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SOME STUDIES ON MONOGENIASIS AND ITS RELATION TO SOME HEAVY METALS LEVELS IN *SCOBEROMORUS COMMERSON* FROM RED SEA

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Abstract

A total number of 100 marine fish (*Scoberomorus commerson*) were randomly collected from the Red Sea to investigate the total and seasonal prevalence of monogeniasis. The infected fish revealed emaciation and bulging operculum with surface breathing in monogenean infestations. The gills of infected fish were congested and/or pale, slight marbling with excusive mucous secretions due to parasitic infestation on gill filaments. Two monogenean species were detected from the gills, *Pricea multae* and *Neothoracocotyle commersoni*. The average infestation rate was 80%, where the highest infestation rate was recorded in summer (92%) while the lowest was during winter (68%). Residues of iron (Fe), zinc (Zn), copper (Cu), cadmium, (Cd) and lead (Pb) were detected in water, monogenean parasite and infected or non infected organs (livers, gills, and muscles) of *Scoberomorus commerson*. The obtained results revealed that all investigated metals in water were lower than the permissible limits. Average Fe, Zn and Cu residues in the non infected organs were significantly ($P<0.05$) lower than its residues in the non infected organs. Monogenean parasites accumulated the highest values of Fe, Zn and Cu compared to the other investigated organs, while there were no any Cd or Pb were detected. The present study indicated that the monogenean parasites are able to accumulate heavy metals in their tissues higher than host tissues and considered as an indicator for heavy metals pollution besides being a competitor to fish organs for heavy metals accumulation.

INTRODUCTION

Monogeneans are found on fresh and marine water fishes throughout the world. They have a direct life cycle and can reproduce in a wide range of temperatures. Monogeneans have a series of hooks that attach to the fish causing irritation, excessive mucus production, and which create an open window for bacterial invasion (Reed *et al.*, 2009).

Otherwise, Monogenean parasites are consider as one of the most important sensitive parasites to any changes in water parameter and especially those of the Red Sea still needed more investigations (Bayoumy *et al.*, 2008).

The relationship of parasitism and pollution is not simple and in essence involves a double edged phenomenon in which parasitism may increase host susceptibility to toxic pollutants or pollutants may result in an increase or decrease in the prevalence of certain parasites. Pollutants may affect an intermediate or alternate hosts in parasite life cycle and on free-living life cycle stages of parasite invasion (Noor El Deen *et al.* 2011).

Pollutants might promote increased parasitism in aquatic animals, especially fish, by impairing the host's immune response. On the other hand, parasites might enhance their hosts' susceptibility to pollutants. Heavy metals such as cadmium, lead, copper and more specifically mercury are potentially harmful to most organisms even in very low concentrations (Kaoud and El-Dahshan, 2010). Over the last few decades; aquatic pollution is still a problem in many freshwater and marine environments as it causes negative effects for the health of the respective organisms (Mouillot *et al.*, 2005) and (Farombi *et al.*, 2007).

The aim of this work is not only to determine the monogeniasis affecting *Scoberomorus commerson* from Red Sea but also to investigate the clinical and post-mortem lesions. Bedsides, the seasonal prevalence of these parasites and its relation with heavy metals were recorded.

MATERIALS AND METHODS

Fish.

The present investigation was done using 100 marine fish samples (*Scoberomorus commerson*) which randomly collected in different seasons from Red Sea. The collected fish were transported to the lab in plastic bags partially filled with its natural water within a short time according to Langdon and Jones (2002).

Clinical and Post-mortem examination of fish.

The collected fish samples were examined carefully, externally and internally for presence of any abnormalities. Gills, fins, skin, bronchial cavity, musculatures and internal organs were submitted for thorough examination according to Conroy and Hermann (1981).

Parasitological examination.

The detected monogenea were put in Petri-dishes containing saline solution to remove any mucous and left in the refrigerator to be fixed in relaxed state, fixed in 4% formalin, stained with Semichon`s acetocarmine, dehydrated in ascending grades of ethyl alcohol and mounted in Canada balsam Lucky (1977) and Schmidt (1992).

Water samples preparation for heavy metals measurements.

