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Trypanorhynch Cestodes from the Musculature of Commercial Fishes from the Arabian Gulf

Abstract: The present communication summarizes information on the occurrence of trypanorhynch cestodes in the flesh of marine fish that were imported to Saudi Arabia from different countries along the Arabian Gulf. The fish were collected from the wholesale market of Qatuf, Eastern Province of Saudi Arabia. A total of 867 fish specimens belonging to 42 species and 27 families were examined between June 1998 and March 2000. Six fish species harboured trypanorhynch cestodes in the muscles, *Johinus maculatus* (48.2% prevalence of infestation), *Psettodes erumei* (31.8%), *Epinephelus chlorostigma* (15.2 %), *Epinephelus tauvina* (14.8%), *Cephalopholis hemistiktos* (8.7%), and *Lethrinus nebulosus* (3.5 %). The following 4 trypanorhynch species were identified: *Callitetrarhynchus speciosus*, *Dasyrhynchus thomasi*, *Pintneriella musculicola*, and *Poecilancistrum caryophyllum*. The most abundant parasite species was *Pintneriella musculicola*, which was found in 3 different host fish species. *Dasyrhynchus thomasi* and *Poecilancistrum caryophyllum* occurred in a single host fish species only. *Psettodes erumei* had the highest intensity (maximal 45 plerocercoids per fish) of infestation. *Dasyrhynchus thomasi*, *Pintneriella musculicola* and *Poecilancistrum caryophyllum* represent first locality records for these trypanorhynchs in the studied area, which is now known to harbour 18 different trypanorhynch species. It was observed that the infestation rate increased with fish length, since larger fish either might have a greater opportunity of getting infected or simply accumulate the worms. Histopathological alterations induced by these parasites in the fish flesh were also detected, demonstrating a negative impact of the parasites on the infested fish.

Keywords: Arabian Gulf, commercial fish, musculature, parasites, *Callitetrarhynchus speciosus*, *Dasyrhynchus thomasi*, *Pintneriella musculicola*, *Poecilancistrum caryophyllum*, Trypanorhyncha.

برقات ديدان الترايبانورينكا الشريطية التي تصيب عضلات الأسماك
بالخليج العربي
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المستخلص: تلخص هذه الدراسة معلومات عن مدى تواجد يرقات ديدان الترايبانورينكا الشريطية في لحوم الأسماك البحرية المستوردة إلى المملكة العربية السعودية من الأسواق المختلفة في الخليج العربي. تم جمع عينات هذه الأسماك من سوق الجملة بالقطيف بالمنطقة الشرقية من المملكة العربية السعودية، 867 عينة منها تنتمي إلى 42 فصيلة و 27 عائلة، تم فحصها خلال الفترة من يونيو 1998 إلى مارس 2000. 6 أنواع فقط من عينات الأسماك كانت تأوي يرقات ديدان الترايبانورينكا الشريطية باللحم الخاص بها. أعلى نسبة إصابة وجدت بأسمك شمهي *maculatus* *Johinus* (48.2%) تبعها بعد ذلك أسماك كل من الخوفع *erumei* *Psettodes* (31%)، السممان *Epinephelus chlorostigma* (15.2%)، الهامور *Epinephelus tauvina* (14.8%)، السنور *Cephalopholis hemistiktos* (8.7%) ثم الشعري *Lethrinus nebulosus* (3.5%) وتم التعرف على أربعة أنواع من يرقات ديدان الترايبانورينكا وهي: كاليتيتراينكس سبكويز، ديزيرينكس ثوماسي، بنتينيريل مسكوليكولا و بوسيلانزسترم كاريوفيلم. وكانت يرقات دودة بنتينيريل مسكوليكولا أكثر الطفيليات وجوداً، حيث وجدت في 3 أنواع مختلفة من الأسماك. أما أنواع كل من ديزيرينكس ثوماسي و بوسيلانزسترم كاريوفيلم فوجدت في عائلة واحدة فقط من الأسماك. أعلى شدة إصابة وجدت بأسمك الخوفع (45 يرة بالسمة الواحدة). مع ملاحظة أن درجة الإصابة تزداد مع زيادة طول السمكة، تم تحديد التغيرات الباثولوجية والتأثير السلبي لهذه الطفيليات بأنسجة الأسماك المصابة. هذا وتمثل الخليج العربي مأوى لثمانية عشر نوعاً من الأنواع المختلفة ليرقات ديدان الترايبانورينكا.

كلمات مدخلية: الخليج العربي، الثروة السمكية، يرقات، ديدان الترايبانورينكا، إصابة عضلات.

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Introduction

Trypanorhynch cestodes mature in elasmobranchs and often use teleost fish as second intermediate hosts. Trypanorhyncha that inhabit the flesh of marine fish have been reported from nearly all parts of the world by various authors (Dollfus, 1942; Subhadrappa, 1955; Szuks, *et al.* 1975; Seyda, 1976; Overstreet, 1977; 1978; Reimer, 1984; Collins, *et al.* 1984; Sakanari & Moser, 1986; Palm, 1997a; Palm, *et al.* 1993; 1994; Palm & Overstreet, 2000a). Their infestation of the fish musculature can reduce the market value of the affected fish. Heavy infestation with plerocercoids of *Gymnorhynchus thyrstitae* has seriously affected the exploitation of the highly valued barracouta (*Thyrstites atun*) in New Zealand (Mehl, 1970), and infestation with plerocercoids of *Nybelinia surmenicola* was the reason that Alaska Pollack (*Theragra chalcogramma*) had been considered as not acceptable for human consumption (Grabda, 1977). Together with a lower fat content, the high intensity of muscle inhabiting *Otobothrium cysticum* in stomateid fish of the Gulf of Mexico has generated a lower market acceptability and price for these stocks than for their Atlantic counterparts (Palm & Overstreet, 2000a).

