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الإدارة العامة للمشروعات البيئية

أبحـاث
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"تقييم التلوث البيئى لمياه فرع دمياط من نهر النيل وبعض قنوات المياه العذبة وبعض المصارف الزراعية فى منطقة المنصورة ودراسة تأثير التلوث البيئى على صحة بعض الأسماك الشائعة والتنوع الأحيائى لعشائر الطفيليات القاطنه لتلك الأسماك"

الباحث الرئيسى

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جامعة المنصورة

Second Report
On Research Project

Assessment of the Pollution Status of the River Nile, its Tributaries and Some Agricultural Canals and the Impact of Pollution on Fish Health and Biodiversity of their Parasite Populations

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INTRODUCTION

The importance of fish as a comparatively cheap source of animal protein needs no emphasis. In Egypt with increasing population, the country faces a serious deficiency of animal protein. The existing natural fisheries are not sufficient to satisfy the protein needs of the people in Africa. Recently, there has been a considerable development of fish farming to supplement the natural stocks and therefore increase animal protein supplies. However, the increasing interest in the development of fish aquaculture requires adequate awareness of the importance of parasitic diseases as one of the major limiting factors in production of fish commercially. Parasites of fishes may harm their hosts in a number of ways and affect fish production. Also, fish may serve as intermediate hosts of parasites that are harmful to human and fish-eating mammals (Batra, 1984).

The ecological niche of a parasite species may be defined as the environment of the species. The environmental factors were found by many authors to determine the community structure and species diversity of the parasite assemblage of fishes (see Kennedy, 1978; Anderson, 1981; Koskivaara *et al*., 1991, 1992).

The majority of monogenean parasites show high degree of host and site specificity (Liewellyn, 1956; Poulin, 1991). The present study aims to assess the pollution status of the River Nile and its influence on the infestation level of the monogenean parasites infecting the gills of *O. niloticus* and *T. zilli* in four stations. Also, the goals of the present investigation are to study the relationship between the chemical factors of water and mean intensity of the studied monogeneans in the different stations.

MATERIALS AND METHODS

The study area includes four stations of differing-water qualities: station I in front of Talkha electricity station, station II near Talkha bridge in Mansoura city, station III Meniett-Sandoub station on Mansouria canal of the River Nile (fresh water) and station IV from the agricultural drainage near Mansoura city.

For studying the chemical environmental parameters, a water sample from each station was taken at the same time of fishing. Also soil analysis was done and selected fish species were examined for parasitological study.

Estimation of chemical elements and heavy metals found in water and soil was done also heavy metals in gill tissues was performed by using atomic absorption spectroscopy spectrophotometer.

Specimens of the cichlid host fishes Oreochromis niloticus and Tilapia zilli were caught monthly between January 2005 and December 2005.

RESULTS

Chemical analysis of water:

Tables 1-4 represents the monthly fluctuations of chemical environmental factors of water including heavy metals from the four stations from January 2005 to December 2005.

Total dissolved solids of water in the three stations (I, II and III) are very similar but the fourth station (IV) completely different (very high) in station I the maximum value was 358.4 ppm in January, while the minimum value was