Water samples were collected in different seasons of the year. Twelve water samples were collected from the same locality of fish capture in different times at a rate of three samples for each season, kept refrigerated and transferred cold to the laboratory for analysis. Five cm^3 of concentrated hydrochloric acid was added to 250 cm^3 of water sample at the time of analysis and evaporated to 25 cm^3. The concentrate was transferred to a 50-cm^3 flask and diluted to the mark with distilled de-ionized water **(Parker, 1972).**

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Fish samples Preparation for heavy metals measurements.

Fishes were dissected to get gills, liver, kidney, and muscle, kept frozen until biochemical analysis. To the dried sample, add 2 ml. HNO_3 and swirl. Evaporate carefully just to dryness on hot plate, transfer to cooled furnace, slowly raise temp. to 450ºC-500ºC and hold at this temp. for 1 hour. Add 10 ml of 1N HCl and dissolve ash by heating cautiously on a hot plate. Transfer to 25 ml volumetric flask and add HCl as necessary. Cool and dilute to volume (Official Methods of Analysis, 1980).

Parasites preparation for heavy metals determination.

Samples were weighted (around 100–150 mg wet weight) and digested in Teflon vessels with 2 ml HNO_3 and 1 ml H_2O_2 at 90 °C in an oven and left overnight, according to the method mentioned by Brázová *et al*. (2012). After the complete digestion, samples were diluted with 30 mم of Milli-Q water and then analyzed for trace elements by the mentioned instrument.

Different investigated heavy metals in water, monogenean parasite and in the different fish organs were detected with Atomic Absorption Spectrophotometer (Model Thermo Electron Corporation, S. Series AA Spectrometer, UK,).

Statistical analysis.

Comparison of treatment means using one-way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) was performed to compare the different treatment means at 5% level of significance. The software SPSS, version 10 (SPSS, Richmond, USA) was used as described by Dytham (1999).

RESULTS AND DISCUSSION

Clinical and Postmortem Finding.

The clinical signs of most examined fish revealed emaciation and bulging operculum with surface breathing in monogenean infestations. On the other hand, post-mortem examination of the infested marine fish revealed congestion of the gills and/or pale, slight marbling of gills with excessive mucus secretion somewhat emaciation. The gills of infested fish showing sticking, grayish coloration and presence of Monogenean parasites (Plate 1 and Plate 2). These descriptions were nearly similar to the findings reported by El-lamie (2007); Bayoumy *et al.* (2008); Morsy *et al.* (2011); Abdel-Mawla and Abo-Esa (2011) and Abo-Esa & Abdel-Mawla (2012).

Parasitological finding.

Phylum: Platyhelminths.
Class: Monogenea.
Family: Gastrocotylidae.

1- Species: *Pricea multae* (Chauhan, 1945).

Microscopic smears showed long cylindrical flukes collected from gills (plate 3: A) its length was 3.16mm and the width was 0.4mm. Oral suckers are kidney-shape. Genital atrium is armed and ovoid in shape. Intestine is ramified, Co-extensive with vitellaria and extending to the haptor. The haptoral clamps are typical of Gastrocotylidae. They are arranged in approximately equal row in each side, similar in shape and with few oblique rib-like thickenings. A single pair of anchor on an oval lappet is present at posterior end of opithohaptor. This parasite was identified as monogenetic trematodes. *Pricea multae* (plate 3: B & C) these finding agree with those described by Abdel Aal *et al* . (2001) and El-Lamie (2007).

2- Species: *Neothoracocotyle commersoni* (Yamaguti 1958).

Microscopic smears showed long lanculate flukes collected from gills (plate 4: A). its length was 2.24mm and the width was 0.26mm. There is a bear of buccal sucker at the anterior end of the flukes. The intestinal ceaca are with outer diverticular, not extended into opithohaptor and not united posterior. Testes are numerous, arranged in multiple rows at the third part of the body. Ovary is lobed with distal end directed backward and located median and pretesticular. Vitellaria are largely co-extensive with intestinal ceaca. Opithohaptor is symmetrical with a row of similar clamps at each side. Clamps are of a uniform structure with accessory sclerite and of oblique circular rib-like thickenings. This parasite was identified as monogenetic trematodes *Neothoracocotyle commersoni* (plate 4: B&C). This morphological description was agreed with that given Abdel Aal *et al.* (2001); El-Lamie (2007) and Bayoumy *et al.* (2008).