Information on trypanorhynch cestode infestation along the coasts of the Arabian Gulf is limited. Plerocercoids of *Floriceps* sp. were isolated from several different fish species at the coast of the United Arab Emirates (Kardousha, 1991; El Naffar, *et al.* 1992; Al-Ghais & Kardousha, 1994). Recently, Kardousha (1999) reported 14 different trypanorhynch species from Arabian Gulf fishes, with *Pseudogrillotia spratti* and *Pterobothrium heteracanthum* also infesting the fish musculature. His study showed a high species diversity for trypanorhynch cestodes in the Arabian Gulf, as has been also described from other localities such as the Gulf of Mexico (Palm & Overstreet, 2000b).

The present study was carried out to identify cestode parasites which infest the musculature of imported marine fish at the Eastern province of Saudi Arabia. Besides giving prevalence and intensity of infestation, a seasonal variation in the occurrence of the detected trypanorhynch species is also reported. The parasite infestation depending on the host size is analysed, and histo-pathological alterations of the fish muscle due to parasitic infestation has also been observed.

Material and Methods

During a routine fish health survey of imported fish, 867 fresh or chilled specimens belonging to 42 species and 27 families were sampled directly from vehicles carrying imported fish from neighbouring countries: Bahrain, Oman, Qatar, and United Arab Emirates. The fish were purchased at the Qatef wholesale market, Eastern Province of Saudi Arabia, between June 1998 and March 2000. The specimens were placed in bags with ice and transported to the laboratory of the Fisheries Research Center, Al-Qatef.

In the laboratory, all fishes were measured to the nearest cm total length. They were then sorted into different length classes and the weight was recorded to the nearest g. The fish were filleted and skinned, thick fillets being sliced lengthwise. Fillets or slices were pressed between two glass plates of 20x30 cm in size and placed on a candling table over a fluorescent light source. Flesh parasites were easily discernible against the white muscle background. Parasites were removed from the flesh and their blastocyst, counted, relaxed in fresh water or saline solution, flattened, fixed in alcohol and stored in a mixture of 70% ethanol and 5% glycerol.

Specimens were stained in acetic-carmin, dehydrated, and mounted in Canada balsam. Some specimens were embedded in paraffin wax, cut to a thickness of 5-7 μm , and stained with haematoxylin and eosin (Hibiya, 1992). The species were identified following Campbell & Beveridge, 1994; 2000; Carvajal & Rego, 1985; Dollfus, 1942; Palm, 2000; and Yamaguti, 1934.

Results

1. Detected Trypanorhyncha (Diesing, 1863)

The present study yielded 4 trypanorhynch species, namely, *Callitetrarhynchus speciosus* (Linton, 1897), *Dasyrhynchus thomasi* (Palm, 2000), *Pintneriella musculicola* (Yamaguti, 1934), and *Poecilancistrum caryophyllum* (Diesing, 1850) (Table 1). Of the 42 studied fish species, only 6 were found infested within their musculature. *D. thomasi* and *P. caryophyllum* occurred in a single host fish species only, while *P. musculicola* was found in 3 and *C. speciosus* in 2 different host fish species (Table 1).

Table 1: Occurrence of Trypanorhynch cestodes in the musculature of fish species from the Arabian Gulf

Species	Length (cm)	No. examined	%	Cestode species
<i>Acanthopagrus berda</i>	34 - 35	2		n.i
<i>Acanthopagrus bifasciatus</i>	27 - 30	6		n.i
<i>Aphoreus rutilanus</i>	25	1		n.i
<i>Arius thalassinus</i>	50	1		n.i
<i>Caesio sp.</i>	32.5 - 36	5		n.i
<i>Cephalopholis hemistiktos</i>	19 - 40	23	8.7	<i>C.speciosus</i>
<i>Cheimereus nufar</i>	28.5 - 39.5	30		n.i
<i>Dussumieria acuta</i>	17.5 - 19.5	25		n.i
<i>Epinephelus areolatus</i>	25.5 - 56.5	38		n.i
<i>Epinephelus chlorostigma</i>	34.5 - 88	138	15.2	<i>P.musculicola</i>
<i>Epinephelus tauvina</i>	28 - 95	108	14.8	<i>P.musculicola</i>
<i>Euryglossa orientalis</i>	29 - 46	5		n.i
<i>Halichoeres stigmaticus</i>	29 - 34.5	9		n.i
<i>Himiramphus far</i>	23 - 26.5	5		n.i
<i>Johinus maculatus</i>	29 - 62	27	48.1	<i>P. caryophyllum</i>
<i>Lethrinus nebulosus</i>	27.5 - 63	226	3.5	<i>P. musculicola</i> & <i>C.speciosus</i>
<i>Liza alata</i>	36 - 37	5		n.i
<i>Lutjanus ehrenbergi</i>	17 - 37.5	16		n.i
<i>Lutjanus malabaricus</i>	20.5 - 48.5	14		n.i
<i>Nematalosa nasus</i>	10 - 12	4		n.i
<i>Nemipterus japonicus</i>	27 - 53	9		n.i
<i>Pampus argenteus</i>	32	1		n.i
<i>Parastromateus niger</i>	35.5 - 36.5	5		n.i
<i>Pardachirus marmoratus</i>	23.5 - 34.5	8		n.i
<i>Parupeneus heptacanthus</i>	23 - 36	10		n.i
<i>Plectorhinchus gaterinus</i>	26.5 - 45.5	15		n.i
<i>Plectorhinchus pictus</i>	33	1		n.i
<i>Pomacanthus maculosus</i>	30.5	1		n.i
<i>Pomadasys argenteus</i>	35 - 58	8		n.i
<i>Psettodes erumei</i>	36 - 57.5	22	31.8	<i>D.thomasi</i>
<i>Rastrelliger kanagurta</i>	11.5 - 20	6		n.i
<i>Rhabdosargus haffara</i>	31 - 33	5		n.i
<i>Scolopsis taeniatus</i>	20 - 22.5	2		n.i
<i>Scomberomorus commerson</i>	58 - 65	10		n.i
<i>Seriolina nigrofasciata</i>	34.5 - 53.5	10		n.i
<i>Siganus canaliculatus</i>	20 - 37.5	19		n.i
<i>Sorsogona tuberculata</i>	54.5	1		n.i
<i>Sphyræna obtusata</i>	38.5 - 58	13		n.i
<i>Squirida tumbil</i>	25	1		n.i
<i>Trachurus indicus</i>	24 - 43	15		n.i
<i>Trichiurus lepturus</i>	65 - 84.5	14		n.i
<i>Tylosurus crocodilus</i>	69.5 - 91	3		n.i
		867	7.73	