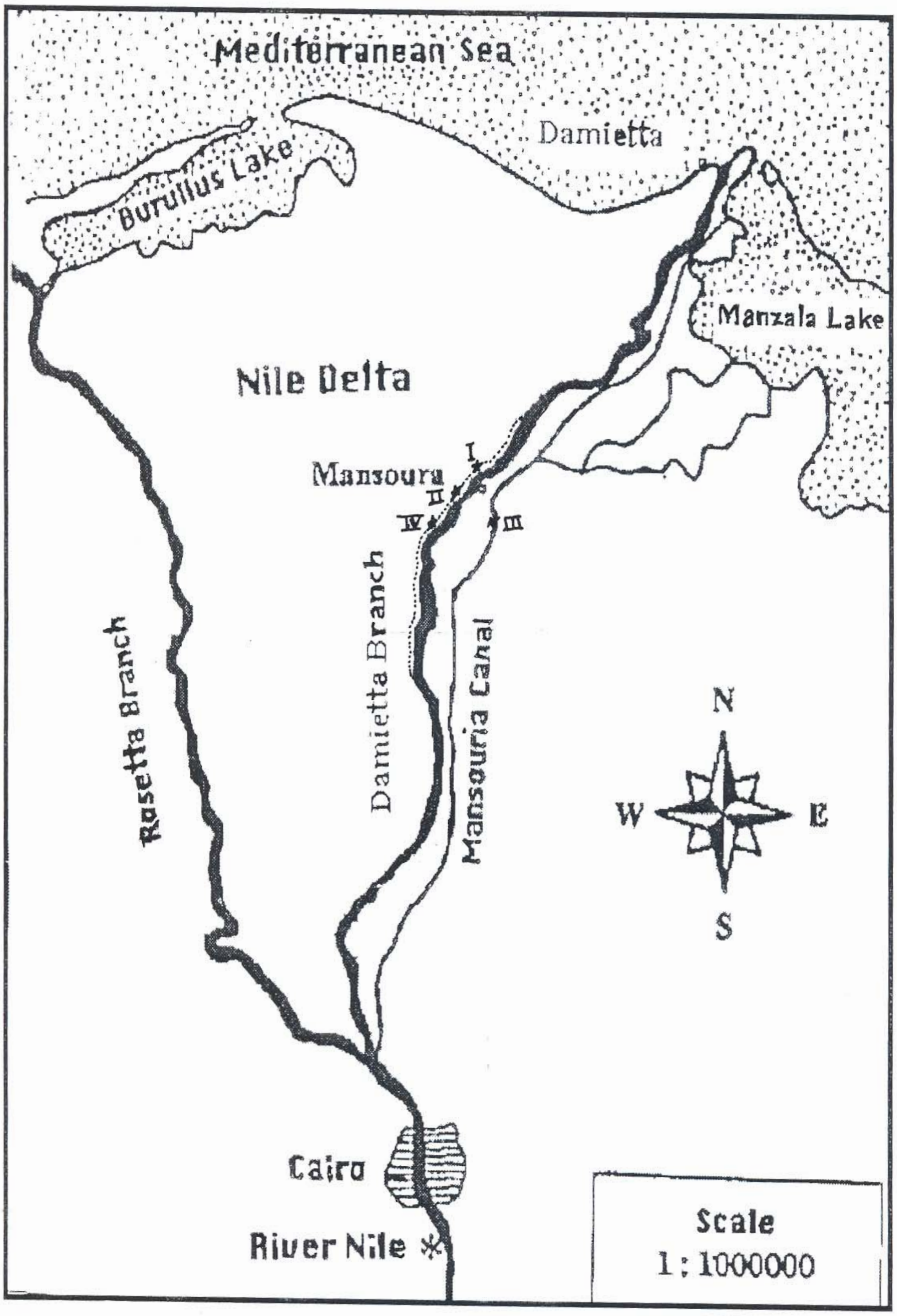

Fig. (1): A map showing the area of study.

236.8 ppm during June. In station II the maximum value was found during January (358.4 ppm), while the minimum was 224 ppm during June. In station III the maximum value was found during April (313.6 ppm) while the minimum value was found during May (198.4 ppm). In station IV the maximum value was found during January (2118.4 ppm), while the minimum value was found during August (608 ppm), Tables (1-4).

The maximum value of bicarbonate content in station I was recorded during January (228.75 ppm) while the minimum value was (69.78 ppm) during September. In station II the maximum value was recorded during January (244 ppm), while the minimum value was (60 ppm) during May. In station III the maximum value was recorded during January (198.25 ppm), while the minimum value was (60 ppm) during May. In station IV the maximum value was estimated during January (701.5 ppm), while the minimum was (106.75 ppm) during August, Tables (1-4).

