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Trypanorhynch cestodes of elasmobranchs from the Persian Gulf

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Abstract

The first large scale study of trypanorhynch cestodes of elasmobranchs from the Persian Gulf was carried out during November to December 2007. A total of 194 elasmobranch specimens belonging to six families and 15 species was infested with the following cestodes, most representing new locality and 23 new host records: *Kotorella pronosoma* (Stossich, 1901), *Kotorella* sp. and *Nybelinia* spp. from the stomach, and *Pterobothrium lesteri* Campbell & Beveridge, 1996, *Pseudogrillotia perelica* (Shuler, 1938), *Callitetrarhynchus gracilis* Pintner, 1931, *Proemotobothrium southwelli* Beveridge & Campbell, 2001, *Otobothrium carcharidis* (Shipley & Hornell, 1906), *Otobothrium* sp., *Halysiorhynchus macrocephalus* (Shipley & Hornell, 1906), *Trygonicola macropora* (Shipley & Hornell, 1906), *Eutetrarhynchus platycephali* Palm, 2004, *Eutetrarhynchus* sp., *Oncomegoides celatus* Beveridge & Campbell, 2005, *Parachristianella monomegacantha* Kruse, 1959, *P. indonesiensis* Palm, 2004, *Parachristianella* sp., *Pseudochristianella southwelli* Campbell & Beveridge, 1990, *Prochristianella macracantha* Palm, 2004, *Prochristianella* spp. and *Dollfusiella* spp. from the host intestine. The most abundant trypanorhynchs were *Dollfusiella* that were found in seven different elasmobranch species. *Pastinachus* cf. *sephen* (Forsskål) was most species rich, with at least eight different trypanorhynch species. Highest prevalence (100%) was recorded for *Pseudochristianella southwelli* with a maximum intensity of 24 in *Rhinobatos* cf. *punctifer* Compagno & Randall (n=5). Within the elasmobranchs, highest prevalence (83.3%) was seen for *Otobothrium carcharidis* with a maximum intensity of 39 in *Rhizoprionodon acutus* (Rüppell). Host specificity values were recalculated for *Kotorella pronosoma*, *Pseudogrillotia perelica*, *Callitetrarhynchus gracilis* and *Proemotobothrium southwelli*.

Key words: Trypanorhyncha; fish parasites; sharks; rays; host specificity; zoogeographical distribution

Introduction

The order Trypanorhyncha Diesing, 1863 is a cosmopolitan group of marine cestodes, with more than 270 recorded species (Palm 2010). Larval trypanorhynchs parasitize marine invertebrates or teleosts, and the adults are among the most common parasites of elasmobranchs (Palm 2004; Palm *et al*. 2009). They have been reported to be less host specific than other parasite taxa (Palm & Caira 2008), making them an interesting group to study as biological indicators in the marine environment. Trypanorhynchs are common teleost parasites especially in the tropical and subtropical regions, according to the relative abundance and species richness of their elasmobranch final hosts.

Fish parasites are a major component of marine biodiversity, with cestodes playing a significant role in aquatic environments (Rohde 2005; Kuris *et al*. 2008). Parasites can be used as biological indicators for fish stock separation (Mackenzie 1983; Moser 1991; Arthur 1997; Williams *et al*. 1992; Humphreys *et al*. 1993; Mackenzie & Abaunza 1998; Malek 2004; Mackenzie *et al*. 2008), feeding ecology of their fish hosts (Campbell *et al*. 1980; Palm 1999) and they also have been used as an early warning system to monitor pollution and environmental degradation (Mackenzie 1999; Sures *et al*. 1999; Thielen *et al*. 2004; Marcogliese 2005). Most recently, Palm and Rückert (2009) have presented a new method to monitor environmental change by using fish parasites.

