

## BIODIVERSITY OF HELMINTH PARASITES OF FISHES IN THE ARABIAN GULF, WITH SPECIAL REFERENCE TO DIGENETIC TREMATODES AND CESTODES

By

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### التنوع البيولوجي للديدان الطفيلية في أسماك الخليج العربي ، خاصة من التريماتودات ثنائية العائل والديدان الشريطية

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يتميز الخليج العربي بفونة غنية من الأسماك حيث يعرف مايزيد عن أربعمائة وخمسين نوعاً من الأسماك الغضروفية والعظمية ، وتتضمن الدراسة الحالية عرضاً تحلياً كاملاً للوضع الراهن لمعرفةنا عن الديدان الطفيلية في أسماك الخليج ، خاصة في ضوء نتائج دراسة حديثة عن تلك الطفيليات في الأسماك التي تم الحصول عليها من المياه القطرية في الخليج .

وقد تبين أنه من بين إحدى وستين نوعاً من الأسماك العظمية تم تسجيل ستة وثلاثين جنساً من التريماتودات ثنائية العائل ، كما تم تسجيل تسعة أجناس من الديدان الشريطية التي تصنف في رتب الديفيلليديا ، التترافيلليديا والليسانيسيفاليديا فضلاً عن سستودات التريبانورينكا وذلك من أربع عشر نوعاً من الأسماك الغضروفية .

وقد سجل الباحثون مدى التنوع في أجناس الديدان الطفيلية ونسب الإصابة بكل منها في أنواع الأسماك المختلفة ، كما تم مناقشة نواحي معينة في علاقات تلك الديدان الطفيلية بعوائلها من الأسماك ، خاصة فيما يتعلق بتحديد نوعية العائل .

*Key Words:* Helminth parasites, Digenetic trematodes and Cestodes, Bony and Cartilaginous Fishes, Arabian Gulf.

#### ABSTRACT

Biodiversity of the fish fauna in the Arabian Gulf is remarkable with more than 450 species known to date in this offshoot from the Indian Ocean. The present status of our knowledge on helminth parasites of fishes in the Arabian Gulf is reviewed in the light of the results of a recent investigation on fishes caught from Qatari waters. Biodiversity of digenetic trematodes and cestodes at the generic level in both bony and cartilaginous fishes of the Arabian Gulf is more remarkable. So far 36 genera of digenetic trematodes have been recorded from 61 species of bony fishes. Infections with one genus of digenetic trematodes are known from 26 species of fish. Infections with two genera of these parasites are reported from 16 species of fish hosts while three genera of digeneans occur in 11 species of fish. Four - ten genera of digenetic trematodes are reported from another 8 species of fish in the Gulf. On the other hand, 14 species of cartilaginous fishes have infections with 9 genera of adult cestodes, distributed throughout the cestode orders Diphyllidea, Tetraphyllidea and Lecanicephallidea, in addition to some unidentified trypanorhynchans. Variations in the prevalence and the generic diversity of digenetic trematodes and cestodes in fishes of the Arabian Gulf are presented together with a discussion on certain aspects of the relationships between these helminths with their respective fish hosts.

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## I- BIODIVERSITY: BASIC CONCEPTS AND PERSPECTIVES

Biological diversity or biodiversity describes the diversity of life on earth. Global biodiversity is usually divided into three fundamental categories:

1. Genetic diversity.
2. Generic and species diversity.
- and 3. Ecosystem diversity.

Amongst these categories, taxonomists are concerned with species diversity. It is usually assessed in terms of the number of species or range of different types of species an area contains. So far about 1.4 million species have been described world wide but estimates of the total number of species far exceeds this number, 10 million being a conservative working estimate [1]. Most of the species are evidently insects and microorganisms, yet this is not reflected in the types of species that have been described to date, particularly in the latter group. There has been a definite bias towards describing larger organisms and those which can be studied without complex procedures or sophisticated equipment as have those which are relatively easier to locate. It is believed that this has led to dramatic under estimate of microorganisms, including particularly bacteria, fungi, protozoa and other small helminths, less than 3-5 percent of them have been described [2].