The sulphate content of water sampled from station I was recorded the maximum value during October (96.67 ppm), while the minimum value was (22.56 ppm) during January. In station II the maximum value of sulphate was recorded during September (93.22 ppm), while the minimum value was (6.14 ppm) during January. In station III the maximum value was recorded during December (81.41 ppm), while the minimum value was (11.14 ppm) during February. In station IV the maximum value was recorded during January (440.64 ppm) while the minimum value was (40.17 ppm) during May, Tables (1-4).

Calcium, Mangnesium, Sodium and Potassium:

These minerals are very important. Calcium was recorded maximum value (55.12 ppm) during October, (50.88 ppm) during October, (50.88 ppm) during October and (109.2 ppm) during January from stations I, II, III and IV respectively. The minimum values were recorded during May (13.3 ppm), (10 ppm) during May, (16.6 ppm) during May and June and (29.88 ppm) during April from stations I, II, III and IV respectively.

Magnesium was recorded the maximum value (19.22 ppm) during January, (27.12 ppm) during Septebmer, (18.5 ppm) during March and (51.98 ppm) during January from stations I, II, III and IV respectively. While the minimum values were recorded (6.2 ppm) during May, (4.7 ppm) during May,(9.14 ppm) during August and (16.18 ppm) during October from stations I, II, III and IV respectively, Tables (1-4).

Sodium was recorded the maximum value during January in all stations. These were 89.2 ppm, 89.6 ppm, 71.2 ppm and 648 ppm from stations I, II, III and IV respectively. While the minimum value was estimated during August (20 ppm) from stations I and II, from station III it was (16.4 ppm) during October and reached (109.8 ppm) during September in station IV, Tables (1-4).

Potassium was recorded the same maximum value (4.8 ppm) during January and February, January and May from stations I, II and III respectively whereas their minimum values were estimated during May (2.9 ppm and 3.4 ppm) from stations I and II respectively, but from station III (3.36 ppm) during June and reached to (4.8 ppm) during August from stations IV, Tables (1-4).

Copper rarely was recorded in all stations, also iron with small traces. Phosphorus was recorded with very small amounts from the stations I, II and III (stations of the River Nile I and II, and III from Mansouria canal). The station IV (drainage canal) was recorded the maximum value (9.75 ppm) during January and the minimum value (1.31 ppm) during August, Tables (1-4).

Nitrates was recorded the maximum value during September (23.7 ppm), (10.56 ppm) during February, (8 ppm) during September and (20.3 ppm) during January from stations I, II, III and IV respectively. While the minimum values were recorded (0.17 ppm) during October, (0.13 ppm) during December,(0.1 ppm) during December and (0.19 ppm) during October from stations I, II, III and IV respectively, Tables (1-4).

Heavy metal concentrations in the water:

Concentrations of the detected heavy metals (Lead, Cadmium, Chromium, Mercury and Arsenic) in surface water samples of the four stations (I, II, III and IV), Tables (1-4). It is generally noticed that these concentrations are obviously very low especially for mercury and arsenic.

Heavy metal concentrations in the gill tissues:

Only iron and chromium were detected in the gill tissue of both hosts at all stations, but the other metals were not detected, Table (5).

Soil analysis:

The variations between the stations I, II and III not big, but the fourth station had higher value especially in sodium, calcium, chloride, sulphate and total dissolved solids (Tables 6,7).

Monogenean parasites:

Tables (8-15) show the prevalence (P%) and intensity (INT.) of the monogenean gill parasites on two host fish, Oreochromis niloticus and Tilapia zilli, during the different seasons.

The present investigation indicated that many monogeneans of O. niloticus and T. zilli exhibited their highest mean prevalence and mean intensity in spring while their lowest values were recorded in winter.

DISCUSSION

Paperna and Thurston (1969) reported that salinity of water is an important factor in the distribution of cichlidogyrid monogeneans. Crespo et al. (1995) found that sodium chloride was highly efficient in the control of Cichlidogyrus infestation. Yoon et al. (1992) reported that O. niloticus can tolerate moderately saline environment. These findings indicate that O. niloticus can survive well in both freshwater and brackishwater environments.

