity of helminth parasites

The present results, as shown in Table (2), reveal 81 infected fish out of 176 fish examined. Overall prevalence was 46%. General prevalence of helminth parasites was almost similar (45.4%, 47.4% and 50%) for the three studied sites; fishing site, sewage treatment station and Aramco Company, respectively. The prevalence of helminth parasitism in female fish was higher than male fish in all studied sites.

Table 2. Prevalence of infection in male and female fish inhabited the three studied sites**.**

Site	**Sex**	**Total examined**	**Total infected**	**Prevalence (%)**
Fishing site	**Male**	**60**	**26**	**43.3%**
	Female	**81**	**38**	**46.9%**
Total		**141**	**64**	**45.4%**
Sewage treatment station	**Male**	**11**	**5**	**45.5%**
	Female	**8**	**4**	**50%**
Total		**19**	**9**	**47.4%**
Aramco Company	**Male**	**9**	**4**	**44.4%**
	Female	**7**	**4**	**57.1%**
Total		**16**	**8**	**50%**
Grand total		**176**	**81**	**46 %**

Examining 76 samples of *Lethrinus nebulosus* from the Jazan fishing site (Table 3), there were 35 samples infected with helminth parasites, 12 males and 23 females. 15 *Lethrinus* sp. were investigated, 3 males and 3 females fish were only parasitized. Examining 47 samples of *Epinephelus tauvina* fish collected from the Jazan fishing site, 16 fish samples were infected with helminth parasites; 8 males and 8 females, and after examining 8 samples of *Orthogrammus,* 7 samples were infected with helminth parasites, 3 males and 4 females. Seventeen samples of *Siganus rivulatus* fish were examined from a location close to sewages treatment. Only 9 samples were infected with intestinal helminth parasites, 5 males and 4 females. Eight infected fish samples (4 males and 4 females) were recorded out of 13 *Siganus rivulatus*, caught from a coastal area close to Aramco.

Highest prevalence of helminthes parasites for fish caught from Jazan fishing station was shown for female *Carangoides Orthogrammus* (100%), and lowest prevalence was recorded for male *Lethrinus* sp. (37.5%). Male *Siganus rivulatus* fish, collected from coastal area close to the sewage treatment station, showed higher helminth parasite prevalence of 55.56% relative to the females (50%). At the coastal area close to Aramco Company, the prevalence of helminthes parasites for male *Siganus rivulatus* was 66.67%, while in females was 57.14%.

Table 3. Total prevalence, abundance and intensity of helminthes parasites in different examined fish species collected from Jazan fishing site, coastal area near sewage treatment and Aramco

	Weight (gm) (mean± SD)	Parasite prevalence (%)	Parasite abundance (mean± SD)	Mean intensity (mean± SD)	Location
Epinephelus tauvina (male)	217.22±49.97	52.91	0.5±0.08	1.125±0.52	Jazan fishing site
Epinephelus tauvina (female)	271.14±162.69	46.67	1.14±0.28	4.125±1.2	Jazan fishing site
Lethrinus nebulosus (male)	195.4±78.52	41.46	0.64±0.15	1.6±0.62	Jazan fishing site
Lethrinus nebulosus (female)	251.63±116.68	74.28	1.97±0.73	3.57±1.8	Jazan fishing site
Carangoides orthogrammus (male)	309.25±203.67	75	1.75±1.24	2.33±0.23	Jazan fishing site
Carangoides orthogrammus (female)	317.5±314.66	100	2±1.41	2±1.41	Jazan fishing site
Lethrinus sp. (male)	254.57±96.46	37.5	0.43±1.68	1.5±0.71	Jazan fishing site
Lethrinus sp. (female)	236±105.15	42.86	0.5±0.99	1±0.32	Jazan fishing site
Siganus rivulatus (male)	107.75±25.24	55.56	0.78±0.08	1.4±0.35	Sewage treatment station
Siganus rivulatus (female)	148.5±42.09	50	0.75±0.35	1.5±1.06	Sewage treatment station
Siganus rivulatus (male)	97.17±31.16	66.67	3.33±1.36	5±1.6	Aramco Company
Siganus rivulatus (female)	109.86±34.63	57.14	2.29±1.2	4±1.06	Aramco Company