Prevalence and seasonal variation of the detected parasites.

The total prevalence of Monogenean infestation was (80%) (Table, 1). This result agreed with_that obntained by Hassan *et al.* (1996) from Mediterranean Sea (70.6%), El-Lamie (2007) from S. *commerson* (82%) and Morsy *et al.* (2011) from brown-spoted grouper fish (74.1%). Meanwhile, it was higher than the finding recorded by Osman (2005) from marine fish, El-Lamie (2007) from *Siganus revulatus* & *Morone labrax*, Abdel-Mawla and Abo-Esa (2011) from *Siganus revulatus* and Abo-Esa and Abdel-Mawla (2012) from Lutjanus spp in which the percentages were 43.7, 41, 28, 31.7 and 36.25% respectively. The prevalence was lower than that recorded from Fuentes-Zambrano *et al.* (2003) from *Lutijanus griseus*, Venezula (95.7%). This difference may be attributed to the locality from which fish samples obtained and the species of examined fish.

The total seasonal prevalence was the highest in summer (92%) followed by spring (84%), autumn (76%) and winter (68%) (Table, 1). This result agreed with that obtained by Bayoumy *et al.* (2008) who recorded the highest infestation of monogenea in summer 60.89% while the lowest in winter 15.12%. Bayoumy (2003) who found that monogenean infestation is temperature dependent. Meanwhile, disagreed with El-Lamie (2007) who found the highest infestation in spring season in Morone labrax(52%) and *Siganus revulatus* (60%) but in *S. commerson* was recorded the same rate (92%) in Summer, winter and spring. Abdel-Mawla and Abo-Esa (2011) recorded the highest rate in spring (50%) from *Siganus revulatus* This variation in prevalence may be attributed to the unequal samples, fish species, the type of searched parasites and different sites from which samples are collected as well.

Heavy metals concentrations in water.

Table (2), Revealing that the highest iron and zinc concentrations were detected during autumn, while the highest copper concentrations were detected during winter. There was no cadmium detected in water samples collected during winter and spring, while its concentration during autumn and summer was 0.001 mg/l. Lead concentration during winter was 0.0486 mg/l, while there was no any detected cadmium during the other seasons. The average Fe, Zn, Cu, Cd and Pb were 0.516, 0.175, 0.032, 0.0005 and 0.012 mg/l, respectively. All investigated metals were lower than the permissible limits mentioned by WHO (2011).

Heavy metals residues in investigated organs during different season and in the isolated parasite.

As shown in Table (3), iron concentrations in *monogenia* infected liver during autumn; winter and summer were significantly lower than its concentrations in the non-infected liver during the same seasons. Average iron concentration in the infected liver (17.28 mg/kg) was significantly lower than the average value in the not-infected liver (26.73 mg/kg).

Concerning iron concentrations in the infected livers among different seasons, they represented the following order: spring > winter > autumn summer, while its concentrations in non-infected liver had the order winter > spring > autumn > summer.

Fe values in the non-infected gills were higher than its values in the infected gills during different seasons. Its average values in the infected and not-infected gills were 1.97 and 3.91 mg/kg, respectively. Concerning Fe values among different seasons, in the infected gills, it's followed the order: autumn > summer > spring > winter, while these concentrations in the non-infected gills had the order: winter > autumn spring > summer.

Iron values in the infected muscles were lower than those in the not-infected muscles during different seasons. Average Fe values in infected and non-infected muscles were 0.382 and 2.735 mg/kg, respectively. The order of Fe concentrations in both infected and non-infected muscles among different seasons had the following order: autumn > spring > summer > winter.