Several studies demonstrated that salinity of water can influence the occurrence of adult monogeneans in different water bodies (Isakov and Shullman, 1956; Paperna, 1963a, 1979; El-Naggar and Khidr, 1986a; Kennedy and Koie, 1991; Buchmann, 1993; El-Naggar, 1994).

The relationship between water alkalinity and fish parasites was studied by many investigators (Narasimhamurti and Kalavati, 1984; Buchmann et al., 1987; Osborne et al., 1989). Narasimhamurti and Kalavati (1984) attributed, in part, the absence of the myxosporidian Henneguya waltairensis from the gills to the freshwater fish Channa punctatus to the high alkalinity of water.

Buchmann et al. (1987) demonstrated a negative impact of bicarbonate on the survival of the monogeneans Pseudodactylogyrus anguillae and P. bini on the gills of the European eel, Anguilla anguilla under laboratory conditions. In contrast, Osborne et al. (1989) found no relationship between the abundance of Aeromonas hydrophila and total alkalinity of water.

Ramadan and Abdel-Salam (1986) successfully used copper sulphate to control several ectoparasitic ciliate protozoan of the genera Chilodonella, Tetrahymena, Epistylis and Trichodina infecting the young states of the grass carp, Ctenopharyngodon idella. Markovic et al. (1996) used copper sulphate to wash many aquarium fishes off the saprolegniosis, a secondary contagious disease of fish caused by fungus of the family Saprolegiacae.

Hecht and Endemann (1996) treated many fishes in aquaculture system in Africa infected with parasitic ectoprotozoans, cestodes, trematodes, nematodes, polychaetes and crustacea using the same chemical compound.

The concentrations of sodium, potassium, calcium and magnesium were moderate. Little is known about the roles of these minerals in the survival of monogenean parasites. Hoever, it is possible that these minerals have an important role in the metabolic activities of these parasites. Many minerals and trace elements have biological functions which affect the defense mechanisms and immune competence of the host through their interactions with metalloenzymes that are vital for maintenance of cellular viability and functions of immunocompetent cells (Beisel, 1982). Some minerals may play important roles in osmoregulation of fish. The hydrolytic activity of ATPase is described as magnesium dependent. ATPase affects the utilization of stored energy from ATP which is required for excretion or acquisition of salts across the gill membranes (DeRenzis and Bornancin, 1984). Magnesium, calcium and several essential trace elements can be absorbed by the host fish from the external environments (Lall, 1989; Steffens, 1989).

Numerous investigations have been dealt with the morphological, physiological and histological abnormalities of fishes exposed to heavy metal pollutants (e.g. Skidmore and Tovell, 1972; Badr and El-Dib, 1978; Spry et al., 1988; Spry and Wood, 1989; Vallee and Falchuk, 1993; Hogstrand et al., 1994, 1995; Yang and Wong, 1994; Magouz et al., 1996; Galvez et al., 1998. Cadmium and copper were reported by Magouz et al. (1996) to induce alterations in the structure of cell chromosomes and reduce the number of divided cells and mitotic index in the tissues of Oreochromis aureaus. Yang and Wong (1994) found that the coughing rates of tilapia and bighead carp was increased at copper concentrations of 0.3 and 0.2 microgram/ml, respectively.

The present data (in stations I, II and III) indicate that the chemical analysis of water and heavy metals analysis within limits according to Canadian water quality guidelines (1987).

The present investigation indicted that the concentration of heavy metals (in particular mercury and arsenic) in surface water sample may have a negative impact on the population growth of the studied monogenean species. Regarding the monogenean parasites, the concentrations of these heavy metals are expected to harm the biological mechanisms of these delicate organisms, especially if they are absorbed through the tegument of the monogeneans.

Most of the studies were restricted to the water quality only (Hamza, 1973; Seleim, 1974; Abdel-Backy, 1977 and Borhan, 1978; etc…).Various authors emphasized the importance of the mud surface as the chemical “laboratory” of the ponds (Lantsch, 1924; Demoll, 1925; Einsele, 1938; Pearsall and Mortimer, 1934; etc..).