From the parasitological point of view, the existence of several parasites either as numbers of individuals or as diverse species or genera in a single host has important effects on the host-parasite system. Pavlovski [3] applied the term **Parasitocoenosis** to the entire parasite population of one host. Noble [4] introduced the concept of the **parasite mix** while very recently, Roberts and Janvoy [5] used **parasite species assemblage**, to describe those parasite species infecting a single host. Pavlovski [6] pointed out the existence of certain interrelationships among the individual members of the parasitocoenosis of the same or of different species. These relationships are in some instances antagonistic, with the presence of individuals of some species preventing the occurrence of members of another. However, if the relationships is synergistic one parasite increases the chances of the existence of the other. These inter-relationships between helminth parasites have been studied in several groups of vertebrates e.g. bats [7] and marine as well as freshwater fishes [8,9,10].

## II- BIODIVERSITY OF FISH FAUNA IN THE ARABIAN GULF

The Arabian Gulf is an offshoot from the Indian Ocean with surface area of approximately 226,000 . It is a shallow semi-enclosed area in a highly arid climatic zone [11].

In context of tropical fish distribution, the Arabian Gulf is part of the Indo-Western Pacific region [12]. Biological studies of fishes in the Arabian Gulf have been limited both in scope and extent compared with similar studies that accumulated from the

neighbouring areas, such as the Red Sea and eastern coast of Africa [12,13].

Several publications dealt with biodiversity of fish fauna in the Gulf. Some of these publications dated back to the 1st decade of the present century [14], but the main bulk of information clearly increased around the middle of the century. Blegvad [15] recorded 214 species of fish in 70 families but this study focused on the northern part of the Iranian side. Khalaf [16] and Mahdi [17] recorded 125 species and 103 species, but both included freshwater species. White and Barwani [18] recorded 199 species from the eastern coast and the Gulf of Oman. Kurunuma and Abe [19] recorded in their book **Fishes of Kuwait** a total of 130 species. The report edited by Kurunuma (1974)\* on "Arabian Gulf Fishery - Oceanography Survey" recorded 152 species from the Kuwait coast and off the Qatar-Trucial coast. Undoubtedly, the most comprehensive work published on fishes of the Arabian Gulf is that of Kurunuma and Abe [12] who reported a total of 465 species in 101 families.

## III- PARASITOLOGICAL STUDIES ON FISHES OF THE ARABIAN GULF

Literature of Fish Parasitology in the Arabian Gulf is very recent, only dating back to the last two decades. Two types of investigations were known: the first included basic taxonomic studies, dealing with morphological and anatomical descriptions of certain taxa of parasites in some fish hosts, while the second group included wider range surveys which varied considerably in their scope as well as their extent. It is noteworthy to mention that these investigations included helminthological studies while studies on other animal parasites, namely Protozoa and Crustacea are almost lacking.

Over the last two decades, the results of several studies contributed to a better understanding of the parasites in fishes of the Gulf. Amongst helminth parasites, only two major groups of helminths have received some attention, namely digenetic trematodes [9,20,21,22,23, 24,25,26,27] and cestodes [27,28,29,30,31]. On the other hand, the three other groups of helminths, namely monogenetic trematodes, nematodes and acanthocephalans received much less attention and the results of few studies were published; viz monogenetic trematodes [32,33, 40], larval nematodes [27, 41] and acanthocephala [9, 34].

## IV- DIGENETIC TREMATODES IN FISHES OF THE ARABIAN GULF

About 100 species of fish have been surveyed for digenetic trematodes (Al Yamany and Nahhas [20] in Kuwait, Saoud *et al.* [9] in Qatar and El Naffar *et al.* [27] in the U.A.E). Although the species of fish surveyed represent a small proportion of the total number of species known from the Arabian Gulf, yet it is believed that these surveys covered most of the common species, particularly those of economic importance.

\* Cited in Kurunuma and Abe [12].

Recently, our work in Qatar on the digenetic trematodes of fishes from the Arabian Gulf was extended with two objectives, namely: 1- to cover other species of fish which were not examined in our previous survey and 2- to examine some more specimens from certain species of fish which was examined before. The new data thus obtained was added to those available from other published studies and presented in Tables 1-6. It is evident that the generic diversity of digenetic trematodes\* found in fishes of the Arabian Gulf is remarkable, with numerous genera of these parasites being recorded in these fishes. Twenty six species of fish had trematodes belonging to one genus (Table 1), others had infections with two - ten genera of digenetic trematodes being recorded in each of the fish species investigated (Tables 2-6). It is worth mentioning that the maximum number of digenetic trematode genera observed in the fish *Epinephelus tauvina* (10 genera) is still lower than that recorded by Saoud and Ramadan [8] who reported 14 genera of digenetic trematodes from *Anampses caeruleopunctatus* in the Red Sea.