n.i = non-infected

The blastocysts of the different Trypanorhyncha were distinguishable by their different shapes, sizes and colours. The plerocercoids of *P. musculicola*, which were removed from the muscle of *Epinephelus chlorostigma* (Forskål, 1775), *E. tauvina* (Forskål, 1775) and *Lethrinus nebulosus*

(Forskål, 1775) (Fig.1), were long, white in colour, and 3 - 6 cm in total length. They appeared as illustrated by Yamaguti (1934). The blastocysts of *D. thomasi*, which were found in *Psettodes erumei* (Bloch & Schneider, 1801), were white in colour, large in size, and oval in shape (Fig.2). Blastocysts

of *C. speciosus*, which were isolated from *L. nebulosus*, ranged from 1 – 3 cm and were also white in colour. Black coloured blastocysts of *C. speciosus* were detected in the musculature of *Cephalopholis hemistiktos* (Ruppell, 1830) (Fig. 3). The plerocercoids of *P. caryophyllum*, which were found in the muscle of *Johinus maculatus* (Bloch & Schneider, 1801), were white or yellow in colour, oval in shape, and had a very long appendix between 6 – 19 cm in total length (Fig.4)

The characteristic site of infestations as well as the parasite distribution within the muscle varied. Both the plerocercoids of *P. musclicola* and *C. speciosus* from *L. nebulosus* were usually found within the muscle layers of the posterior part of the caudal peduncle (Fig.1), while those of *D. thomasi* were found in the muscles of the whole tail region (Fig. 2). The plerocercoids of *P. caryophyllum* usually infested the muscle of the trunk region, while those of *C. speciosus* from *C. hemistiktos* were removed from the abdominal muscle (Fig.3) (Table 2).

Table 2: Infestation site of Trypanorhynch plerocercoids in the fish musculature.

Parasite species	<i>D. thomasi</i> , <i>P. caryophyllum</i> ,	<i>P. caryophyllum</i> <i>C. speciosus</i>	<i>D. thomasi</i>	<i>P. musclicola</i> <i>C. speciosus</i> , <i>D. thomasi</i>
Fish species	Trunk region	Abdominal region	Between vertebral spines	Tail region
<i>Epinephelus chlorostigma</i>	-	-	-	+++
<i>Epinephelus tauvina</i>	-	-	-	+++
<i>Lethrinus nebulosus</i>	-	-	-	+++
<i>Psettodes erumei</i>	+	-	++	+++
<i>Johinus maculatus</i>	+++	++	-	-
<i>Cephalopholis hemistiktos</i>	-	+++	-	-

2. Prevalence and intensity of infestation

The total prevalence of trypanorhynch infestation among the investigated fish was 7.73 %. The highest prevalence of infestation was found in *J. maculatus* (48.2%), followed by *P. erumei* (31.8%), *E. chlorostigma* (15.2 %), *E. tauvina* (14.8%), *C. hemistiktos* (8.7%), and *L. nebulosus* (3.5 %) (see, Table 1).

The highest mean intensity of infestation with Trypanorhyncha plerocercoids was found in *P. erumei* (18 (1-45) larvae per fish). A moderate mean intensity of infestation was detected in *E. chlorostigma* (6.6 (3 - 12) larvae per fish), followed by *E. tauvina* (5.4 (2 - 16) larvae per fish) and *C. hemistiktos* (4.5 (1 - 8) larvae per fish). The lowest mean intensity of infestation was found in *J. maculatus* (2.9 (1 - 10) larvae per fish) and *L. nebulosus* (2.8 (1 - 5) larvae per fish).

The prevalence and intensity of trypanorhynch infestation within the different fish species was directly related to the host length, as given in Tables 4-10. In all 6 fish species, the prevalence, intensity and mean intensity of infestation increased with fish length. The smallest length class (27.5 – 39 cm) of

L. nebulosus, *P. erumei*, *J. maculatus*, *E. chlorostigma*, and *E. tauvina* were not infested with the respective parasite species, and *C. hemistiktos* of the same length class was found infested with a prevalence of 5%. The medium length class (40-50 cm) had a medium infestation rate, with *C. hemistiktos* (33.3%), *J. maculatus* (22.2%), *P. erumei* (14.3%), and *L. nebulosus* (1.6% for *P. musclicola* and 0.8 % for *C. speciosus*). *E. chlorostigma* and *E. tauvina* were free of trypanorhynchs. The largest length class (> 50 cm) had the highest prevalence of infestation, with *J. maculatus* (78.6%), *P. erumei* (60%), *E. tauvina* (20.8%), *E. chlorostigma* (17.9%) and *L. nebulosus* (5% for *P. musclicola* and 3.3% for *C. speciosus*).