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Following the statement that a fish is infested by an average of more than three metazoan parasite species throughout its life time (see Palm *et al*. 1999; Klimpel *et al*. 2001), the existence of a diverse teleost and elasmobranch fauna in the Persian Gulf (Randall *et al*. 1978; Carpenter *et al*. 1997; Assadi & Dehghani 1997) makes this region an interesting ecosystem to study. So far, no comprehensive survey of trypanorhynchs from the Persian Gulf (see Palm 2004) has been carried out. Data on trypanorhynchs from the Iranian side of the Persian Gulf are restricted to a *Pterobothrium* species from the intestine of a carangid (Mirzayans 1970), trypanorhynch larvae from *Scomber microlepidotus* Rüppell, a synonym of *Rastrelliger kanagurta* (Cuvier), and *Lutjanus coccineus* (Cuvier), a synonym of *Lutjanus gibbus* (Forsskål), from the area close to Bandar Lengeh (Ghiasi 1988), the trypanorhynch larvae from *Psettodes erumei* (Bloch & Schneider) isolated by Sheini mandani (1994), and the larvae of *Callitetrarhynchus* sp. and *Tetrarhynchus* sp. in *Epinephelus coioides* (Hamilton) in the western part of the Persian Gulf, Iran (Peighan *et al*. 2004). Other studies were published by Kardousha (1991), El Naffar *et al*. (1992), Saif *et al*. (1994), Kardousha (1999) and Hassan *et al*. (2002) who reported larval trypanorhynchs from commercially important fishes in the Persian Gulf or the western part of the Gulf of Oman. However, studies of adult trypanorhynchs in the Persian Gulf are practically non-existent. Haseli (2005) for the first time studied the cestode parasites of the White cheek shark, *Carcharhinus* cf. *dussumieri* (Müller & Henle), from waters off Hormozgan and Boushehr, Iran, and recorded four species of trypanorhynchs, including *Callitetrarhynchus gracilis* Pintner, 1931, *Pseudogrillotia* sp., *Proemotobothrium* sp. and *Heteronybelinia heteromorphi* Palm, 1999.

The purpose of the present study was an examination of the trypanorhynch fauna of several elasmobranchs collected from the Persian Gulf, adding information to the comprehensive host data for trypanorhynchs published by Palm (2004). Host specificity indices at the species level were calculated to update adult host specificity data published by Palm and Caira (2008).

Materials and methods

During November–December 2007, a total of 194 elasmobranchs belonging to *Carcharhinus* cf. *dussumieri* (10 males and 25 females, 400 to 5500 g), *Rhizoprionodon acutus* (Rüppell) (13 males and 5 females, 650 to 2250 g), *Carcharhinus* cf. *sorrah* (Müller & Henle) (1 male and 2 females, 2500 to 16000 g), *Gymnura* cf. *poecilura* (Shaw) (11 males and 24 females, 300 to 7500 g), *Himantura* sp. (7 males and 28 females, 400 to 5000 g), *Aetomylaeus* cf. *nichofii* (Bloch & Schneider) (16 males and 11 females, 400 to 3200 g), *Pastinachus* cf. *sephen* (Forsskål) (7 males and 4 females, 2800 to 8000 g), *Himantura imbricata* (Bloch & Schneider) (5 males and 4 females, 200 to 450 g), *Torpedo sinuspersici* Olfers (5 males and 3 females, 900 to 2000 g), *Rhina ancylostoma* Bloch & Schneider (1 female, 5000 g), *Rhinobatos* cf. *punctifer* Compagno & Randall (5 females, 800 to 2000 g), *Himantura* cf. *uarnak* (Gmelin) (1 male and 1 female, 20000 to 24000 g), *Rhynchobatus* sp. (1 male, 15000 g), *Rhinoptera* sp. (2 females, 9000 g) and *Aetomylaeus maculatus* (Gray) (2 males, 1000 to 4000 g) were collected on board the research vessel *Ferdous I* at a water depth of between 12–89 m in the Persian Gulf (26° 15’–27° 07’N, 52° 53’–56° 28’ E).

Directly after catching, identification was carried out according to published keys for the Persian Gulf (Compagno 1984; Bianchi 1985; Randall 1995; Assadi & Dehghani 1997; Carpenter *et al*. 1997). An ongoing molecular study suggests these taxa are distinct from the typical forms (G. Naylor pers. comm), leaving an ambiguous situation for elasmobranchs from the Persian Gulf. For this reason, we use cf. for most of the elasmobranchs in the present study.