It is emphasized that the figures related to the prevalence of digenetic trematodes in fish should be interpreted cautiously, in particular where very few fish were available for examination. However, significant results are available in the case of the more common species of fish from which fairly good numbers have been examined.

#### V- CESTODES OF ELASMOBRANCHS IN THE ARABIAN GULF

A careful search of literature indicates that few studies have been published on cestode parasites of fishes in the Gulf. These include:

- a. Mirzyans [36], a limited study on larval cestodes observed in a fish market in Iran.
- b. Khalil and Abu Hakima [28] and Khalil and Abdul Salam [29]; both were taxonomic studies on cestodes in fishes from the Arabian Gulf.
- c. El Naffar *et al.*, [27]; a survey that recorded several larval cestodes and one species of adult cestodes from fishes of the Gulf.
- d. Al Kawari, Saoud and Wanas [31]; on a species of cestodes from fishes of the Gulf.

During the present work, some elasmobranchs caught from Qatari waters have been surveyed for cestodes to fill in important gaps in our knowledge of cestodes of fishes in the Gulf. Attention has been given to elasmobranchs which are known to be hosts of unique orders of the Class Cestoda, namely Diphyllidea, Tetraphyllidea, Trypanorhyncha and Lecaniccephalidea [37].

Parasitological studies on elasmobranchs are usually met with certain limitations which make the numbers of fish in these studies much less than those of bony fishes. These limitations include:

- a. Most of these fishes live away from the normal commercial fishing activities.
- b. The effort and time consumed in examining relatively larger adult specimens of these fish.

Altogether 14 species of elasmobranchs were investigated. Nine genera of adult cestodes belonging to five families were recorded (Tables 7,8). In addition, trypanorhynch cestodes were also recorded.

#### 1- Diversity of Cestode Genera in Infected Fish

Except for trypanorhynch cestodes, the worms collected were identified to the generic level using Schmidt [87] and Euzet [38].

One genus of cestodes was found in certain species of elasmobranchs while 2-5 genera of cestodes were reported in the other species as follows:

- a. **Fish Infected with One Genus of Cestodes:** *Dasyatis imbricatus*, *Aetobatus narinari*, and *Rhinoptera adpersa*.
- b. **Fish Infected with Two Genera of Cestodes:** *Galeocerdo cuvieri* and *Himantura uarnak*.
- c. **Fish Infected with Three Genera of Cestodes:** *Rhinobatos granulatus*, *Aetomylaeus nichofii*, *Carcharhinus seali*, *Carcharhinus parasorah* and *Gymnura poecilura*.
- d. **Fish Infected with Four Genera of Cestodes:** *Rhynchobatos djiddensis*, *Chiloscyllium griseum*, and *Carcharhinus brevipinna*.
- e. **Fish Infected with Five Genera of Cestodes:** *Dasyatis pastinica*.

#### 2- HOST SPECIFICITY

At the generic level *Thysanocephalum*, *Yorkeria* and *Eniochobothrium* showed marked fish host specificity; *Thysanocephalum* occurs exclusively in *Galeocerdo cuvieri*, *Yorkeria* is reported from *Chiloscyllium griseum* while *Eniochobothrium* is only present in *Rhinoptera adpersa*.

\* Identification of digenetic trematodes is based mainly on Yamaguti [35].