Similarly, the mean intensity was highest in the largest length class, and decreased with decreasing fish length. In the >50 cm class type, the mean intensity was 20.8, 6.6, 5.4, 3.1 and 3.3 / 4 larvae per fish for *P. erumei*, *E. chlorostigma*, *E. tauvina*, *J. maculatus* and *L. nebulosus* respectively, while that within the length class 40-50 cm was lower, 1, 0, 0, 2 and 1.5 / 2 larvae per fish respectively. The highest mean intensity of the same length class was found in *C. hemistiktos* (8 larvae per fish). *C. hemistiktos*

was the only infested fish species in the smallest length class, between 27.5 – 39 cm in total fish length, with a mean intensity of 1 larvae per fish. The smallest infestation size for the different fish species was 35 cm in *C. hemistiktos*, 40 cm in *L. nebulosus*, 45 cm in *J. maculatus*, 48 cm in *P. erumei*, 74 cm in *E. chlorostigma* and 79 cm in *E. tauvina*.

3. Seasonality

It was observed that the highest prevalence of infestation among the infested fish occurred during June 1998 (100%), followed by September 1999 (42.85%), March 1999 (29.82%), and July 1998 (27.27%). The seasonality of infestation for the different trypanorhynch species is given in Table 3.

The plerocercoids of *D. thomasi*, which were isolated from *P. erumei*, reached the highest prevalence of infestation in June 1998 and May 1999 (both 100%), followed by October 1999 (40%). *P. musculicola*, which was isolated from the muscle of *E. chlorostigma*, *E. tauvina* and *L. nebulosus*, showed the highest prevalence in March 1999 (30.35%), July 1998 (27.27%), and September 1998 (21.42%). Similarly, there was a conspicuous higher prevalence of infestation in September 1999 (9%), May 1999 (50%) and lower in October 1999 (4%) in *J. maculatus* infested with *P. caryophyllum*. The prevalence of infestation among *C. hemistiktos* infested with *C. speciosus* reached maximum infestation rate in December 1999 (100%), and those of *C. speciosus* that parasitizes *L. nebulosus* reached 5.56% in August 1998.

Table 3: Prevalence of the infestation with Trypanorhyncha larvae during the different months of study

Date	<i>L. nebulosus</i>			<i>P. erumei</i>			<i>J. maculatus</i>			<i>C. hemistiktos</i>			<i>E. chlorostigma</i>			<i>E. tauvin</i>		
	No. Exam.	No. Infect.	%	No. Exam.	No. Infect.	%	No. Exam.	No. Infect.	%	No. Exam.	No. Infect.	%	No. Exam.	No. Infect.	%	No. Exam.	No. Infect.	%
June 98	0	0	0	2	2	100	0	0	0	0	0	0	0	0	0	0	0	0
July 98	22	5	22.73	0	0	0	0	0	0	0	0	0	0	0	0	11	4	36.36
August 98	54	3	5.56	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0
September 98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	3	21.43
October 98	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
November 98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December 98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
January 99	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
February 99	52	0	0	3	0	0	0	0	0	0	0	0	37	9	24.32	21	0	0
March 99	3	0	0	1	0	0	0	0	0	0	0	0	21	8	38.10	32	9	28.13
April 99	3	0	0	0	0	0	1	0	0	1	0	0	52	4	7.69	4	0	0
May 99	8	0	0	2	2	100	2	1	5	0	4	0	0	2	0	0	6	0
June 99	12	0	0	0	0	0	3	1	33.33	5	1	20	2	0	0	9	0	0
July 99	4	0	0	2	0	0	1	0	0	2	0	0	3	0	0	1	0	0
August 99	5	0	0	2	0	0	4	0	0	2	0	0	2	0	0	2	0	0
September 99	5	0	0	1	0	0	10	9	90	1	0	0	2	0	0	2	0	0
October 99	5	0	0	5	2	40	5	2	40	2	0	0	5	0	0	4	0	0
November 99	36	0	0	3	1	33.33	1	0	0	1	0	0	3	0	0	0	0	0
December 99	3	0	0	1	0	0	0	0	0	1	1	100	0	0	0	0	0	0
January 2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February 2000	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
March 2000	4	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Total	226	8	3.54	22	7	31.82	27	13	48.15	23	2	8.7	138	21	15.22	108	16	14.8

4. Histopathology

Fish specimens infested with trypanorhynch cestodes in their muscles showed no clinical abnormalities, but in *post-mortem* examination, the plerocercoids were easily visible by naked eye against the whitish fish musculature. The worms were found in whitish, yellowish or blackish cysts of different size within the muscle tissue (see, Figs. 1 – 4). Muscles of highly infested fish showed severe inflammatory reaction around the plerocercoids (see, Fig. 2).

In histopathological examination, several severe host reactions due to the presence of trypanorhynch cestodes in the musculature could be observed. The muscles of *E. chlorostigma*, *E. tauvina* and *L. nebulosus*, which were heavily infested with *P. musculicola*, showed atrophied muscle fibers and oedema around the plerocercoids (Fig. 8). In contrast, the musculature of *P. erumei* showed oedema only (Fig. 9). *J. maculatus* muscles, which were highly infested with *P. caryophyllum*, were surrounded with atrophied muscle and showed severe inflammatory reactions (Fig. 10). The musculature of *C. hemistiktos*, which was infested with *C. speciosus*, showed a delicate layer of fibrous connective tissue around the plerocercoids (Fig. 11).

Discussion

Trypanorhynch cestodes are widely spread within the world oceans. About 200-250 species belonging to the cestode order Trypanorhyncha are currently recognized (Palm, 1997b), occurring around all continents (see Bates, 1990). According to numerous authors (Dollfus, 1942; Mehl, 1970; El Naffar, *et al.* 1992; Palm, *et al.* 1993; 1994; and Sao Clemente, *et al.* 1997), these cestodes use invertebrates (small crustaceans) as first intermediate hosts, with teleosts and some invertebrates as second intermediate or paratenic hosts. The adult cestodes are parasites of elasmobranchs such as sharks, skates and rays. The present larvae recovered from the musculature of Arabian Gulf teleost fishes all represent larval trypanorhynch stages, illustrating the role of the infested teleosts in the Arabian Gulf food chain.