Biometry of the elasmobranchs was taken directly on board. The body cavity was opened, the intestine and stomach removed, and subsequently opened longitudinally before placement into a plastic bag with 10% seawater-buffered formalin. The plastic bags were shaken for 30 seconds to fix the whole tissue including the worms, and transported to the laboratory. Removed trypanorhynchs were stored in 70% ethanol, stained in acetic carmine, dehydrated in an alcohol series, cleared in methyl salicylate and mounted on slides in Canada balsam.

Identification was carried out using original descriptions and available keys (Palm 2004). The following scolex measurements were made: Scolex length (SL), scolex width at pars bulbosa (SW at pb), scolex width at pars bothrialis (SW at pbo), scolex width at pars vaginalis (SW at pv), pars bothrialis (pbo), pars vaginalis (pv), pars bulbosa (pb), pars post bulbosa (ppb), velum (vel), scolex proportion (SP) that is the ratio of the lengths of the three scolex regions pbo, pb and pv, bulb length (BL), bulb width (BW), bulb ratio (BR), width of tentacle sheaths (TSW), tentacle width (TW) and tentacle length (TL). All measurements are given in micrometers. Voucher specimens have been deposited in the ZUTC, Collection of the Zoological Museum, University of Tehran, Tehran, Iran (ZUTC Platy 1153, *Kotorella pronosoma* (Stossich, 1901); ZUTC Platy 1167, *Kotorella* sp.; ZUTC Platy 1168, *Nybelinia* sp. I; ZUTC Platy 1166, *Nybelinia* sp. II; ZUTC Platy 1122, *Pterobothrium lesteri* Campbell & Beveridge, 1996; ZUTC Platy 1169, ZUTC Platy 1170, ZUTC Platy 1171, *Pseudogrillotia perelica* (Shuler, 1938); ZUTC Platy 1120, ZUTC Platy 1161, ZUTC Platy 1162, ZUTC Platy 1163, *Callitetrarhynchus gracilis*; ZUTC Platy 1119, ZUTC Platy 1121, *Proemotobothrium southwelli* Beveridge & Campbell, 2001; ZUTC Platy 1114, ZUTC Platy 1116, ZUTC Platy 1133, ZUTC Platy 1134, ZUTC Platy 1135, ZUTC Platy 1136, ZUTC Platy 1137, *Otobothrium carcharidis* (Shipley & Hornell, 1906); ZUTC Platy 1113, ZUTC Platy 1115, *Otobothrium* sp.; ZUTC Platy 1138, ZUTC Platy 1139, ZUTC Platy 1140, *Halysiorhynchus macrocephalus* (Shipley & Hornell, 1906); ZUTC Platy 1142, ZUTC Platy 1172, ZUTC Platy 1173, ZUTC Platy 1174, *Trygonicola macropora* (Shipley & Hornell, 1906); ZUTC Platy 1109, ZUTC Platy 1110, ZUTC Platy 1111, *Eutetrarhynchus platycephali* Palm, 2004; ZUTC Platy 1160, ZUTC Platy 1177, *Eutetrarhynchus* sp.; ZUTC Platy 1123, *Oncomegoides celatus* Beveridge & Campbell, 2005; ZUTC Platy 1154, *Parachristianella monomegacantha* Kruse, 1959; ZUTC Platy 1112, ZUTC Platy 1126, ZUTC Platy 1128, ZUTC Platy 1131, ZUTC Platy 1141, ZUTC Platy 1147, ZUTC Platy 1150, ZUTC Platy 1152, ZUTC Platy 1155, *Parachristianella indonesiensis* Palm, 2004; ZUTC Platy 1179, *Parachristianella* sp.; ZUTC Platy 1157, ZUTC Platy 1158, *Pseudochristianella southwelli* Campbell & Beveridge, 1990; ZUTC Platy 1117, *Prochristianella macracantha* Palm, 2004; ZUTC Platy 1125, ZUTC Platy 1127, ZUTC Platy 1130, ZUTC Platy 1156, ZUTC Platy 1175, ZUTC Platy 1180, *Prochristianella*; ZUTC Platy 1118, ZUTC Platy 1124, ZUTC Platy 1129, ZUTC Platy 1132, ZUTC Platy 1143, ZUTC Platy 1144, ZUTC Platy 1145, ZUTC Platy 1146, ZUTC Platy 1148, ZUTC Platy 1149, ZUTC Platy 1151, ZUTC Platy 1159, ZUTC Platy 1164, ZUTC Platy 1176, ZUTC Platy 1178, ZUTC Platy 1181, *Dollfusiella*), and the ZMB, Zoological Museum Berlin, Germany.