**Table 1**  
Fishes infected with one genus of digenetic trematodes

Fishes	Number Examined	Genera	Infections	
			No.	Prevalence %
<b>CLASS OSTEICHTHYES</b>				
<b>1. ORDER ATHERINIFORMES</b>				
Family Belonidae				
<i>Ablennes hians</i>	11	<i>Bucephalopsis</i>	1	9.1
<i>Strongylura leiura</i>	5	<i>Bucephalopsis</i>	2	40
<b>2. ORDER PERCIFORMES</b>				
Family Serranidae				
<i>Cephalopholis miniata</i>	5	<i>Ectenurus</i>	1	20
Family Sillagindae				
<i>Sillago sihama</i>	2	<i>Lepidapedon</i>	1	50
Family Carangidae				
<i>Caranx sem</i>	30	<i>Prosorchis</i>	1	3.3
<i>Caranx leptolepis</i>	20	<i>Derogenes</i>	5	25
<i>Trachinotus blochii</i>	6	<i>Prosorchis</i>	4	66.7
Family Formionidae				
<i>Formio niger</i>	60	<i>Lecithocladium</i>	1	1.6
Family Lutjanidae				
<i>Lutjanus kasmira</i>	30	<i>Paracryptogonimus</i>	14	46.6
<i>Lutjanus lineolatus</i>	24	<i>Ectenurus</i>	12	50
<i>Lutjanus johni</i>	25	<i>Centrovarium</i>	8	32
Family Nemipteridae				
<i>Nemipterus delagoae</i>	11	<i>Ectenurus</i>	1	9.1
Family Pomadasyidae				
<i>Plectorhinchus schotaf</i>	2	<i>Proenentrum</i>	1	50
Family Sparidae				
<i>Sparus sarba</i>	11	<i>Lecithochirium</i>	1	9.1
Family Sciaenidae				
<i>Otolithes ruber</i>	10	<i>Pleorchis</i>	1	10
<i>Johnius aneus</i>	2	<i>Lecithocladium</i>	1	50
Family Mullidae				
<i>Parupeneus pleurotaenia</i>	46	<i>Proenentrum</i>	2	4.3
Family Sphyraenidae				
<i>Sphyraena obtusata</i>	3	<i>Bucephalus</i>	1	33.3
Family Polynemidae				
<i>Eleutheronema tetradactylum</i>	2	<i>Clupenuroides</i>	2	100
Family Scaridae				
<i>Scarus ghobban</i>	86	<i>Rhagorchis</i>	41	47.6
Family Scombridae				
<i>Euthynnus affinis</i>	45	<i>Lecithochirium</i>	11	24.4
<b>3. ORDER PLEURONECTIFORMES</b>				
Family Psettodidae				
<i>Psettodes erumei</i>	45	<i>Stephanostomum</i>	2	4.4
Family Bothidae				
<i>Pseudorhombus arsius</i>	1	<i>Ectenurus</i>	1	100
<b>4. ORDER TETRAODONTIFORMES</b>				
Family Triacanthidae				
<i>Pseudotriacanthus strigilifer</i>	9	<i>Stephanostomum</i>	6	66.7
Family Tetraodontidae				
<i>Chelodan patoca</i>	2	<i>Schistorchis</i>	1	50
<i>Arothron stellatus</i>	4	<i>Schistorchis</i>	3	75

**Table 2**  
Fishes infected with one genus of digenetic trematodes

Fishes	Number Examined	Genera	Infections	
			No.	Prevalence %
<b>CLASS OSTEICHTHYES</b>				
<b>1. ORDER CLUPEIFORMES</b>				
Family Chirocentridae				
<i>Chirocentrus dorab</i>	3	<i>Triganodistomum</i>	3	100
		<i>Stephanostomum</i>	1	33.3
<b>2. ORDER SCORPAENIFORMES</b>				
Family Platycephalidae				
<i>Platycephalus maculipinna</i>	4	<i>Ectenurus</i>	3	75
		<i>Helicometrina</i>	3	75
<b>3. ORDER PERCIFORMES</b>				
Family Carangidae				
<i>Scomberoides commersonianus</i>	63	<i>Ectenurus</i>	24	38.1
		<i>Bucephalopsis</i>	7	11.1
<i>Caranx speciosus</i>	47	<i>Monorcheides</i>	19	40.7
		<i>Bucephalopsis</i>	7	14.8
<i>Caranx malabaricus</i>	48	<i>Bucephalopsis</i>	7	14.5
		<i>Lecithocladium</i>	1	2.1
<i>Seriola dumerili</i>	10	<i>Ectenurus</i>	9	90
		<i>Bucephalopsis</i>	8	80
Family Nemipteridae				
<i>Nemipterus japonicus</i>	112	<i>Ectenurus</i>	12	10.7
		<i>Plagioporus</i>	1	0.9
Family Pomadysidae				
<i>Plectorhinchus pictus</i>	9	<i>Lepidapedon</i>	5	55.5
		<i>Paraproctotrema</i>	4	44.4
<i>Plectorhinchus gaterinus</i>	6	<i>Lepidapedon</i>	4	66.7
		<i>Bucephalopsis</i>	1	16.7
Family Sparidae				
<i>Acanthopagurus bifasciatus</i>	102	<i>Derogenes</i>	9	8.8
		<i>Plagioporus</i>	2	1.96
<i>Argyrops spinifer</i>	77	<i>Metadena</i>	8	10.3
		<i>Proenentrum</i>	2	2.5
Family Mullidae				
<i>Parupeneus cyclostomus</i>	55	<i>Pseudopecoelina</i>	1	1.8
		<i>Stephanostomum</i>	1	1.8
Family Mugilidae				
<i>Valamugil seheli</i>	26	<i>Proctotrema</i>	6	23
		<i>Opisthadena</i>	1	3.8
Family Sphyraenidae				
<i>Sphyraena jello</i>	39	<i>Bucephalopsis</i>	16	41
		<i>Lecithochirium</i>	1	2.6
Family Siganidae				
<i>Siganus javus</i>	50	<i>Prosorchiopsis</i>	25	50
		<i>Prosogonotrema</i>	7	14
<i>Siganus canaliculatus</i>	51	<i>Hexangium</i>	9	17.6
		<i>Hysterolecitha</i>	8	15.6