Ruttner (1953) pointed out that the quality of the soil in a brackishwater fish pond is of even greater significance in productivity than in a freshwater pond. Schuster (1949) stresses the importance of the pond soil in brackishwater fish, ponds. In Indonesia he mentioned that the alluvial soil can be expected to be fairly fertile. Gervais Markham (cit. from Hickling, 1962) pointed out the best soil for fish were those which are either marsh, boggy, or full of springs.

Alikhuni (1957) confirms that in India water on acid soil is generally less productive of fish than that on alkaline soil.

Hickling (1962) showed that nitrate and nitrite are not absorbed on the soil colloids, they may in part diffuse down into the lower reduced layer of the soil. Morttmer (1954) showed that in Congo where both water and soil are poor in nutrients, the fish crop due to these alone is comparatively small.

The present data indicate that the nitrate and phosphorus seem to be the soil is rich in nutrients, copper and iron within a limited range and other elements also. For the heavy metal, cadmium, chromium, mercury and arsenic their values are low with only one exception recorded in the station IV (drainage canal). Lead also was recorded with rise value in all stations but also within limits.

Seasonal variations in the mean prevalence and mean intensity of the monogeneans under investigation may be attributed to four main elements: (1) seasonal changes in the physical and chemical environmental parameters (e.g. total dissolved solids alkalinity, temperature), (2) spawing time of the hosts (O. niloticus andT. zilli), in which the immune responses and other defense mechanisms of the fish clearly decrease, (3) seasonal variations in the reproductive potential of each monogenean species, for example egg fecundity, hatching success, growth rate of the larval stage concomiracidia), host-finding ability of the infective stages concomiracidia) and their successful establishment on their gill micro-settlement sites, or (4) combination of two or more of the above mentioned elements.

Members of the monogenean assemblage exhibited variable degrees of host specificity. The monogeneans C. halli typicus and C. arthracanthus exhibited high degree of host specificity where the mean prevalence and mean intensity values of C. halli typicus were higher on O. niloticus than on T. zilli while the mean prevalence and mean intensity values of C. arthracanthus were higher on T. zilli than on O.niloticus. In contrast, the other monogeneans showed a lower degree of specificity.

A comparison among various monogenean species collectively from all stations revealed that C. halli typicus was the most numerous species while C. cirratus was the least numerous species. Seasonal differences in the mean prevalence and mean intensity of the monogenean parasites varied from host to host. The viviparous monogenean G. cichlidarum was not encountered on the gills of the cichlid hosts O. niloticus and T. zilli during winter.

Siddall et al. (1997) studied the occurrence of dactylogyrid monogeneans on the gills of roach (Rutilus rutilus) experimentally exposed to a source of pollution. They reported that this kind of pollution did not prevent the reproduction of dactylogyrid monogeneans, where the post-larval abundance increased significantly during the experiment on both exposed and control fish.

It can be suggested that the pollutants (heavy metals) may have direct impacts on the deposited eggs, oncomiracidia, post-larvae and adult monogenean worms, or may act through changes in the density of hosts (Hirschfield et al., 1983), hosts overlap in distribution (Marcogliese et al., 1990), and changes in the physiology, particularly the immune responses of fish (Jokinen et al., 1995).

Skinner (1982) suggest that the pollutants in the water acted as an irritant, stressing the fish, and producing physical and physiological changes which reduce the resistance of the fish to infestation with monogenean parasites.

The low infestation levels of many species during winter may be a reflection of the fact that the reproductive activity of these parasites represented by egg production, hatching success, survival of the newly emerged oncomiracidia, successful host-finding of the growing oncomiracidia and final establishment on the host fish, diminishes dramatically around this period. In contrast, the population growth of these parasites during hot months (spring) may be attributed to the increase in the biological activities of these parasites around these periods.