Data analyses of the parasites and hosts were conducted using SPSS Package, ver. 13. Dominance indices for each host were calculated according to Magurran (1988). The terms prevalence, mean abundance and mean intensity were used according to Bush *et al*. (1997). Data normality was assessed using the Kolmogorov-Smirnov test. For normally distributed data, two independent sample *t*-test and One-Way ANOVA were performed. Otherwise, the Mann-Whitney *U* test and Kruskal-Wallis test were applied. Statistical analyses were not applied for the parasites with low prevalence and abundance. Host specificity indices were calculated according to Caira *et al*. (2003).

Results

A total of 14 trypanorhynchs were identified to species level. Because of a number of specimens with invaginated tentacles, eight taxa were identified to the genus level. All identified species, except *Callitetrarhynchus gracilis* and the genus *Nybelinia* Poche, 1926 represent new locality records. Twenty–three new host records are established (Table 1).

TABLE 1. Abundance, prevalence, mean intensity, intensity and infection site of the cestodes found in the elasmobranchs from the Persian Gulf, showing significant differences of abundance and prevalence of each parasite species among the hosts. New host records are indicated in light grey.

Site of infection	$\chi 2$ *(P)*	Prevalence (%)	Mean intensity± SE	Statistical analysis (*P*)	Mean abundance± SE	Intensity	Host species	Parasite species
								Tentaculariidae Poche, 1926
Stomach		50%	1		0.5±0.5	1	*Himantura* cf. *uarnak*	*Kotorella pronosoma*
		100%	2		2	2	*Rhynchobatus* sp.	
Stomach		11.1%	1		0.11±0.11	1	*Himantura imbricata*	*Kotorella* sp.
Stomach		5.6%	1		0.05±0.05	1	*Rhizoprionodon acutus*	*Nybelinia* sp. I
Stomach		11.1%	3		0.33±0.33	3	*Himantura imbricata*	*Nybelinia* sp. II
								Pterobothriidae Pintner, 1931
Intestine		2.9%	1		0.02±0.02	1	*Gymnura* cf. *poecilura*	*Pterobothrium lesteri*
								Lacistorhynchidae Guiart, 1927
Intestine		20%	3.28±1.96		0.65±0.43	1–15	*Carcharhinus* cf. *dussumieri*	*Pseudogrillotia perelica*
Intestine		31.4%	1.36±0.20		0.42±0.12	1–3	*Carcharhinus* cf. *dussumieri*	*Callitetrarhynchus gracilis*
		27.8%	1.60±0.60		0.44±0.23	1–4	*Rhizoprionodon acutus*	
		33.3%	2		0.66±0.66	2	*Carcharhinus* cf. *sorrah*	

TABLE 1. (continued)

Site of infection	$\chi^{2\ (P)}$	Prevalence (%)	Mean intensity± SE	Statistical analysis (*P*)	Mean abundance± SE	Intensity	Host species	Parasite species
								Otobothriidae Dollfus, 1942
Intestine		2.9%	1		0.02±0.02	1	*Carcharhinus* cf. *dussumieri*	*Proemotobothrium southwelli*
		2.9%	1		0.02±0.02	1	*Gymnura* cf. *poecilura*	
		16.7%	1		0.16±0.09	1	*Rhizoprionodon acutus*	
Intestine	$^{1\&3}$ 5.15 (p=0.023)	51.4%	10±4.14	Mann-Whitney U test	5.14±2.26	1–60	1. *Carcharhinus dussumieri*	*Otobothrium carcharidis*
		33.3%	7	$^{1\&3}$ 161.5 (P=0.003)	2.33±2.33	7	2. *Carcharhinus* cf. *sorrah*	
		83.3%	11.46±2.57		9.55±2.37	1–39	3. *Rhizoprionodon acutus*	
Intestine		14.3%	9±5.06		1.28±0.85	1–28	*Carcharhinus* cf. *dussumieri*	*Otobothrium* sp.
		5.6%	97		5.38±5.38	97	*Rhizoprionodon acutus*	
								Mixodigmatidae Dailey & Vogelbein, 1982
Intestine		18.2%	5±4	Mann-Whitney U test	0.90±0.81	1-9	*Pastinachus* cf. *sephen*	*Halysiorhynchus macrocephalus*
		100%	14	0.000 (p=0.037)	14	14	*Rhynchobatus* sp.	
Intestine	$^{1\&2}$ 9.69 (p=0.002)	2.9%	1	Mann-Whitney U test	0.02±0.02	1	1. *Himantura* sp.	*Trygonicola macropora*
	$^{1\&3}$ 15.87 (<0.005)	36.4%	1.25±0.25	$^{1\&3}$ 36.5 (p<0.005)	0.45±0.20	1-2	2. *Pastinachus* cf. *sephen*	
	$^{1\&4}$ 8.22 (p=004)	60%	3±1.15	$^{1\&4}$ 18 (p=004)	1.80±0.96	1-5	3. *Rhinobatos* cf. *punctifer*	
		50%	6		3±3	6	4. *Himantura* cf. *uarnak*	