Average iron in both infected and not-infected organs followed the order: liver > gills > muscles, except in infected livers during autumn where Fe residues were lower than its residues in infected gills. These finding agreed with ElNemaki and Badawy (2005 & 2006) who found out that Fe concentrations in the carp and mullet liver were higher than those in the fish muscles. Obtained results revealed that Fe residues in different organs were the highest among the investigated metals. The increased accumulation of Fe in different fish organs can be attributed to the large quantities of Fe in water. This agrees with the findings of Ghazaly *et al*. (1992); Tariq *et al*. (1993) and Bahnasawy *et al*. (2011). WHO (2011) reported that the recommended daily intake for an adult is: up to 50 mg Fe/day, so, a normal daily diet including this fish species poses no health risk to consumer.

Zn concentrations in the infected livers were significantly lower than its concentrations in the non-infected livers among different seasons. Average zinc concentrations in infected and non-infected livers along the experimental period were 0.705 and 4.454 mg/kg, respectively. These concentrations in both infected and non-infected livers had the following order: autumn > winter > summer > spring. Zn concentrations in the infected gills were significantly lower than its concentrations in the non infected gills among different seasons. Average gills concentrations in the infected and non-infected gills were 0.098 and 0.191 mg/kg, respectively. These concentrations in the infected gills had the order spring > summer > winter > autumn, while in the non-infected gills, they had the order: spring > winter > summer > autumn.

Zinc concentrations in infected muscles were lower than its concentrations in non infected muscles during all seasons. Average Zn residues in infected and non-infected muscles were 0.285 and 0.388 mg/kg, respectively. These concentrations in the infected muscles among different seasons had the order winter > summer > autumn > spring, where these concentrations in the non-infected muscles had the order: autumn > winter > summer > spring. Zn residues in different investigated organs in both infected and non infected organs had the order: livers > muscles > gills. These finding agreed with ElNemaki and Badawy (2005 & 2006) who found out that Zn concentrations in the carp and mullet liver were higher than those in the fish muscles. Obtained results showed that Zinc values in *Scoberomorus commerson* were lower than the acceptable concentration (50 mg/kg) mentioned by FAO (1983) and according to WHO (2011) which recommended that daily intake for an adult is 1 mg Zn/kg of body weight/day, so a normal consumption of these fish species considered quite safe for human.

Copper concentrations in the infected livers among different seasons were significantly lower than its concentrations in the non-infected livers. The average values of Cu in the infected and non-infected livers were 0.457 and 4.557 mg/kg, respectively. These values in both infected and non-infected livers had the same order among different seasons which is: winter > summer > spring > autumn. Copper residues in the infected gills were significantly lower than its residues in the non-infected gills during all seasons. Its average values in the infected and non-infected gills were 0.029 and 0.236 mg/kg, respectively. Obtained data revealed that Cu residues in the infected gills were had the order: spring > winter > autumn > summer, while in the non-infected gills, the order of copper residues among different seasons during the study period were: winter > spring > autumn > summer. Manipulated data concerning copper residues in the investigated fish muscles that obtained along the study period revealed that its residues in the infected muscles were lower than its values in the non-infected muscles during different seasons. Average Cu residues in both infected and non-infected fish muscles were o.058 and 0.112 mg/kg, respectively. The order of these concentrations in the infected muscles were: autumn > spring > winter >summer, while the order of these concentrations in the non-infected fish muscles were: spring > summer > winter > autumn.

Among different organs, Cu in both infected and non-infected organs followed the order: liver > gills > muscles except in infected gills during summer and spring which were lower than these concentrations in muscles. Similarly, ElNemaki and Badawy (2005 & 2006) found out that Cu residues in the carp and mullet liver were higher than those in the fish muscles. All copper concentrations that detected in the edible muscles during the present work were below the permissible concentration (20 mg/kg) mentioned by FAO (1983), so they quite safe for human consumption.

There was no detected cadmium in either infected or non-infected livers except in infected livers during summer and infected muscles during autumn. There was no health risk on the consumption of the edible muscles of *Scoberomorus commerson* fish, where the permissible Cd concentration mentioned by FAO (1983) is 0.5 mg/kg.

There were no Pb residues detected in all investigated organs during different seasons except in infected gills during winter. The absence of lead from different investigated fish organs may be due to the much decreased pb concentrations in water. Similar result obtained by Victor *et al*. (2012) who reported that pb concentrations in *C. gariepinus* muscles, gills and livers increased as its concentration in the surrounding medium increase. WHO (2011) recommended 25 µg/kg body weight/day for an adult daily intake; consequently, there were no health risk on the consumption of the edible muscles of *Scoberomorus commerson* fish.

