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A record of two species of Acanthocephala (Echinorhynchida: Rhadinorhynchidae) from Red Sea fishes, Yemeni coastal waters

A.B. Al-Zubaidy[1] and F.T. Mhaisen[2*]

[1]*Department of Marine Biology and Fisheries, Faculty of Marine Science and Environment, Hodeidah University, Yemen,* [2]*Tegnervägen 6B, 641 36 Katrineholm, Sweden*

[*]*e-mail: mhaisenft@yahoo.co.uk*

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Abstract - A total of 198 specimens belonging to four fish species (*Thunnus tonggol*, *Sphyraena barracuda*, *Pomadasys argenteus* and *Lutjanus gibbus*) were purchased from Al-Mehwat fish market, Hodeidah, Yemen and inspected for acanthocephalan infections. Two acanthocephalans were detected. Juveniles of *Serrasentis sagittifer* were recovered from the intestine, pyloric caeca, body cavity, mesenteries and some internal organs of the above- named fishes with prevalence of 11.7%, 11.9%, 24% and 4.4%, respectively and a mean intensity of 3.3, 2.2, 5 and 2, respectively. Generally, male fishes showed higher values of infection in comparison with female fishes. Encysted juveniles of *Gorgorhynchus* sp. were recovered from the intestinal mesenteries of *T. tonggol* only with a prevalence of 3.3% and intensity of 2.5. The occurrence of the above-named acanthocephalans represents their first record from the Yemeni fishes of the Red Sea.

Key words: Acanthocephala, Echinorhynchida, Red Sea, Fishes, Yemen.

Introduction

The Red Sea, an important offshoot from the Indian Ocean, has a very rich and varied fish fauna (Saoud and Ramadan, 1983). It is one of the major centers of global marine biodiversity and supports 1,248 species of fishes, representing 157 families (See Galli *et al*., 2007). Marine fishes are considered as one of the most important sources of animal protein in Yemen.

Knowledge of fish parasites is of particular interest in relation not only to fish health but also to understand ecological problems (Dudgeon *et al*., 2006).

The parasites play a very important role in the lives of their hosts (Dogiel, 1964). They have proved to be a good model systems for investigations of general ecological theories (Moore, 2002), and they have been proposed as excellent indicators of the biodiversity both on host species and at the ecosystem level (Chambers and Dick, 2005).

Acanthocephalans are commonly considered as parasites with a low specificity to their intermediate, definitive or transport hosts (Taraschewski, 2000). They are relatively poorly known helminth group in marine fishes

(Oliva and Luque, 1998). Acanthocephalan parasites of fishes live either as adults in the intestine or as larvae (post-cystacanths) in fish tissues. All acanthocephalans utilize arthropods as intermediate hosts and vertebrates as definitive hosts. Occasionally, vertebrates serve as paratenic hosts harboring larval acanthocephalans that do not develop to adults unless ingested by the appropriate definitive hosts (Tingbao and Xianghua, 2001).

Diagnosis of classes, orders, families, genera and species of Acanthocephala depends upon the structure, number, shape, size, and distribution of hooks on the proboscis, proboscis receptacle, lemnisci of both males and females as well as various other structures in males such as testes, cement glands, bursal cap and bursa (Huffman and Bullock, 1975). The acanthocephalans of the marine fishes of Yemen are totally neglected. Human acanthocephaloses are acquired through the consumption of raw or uncooked seafood (Adams *et al.*, 1997). For these reasons, the present study was aimed to contribute on the knowledge of acanthocephalans from some Red Sea fishes from Yemen.

Materials and Methods

One hundred and ninety eight fish specimens belonging to four species were purchased from Al-Mehwat fish market in Hodeidah, Yemen, during the period from October 2007 to September 2009. These included *Thunnus tonggol* (Bleeker, 1851), *Sphyraena barracuda* (Edwards, 1771), *Pomadasys argenteus* (Forsskål, 1775) and *Lutjanus gibbus* (Forsskål, 1775). Fish scientific names were done in accordance of Froese and Pauly (2011).

