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Monogenean Parasites as Bioindicators for Heavy Metals Status in Some Egyptian Red Sea Fishes

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Abstract: A total of 900 fish belonging to five species caught from Suez Gulf was examined during 2005-2006. Five monogenean species were detected from the gills of the examined fishes. *Halotrematiodes* sp. (31.66±16.11) from *Morone labrax, Paranaella* sp. (36.12±19.58) from *Carnagoides bayed, Neothoracocotyle* sp. (38.33±19.30) from *Parupeneus forsskåli, Diplectanum* sp. (41.66±22.94) from *Epinephelus mcrodon* and *Haliotrema* sp. (35.55±20.16) from *R. sarba* were observed. The highest rate of monogenean infection was 60.89±7.71 during summer while, the lowest rate was 15.12±0.76 in winter. A high positive significant correlation was observed between temperature and the monogenean infestation in all investigated fishes. Moreover, the correlations between some heavy metal concentrations and all cases of monogeneans prevalence were recorded. It is concluded that there is a correlation between monogeniasis prevalence and the distribution of heavy metal pollutant. With the rise of water temperature the life cycle of monogenea become enhanced.

Key words: Heavy metals · monogenean species · temperature · red sea fishes · Egypt

INTRODUCTION

Red Sea fishes are considered as one of the most important sources of animal protein. Knowledge of fish parasites is of particular interest in relation not only to fish health but also to understand ecological problems [1, 2]. Many participations were interested in parasites of Red Sea fishes [3-6], however, little of these studies dealt with monogenean ones, especially from the taxonomic point of view [7, 8]. In the same time, parasites are indicative of many biological aspects of their hosts, including diet, migration, recruitment and phylogeny [9]. They may also be good direct indicators of environmental quality status [10, 11]. Thus, parasites could be considered as a complementary to chemical analysis or traditional biologicsurveys (bacteria counts or invertebrate assessments) as indicators of dysfunction at the ecosystem level [12].

Monogenean parasites are consider as one of the most important sensitive parasites to any changes in water parameters and especially those of the Red Sea still needed more investigations.

The growing environmental pollution by potentially toxic metals gives rise to particular problems in the aquatic environments [13, 14]. The close contact and reactivity of these metal pollutants with aquatic organisms, lead to accumulation of such pollutant in fish, with consequent hazards not only for their survival, but also for humans with unpredictable consequences [15].

The present work aimed to investigate the correlation between the rate of infection of fish with monogenean parasite, temperature degrees and heavy metal concentrations. Moreover, the use of monogenean parasites of some Red Sea fishes as pollution bioindicators was another target.

MATERIALS AND METHODS

Gills of 900 fish belonging to 5 families and species caught from Suez Gulf at Ras Sedr area were examined since December 2005 to November 2006. Fish samples were collected monthly (15 specimen of each fish species) to investigate the infecting monogenetic trematodes. They were brought to the laboratory alive and clasified according to [16]. They were Hemiramphidae

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(*Morone labrax*), Mullidae (*Parupeneus forsskåli*), Pomatonidae (*Carnagoides bayed*), Serranidae (*Epinephelus microdon*) and Sparidae (*Rhabdosargus sarba*).

Postmortem examination: The external body surface and gills of the investigated fishes were examined according to [17].

Detection of parasite: Gills of the examined fishes were removed and put in natural seawater to remove any mucus. Collection and permanent slide preparations for monogenean parasites were carried out according to [18].

Water analysis: Three water samples were collected each month from Ras Sedr area at depth of 1.5 meters under water surface. The heavy metals examined in this investigation were Nickel, Lead, Cobalt, Cadmium, Selenium, Chromium, Manganese and Zinc. Sample preparation and analyses were done according to method described by [19].

Data were analyzed for significant differences using the ANOVA test at P<0.05 and the correlation and regression (linear and quadratic) at confidence levels of 95 and 99% was performed using SPSS program version 9.0.

RESULTS

Postmortem examination: Gills of the infected fishes appeared congested and/or pale, with excusive slimness secretions. Marbling appearance was present with thickening and sticking with grayish colouration of the gill tips.