**Table 3**  
Fishes infected with three genera of digenetic trematodes

Fishes	Number Examined	Genera	Infections	
			No.	Prevalence %
<b>CLASS OSTEICHTHYES</b>				
<b>1. ORDER SCORPAENIFORMES</b>				
Family Platycephalidae				
<i>Platycephalus indicus</i>	20	<i>Ectenurus</i>	14	70
		<i>Helicometrina</i>	8	40
		<i>Proenentrum</i>	1	6.2
<b>2. ORDER PERCIFORMES</b>				
Family Serranidae				
<i>Cephalopholis rogae</i>	13	<i>Lepidapedon</i>	5	38.4
		<i>Metadena</i>	2	15.3
		<i>Proctotrema</i>	1	7.6
Family Carangidae				
<i>Decapturus kiliche</i>	6	<i>Lecithochirium</i>	4	66.7
		<i>Bucephalopsis</i>	1	16.7
		<i>Lepidapedon</i>	1	16.7
<i>Caranx (Atule) mate</i>	10	<i>Lecithochirium</i>	5	50
		<i>Proctotrema</i>	5	50
		<i>Bucephalopsis</i>	2	20
Family Lutjanidae				
<i>Lutjanus coccineus</i>	20	<i>Prosogonotrema</i>	6	30
		<i>Pseudocreadium</i>	1	5
		<i>Stephanostomum</i>	1	5
<i>Lutjanus malabaricus</i>	40	<i>Hamacreadium</i>	4	10
		<i>Plagioporus</i>	2	5
		<i>Allacanthochasmus</i>	2	5
Family Nemipteridae				
<i>Nemipterus tolu</i>	42	<i>Lecithochirium</i>	2	4.7
		<i>Helicometrina</i>	2	4.7
		<i>Plagioporus</i>	1	2.3
Family Gerreidae				
<i>Gerres oyena</i>	74	<i>Proenentrum</i>	8	10.8
		<i>Bucephalopsis</i>	3	4.1
		<i>Lepidapedon</i>	2	2.7
Family Pomadysidae				
<i>Plectorhynchus sordidus</i>	18	<i>Lepidapedon</i>	8	44.4
		<i>Hysterorchis</i>	7	38.8
		<i>Bucephalopsis</i>	1	5.5
Family Mugilidae				
<i>Liza macrolepis</i>	36	<i>Proctotrema</i>	12	33.3
		<i>Monorcheides</i>	12	33.3
		<i>Derogenes</i>	2	5.5
Family Scombridae				
<i>Rastrelliger kanagurta</i>	31	<i>Bucephalopsis</i>	7	22.5
		<i>Proctotrema</i>	2	6.4
		<i>Lecithocladium</i>	2	6.4

**Table 4**  
Fishes infected with four genera of digenetic trematodes

Fishes	Number Examined	Genera	Infections	
			No.	Prevalence %
CLASS OSTEICHTHYES				
1. ORDER PERCIFORMES				
Family Serranidae				
<i>Epinephelus summana</i>	8	<i>Hamacreadium</i>	8	100
		<i>Ectenurus</i>	8	100
		<i>Helicometrina</i>	4	50
		<i>Podocotyle</i>	4	50
Family Lethrinidae				
<i>Lethrinus lentjan</i>	64	<i>Pseudoplagioporus</i>	9	14.1
		<i>Hamacreadium</i>	7	10.9
		<i>Plagioporus</i>	7	10.9
		<i>Hairana</i>	5	7.8