Fishes were examined for acanthocephalan infections. Cystacanths were liberated from their cysts by using a digestive water solution (1% of pepsin, 0.4% of HCl). Larvae were relaxed in fresh cold water and fixed in 75% ethanol, cleared in lacto phenol and dehydrated in graded ethanol without staining. Determination of cleared specimens was done on temporary total mounts in clearing solution using an Olympus compound microscope. Drawings were done with a camera lucida and in a microscope. The specimens were deposited in the Department of Marine Biology and Fisheries, Faculty of Marine Science and Environment, Hodeidah University, Hodeidah, Yemen.

Species identification was mainly made in accordance with the systematic works by Yamaguti (1963), Amin (1987) and Santos *et al.* (2008). Parasite taxonomy followed that of WoRMS (2011) and the Integrated Taxonomic Information System (ITIS, 2011). Calculation of infection parameters: Prevalence (percentage of infection), mean intensity and abundance were done according to Bush *et al.* (1997). T-test was applied to detect the significance of infection among male and female fishes.

Results

The inspection of fish specimens revealed the occurrence of two acanthocephalan species which are arranged in the following systematic account of WoRMS (2011):

Phylum Acanthocephala
 Class: Palaeacanthocephala

Order: Echinorhynchida
Family: Rhadinorhynchidae
Subfamily: Serrasentinae
Serrasentis sagittifer (Linton, 1889)
Subfamily Gorgorhynchinae
Gorgorhynchus sp.

***Serrasentis sagittifer* (Linton, 1889) (Figs. 1 - 4)**

Site of infection and host fishes: *S. sagittifer* was isolated from the intestine, pyloric caeca, body cavity, mesenteries and the external surfaces of some internal organs of *T. tonggol, S. barracuda, P. argenteus* and *L. gibbus.*

Type locality: Red Sea, Yemeni coastal waters.

Infection parameters: Prevalence of infection varied according to fish host and ranged from 4.4% - 24%, while the mean intensity ranged from 2-5 parasites/infected fish and the abundance ranged from 0.08-1.2. The overall prevalence of infection was 13.1%, the mean intensity was 3.8 and the abundance was 0.5. The detailed parameters of infection for each of the four infected fish species are shown in Table (1).

Relationship between sex of fish hosts and parasite infection: The prevalence and mean intensity of infection of *S. sagittifer* in male fish hosts (Table 2) were significantly ($P< 0.01$) higher than those of female fishes.

Description of cystacanths:
Males: The body is elongated with a narrow posterior end (Figures 1 & 2). The proboscis is club-shaped and broad anteriorly. It has 22 longitudinal rows of hooks each with 16 recurred hooks. Proboscis hooks decrease in length from apex to base of proboscis, although apical hooks are slightly smaller than sub apical ones. The neck is smooth. The double-walled receptacle is attached to the proboscis wall. The trunk is spinose anteriorly. The spines are arranged in nine collar rows, each with 18 spines. Following the collar spines, 24 incomplete rows, like combs, are present which extend beyond the med-level of the trunk. Each comb has 24 spines. Two lemnisci, variable in shape and length, arise from the base of the neck, and extend up to the med level of the trunk, reaching a level beyond the testes. Testes, nearly equal and tandem, with ovoid shape. Primordial of four pyriform cement glands are located at the posterior end of the body. The copulatory bursa is bell-shaped and muscular, with a ring- like sphincter.

Females: Female of *S. sagittifer* is usually larger than the male (Table 3 and Figures 3 & 4). It has distinctive rows of spines (combs) on the ventral surface of its body in adult and encysted stages. The proboscis is short, bulbous and expanded on the anterior end, and covered with numerous, uniform spines (22 longitudinal rows of 16 hooks each). The topography of the hook arrangement, receptacle and lemnisci are as described in the males. The trunk armature resembles that of the male. The vagina is surrounded by two pairs of vaginal muscles. The uterus has a conical shape.

Measurements: Table (3) summarizes the results of measurements of the body and some internal organs of female and male *S. sagittifer* larvae from Red Sea fishes of the present investigation.