Various infestation modes of helminthes parasites are recorded in marine fish collected from fishing site (Table 3 and Figs. 2, 3&4). Different plans of sex infestation are shown for male and female fish. *Epinephelus tauvina* fish. Fig. (2) shows infestation of four helminthes groups; nematode, trematode, cestode and Acanthocephala. Highest prevalence was shown for trematode *Crepidostomum* sp. at both male (17.05%) and female (20 %) fish. Lowest infestation prevalence was shown for cysticercoid larva (6%) in male fish and acanthocephalan, nematode or trematode larva (3.33%) in female fish. *Lethrinus nebulosus* infestation prevalence (Fig. 3) was higher for female than male fish. Highest nematode *Capillaria* sp. or trematode *Plagioporus shawi* prevalence (31.43%) was shown for female fish. Lowest infestation was for trematode larva and acanthocephalan larva (2.86%) in female fish. Male *Lethrinus* sp. (Fig. 4) showed highest prevalence for trematode *Plagioporus shawi* infestation (25%). Female *Lethrinus* sp. showed trematode *Plagioporus shawi* and cysticercoid larva infestation with higher prevalence of cysticercoid larva (28.57%). *Carangoides orthogrammus* fish (Fig. 4) showed trematode *Prosorhynchus* sp. and nematode *Anisakus* sp. infestation with higher prevalence at female individuals (100%).

Siganus rivulatus fish, collected from sewage treatment site, showed trematode *Helicometra siganus* and nematode *Anisakus* sp. infestation in male fish with higher prevalence for trematode parasite (44.4%). Only trematode infestation was recorded for female fish (Table 3 and Fig. 5). Trematode, acanthocephalan and nematode were recorded for male *Siganus rivulatus* collected from coastal area near Aramco (Table 3 and Fig. 6) with highest prevalence of nematode *Anisakus* sp. parasites (66.7%). Female *Siganus rivulatus* showed only trematode *Helicometra siganus* prevalence (14.3%) and nematode *Anisakus* sp. prevalence (57.1%).

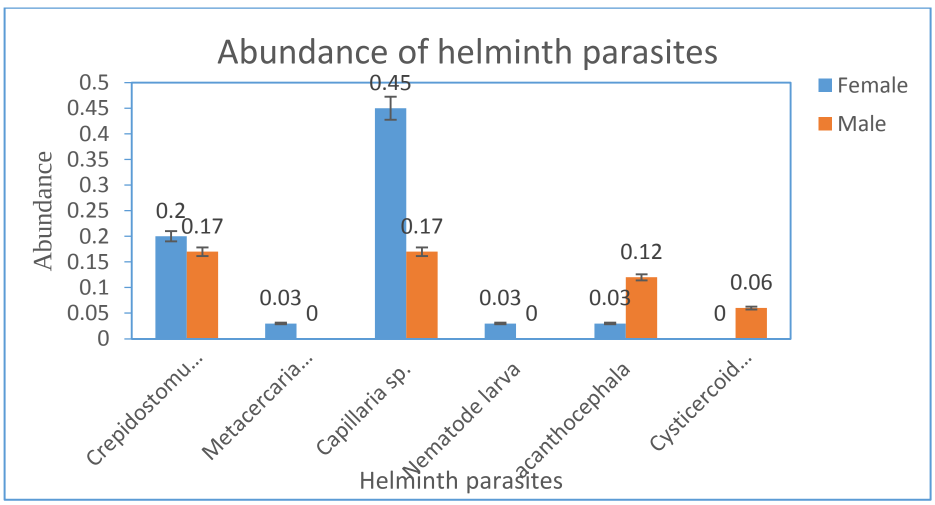

Fig. 2. Average helminthes abundance in male and female *Epinephelus tauvina* species collected from Jazan fishing site.