Table (5). Heavy metal concentration (ppm/1 gm dry weight in gill tissue samples of *Orcochromis niloticus* and *Tilapia zilli* at four stations.

Heavy	***Oreochromis niloticus***				***Tilapia zilli***			
Metal	**Station I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**
Iron	5.2	4.9	6.1	4.5	3.4	3.13	3.5	3.15
Copper	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-
Chromium	0.09	0.10	0.15	0.16	0.29	0.30	0.25	0.33
Mercury	-	-	-	-	-	-	-	-
Arsenic	-	-	-	-	-	-	-	-

Table (8). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Oreochromis niloticsu* during winter.

Monogenean	Station I		Station II		Station III		Station IV	
Species	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	60.0	13.3	53.3	16.25	50.0	14.66	40.0	19.16
C. arthracanthus	33.3	16.0	26.6	18.75	30.0	16.4	26.66	17.62
C. thurstonae	53.3	13.1	50.0	14.66	46.66	13.57	40.0	14.16
C. ergensi	20.0	16.7	23.33	15.71	20.0	17.66	16.66	16.0
C. tiberianus	16.7	16.0	26.66	11.5	20.0	1.66	16.66	13.6
C. cirratus	10.0	3.3	13.33	5.0	14.66	5.0	13.33	4.0
S. longicornis	13.3	12.5	16.66	12.0	13.33	10.0	14.0	9.04
G. cichlidarum	-	-	-	-	-	-	-	-

Table (9). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Oreochromis niloticsu* during spring.

Monogenean	Station I		Station II		Station III		Station IV	
Species	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	26.66	10.12	30.0	11.11	33.33	12.1	30.0	10.0
C. arthracanthus	66.66	10.5	63.3	11.68	65.33	11.73	56.00	11.17
C. thurstonae	30.0	10.0	33.3	10.2	36.66	8.90	30.0	8.89
C. ergensi	33.33	9.8	30.0	8.44	36.66	8.72	30.0	8.44
C. tiberianus	40.0	9.17	40.0	8.33	50.0	7.6	36.66	8.90
C. cirratus	53.33	5.0	60.0	6.72	56.66	6.94	50.00	5.33
S. longicornis	48.0	3.47	50.0	3.86	53.33	4.73	46.66	4.36
G. cichlidarum	63.3	4.21	65.33	3.57	66.66	3.0	56.66	4.0

Table (10). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Oreochromis niloticsu* during summer.

Monogenean	Station I		Station II		Station III		Station IV	
Species	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	26.66	12.5	33.33	9.0	30.0	8.88	26.66	8.75
C. arthracanthus	46.66	4.28	50.0	4.66	52.0	2.56	43.33	3.84
C. thurstonae	29.33	6.36	26.66	5.0	30.0	5.55	26.66	3.75
C. ergensi	37.33	3.57	36.66	2.72	40.0	3.16	36.66	3.09
C. tiberianus	40.0	5.15	43.33	5.38	46.66	5.42	38.66	5.21
C. cirratus	38.66	3.27	40.0	3.33	43.33	3.23	36.66	3.27
S. longicornis	36.0	3.33	38.66	3.27	40.0	3.33	34.66	3.04
G. cichlidarum	40.0	5.0	43.33	3.84	44.0	4.39	38.66	4.14

Table (11). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Oreochromis niloticsu* during autumn.

Monogenean Species	Station I		Station II		Station III		Station IV	
	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	20	26.66	23.33	24.28	25.33	22.11	13.33	35.0
C. arthracanthus	36.66	12.73	40.0	12.66	26.66	18.75	20.0	16.66
C. thurstonae	20.0	16.66	16.66	22.0	21.33	16.56	13.33	21.0
C. ergensi	40.0	10.0	36.66	12.18	33.33	13.6	26.66	14.5
C. tiberianus	33.33	10.4	30.0	13.33	36.66	10.73	28.0	10.48
C. cirratus	26.66	5.0	29.33	6.60	32.0	6.46	23.33	6.86
S. longicornis	40.0	7.5	33.33	6.8	43.33	5.08	30.0	6.22
G. cichlidarum	43.33	10.77	46.66	11.14	40.0	12.33	36.66	11.82

Table (12). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Tilapia zilli* during winter at the different stations.