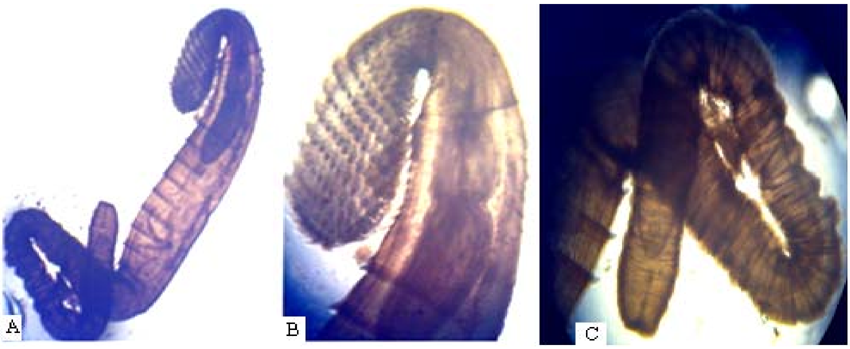

Figure 1. Photomicrographs of male *S. sagittifer* larva.
A: Whole mount of juvenile male. B: The anterior part of body showing the proboscis and receptacle. C: Posterior end of body.

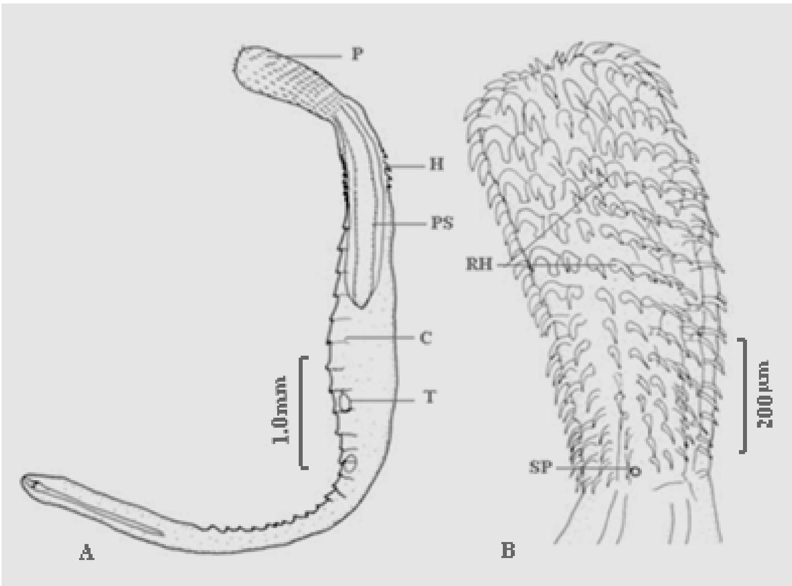

Figure 2. Male *S. sagittifer*. A: Whole mount, B: Proboscis.
C = comb, H = hooks, P = proboscis, PS = proboscis sheath, RH = rows of hooks, SP = sensory papilla, T = testis.

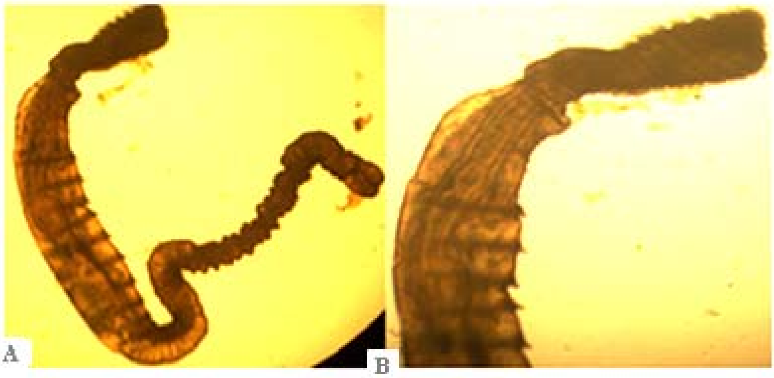

Figure 3. Photomicrographs of female *S. sagittifer* larva.
A: Whole mount,
B: Anterior end of body.