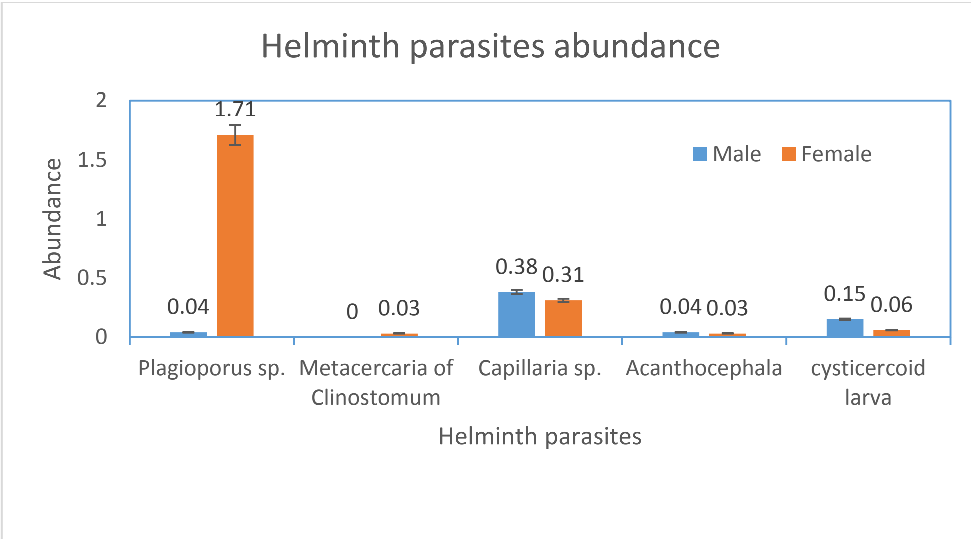

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Fig. 3. Average helminthes abundance in male and female *Lethrinus nebulosus* species collected from Jazan fishing site.

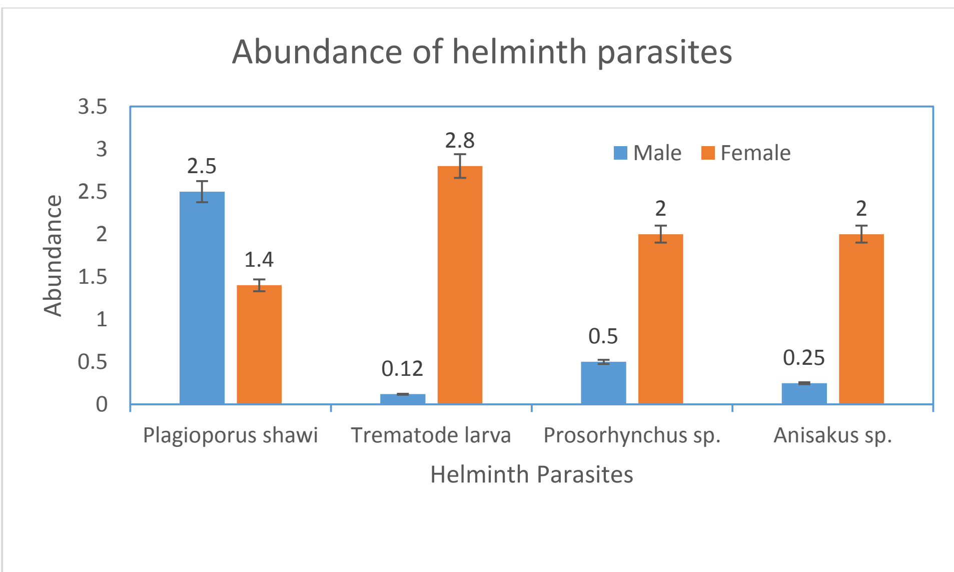

Fig. 4. Average helminthes abundance in male and female *Lethrinus* sp. and *Carangoides orthogammus* fish species collected from Jazan fishing site**.**