While *C. speciosus* was already recorded from the Arabian Gulf by Kardousha (1999), the presence of *D. thomasi*, *P. musculicola*, and *P. caryophyllum* is new for this locality. Knowing the latter already as a worldwide distributed species, *P. musculicola* was earlier recorded from *Chrysophrys auratus*

and *Epinephelus akaara* from Japan (Yamaguti, 1934; Campbell & Beveridge, 2000), and *D. thomasi* has been recently described from *P. erumei* from the southern Sumatra coast, Indonesia (Palm, 2000). Kardousha, 1991; El Naffar, *et al.* 1992 and Al-Ghais & Kardousha, 1994, earlier recorded *Floriceps* sp. from the viscera of several Arabian Gulf fish (coast of United Arab Emirates), and Kardousha (1999) reported 14 further trypanorhynch species, belonging to the genera *Callitetrarhynchus*, *Grillotia*, *Nybelinia*, *Otobothrium*, *Progrillotia*, *Pseudogrillotia*, *Pseudotobothrium*, *Pterobothrium*, *Pterobothrioides*, and *Tentacularia*. Thus, a total of 18 different trypanorhynch species are known to occur in the Arabian Gulf.

Kardousha (1999) found 33 of 42 studied fish species to be infested with trypanorhynch cestodes, with *Callitetrarhynchus gracilis* infesting 20 different fish species. Only 2 species, *Pterobothrium heteracanthum* and *Pseudogrillotia spratti*, were isolated from the fish musculature, while the other species were found in the mesentery or the body cavity. These findings correspond to records from other localities, where for example *C. gracilis* also was the most predominant species (Palm, *et al.* 1994; Palm, 1997b). Similarly, the trypanorhynch species that were recorded during the present study were also found in the fish musculature of the same or related fish species at other localities. Thus, the trypanorhynch cestode fauna from the Arabian Gulf is characterized by widely distributed species, being similarly abundant and inhabiting a similar site in the fish second intermediate host as already observed in other parts of the world oceans. This implies that several further trypanorhynch species might occur within the Gulf region, in crustacean, teleost or elasmobranch hosts that have not yet been studied.

The total prevalence of infestation with trypanorhynch cestodes in the musculature reached 7.73% (see, Table 1). This prevalence is higher than that recorded by Obiekezie, *et al.* (1992) in Nigeria (0.44%) and Palm, *et al.* (1993) in the Philippines (2.25%). On the other hand, high prevalence of infestation were obtained by Sao Clemente, *et al.* (1997) (55.75%) in Brazil, and Abu-Zinada, 1998 (29.4%) in Saudi Arabia (Coast of Red Sea). Such differences can be explained by the fact that the combination of selected fish species and fish size are the major important factors in the total prevalence of musculature infestations during a survey for trypanorhynch flesh parasites. This is

underlined by the present study, which shows a direct relationship between the host length and the prevalence and intensity of infestation (see Tables 4 – 10), which is in accordance with Sao Clement, *et al.* (1997) and Palm & Overstreet (2000a).

Table 4. : Size of *Lethrinus nebulosus* and its degree of infestation with *Pintneriella musculicola*

	Length (cm)		
	27.5 - 39	40 - 50	>50
No. Examined	42	124	60
Prevalence %	0	1.6	5
Intensity	0	1 to 2	1 to 5
Mean intensity	0	1.5	3.3

Table 5. : Size of *Lethrinus nebulosus* and its degree of infestation with *Callitetrarhynchus speciosus*

	Length (cm)		
	27.5 - 39	40 - 50	>50
No. Examined	42	124	60
Prevalence %	0	0.8	3.3
Intensity	0	2	3 to 5
Mean intensity	0	2	4

Table 6. : Size of *Psettodes erumei* and its degree of infestation with *Dasyrhyinchus thomasi*

	Length (cm)		
	27.5 - 39	40 - 50	> 50
No. Examined	5	7	10
Prevalence %	0	14.3	60
Intensity	0	1	2 to 45
Mean intensity	0	1	20.8

Table 7. : Size of *Johinus maculatus* and its degree of infestation with *Poecilancistrum caryophyllum*

	Length (cm)		
	27.5 - 39	40 - 50	> 50
No. Examined	4	9	14
Prevalence %	0	22.2	78.6
Intensity	0	2	1 to 10
Mean intensity	0	2	3.1

Table 8. : Size of *Cephalopholis hemistiktos* and its degree of infestation with *Callitetrarhynchus speciosus*

	Length (cm)		
	27.5 - 39	40 - 50	> 50
No. Examined	20	3	-
Prevalence %	5	33.3	-
Intensity	1	8	-
Mean intensity	1	8	-

Table 9. : Size of *Epinephelus chlorostigma* and its degree of infestation with *Pintneriella musculicola*

	Length (cm)		
	27.5 - 39	40 - 50	> 50
No. Examined	14	7	117
Prevalence %	0	0	17.9
Intensity	0	0	3 to 12
Mean intensity	0	0	6.6

Table 10. : Size of *Epinephelus tauvina* and its degree of infestation with *Pintneriella musculicola*

	Length (cm)		
	27.5 - 39	40 - 50	> 50
No. Examined	13	18	77
Prevalence %	0	0	20.8
Intensity	0	0	2 to 16
Mean intensity	0	0	5.4

The present study also indicates a seasonal variation in infestation rates, as exemplified by a maximum infestation rate for several species during the spring and summer months. The highest prevalence of infestation for *D. thomasi* was recorded in June 1998 and May 1999 (100%) and those of *P. musculicola* in March 1999 (30.35%). *P. caryophyllum* reached a maximum rate of infestation in September 1999 (90%). Palm & Overstreet (2000a) reported an annual variation in the occurrence of *Otobothrium cysticum* in butterfishes, and also noted a slight seasonal variation between July and September 1988 along the northeast American coast. In contrast, *C. speciosus* in the Arabian Gulf reached a maximum infestation rate in December 1999 (100%). At present, the seasonal and annual variations in the occurrence of trypanorhynch cestodes are not really understood. Palm & Overstreet (2000a) proposed that the reason for temporal and spatial differences among infective intermediate hosts is probably related to differences in the abundance of

elasmobranch definitive hosts and to natural fluctuations in environmental conditions, which might especially influence the total abundance of the suitable crustacean first intermediate hosts.