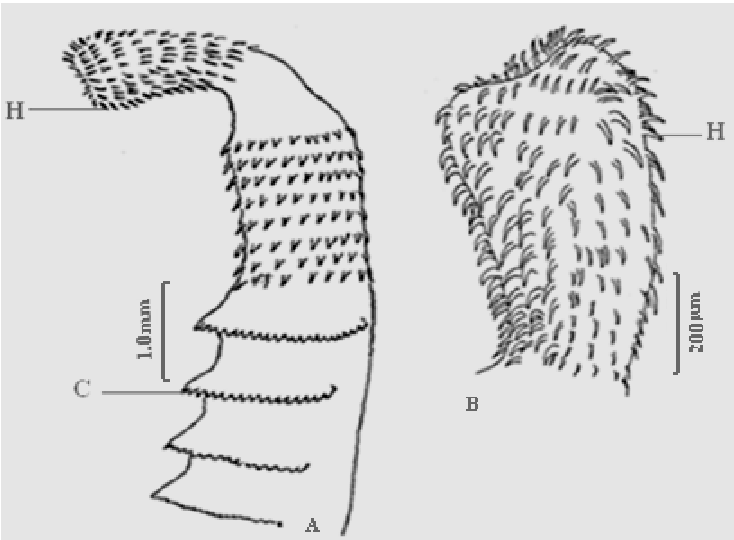

Figure 4. Female *S. sagittifer*.
A: Anterior end with proboscis and neck,
B: Proboscis. C= comb, H = hook.

Table 1. Infection parameters of fish hosts from Red Sea, Yemeni coastal waters infected with the acanthocephalan *S. sagittifer*.

Fish family and species	IF/EF	P (%)	No. P.	I	A	FSL
Scombridae *Thunnus tonggol*	7/60	11.7	23	2-5 (3.3)	0.4	35-62 (50.2)
Sphyraenidae *Sphyraena barracuda*	5/42	11.9	11	1-3 (2.2)	0.3	25-45 (36.4)
Haemulidae *Pomadasys argenteus*	12/50	24	60	3-7 (5)	1.2	20-38 (27.1)
Lutjanidae *Lutjanus gibbus*	2/46	4.4	4	1-3 (2)	0.08	19-39 (29.1)
Total	26/198	13.1	98	1-7 (3.8)	0.5	19-62 (36.5)

IF/EF = Number of infected fish/ number of examined fish, P (%) = Prevalence of infection (%), No. P. = Number of parasites, I = Intensity: range (and mean), A = Abundance, FSL = Fish standard length (cm).

Table 2. The prevalence and mean intensity of *S. sagittifer* larvae in relation to fish sex.

Fish species	IM/EM	P (%)	No. P.	I	IF/EF	P (%)	No. P.	I
T. tonggol	4/28	15.3	17	2-5 (4.3)	3/32	9.4	6	1-3 (2.0)
S. barracuda	3/19	15.8	7	1-3 (2.3)	2/23	8.7	4 (1-3)	1-3 (2.0)
P. argenteus	8/25	32	42	3-7 (5.3)	4/25	16	18	3-5 (4.5)
L. gibbus	2/22	9.1	4	1-3 (2)	0/24	-	-	-
Total	17/94	18.1	70	1-7 (4.1)	9/104	8.7	28	1-5 (3.1)

IM/EM = Number of infected males/ number of examined males, P (%) = Prevalence, No. P. = Number of parasites, I = Intensity: range (and mean), IF/EF = Number of infected females/ number of examined females.

Table 3. Measurements (range and mean in parentheses) of the body and some internal organs of female and male *S. sagittifer* from Red Sea fish, Yemeni coastal waters.

Measurements (mm)	Females (n=5)	Males (n=11)
Body length*	10.6-11.7 (11.4)	7.5-9.0 (8.4)
Body maximum width	0.78-0.94 (0.082)	0.62-0.75 (0.69)
Proboscis length	1.16-1.19 (1.17)	1.0- 1.3 (1.1)
Proboscis width	0.29-0.34 (0.30)	0.23-0.25 (0.24)
Number of rows	22	22
Neck length	0.21-0.23 (0.022)	0.24-0.28 (0.26)
Length of receptacle	1.18-1.26 (1.21)	1.44-2.2 (1.89)
Length of long lemniscus	3.25-3.5 (3.38)	3.3-3.9 (3.55)
Length of short lemniscus	3.11-3.24 (3.18)	3.10-3.7 (3.4)
Length of vagina	0.18-0.22 (0.19)	-
Length of uterus	0.065-0.067 (0.066)	-
Length of immature testis	-	0.14-0.16 (0.15)

*Body length does not include neck, proboscis or bursa.