TABLE 1. (continued)

Site of infection	$\chi^{2(P)}$	Prevalence (%)	Mean intensity± SE	Statistical analysis (*P*)	Mean abundance± SE	Intensity	Host species	Parasite species
								Eutetrarhynchidae Guiart, 1927
Intestine		22.9%	1±0.0001		0.22±0.07	1	*Himantura* sp.	*Eutetrarhynchus platycephali*
		20%	1		0.20±0.20	1	*Rhinobatos* cf. *punctifer*	
		9.1%	1		0.09±0.09	1	*Pastinachus* cf. *sephen*	
Intestine		11.4%	2±0.40		0.22±0.11	1–3	*Himantura* sp.	*Oncomegoides celatus*
Intestine		36.4%	3±1.22		1.09±0.60	1–6	*Pastinachus* cf. *sephen*	*Parachristianella monomegacantha*
		50%	6		3±3	6	*Himantura* cf. *uarnak*	
		100%	19		19	19	*Rhynchobatus* sp.	
Intestine		77.1%	8.66±1.27	Independent - samples t test	6.68±1.16	1–25	1. *Himantura* sp.	*Parachristianella indonesiensis*
		54.5%	2.50±0.84	[1&2] 4.07	1.36±0.59	1–6	2. *Pastinachus* cf. *sephen*	
		50%	66	($p<0.005$)	33±33	66	3. *Himantura* cf. *uarnak*	
		100%	2		2	2	4. *Rhynchobatus* sp.	
Intestine		100%	10.80±3.51		10.80±3.51	3–24	*Rhinobatos* cf. *punctifer*	*Pseudochristianella southwelli*
Intestine		9.1%	4		0.36±0.36	4	*Pastinachus* cf. *sephen*	*Prochristianella macracantha*

TABLE 1. (continued)

Site of infection	$\chi^{2(P)}$	Prevalence (%)	Mean intensity± SE	Statistical analysis (*P*)	Mean abundance± SE	Intensity	Host species	Parasite species
Intestine	$^{1\&4}$ 6 (p=0.014)	33.3%	12.66±4.33	Mann-Whitney U test	4.22±2.45	5–20	1. *Himantura imbricata*	*Prochristianella* spp.
	$^{2\&4}$ 9.74	37.1%	3.69±0.90	$^{1\&4}$ 86 (p=0.017)	1.37±0.44	1–10	2. *Himantura* sp.	
	(p=0.002)	27.3%	1.66±0.66	$^{2\&4}$ 321	0.45±0.28	1–3	3. *Pastinachus* cf. *sephen*	
	$^{3\&4}$ 4.61 (p=0.032)	3.7%	15	(p=0.003) $^{3\&4}$ 115 (p=0.043)	0.55±0.55	15	4. *Aetomylaeus* cf. *nichofii*	
Intestine		66.7%	8±4.43	Mann-Whitney U test	5.33±3.15	2–30	*1. Himantura imbricata*	*Dollfusiella* spp.
		66.7%	2.50±0.60	$^{2\&3}$ 270.5 (p=0.003)	1.66±0.46	1–9	*2. Aetomylaeus* cf. *nichofii*	
		71.4%	14.68±2.49		10.48±2.10	1–51	*3. Himantura* sp.	
		63.6%	6.14±1.28	Independent-	3.90±1.22	1–10	*4. Pastinachus* cf. *sephen*	
		50%	17	samples t test $^{3\&6}$ 3.30	8.5±8.5	17	*5. Aetomylaeus maculatus*	
		80%	3±1.41	(p=0.002)	2.40±1.24	1–7	*6. Rhinobatos* cf. *punctifer*	
		50%	19		9.5±9.5	19	*7. Himantura* cf. *uarnak*	
Intestine		33.3%	1.66±0.66		0.55±0.33	1–3	*Himantura imbricata*	*Parachristianella* sp.
Intestine		22.2%	2.5±1.5		0.55±0.44	1–4	*Himantura imbricata*	*Eutetrarhynchus* sp.
		20%	1		0.20±0.20	1	*Rhinobatos* cf. *punctifer*	