Parasitological examination: Five monogenean parasites were detected from the gills of the studied fishes. They were as follows: *Halotrematiodes* sp. from *M. labrax, Paranaella* sp. from *C. bayed, Neothoracocotyle* sp. from *P. forsskåli*, *Diplectanum* sp. from *E. mcrodon* and *Haliotrema* sp. from *R. sarba.* The incidence of infection was the highest during August (65.33±10.95) and summer (60.89±7.71) and the lowest during December (14.66±8.69), January(14.66±5.58) and winter (15.12±0.76) as shown in Table 2 and 3 and represented in Fig. 1.

Some biological correlations with monogenea infestation: Table 4 shows the correlation between infestations with monogeneans in fishes and temperature as well as different pollutants in their water environment. Significant (P<0.01) correlations were observed between temperature, the percentage of monogenean infestation. Moreover, in case of nickel pollution in water, positive significant (P<0.05) correlation was detected in case of *Neothoracocotyle* sp. Meanwhile, selenium give a highly significant (P<0.01) positive correlation with *Halotrematiodes* sp and *Neothoracocotyle* sp. On the same manner, positive significant (P<0.05) correlations were reported between it and the prevalence of *Paranaella* sp. On the other hand, negative significant (P<0.05) correlations were observed between lead pollution and all cases of monogeneans prevalence.

Table 1: Mean monthly temperatures and heavy metals concentration (ppm)

		Heavy metals (ppm)							
Aspect	Temp (°C)	Ni	Pb	Cr	Zn	Se	Cd	Co	Mn
Dec.	20.5	0.92	1.522	0.005	0.409	0.023	0.032	0.019	0.006
Jan.	13.5	0.39	1.501	0.512	0.195	0.038	0.159	0.793	0.007
Feb.	16.0	0.38	0.914	0.016	0.765	0.004	0.129	0.605	0.403
Mar.	20.0	0.48	0.603	0.016	0.809	0.018	0.106	0.671	1.613
Apr.	31.0	0.75	1.114	0.077	1.307	0.005	0.149	2.285	0.033
May	27.0	0.91	0.345	0.148	1.009	0.618	0.321	1.519	0.077
June	29.0	1.05	0.501	0.361	0.878	0.941	0.636	0.441	0.006
Jul.	31.0	1.12	0.401	0.151	0.288	0.402	0.090	0.133	1.068
Aug.	27.5	0.904	0.523	0.496	0.511	0.590	0.179	0.356	0.977
Sep.	26.0	0.775	0.994	0.793	0.663	0.030	0.092	0.449	0.005
Oct.	23.0	1.05	1.713	0.005	0.507	0.390	0.033	0.075	0.006
Nov.	19.0	0.92	0.812	0.406	0.668	0.074	0.003	0.555	0.007

Table 2: Percentage monthly prevalence of monogeneans in different investigated fish species (15 fish/month)

Aspect	*Halotrematiodes* sp.	*Paranaella* sp.	*Neothoracocotyle* sp.	*Diplectanum* sp.	*Haliotrema* sp.	Mean % of inf.±S.D
Dec.	6.66	13.33	26.66	20.00	6.66	14.66±8.690
Jan.	20.00	6.66	20.00	13.33	13.33	14.66±5.580
Feb.	13.33	20.00	13.33	6.66	26.66	15.99±7.600
Mar.	26.66	33.33	33.33	46.66	33.33	34.66±7.300
Apr.	33.33	46.66	40.00	53.33	46.66	43.99±7.600
May	40.00	40.00	53.33	40.00	53.33	45.33±7.300
Jun.	46.66	53.33	66.66	60.00	33.33	51.99±12.82
Jul.	53.33	66.66	73.33	73.33	60.00	65.33±8.690
Aug.	60.00	60.00	53.33	80.00	73.33	65.33±10.95
Sep.	26.66	46.66	33.33	46.66	40.00	38.66±8.690
Oct.	33.33	33.33	26.66	33.33	26.66	30.66±3.650
Nov.	20.00	13.33	20.00	26.66	13.33	18.66±5.570
Mean%	31.66±16.11	36.12±19.58	38.33±19.30	41.66±22.94	35.55±20.16	36.66±18.51