***Gorgorhynchus* sp. (Figs. 5 & 6)**
Site of infection and host fish: The intestinal mesenteries of two *T. tonggol* were infected with a total of five encysted juveniles of *Gorgorhynchus* sp.

Description: Body slender, measures 13.5-16 (15) mm in length with cylindrical and relatively short proboscis. There are 24-26 longitudinal rows of hooks on the proboscis, each row contains 14-15 hooks. The anterior hooks are larger (60-100 µm) than the posterior hooks (25-55 µm). A series of very small hooks is present at the end of the upper third of the proboscis. The proboscis sheath is about twice as long as the proboscis. The neck is unarmed but the anterior region of the trunk has cuticular hooks in longitudinal rows of spines, each row contains 10-12 spines.

Locality: Red Sea, Yemeni coastal waters.
Infection details: Number of fish infected = 2, Prevalence = 3.3%, intensity (range and mean) = 2-3 (2.5) worm per infected fish.

Discussion

Serrasentis sagittifer (Linton, 1889)
Synonyms: According to ITIS (2011), eight synonyms are known for *S. sagittifer*. These are: *Echinogaster sagittifer* (Linton, 1889); *Echinorhynchus sagittifer* Linton, 1889; *Serrasentis chauhani* Datta, 1954; *Serrasentis giganticus* Bilqees, 1971 ; *Serrasentis longus* Tripathi, 1959 ;

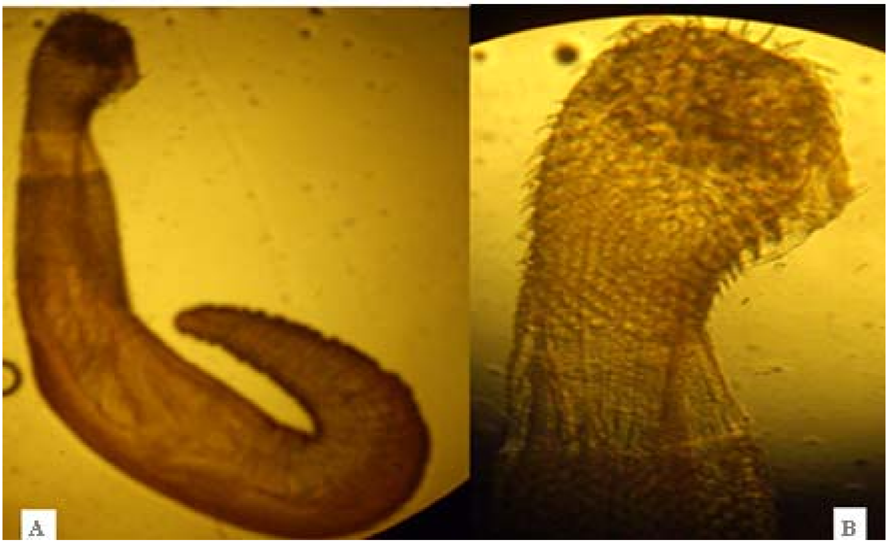

Figure 5. Photomicrographs of *Gorgorhynchus* sp. larva.
A: Whole mount of juvenile,
B: The anterior part showing the proboscis.