Generally, the lowest residues of all investigated metals were in muscles. Similar results were reported from a number of fish species showing that muscle is not an active tissue in accumulating heavy metals (Karadede and Unlo, 2000). Muscle is generally considered to have a weak accumulating potential (Bervoets and Blust, 2003; Erdogrul and Erbilir, 2007and Uysal *et al*., 2009). Saeed and Mohammed (2012) reported that accumulations were lowest in fish muscle where the metabolic activity is relatively low, consequently accumulates less level of metals. Obtained results revealed that the average concentrations of Fe, Zn, and Cu in the investigated parasite were 26.25, 1.55 and 0.15 mg/kg, respectively, while there were no any Cd or Pb residues had been detected. It's obtainable that Fe, Zn and Cu residues in the investigated parasite *Monogeniasis* were higher than their residues in different investigated organs of the infected *Scoberomorus commerson*. Similar results detected by Tekin-Özan and Kir (2007) who revealed that parasite could be used as an indicator of the metal pollution.

Table (1). Seasonal prevalence of monogeniasis from *Scoberomorus commerson*from Red Sea.

Season	Total No of Exam.	Total No of infest.	% of infest.	Parasitic Isolates					
				Mixed infection		Monogenia			
						Pricea multae		*N. commersoni*	
				N	%	N	%	N	%
Autumn	25	19	76	14	56	18	72	15	60
Winter	25	17	68	9	36	15	60	11	44
Spring	25	21	84	18	72	21	84	18	72
Summer	25	23	92	22	88	23	92	22	88
Total	100	80	80	63	63	77	77	66	66

Monogenitic trematodes (*Pricea multae* **)** – **(** *Neothoracocotyle commersoni* **)**

Table (2). Some heavy metals concentrations in water during different seasons.

	Fe (mg/l)	Zn (mg/l)	Cu (mg/l)	Cd (mg/l)	Pb (mg/l)
Autumn	1.017[A] ±0.009	0.359[A] ±0.006	0.016[C] ±0.001	0.001[A] ±0.0005	ND
Winter	0.244[C] ±0.006	0.1078[B] ±0.005	0.062[A] ±0.006	ND	0.049[A] ±0.006
Spring	0.603[B] ±0.03	0.114[B] ±0.008	0.018[C] ±0.002	ND	ND
Summer	0.199[C] ±0.006	0.117[B] ±0.009	0.032[B] ±0.001	0.001[A] ±0.00	ND
Average	0.516 ±0.189	0.175 ±0.062	0.032 ±0.011	0.0005 ±0.0003	0.012 ±0.012
PL	No health-based guideline value has been recorded	No health-based guideline value has been recorded	2	0.003	0.01

Means followed by different capital letters at the same column are statistically different at $p<0.05$level. PL: Permissible levels (mg/ l) according to WHO (2011).

Table (3): Residues of some heavy metals in different investigated organs of *Scoberomorus commerson* fish and *Monogeniasis* parasite during different seasons.

Organs	Fish	Season	Fe (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Cd (mg/kg)	Pb (mg/kg)
Livers	Infested	Autumn	8.2142	1.092	0.214	ND	ND
		Winter	20.474	0.811	0.627	ND	ND
		Spring	34.157	0.297	0.468	ND	ND
		Summer	6.2753	0.618	0.52	0.01	ND
		Average	17.28^{ABab} ±6.44	0.71^{Bb} ±0.167	0.457^{Ba} ±0.088	0.00238^{Aa} ±0.002	ND
	Not infested	Autumn	24.879	7.038	2.69	ND	ND
		Winter	34.19	5.345	6.11	ND	ND
		Spring	28.13	1.463	4.336	ND	ND
		Summer	19.714	3.97	5.09	ND	ND
		Average	26.73^{AX} ±3.03	4.45^{AX} ±1.17	4.56^{AX} ±0.72	ND	ND
Gills	Infested	Autumn	2.9242	0	0.011	ND	ND
		Winter	0.3157	0.091	0.024	ND	0.012
		Spring	1.8679	0.205	0.073	ND	ND
		Summer	2.7813	0.097	0.006	ND	ND
		Average	1.97^{Bb} ±0.599	0.098^{Ac} ±0.042	0.029^{Bc} ±0.01	ND	0.003^{Aa} ±0.003
	Not infested	Autumn	3.8213	0.11	0.09	ND	ND
		Winter	4.7759	0.217	0.62	ND	ND
		Spring	3.8123	0.245	0.145	ND	ND
		Summer	3.2133	0.193	0.087	ND	ND
		Average	3.906^{AY} ±0.323	0.191^{AY} ±0.02	0.236^{AY} ±0.12	ND	ND