The fish infested during the present study showed no visible abnormal clinical signs, but the *post-mortem* examination revealed the presence of the plerocercoids with variable shape, size and colours within the muscle tissue (see, Figs. 1–3). The plerocercoids of the *P. musclicola* and *C. speciosus* were white (see, Fig.1), while the plerocercoids of *P. caryophyllum* (Spaghetti worm) were whitish or yellowish in colour (see, Fig.4). *D. thomasi* appeared white (see, Fig.2), and *C. speciosus* was also found in black coloured blastocysts (see, Fig.3), which were earlier recorded by Palm (1997b) for *Callitetrarhynchus gracilis*. Palm & Overstreet (2000a) associated the yellowish and black appearance of the encapsulation around the plerocerci in some larger fish with the worm longevity in the host. Yellowish encapsulations in the muscle infestation of *P. caryophyllum* in *Cynoscion nebulosus* were suspected to be at least 2 years old (Overstreet, 1977). The present study demonstrates that larger fish had a higher prevalence and intensity of infestation than smaller ones. This can be either explained by an accumulation of parasites due to the longevity of the plerocercoids, or by a better access of larger fish to the parasites' intermediate hosts.

The effects of larval cestodes on the host fish include growth retardation and a lower condition factor (Hoffmann, *et al.* 1986), tissue disruption, metabolic disturbances (Richards and Arme, 1981; Radhakrishnan, *et al.* 1983; Rosen & Dick, 1984), and even mortality in heavy infestation (Bussieras and Aldrin, 1965; Adjei, *et al.* 1986). Moreover, the swimming speed of fish may be reduced by helminth infestation in the musculature (Sprengel and Luchtenberg, 1991; Rohlwing, *et al.* 1998). In our study, the results of histopathological examination proved that the muscles of heavily infested fish showed atrophied muscle fibers, oedema and severe inflammatory reaction around the plerocercoids. Thus, it can be expected that fish heavily infested with muscle inhabiting trypanorhynch become negatively influenced by this infestation, which might also lead to a higher

natural mortality. Palm, *et al.* (1994) stated that trypanorhynch might influence infected hosts in that they would fall easier prey to the final hosts and increase chances for successful transmission. However, the severe inflammatory reaction observed in the present study also demonstrates a possible strong host reaction to the parasites, which also can be disadvantageous for the trypanorhynch. Several authors have recorded degenerated cestodes in the fishes (see Palm & Overstreet, 2000a), which have died due to the strong host response of the fish intermediate host.

The present study was carried out to gain information on the current import of parasitized fish species into Saudi Arabia. We conclude that trypanorhynch are common muscle inhabiting parasites in several food fishes, which are imported through the neighboring countries. However, as mainly larger fish specimens were found infested, we can estimate a size from which the possible infestation with trypanorhynch is more likely. The estimated safety sizes (no trypanorhynch in smaller sized fish) are 35 cm in *C. hemistiktos*, 40 cm in *L. nebulosus*, 45 cm in *J. maculatus*, 48 cm in *P. erumei*, 74 cm in *E. chlorostigma* and 79 cm in *E. tauvina*. This information will help to identify a standard size for imported fresh marine fish from the neighboring countries into the Eastern Province of Saudi Arabia. It is of vital importance for fish consumers as well as the fish processing industry and fish dealers to avoid fish being marketed with a heavy trypanorhynchiasis.