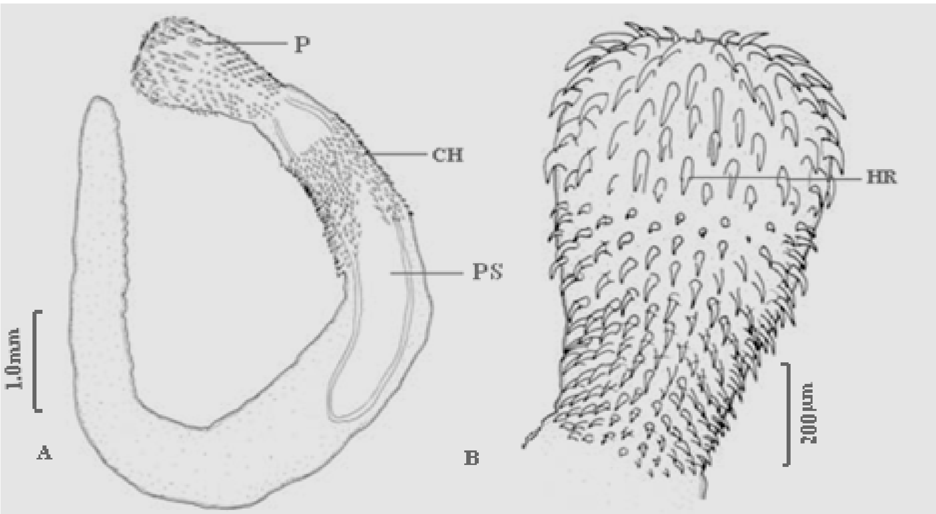

Figure 6. *Gorgorhynchus* sp. A: Whole amount, B: Proboscis.
CH = cuticular hooks, HR = hook row, P = proboscis,
PS = proboscis sheath.

Serrasentis longiformis Bilqees, 1971; *Serrasentis scomberomori* Wang, 1981 and *Serrasentis socialis* (Leidy, 1851).

Site of infection and host fishes: It is known that some acanthocephalan species incorporate an obligate or accidental paratenic host into the life cycle. The paratenic hosts can become infected accidentally by predation on fish with immature worms. They will develop further if the paratenic host is eaten by the definitive host (Eiras *et al.*, 1995). On the other hand, a paratenic host can be ecologically essential in case the definitive host does not predate the intermediate one (Kennedy, 1975). Less frequently, a definitive host may become a paratenic host if the infected intermediate host contained larvae that had not yet reached the infective cystacanth stage. In paratenic hosts, immature worms are usually encysted in or on body cavity organs (Eiras *et al.*, 1995).

Infection parameters: Cystacanths of *S. sagittifer* larvae have been recovered from a wide range of fish hosts (see the geographical distribution below). The considerable difference in the prevalence of cystacanths between hosts of the present study (Table 1) indicates that *P. argenteus* is a more important paratenic host. Little is known about the diet of *P. argenteus*. Al-Zubaidy (In press) found that *P. argenteus* feeds on crustaceans (crabs and shrimps), molluscs (bivalves, gastropods and cephalopods), brittle stars, small fishes and sea weeds. As *P. argenteus* is predatory deep water fish, it is more likely to accumulate cystacanths in comparison with the remaining fish species.

Relationship between sex of fish hosts and parasite infection: Host sex was shown to be a significant factor in determining the abundance of parasites infecting fishes. According to Kennedy (1975) the differences in parasite infection between both sexes can be expected and are explained as a consequence of difference in physiological status, ecological niches and diet. The fact that males were more parasitized than females (Table 2) differs from that observed by Amin (1986), Lasee (1989) and Brasil-Sato and Pavanelli (1999). These authors did not observe the relation between host sex and acanthocephalans infection. The tendency of male vertebrate animals to be more heavily infected than the females have been reported by Leigh (1960), Dudzinski and Mykytowycz (1963), Thomas (1964), Pennycuick (1971) and McVicar (1977). According to these authors, the reasons include variations in the physiological resistance and the ecology or behavior of the two sexes. There may be other biological reasons for males being more infected than females, as has been reported for some other vertebrate species (Poulin, 1996). For instance, Zuk and McKean (1996) emphasized that testosterone is responsible for this phenomenon, because it can induce immune suppression in the male host.

Description of cystacanths: The genus *Serrasentis* was erected by Van Cleave, 1923. Fifteen valid species of this genus are documented by WoRMS (2011). However, only seven species are reported by ITIS (2011). *S. sagittifer* was redescribed by Travassos (1966) and Golvan (1969). The specimens of the present study are similar with that of Golvan (1969) but there are some differences in length of the parasite length and the number of combs. The difference in size can be assigned to the developmental stage of the parasite and the difference in the number of combs is due to intra-specific variation.