Monogenean Species	Station I		Station II		Station III		Station IV	
	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	7.8	1.2	8.1	1.3	7.9	1.4	7	1.1
C. arthracanthus	32	2.3	31.1	2.4	33.2	2.5	30	2.2
C. aegypticus	19.9	1.9	18.8	1.7	19.1	1.8	18.6	1.7
C. ergensi	11.6	1.9	11.6	1.8	11.5	2.0	11.2	1.9
C. tiberianus	13.1	1.2	11.4	1.3	12.1	1.4	11.9	1.3
C. cirratus	6.1	1.0	6.0	1.0	6.5	1.1	6.2	1.1
S. longicornis	6.1	1.0	6.6	1.1	6.3	1.2	6.0	1.2
G. cichlidarum	0	0	0	0	0	0	0	0

Table (13). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Tilapia zilli* during spring at the different stations.

Monogenean Species	Station I		Station II		Station III		Station IV	
	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	11.0	2.9	11.2	2.8	10.4	2.9	9.2	2.1
C. arthracanthus	72.2	11.6	71.6	11.8	74.9	12.0	68.2	11.1
C. aegypticus	48.4	6.1	48.2	5.8	47.1	5.9	42.8	4.6
C. ergensi	24.6	5.0	24.1	4.9	23.4	4.8	21.4	3.9
C. tiberianus	28.3	6.1	27.3	5.6	29.1	6.2	26.2	5.8
C. cirratus	14.4	2.3	13.4	2.2	14.1	2.5	12.4	2.2
S. longicornis	8.4	2.1	8.1	2.0	7.2	1.9	6.0	1.4
G. cichlidarum	12.0	1.8	11.9	1.6	12.6	1.5	11.3	1.2

Table (14). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Tilapia zilli* during summer at the different stations.

Monogenean Species	Station I		Station II		Station III		Station IV	
	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	15.3	2.0	14.0	1.8	14.2	1.9	14.1	1.8
C. arthracanthus	69.3	3.8	68.2	3.9	63.4	3.6	65.1	3.5
C. aegypticus	55.1	4.6	53.8	4.0	50.6	4.1	54.0	4.2
C. ergensi	27.3	2.8	26.2	2.6	25.1	2.7	24.	2.6
C. tiberianus	32.5	4.1	33.1	4.2	31.3	3.9	31.1	3.8
C. cirratus	17.9	1.8	16.9	1.7	18.1	2.1	16.6	1.7
S. longicornis	12.3	1.8	12.6	1.9	11.8	1.8	11.2	1.6
G. cichlidarum	5.0	1.8	4.7	1.6	4.9	2.0	4.8	1.8

Table (15). Prevalence (P%) and intensity (INT.) of the monogenean gill parasites on *Tilapia zilli* during autumn at the different stations.

Monogenean Species	Station I		Station II		Station III		Station IV	
	P%	INT.	P%	INT.	P%	INT.	P%	INT.
C. halli typicus	8.6	1.5	9.2	1.8	8.7	1.7	8.1	1.6
C. arthracanthus	54.2	3.2	55.8	4.1	56.1	3.3	50.2	3.1
C. aegypticus	55.4	3.9	56.4	4.4	57.9	4.2	51.8	3.9
C. ergensi	24.6	5.8	25.6	6.1	24.8	5.9	20.4	4.8
C. tiberianus	28.1	3.9	29.0	4.2	28.2	4.0	25.1	3.7
C. cirratus	12.4	2.2	11.8	2.0	12.9	1.9	11.8	1.5
S. longicornis	6.2	1.4	6.1	1.2	5.0	1.3	4.6	1.1
G. cichlidarum	5.4	2.1	7.0	1.8	5.0	2.0	4.8	1.5

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