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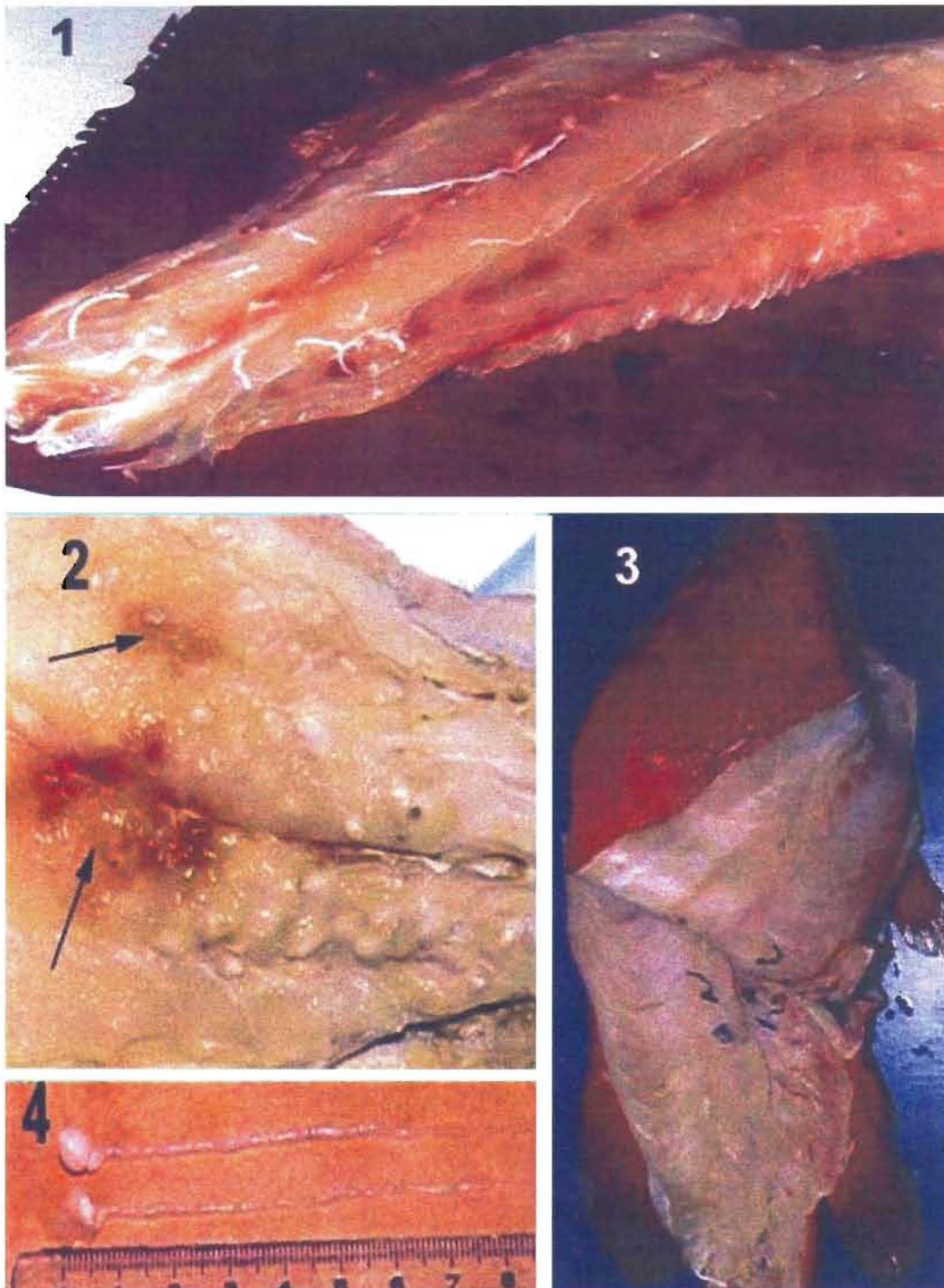


Fig.1: The plerocercoids of *Pintneriella muscolicola* concentrated at the caudal peduncle of *Lethrinus nebulosus*.

Fig.2: Large numbers of the plerocercoids of *Dasyrhynchus thomasi* within the muscle tissue of *Psettodes erumei*. Sever hemorrhage (arrows) occurred around the plerocercoids.

Fig.3: Black coloured blastocyst of *Callitetrarhynchus speciosus* from the musculature of *Cephalopholis hemistiktos*.

Fig.4: The plerocercoids of *Poecilancistrum caryophyllum* (Spaghetti worm).