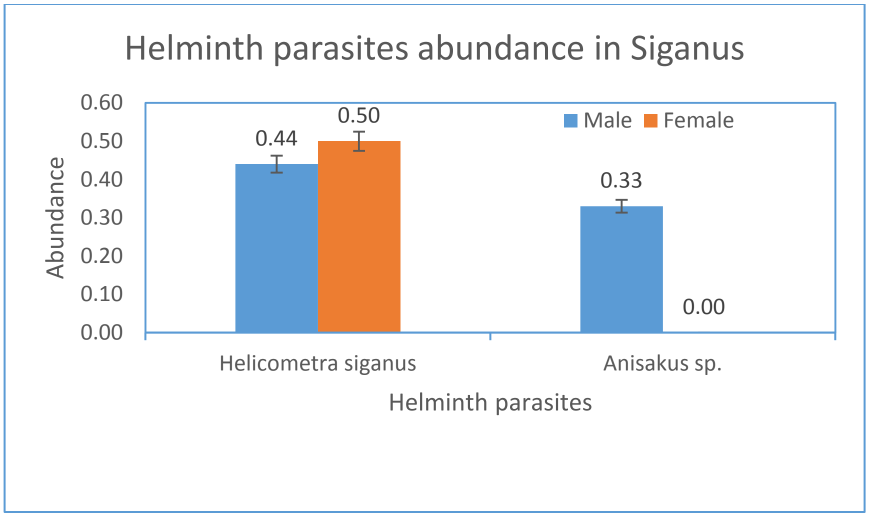

Fig. 5. Helminthes abundance in infected *Siganus rivulatus* collected from a location close to sewages treatment station.

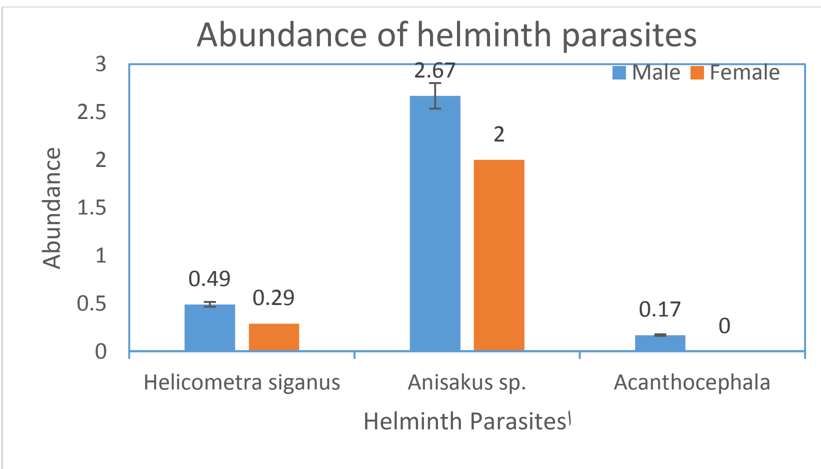

Fig. 6. Helminthes parasites abundance in infected *Siganus rivulatus* fish collected from Jazan coast near Aramco Company.

Single, double and triple infestations

Table (4) shows the recorded single, double and triple infection for the different examined marine fish at the studied sites. Highest single infection was recorded for male and female *Lethrinus* sp. collected from Jazan fishing site. The lowest single infection was recorded for male *Siganus rivulatus* collected from coast area close to Aramco. Double infection was recorded for male and female, *Lethrinus nebulosus*, female *Epinephelus tauvina*, male Carangidae, male *Siganus rivulatus* at coast area near sewage treatment and male and female *Siganus rivulatus* collected from coastal area near Aramco. Triple infection was shown only for female *Lethrinus nebulosus* and male *Siganus rivulatus* collected from coastal area near Aramco Company.