**Table 5**  
Fishes infected with five-six genera of digenetic trematodes

Fishes	Number Examined	Genera	Infections	
			No.	Prevalence %
CLASS OSTEICHTHYES				
ORDER PERCIFORMES				
Family Serranidae				
<i>Epinephelus areolatus</i>	109	<i>Ectenurus</i>	17	15.5
		<i>Hamacreadium</i>	15	13.7
		<i>Prosorhynchus</i>	14	12.8
		<i>Bucephalus</i>	5	5.5
		<i>Stephanostomum</i>	1	0.9
<i>Epinephelus chlorostigma</i>	49	<i>Prosorhynchus</i>	20	40.8
		<i>Hamacreadium</i>	5	10.2
		<i>Stephanostomum</i>	2	4.1
		<i>Rhibidocotyle</i>	2	4.1
		<i>Ectenurus</i>	1	2.0
		<i>Plagioporus</i>	1	2.0
Family Lethrinidae				
<i>Lethrinus nebulosus</i>	88	<i>Hamacreadium</i>	21	23.8
		<i>Plagioporus</i>	15	17.0
		<i>Pseudoplagioporus</i>	8	9.1
		<i>Ectenurus</i>	7	7.9
		<i>Stephanostomum</i>	4	4.5
<i>Lethrinus fulviflamma</i>	49	<i>Helicometrina</i>	1	1.1
		<i>Allacanthochasmus</i>	15	30.6
		<i>Metadena</i>	12	24.4
		<i>Proenentrum</i>	5	10.2
		<i>Ectenurus</i>	4	8.1
		<i>Hamacreadium</i>	4	8.1
	<i>Macradena</i>	1	2.0	

**Table 6**  
Fishes infected with eight-ten genera of digenetic trematodes

Fishes	Number Examined	Genera	Infections	
			No.	Prevalence %
CLASS OSTEICHTHYES				
ORDER PERCIFORMES				
Family Serranidae				
<i>Epinephelus tauvina</i>	61	<i>Ectenurus</i>	24	39.3
		<i>Hamacreadium</i>	17	27.8
		<i>Podocotyle</i>	10	16.3
		<i>Bucephalopsis</i>	9	14.7
		<i>Stephanostomum</i>	5	8.1
		<i>Monorcheides</i>	5	8.1
		<i>Lecithochirium</i>	5	8.1
		<i>Helicometrina</i>	3	4.9
		<i>Plagioporus</i>	3	4.9
		<i>Rhibidocotyle</i>	2	3.2
Family Lutjanidae				
<i>Lutjanus russelli</i>	13	<i>Hamacreadium</i>	5	38.4
		<i>Proctotrema</i>	4	30.7
		<i>Proenentrum</i>	3	23.1
		<i>Ectenurus</i>	2	15.3
		<i>Lecithochirium</i>	1	7.6
		<i>Monorcheides</i>	1	7.6
		<i>Allacanthochasmus</i>	1	7.6
		<i>Metadena</i>	1	7.6

The other seven genera occurred in other fish species either in single genus genera or in different combinations of simultaneous double or triple infections.

Infections in *Chiloscylium griseum* clearly show various combinations of cestode infections. Altogether 37 specimens of this fish have been examined, out of which 32 are positive for cestode infections. These positive cases have cestode infections shown in Tables (9,10). The following remarks are noted:

- The overall prevalence of simultaneous infections with two genera of cestodes is the highest (37.8%) followed by single genus infections (27.0%) followed by concurrent infections with three genera of cestodes (21.6%).
- If the cestode genera are arranged in the order of their frequency in *Chiloscylium griseum* the following pattern is observed:  
*Anthobothrium* > Trypanorhynchan cestode > *Yorckeria* > *Phyllobothrium*
- In the cestode genus *Anthobothrium*, the highest worm load per fish is observed in pure infections with this cestode (69.0) while the lowest load (6.75) is observed in concurrent triple infections.

- In the trypanorhynchan cestodes, the worm loads per fish are much lower than those of *Anthobothrium*, ranging from 4.6 - 10 worms per fish with the highest worm load observed in double infections with *Phyllobothrium* and the lowest in triple infections with both *Anthobothrium* and *Yorckeria*.
- In the genus *Yorckeria*, the worm loads per fish are also much lower than those of *Anthobothrium*, ranging from 5.5 in simultaneous double infections with the trypanorhynchan cestode to 11.7 in double infections with *Anthobothrium*.
- The cestode genus *Phyllobothrium* is reported in one specimen of fish where it occurred in a double infection with a trypanorhynchan cestode, the worm load per fish being 3 only.