Average means followed by different capital letters (A, B and C) between the infested and the non infested particular organ, or different capital letters (X, Y and Z) among the non infested organs, or different small letters among the infested organs are significantly different at $P<0.05$ level. Maximum acceptable* concentrations: mg/kg for Cd (FAO, 1983) and as recommended daily intake (mg/kg of body weight) as WHO (2011) for the other elements.

Table (3). Continued.

Organs	Fish	Season	Fe (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Cd (mg/kg)	Pb (mg/kg)
Muscles	Infested	Autumn	0.4351	0.309	0.086	0.005	ND
		Winter	0.31	0.388	0.054	ND	ND
		Spring	0.409	0.097	0.073	ND	ND
		Summer	0.3737	0.348	0.021	ND	ND
		Average	0.382^{Bb} ±0.027	0.285^{Bc} ±0.064	0.058^{Bc} ±0.013	0.001^{Aa} ±0.00	ND
	Not infested	Autumn	3.1	0.524	0.099	ND	ND
		Winter	2.32	0.49	0.107	ND	ND
		Spring	2.8591	0.163	0.126	ND	ND
		Summer	2.66	0.377	0.114	ND	ND
		Average	2.735^{AY} ±0.164	0.388^{AY} ±0.08	0.112^{AY} ±0.006	ND	ND
Maximum concentrations		acceptable*	50	1	0.025	0.5	0.025
parasites		Average	26.25^{a} ±1.47	1.55^{a} ±0.64	0.15^{b} ±0.009	ND	ND

Average means followed by different capital letters (A, B and C) between the infested and the non infested particular organ, or different capital letters (X, Y and Z) among the non infested organs, or different small letters among the infested organs are significantly different at $P<0.05$ level. Maximum acceptable* concentrations: mg/kg for Cd (FAO, 1983) and as recommended daily intake (mg/kg of body weight) as WHO (2011) for the other elements.

Plate (1). A. *Scoberomorus commerson* fish **B.** The gills of infested fish with monogenia showing paleness and excessive mucous. **C.** pale gills with excessive secretion and presence of monogenia attached to the gills.