Table 4. Single, double and triple infection in examined marine fish collected from studied sites

Locality	Species	Total examined fish		Infected fish		Single infection		Double infection		Triple infection	
		M	F	M	F	M	F	M	F	M	F
Fishing site, Jazan coast	*Lethrinus nebulosus*	41	35	12	23	11	18	1	4	0	1
	Lethrinus sp.	8	7	3	3	3	3	0	0	0	0
	Epinephelus tauvina	17	30	8	8	8	5	0	3	0	0
	Carangidae	4	4	3	4	2	4	1	0	0	0
Sewage treatment station close coastal area	*Siganus rivulatus*	9	8	5	4	4	4	1	0	0	0
Petromin (Aramco) close coast	*Siganus rivulatus*	6	7	4	4	2	3	1	1	1	0

Biodiversity index of helminthes parasites

Species richness was 8. Nematode infestation with *Anisakus* sp. showed the highest abundance (2.25±0.35) and highest relative abundance or percentage composition (0.23). Nematode larva and acanthocephalan larvae demonstrated the lowest abundance (0.015±0.02) and lowest percentage composition (0.002).

Calculated Shannon-Weiner diversity index (Fig. 7) for intestinal helminth parasites at Jazan fishing site was the highest (0.701) amongst the three examined sites during the present study. High trematode abundance (0.54±0.29) and relative abundance (0.77) were recorded for *Siganus rivulatus* fish collected from Coastal area near the sewage treatment station. Shannon-Weiner diversity index was 0.224. Species richness was two. Highest abundance (2.33±0.47) and relative abundance (0.83) were recorded for intestinal nematode parasites isolated from *Siganus rivulatus* fish collected from coastal area near Aramco Company. Acanthocephala demonstrated the lowest abundance (0.08±0.12) and relative abundance was 0.03. Species richness was three. Calculated Shannon-Weiner diversity index was 0.23.

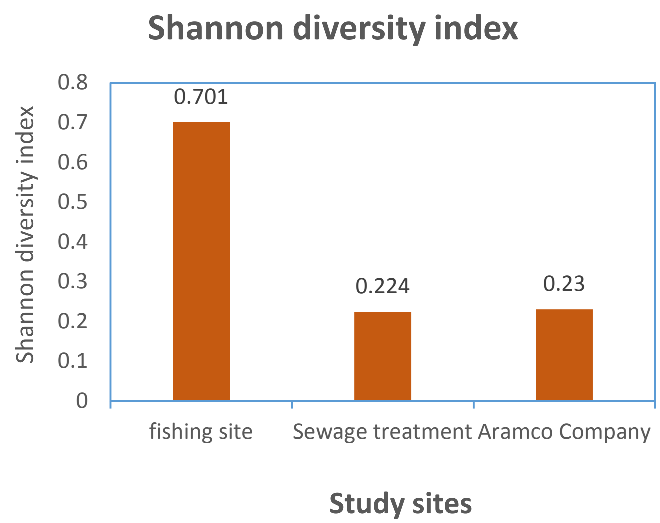

Fig.7. Shannon diversity index values of helminth parasites in the three studied sites.

Correlation analysis between body weight and helminthes parasite abundance at Jazan fishing site was significant at the studied four fish species (r=0.776, P<0.05). *Siganus rivulatus* fish showed significant correlation analysis (r=-1, P<0.001) between fish weight and abundance of helminthes parasites infected male and female fish collected from coastal area near sewage treatment station. Also, significant correlation relationship (r=-1, P<0.001) was found between fish weight (gm) and abundance of helminth parasites infected male and female *Siganus rivulatus* caught from coastal area near Aramco company.