### 3- INTENSITY OF INFECTION

The mean number of worms per fish varied from 20 to 312.5 in two of the genera with observed marked host specificity viz *Thysanocephalum* and *Eniochobothrium*. For other genera of cestodes, this figure varied from 1-69. These numbers are certainly higher than those reported by Saoud and Hassan [39] in elasmobranchs from the Mediterranean and the Red Sea where means varying from 5 - 9.15 cestodes per fish are reported.

**Table 7**  
Prevalence of adult cestode infections in elasmobranchs caught from Qatari waters in the Arabian Gulf

HOSTS	Number Examined	Infected		Cestode Infections	No.	Prevalence %
		No.	%			
<b>CLASS CHONDRICHTHYES</b>						
<b>1. Family Rhynchoatidae</b>						
<i>Rhynchobatus djiddensis</i>	10	8	80	<i>Anthobothrium</i>	4	40
				<i>Rhinebothrium</i>	3	30
				<i>Lecanicephalum</i>	1	10
				Trypanorhynchan cestode	6	60
<b>2. Family Rhinobatidae</b>						
<i>Rhinobatos granulatus</i>	11	8	72.7	<i>Anthobothrium</i>	6	54.6
				<i>Echinobothrium</i>	2	18.2
				Trypanorhynchan cestode	7	63.6
<b>3. Family Dasyatididae</b>						
<i>Himantura uarnak</i>	7	3	42.9	<i>Anthobothrium</i>	2	28.6
				Trypanorhynchan cestode	3	42.9
<i>Dasyatis imbricatus</i>	2	2	100	<i>Uncibilocularis</i>	2	100
<i>Dasyatis pastinica</i>	15	14	93.3	<i>Anthobothrium</i>	11	73.3
				<i>Rhinebothrium</i>	1	6.7
				<i>Unibilocularis</i>	2	13.3
				<i>Lecanicephalum</i>	1	6.7
				Trypanorhynchan cestode	9	60.0
<b>4. Family Gymmuridae</b>						
<i>Gymnura poecilura</i>	7	5	71.4	<i>Echinobothrium</i>	1	14.2
				<i>Lecanicephalum</i>	3	42.9
				Unidentified cestode	2	28.6
<b>5. Family Myliobatididae</b>						
<i>Aetobatus marinari</i>	3	3	100	<i>Lecanicephalum</i>	3	100
<i>Aetomylaeus nichofii</i>	4	3	75	<i>Uncibilocularis</i>	3	75
				<i>Echinobothrium</i>	1	25
				<i>Lecanicephalum</i>	1	25
<i>Rhinoptera adspersa</i>	4	4	100	<i>Eniochobothrium</i>	4	100
<b>6. Family Orectolobidae</b>						
<i>Chiloscyllium griseum</i>	37	33	89.2	<i>Anthobothrium</i>	26	70.3
				<i>Phyllobothrium</i>	1	2.7
				<i>Yorkeria</i>	16	43.2
				Trypanorhynchan cestode	17	43.2
<b>7. Family Carcharhinidae</b>						
<i>Carcharhinus brevipinna</i>	17	15	88.2	<i>Anthobothrium</i>	15	88.2
				<i>Phyllobothrium</i>	1	5.9
				<i>Echinobothrium</i>	1	5.9
				Trypanorhynchan cestode	3	17.6
<i>Carcharhinus seali</i>	4	4	100	<i>Anthobothrium</i>	3	75
				Trypanorhynchan cestode	1	25
<i>Carcharhinus parasorah</i>	18	10	55.6	<i>Anthobothrium</i>	9	50
				Trypanorhynchan cestode	3	16.7
<i>Galoecerdo cuvieri</i>	5	2	40	<i>Rhinebothrium</i>	1	20
				<i>Thysanocephalum</i>	1	20