Mean % of inf±S.D: Mean percentage of infection±standard deviation

Table 3: Percentage of seasonal prevalence of monogeneans in different investigated marine fishes (45 fish/season-%of infection±Standard deviation)

Aspect	*Halotrematiodes sp.*±S.D	*Paranaella sp.*±S.D	*Neothoracocotyle sp.*±S.D	*Diplectanum sp.*±S.D	*Haliotrema sp.*	Total mean %±S.D
winter	13.33±6.67	13.33±6.67	19.99±6.66	13.33±6.67	15.55±10.18	15.12±0.76
spring	33.33±6.67	39.99±6.66	42.22±10.18	46.66±6.66	44.44±10.18	41.33±5.81
summer	53.33±6.67	59.99±6.66	64.44±10.18	71.11±10.18	55.55±20.36	60.89±7.71
autumn	26.66±6.66	31.12±16.75	26.66±6.66	35.55±10.18	26.66±13.33	29.33±10.06

Total mean %±SD: Mean percentage of infection±standard deviation

Table 4: Pearson Correlation matrix between the prevalence of monogenea parasites of the investigated fish species, temperature and heavy metals

Aspect	*Halotrematiodes sp.*	*Paranaella sp.*	*Neothoracocotyle sp.*	*Diplectanum sp.*	*Haliotrema sp.*	*Mean%*
Temp.	0.759**	0.903**	0.841**	0.849**	0.746**	0.871**
Ni	0.541	0.537	0.634*	0.555	0.310	0.545
Pb	-0.616*	-0.610*	-0.682*	-0.605*	-0.661*	-0.672*
Cr	0.194	0.137	0.071	0.211	0.137	0.160
Zn	0.065	0.216	0.104	0.130	0.225	0.160
Se	0.763**	0.594*	0.762**	0.569	0.487	0.665*
Cd	0.444	0.374	0.576	0.313	0.240	0.406
Co	0.029	0.048	0.019	0.016	0.223	0.072
Mn	0.364	0.379	0.296	0.465	0.463	0.421

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed)

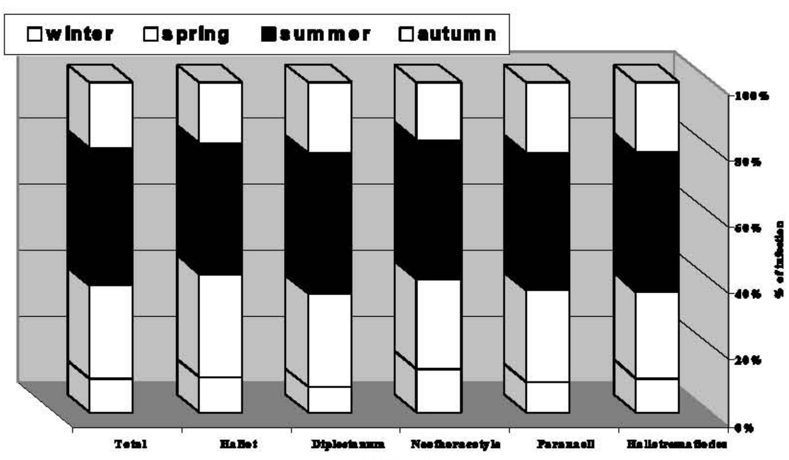

Fig. 1: Seasonal prevalence of the detected monogenean prasites

DISCUSSION

Gills are of primary importance as a route whereby fish take up metals in the water. In the current study, gills of the infested fishes were congested or pale haemorrhagic with hyper secretion of mucous. This signs may due to sever irritation caused by movement feeding activity fixation of monogenean. In addition, the presences of thick mucous secretion lead to respiratory failure and osmotic stress resulting in death of fishes [17, 20].