Regression analysis for the relationship between the abundance of helminthes parasites and the measured water criteria; pH, dissolved oxygen and conductivity was shown in Table (5). The pH showed significant effect (P<0.05) on abundance of trematode and nematode parasites at the three studied sites. A highly significant (P<0.01) effect was determined on the abundance of the acanthocephalan parasite. Dissolved oxygen showed a highly significant effect (P<0.01) on nematode abundance and a significant relationship (P<0.05) with the abundance of acanthocephalan at the examined sites. Conductivity showed a significant regression relationship (P<0.05) on the trematode and nematode abundance. A highly significant regression relationship (P<0.01) with the abundance of acanthocephalan parasites in the three examined sites was performed.

Table 5. Regression coefficient (r^2) values between measured water criteria and abundance of helminthes parasites at the three examined sites, r^2; regression coefficient, *; P<0.05, **; P<0.01.

Helminth parasites	pH (r^2)	Dissolved Oxygen (r^2)	Conductivity (r^2)
Trematode	0.825*	0.32	0.839*
Trematode larva	0.352	0.019	0.362
Nematode	0.859*	0.986**	0.845*
Nematode larva	0.348	0.016	0.367
Cysticercoid larva	0.348	0.016	0.036
Acanthocephala	0.988**	0.852*	0.983**
Acanthocephala larva	0.348	0.016	0.367

Duncan's test showed no significant difference (P>0.05) between male and female fish regarding abundance, prevalence of intensity of defined helminthes parasites.

DISCUSSION

Parasites rarely regulate their host population or influence either natural or sexual selection of host **(Price, 1980)**. Knowledge of the characteristic features and diversity of economic fish species is essential to set a plan for their rearing and breeding. Little information is available on the identity and abundance of helminth parasites of marine fish in Jazan coastal habitats.

It is obvious from the present study that the distribution of fish populations in Jazan fishing site, coastal zone near sewage treatment station and the coast near Aramco Company, is changing due to the period, place, and way of fishing, besides the physical and chemical characters of the marine water. The results are in agreement with previous study of **Abdullah (2013)**. The disappearance of certain fish species in some studied areas might be attributed to the nature of the available nutrition **(Abdullah *et al.*, 2007)**.

Saoud *et al.* (1987) have isolated two genera of trematodes; *Hamacreadium* sp. and *Cainocreadium* sp. from the marine fishes in the Arabian Gulf *Epinephelus* sp. and *Lethrinus* sp. The present study recorded *Crepidostromum* sp. from *Epinephalus tauvina* and *Plagioporus* sp. infested *Lethrinus* sp. fish collectd from Jazan fishing site.

No definite explanation is available for the differences in the incidence of helminthes parasites between males and females. An explanation might be related to the differences in their habits and ecology. The present study demonstrated higher prevalence of helminthes infestation in female than male fish. The data were supported by those of other authors who reported a greater susceptibility of females **(Ibiwoye *et al*., 2004; Singhal & Gupta, 2009)**. Several studies demonstrated no association between the prevalence of helminthes parasites and sex **(Saoud *et al.*, 1987; Lee *et al.*, 2004)**. **Kennedy (1995)** reported that the difference in parasite distribution between animal of different sexes is less common and less understood and that for short periods; the parasite may show preference for one sex than the other. **Dobson (1961)** has suggested the possible role of female sex hormone estrogen in increasing the immune resistance of the definitive host toward the helminth parasites infestation. In addition, the influence of male hormone in increasing the growth and survival of the parasites was suggested indicating that the males are more susceptible to parasitic infestation than female. **Gray (1973)** stated that estrogens were responsible for the reduced resistance of female during egg-laying period against *Rellatina cesticillus* infection. Results of the present work showed no significant association between sex and abundance of helminth parasites.

The current findings showed different values of prevalence of helminthes parasites for different examined fish ranging from 37.5% for *Lethrinus nebulosus* and 75% for *Carangoides orthogammus*. This agrees with **Abdou and Ashour (2002)** who noted that helminth parasite prevalence in Red sea fish was (52%), while **El-Ekiaby (2009)** recorded a percentage of 76.87 at Suez Canal. The results are higher than 34.2% recorded in the study of **Hassan (2014)** of Egyptian Lakes. Also, the prevalence of infection in the present finding was higher than that recorded in the investigation of **Amaechi (2015)** for prevalence (35.9%) of helminthes parasites infestation in *Oreochromis niloticus*. Variation in prevalence of helminthes parasites might be attributed to differences in host immunity and the development of intermediate host **(Gautam *et al*., 2018)**.