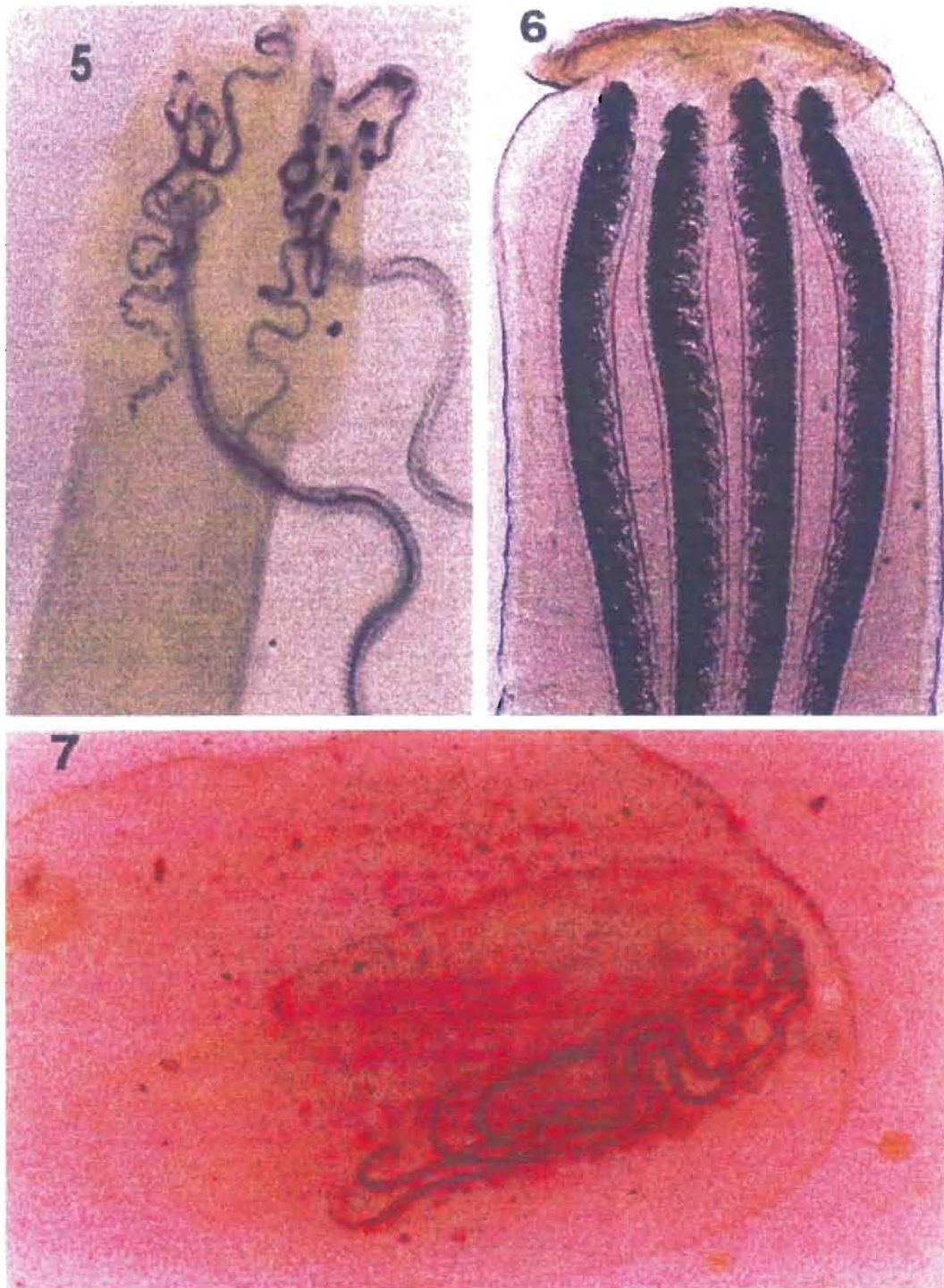


Fig.5: Scolex of *Pintneriella muscolicola* with four everted tentacles and 2 bothridia.

Fig.6: Scolex of *Dasyrhynchus thomasi*.

Fig.7: Blastocyst of *Callitetrarhynchus speciosus*.

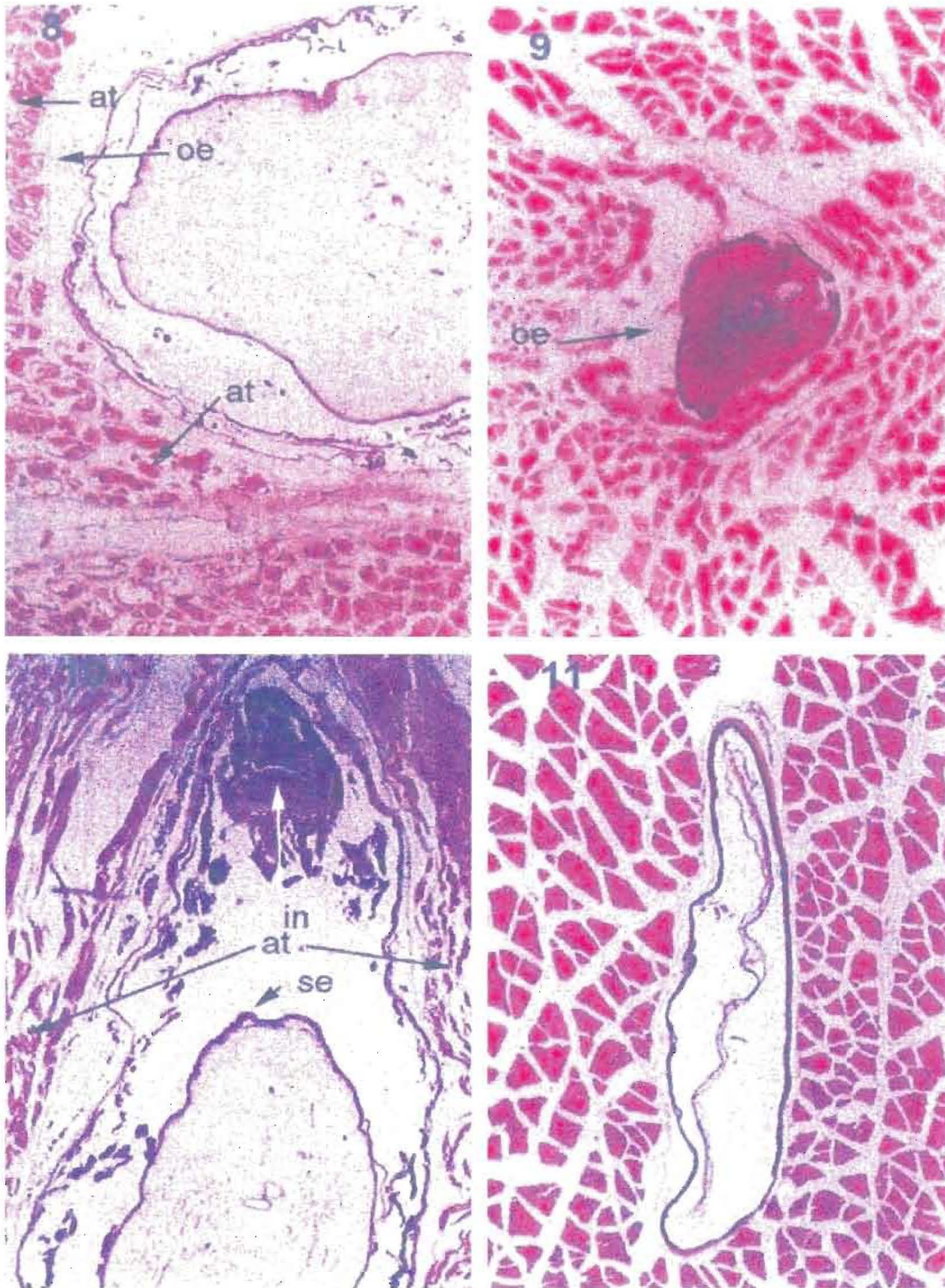


Fig.8: Muscle of *Lethrinus nebulosus* infested with *Pintneriella muscolicola*, note large parasites deeply penetrating the muscular tissue, which is surrounded by atrophied muscle fibers (at) and oedema (oe).

Fig.9: *Psettodes erumei*, part of the parasite embedded between the muscle fibers together with oedema (oe).

Fig. 10: *Johinus maculatus* muscle infested with *Poecilancistrum caryophyllum*, cross section of the parasite with serrated borders (se) and surrounded by atrophied muscle (at) and sever inflammatory reaction (in).

Fig.11: Muscle of *Cephalopholis hemistiktos* infested with *Callitetrarhynchus speciosus*, characteristic parasite between the muscle bundles surrounded by a delicate layer of fibrous connective tissue.

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