Temperature is the most important abiotic parameter and affects parasites at all life-cycle stages whereas, in this study, highly positive significant correlations were detected between temperature and the prevalence of the present monogeneans. In general, it could be explains that increases in temperature accelerate growth rates, development and evolution probably by shortening generation time and enhancing the speed of life cycle of the monogeneans [21-23]. Therefore, parasites should be able to complete their life cycles, even complex ones, more rapidly. In temperate latitudes, fish parasites possessing complex life cycles and typically produce one or two generations per year. An earlier onset of spring, combined with increased temperatures and longer growing seasons, could lead to the production of one or more additional generations annually. Physiological tolerance in terms of temperature minima and maxima, as well as the optimum temperature, varies not only among parasite species but also among the stages within the life cycle of a given species [21, 22, 24]. Moreover, the condition is depending on the optimal temperature for each species [24]. Temperature affects the release of eggs or larvae by adult worms, embryonic development and hatching, longevity of free-living stages, infectivity to intermediate hosts, development in these hosts, infectivity to definitive hosts, time to maturation and the longevity and mortality of adults (especially in fish hosts). In addition, temperature plays a key role in host feeding and behavior, host range and ecology and host resistance in fish. The seasonal infestation of monogeneans was differing from season to another. The highest rate occurred in summer and spring while, the lowest rate was in autumn and winter. This may be due to increase in water temperture in summer and spring. Like any aquatic system, parasites play an important role in the ecology of marine ecosystems. Although, mariculture parasites species cause no or limited pathological damage in wild fish, but they may become pathogenic, under conditions of marine culture [25, 26]. A variety of organisms had been investigated to evaluate their potential as biological indicators of different forms of pollution in the aquatic environment. Certain species have been identified as being highly sensitive either in their physiological response to aquatic contaminants or in their ability to accumulate particular toxins in a dose-time dependent manner. Regarding the effect of pollution, heavy metals and monogenean prevalence in marine fishes change in the diversity and structure of biological communities. The present data showed that there is antagonistic action of both lead and selenium on the current monogenean parasites. Whereas, lead gives significant negative correlation while selenium revealed opposite correlations. This may be due to multiple environmental stresses that have recently received increased attention from the perspective of their application as indicators of ecosystem integrity [27]. Therefore, generally fish parasites proved a useful indicative model for indication of environmental disturbances [27]. Consequently, studies of parasitic infection of economically important in marine fish species, which have recently become of interest. However, very little is known about the parasitic fauna of marine fishes.

The presence of a given metal at high concentrations in water and sediments does not involve direct toxicological risk to fish, especially in the absence of significant bioaccumulation. It is of importance to examine what may happen when stressors to a population of fish overlap with parasitism. There are several possible qualitative outcomes when parasites interact with other stressors (heavy metal pollution or and water temperatures). The most obvious concept is that some stressors may make hosts more susceptible to parasitism. This appears to be due to an increase in susceptibility because toxic conditions compromise a fish's immune system [25, 28]. Exposure to heavy metals compromises humeral and several aspects of cell-mediated immunity by decreasing antibody titers and the number of antibody-producing cells [29], enhancing natural killer cell activity [30]. Moreover, by interfering with melano-macrophage numbers and macrophage functions, which are important for maintaining host resistance against infectious agents [25]. Also, it is important to gain a working knowledge of fish immune response for more fully understand how metals act to bring about alterations in host defense and why an immuno-compromised host may be more susceptible to infectious diseases [25, 26]. The pathology that seems most directly causal to success of these with monogeniasis is a toxicant's ability to impair also mucus production a fish's main defense against gill and skin parasites [25, 31]. Many factors can alter water quality, like heavy metals which make interaction between water quality and parasitism [1, 13, 32, 33]. However, one obvious prediction is that pollutants as heavy metals may reduce the immunological capabilities of host, rendering them more susceptible to parasites.

It is concluded that there is a correlation between monogeniasis prevalence and the distribution of heavy metal pollutant. With the rise of water temperature the life cycle of monogenea become enhanced. This monogenean parasites and their diversity appear to be a sensitive and meaningful model for environmental studies. In order to evaluate the relationship between environmental exposure and monogenean metal bioconcentration and to validate the role of parasites in environmental biomonitoring it will be necessary to carry out more laboratory studies on experimentally infected fish to determine the ratio between metal concentrations in the parasites at equilibrium and the exposure concentration (bioconcentration factor).

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