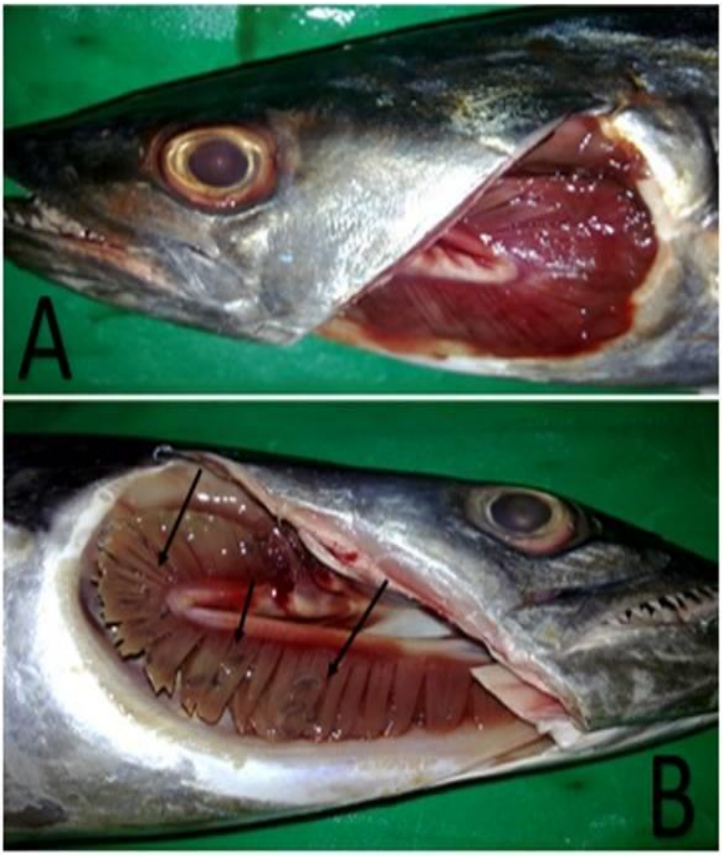

Plate (2). A. gills of *Scoberomorus commerson* infested with monogenia showing congestion and excessive mucous with slight marbling. **B.** The gills of infested fish showing sticking, grayish coloration and heavy attachment of Monogenean parasites.

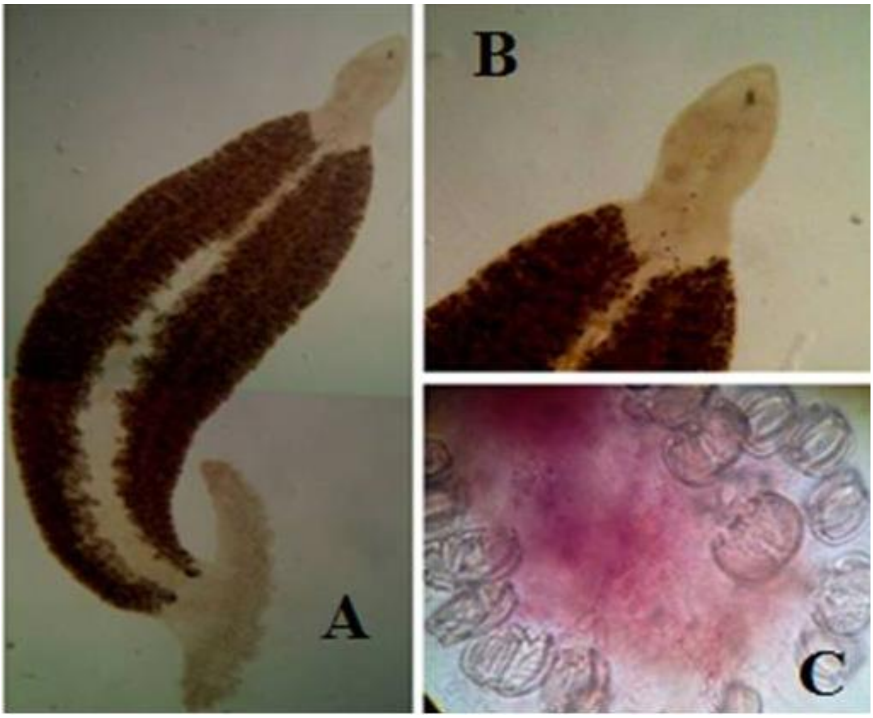

Plate (3). A. whole fluke of *Pricea multae.* **B**. Prohaptor showing two oral suckers and pharynx. **C**. Posterior portion of opisthohaptor showing terminal clamp.