Geographical distribution: Larvae of *S. sagittifer* have a wide range of fish hosts. They were reported from 13 fish species from Arabian Gulf, especially from Iran, Kuwait and Emirati coastal (Amin *et al.*, 1984; El-Naffar *et al.*, 1992; Kardousha, 2005, Maghami *et al.*, 2008), from five fish hosts from Karachi coast (Bilqees and Khan, 1993), from 20 species from Atlantic (Meyers, 1978; Overstreet, 1978; Amin, 1998), and from six species from Brazil (Luque *et al.*, 1995; 1996a, b; Takemoto *et al.*, 1996; Luque *et al.*, 2003; Luque and Poulin, 2004; Alves *et al.*, 2005; Santos *et al.*, 2005) and So, *S. sagittifer* of the present study is the first species of the genus *Serrasentis* which is reported from the Red Sea fish, Yemeni coastal water and the four fish species (*T. tonggol*, *S. barracuda*, *P. argenteus* and *L. gibbus*) are new host records for this parasite.

Gorgorhynchus sp.

Seven valid species of *Gorgorhynchus* Chandler, 1934 are documented by WoRMS (2011). However, ITIS (2011) stated nine species for this genus. The juvenile of *Gorgorhynchus* sp. presents the typical generic characteristics related to the form of the body and the proboscis, the distribution of trunk spines and length of proboscis sheath.

As no previous report on any species of the genus *Gorgorhynchus* is available from Yemeni waters, the present study represents the first occurrence of *Gorgorhynchus* specimens in teleost fish of Yemeni water with *T. tonggol* as a host record.

Among the non specified *Gorgorhynchus* specimens, Jakob and Palm (2006) reported *Gorgorhynchus* sp. from the pyloric caeca of *Trichiurus lepturus* which has a proboscis with 23 rows of eight to nine hooks each. In southern coast of Brazil, Knoff *et al.* (2001) recorded a juvenile of *Gorgorhynchus* sp. in the spiral valve of *Sphyrna zygaena* whose proboscis had 9 rows of 13-14 hooks each. In Peru, Tantaleán and Lefevre (2004) recorded *Gorgorhynchus* sp. from *Hemilutjanus macrophthalmos* whose proboscis had 18 rows hooks. In all these cases, the number of rows hooks is less than those of the present investigation.

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تسجيل نوعين من الديدان شوكية الرأس (رتبة شوكية الخطم، عائلة هشة الخطم) من أسماك البحر الأحمر، المياه الساحلية اليمنية

علي بناوي الزبيدي[1] وفرحان ضمد محيسن [2]

[1]*قسم الأحياء البحرية والمصائد، كلية علوم البحار والبيئة، جامعة الحديدة، اليمن*

[2]*Tegnervägen 6B, 641 36 Katrineholm, Sweden*

المستخلص - تم شراء ما مجموعه 198 عينة تعود لأربعة أنواع من الأسماك (التونة طويلة الذنب أو الزينوب، القد، البركودة الكبيرة أو الناقم أو الناجم، والنهاش الأحمر أحدب الظهر أو الحمرا) من سوق أسماك المحوات في الحديدة، اليمن وفحصت بحثا عن الإصابات بالديدان شوكية الرأس. عثر على يافعات النوع *Serrasentis sagittifer* في أمعاء، الردوب البوابية، جوف الجسم، المساريق وبعض الأعضاء الداخلية للأنواع الأربعة من الأسماك بنسبة إصابة قدرها 11.7%، 11.9%، 24% و4.4% على التوالي وشدة إصابة قدرها 3.3، 2.2، 5 و 2 على التوالي. عموما، أظهرت ذكور الأسماك قيما أعلى للإصابة مقارنة مع الإناث. أما يافعات النوع *Gorgorhynchus* sp. المتكيسة فقد عثر عليها في مساريق أمعاء سمكة الزينوب فقط بنسبة إصابة قدرها 3.3% وشدة إصابة قدرها 2.5. يعدّ ظهور النوعين أعلاه من الديدان شوكية الرأس في الدراسة الحالية بمثابة أول تسجيل لهما من أسماك البحر الأحمر في اليمن.