Hassan (2014) showed highest prevalence of trematode parasites (56.14%) followed by acanthocephalans (25.14%) and nematodes (24.56%). The present study agrees with this result for infestation in *Epinephelus tauvina* where the prevalence of trematode infestation was higher than nematode and followed by acanthocephalan parasites. However, the results were different for *Lethrinus nebulosus*, where nematode prevalence was the highest followed by trematode and acanthocephalan respectively.

Parasitic infection in the present study was affected by water criteria. Cestode infection disappeared at coastal areas close to sewage treatment or Aramco. Acanthocephala disappeared at *Siganus rivulatus* fish collected from coastal area close to sewage treatment. Nematode disappeared in female *S. rivulatus* collected from coastal area close to sewage treatment in addition to male and female *S. rivulatus* caught at coastal area close to Aramco. The results are in agreement with those of similar studies **(Moravec *et al*., 1997; Shahat *et al*., 2011; Sures *et al.*, 2017)**.

Several authors recommended fish parasites as proper bioindicators that might detect and quantify toxic substances in aquatic habitats. The study of helminthes parasites as sentinel organisms for environmental pollutants revealed that they have advantages over other established bioindictor organisms **(Sures *et al.* 1999b; Shahat *et al.*, 2011; AbdAllah, 2017; Sures *et al.*, 2017)**. Results of the present study confirmed and demonstrated more prevalence and higher abundance of helminth parasites in Jazan fishing sites compared to coastal area close to sewage treatment station or Aramco Company. The lower prevalence of helminth parasites at Aramco, or sewage treatment station might be attributed to the lower abundance of the intermediate host, which could be a function of the pollution level or higher eutrophication **(Nachev, 2010)**.

The results of water criteria recorded lowest dissolved oxygen value for coastal area close to sewage treatment station. This might be attributed to the increase of organic contaminants and eutrophication that consume high oxygen for bacterial degradation **(Ait Alla *et al*., 2006; Shahat, *et al.*, 2011)**. Highest oxygen concentration and highest conductivity values were recorded for coastal area close to Aramco Company. This might be due to the increase of ionic concentrations **(Abdo *et al.*, 2010; Shahat *et al.*, 2011)**.

Regression analysis relationship for results of the present study showed significant relationship between the abundance of trematod and acanthocephalan parasites with pH and conductivity. Dissolved oxygen affected the abundance of nematode and acanthocephalan parasites. The results agree with the results of **Shahat *et al.* (2011)**. In the current study, conductivity significantly affected the abundance of acanthocephalan, trematode and nematode parasites. The result is in accordance with the finding of **Gilbert and Avenant-Oldewage (2016)** who found that the conductivity significantly affected the infection of monogenean parasites.

Low Shannon-Weiner diversity index of helminthes parasites in coastal area close to Aramco (H^- =0.23) and the coastal area close to sewage treatment station (H^- =0.224) revealed the effect of environmental heavy metal and organic pollutants on the abundance of helminthes parasites. **Lafferty (2008)** stated that some environmental factors might affect fish parasitism such as fishing and other environmental disturbances, which could be detrimental factors that control the biodiversity of helminth parasites in different aquatic environments. High value of Shannon- Weiner diversity index at Jazan fishing station (H^- = 0.701) demonstrated the healthy value of the marine ecosystem **(Nachev, 2010; Shahat *et al.*, 2011; Sures *et al.*, 2017; AbdAllah, 2017).**

Future studies are needed to demonstrate the helminth parasite infestation in marine fish in other marine habitats at Jazan coastal area and the biotic and abiotic factors that govern abundance of helminth parasites.

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