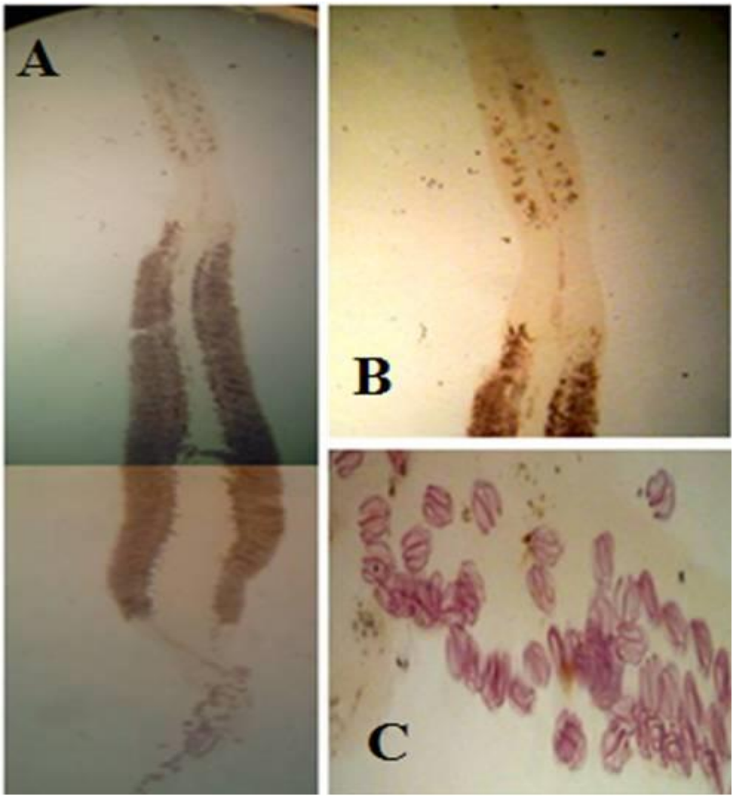

Plate (4). A. whole fluke of *Neothoracocotyle commersoni*. **B.** Prohaptor. **C**. Posterior portion of opisthohaptor showing terminal clamp.

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بعض الدراسات علي علاقة الإصابة بالمونوجينيا و مستويات بعض المعادن الثقيلة فى أسماك الدراك من البحر الأحمر

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**قسم بحوث المياه والتربة - المعمل المركزى لبحوث الثروة السمكية بالعباسة- مركز البحوث الزراعية.*

الملخص العربى

أجريت هذه الدراسة علي 100 سمكه من أسماك الدراك البحري وجمعت عشوائياً من البحر الأحمر في المواسم المختلفة. أسفر الفحص الاكلينكي لبعض الأسماك المصابة تضخم الغشاء الخيشومى والهزال والعوم قرب سطح الماء فى حالة الإصابه بالديدان أحادية العائل. والصفة التشريحية كانت إحتقان مع وجود الظاهرة الرخامية او شحوب فى الخياشيم مع ظهور بعض الديدان احادية العائل ملتصقة بالخياشيم. تم عزل نوعين من المونوجينيا وهى: (بريسيا مالتى و نيوثوراكوكوتيل كومرسونى) وكان متوسط النسبة الكلية للإصابة ٨٠ % بينما سجلت أعلى نسبة إصابة في فصل الصيف (٩٢٪)، بينما النسبة الأقل كانت في فصل الشتاء (٦٨٪).

تم قياس تركيزات كل من الحديد (Fe) والزنك (Zn) والنحاس (Cu)، الكادميوم (Cd) والرصاص (Pb) في عينات المياه والطفيليات المفلطحة وحيدة العائل و(الكبد والخياشيم، والعضلات) من أسماك الدراك المصابة بالمونوجينيا والغير مصابة.

أوضحت نتائج الدراسة ان أعلى تركيز من الحديد والزنك، والنحاس خلال فصل الخريف، الخريف والشتاء على التوالى. بالإضافة إلى ذلك، كان تركيز جميع العناصر أقل من الحدود المسموح بها في الماء. كان تركيز الحديد، الزنك، النحاس في الكبد والخياشيم والعضلات من الأسماك المصابة بالمونوجينيا أقل من تركيزها في أعضاء الأسماك الغير المصابة خلال كل الفصول بينما كانت بقايا الحديد الأعلى في مختلف الأعضاء بين المعادن الأخري. كما سجلت بقايا الكادميوم و الرصاص بالتفصيل فى الأسماك المصابة والغير مصابة بالطفيل. وجد أن أعلى نسبة تركيز من الحديد، الزنك، النحاس في أنسجة الطفيليات المفلطحة وحيدة العائل مقارنة مع الأنسجة الأخرى ولم تسجل أي بقايا من الكادميوم أو الرصاص فى الطفيل.

تخلص الدراسة إلى أن الطفيليات المفلطحة وحيدة العائل قادرة على تراكم المعادن الثقيلة في أنسجتها أعلى من الأنسجة المضيفة ويعتبر كمؤشر لتلوث المعادن الثقيلة إضافة إلى كونه منافسا لأعضاء الأسماك لتراكم المعادن الثقيلة.