**Table 8**  
Diversity of cestodes in elasmobranchs caught from Qatari waters in the Arabian Gulf

CESTODES	ELASMOBRANCHS	Prevalence %	Mean No. Worms/Fish
<b>I ORDER DIPHYLLIDEA</b>			
<b>FAMILY ECHINOBOUHRIDAE</b>			
GENUS <i>Echinobothrium</i> van Beneden, 1849	<i>Rhinobatos granulatus</i>	18.2	27.5
	<i>Aetomyloeus nichofii</i>	25.0	10.0
	<i>Carcharhinus brevipinna</i>	5.9	10.0
	<i>Gymnura poecilura</i>	14.2	5.0
<b>II ORDER TETRAPHYLLIDEA</b>			
<b>1. FAMILY PHYLLOBOUHRIDAE</b>			
<b>a. SUBFAMILY THYSANOCEPHALINAE</b>			
GENUS <i>Thysanocephalum</i> Euzet, 1953	<i>Galocercdo cuvieri</i>	20.0	15.0
<b>b. SUBFAMILY PHYLLOBOUHRINAE</b>			
GENUS <i>Anthobothrium</i> van Beneden, 1850	<i>Rhynchobatus djiddensis</i>	40.0	16.5
	<i>Rhinobatos granulatus</i>	54.6	13.7
	<i>Himantura uarnak</i>	28.6	15.5
	<i>Dasyatis pastinica</i>	73.3	16.3
	<i>Chiloscyllium griseum</i>	70.3	26.0
	<i>Carcharhinus brevipinna</i>	88.2	22.8
	<i>Carcharhinus seali</i>	75.0	33
	<i>Carcharhinus parasorah</i>	50.0	11.7
GENUS <i>Phyllobothrium</i> van Beneden, 1850	<i>Chiloscyllium griseum</i>	2.7	3
	<i>Carcharhinus brevipinna</i>	5.9	30
<b>c. SUBFAMILY RHINEBOUHRINAE</b>			
GENUS <i>Rhinebothrium</i> Linton, 1890	<i>Rhynchobatus djiddensis</i>	30.0	13.3
	<i>Dasyatis pastinica</i>	6.7	20.0
	<i>Galocercdo cuvieri</i>	20.0	1
<b>2. FAMILY ONCHOBOUHRIDAE</b>			
GENUS <i>Uncibilocularis</i> Southwell, 1925	<i>Dasyatis imbricatus</i>	100	1.5
	<i>Dasyatis pastinica</i>	13.3	14.0
	<i>Aetomylaeus nichofii</i>	75.0	5.0
GENUS <i>Yorkeria</i> Southwell, 1927	<i>Chiloscyllium griseum</i>	43.2	8.2
<b>III ORDER LECANICEPHALIDEA</b>			
<b>1. FAMILY LECANICEPHALIDAE</b>			
GENUS <i>Lecanicephalum</i> Linton, 1890	<i>Rhynchobatis djiddensis</i>	10.0	13.0
	<i>Dasyatis pastinica</i>	6.7	16.0
	<i>Gymnura poecilura</i>	42.9	15.7
	<i>Aetomyloeus nichofii</i>	25.0	20.0
<b>2. FAMILY LITOBOTHRIIDAE</b>			
GENUS <i>Eniochobothrium</i> Shiple and Hornell, 1906	<i>Rhinoptera adspersa</i>	100	312.5

**Table 9**  
Cestode infections in *Chiloscylium griseum*

Infections	Number	Prevalence %	Worms per Fish	
			Range	Mean
1. ONE GENUS (10)				
a. <i>Anthobothrium</i>	7	18.9	10-200	69.0
b. Trypanorhynchan cestode	3	8.1	3-10	5.7
2. TWO GENERA (14)				
a. <i>Anthobothrium</i> + <i>Yorkeria</i>	6	16.2	2-40 1-35	17.5 11.7
b. <i>Anthobothrium</i> + Trypanorhynchan cestode	5	13.5	3-12 3-8	7.4 5.0
c. <i>Yorkeria</i> + Trypanorhynchan cestode	2	5.4	7-10 5-6	8.5 5.5
d. <i>Phyllobothrium</i> + Trypanorhynchan cestode	1	2.7	3 10	3 10
3. THREE GENERA				
<i>Anthobothrium</i> + <i>Yorkeria</i> + Trypanorhynchan cestode	8	21.6	2-10 1-20 2-15	6.75 6.1 4.6

**Table 10**  
The frequency of cestode genera in *Chiloscylium griseum*

Cestodes	Frequency
<i>Anthobothrium</i>	26
Trypanorhynchan cestode	17
<i>Yorkeria</i>	16
<i>Phyllobothrium</i>	1

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