Species identification

Superfamily Eutetrarhynchoidea Guiart, 1927

Two species belonged to the family Mixodigmatidae Dailey & Vogelbein, 1982, including *Halysiorhynchus macrocephalus* and *Trygonicola macropora*.

The Eutetrarhynchidae Guiart, 1927 was the most diverse family. A total of six parasite species were identified, including *Eutetrarhynchus platycephali*, *Oncomegoides celatus*, *Parachristianella indonesiensis*, *P. monomegacantha*, *Pseudochristianella southwelli* and *Prochristianella macracantha*. Because of invaginated tentacles, other taxa were identified to the genus level only, including *Prochristianella* Dollfus, 1946, *Parachristianella* Dollfus, 1946, *Dollfusiella* Campbell and Beveridge, 1994 and *Eutetrarhynchus* Pintner, 1913 (Figure 2). For *P. macracantha* (Figure 1) which has been known only from Indonesia (Palm 2004) and Australia (Campbell & Beveridge 2009) and also for *E. platycephali* (Figure 2), which has been known so far only from Indonesia (Palm 2004), the following measurements were made.

Prochristianella macracantha
(Fig. 1)

(N=4): SL=1362 (1214–1601), SW at pb=228 (170–299), SW at pbo=171 (141–196), SW at pv=193 (148–228), pbo=248 (209–294), bothrium length=245 (200–282), TW=27 (23–29) basal, TW=17 metabasal, TL=1540 (1372–1748), pv=867 (747–966), TSW=25 (17–30), pb=502 (411–588), BL=487 (380–576), BW=92 (49–146), BR=5.3, SP=1:3.5:1.7. Metabasal armature heteroacanthous typical, heteromorphous, in ascending half spirals of 8–9 solid hooks; hooks 1(1′), L=7 (6–8), B=5 (2–9). Hooks 2 (2′), L=8, B=4. Hooks 3 (3′)–6 (6′), L=8 (7–10), B=3. Hooks 7 (7′)–9 (9′), L=6 (5–7), B=2. Characteristic basal armature present. First 1-2 row of hooks small, uncinate, L=8, B=5. Large uncinate hooks in basal armature, L=16 (14–17), B=9 (7–11). Next rows with hastate hooks, L=7 (6–8), B=3. Basal swelling with long hooks on antibothrial surface, L=9 (8–10), B=1. Uncinate hooks with long base on basal swelling, L=5, B=4 (3–5); bill hooks on bothrial surface of basal swelling, L=5, B=9 (8–10). Long worms, L=6721 (6688–6753), with 11–12 segments. Strobila acraspedote. Mature segment, L=1794 (1472–2116), W=331. Cirrus sac 172 in diameter. Number of testes 50–58, arranged in 2 longitudinal rows; testes 111 (93–130) in diameter. Ovarian lobes, L=277 (233–322), W=59 (54–64). Mehli's' gland, L=129 (98–159), W=80 (61–98). Vitelline follicles, L=56 (54–59), W=27 (25–29).

Remarks: *Prochristianella macracantha* was described for the first time by Palm (2004) from the spiral valve of *Pastinachus sephen* from Pelabuhan Ratu, Indonesia. Campbell and Beveridge (2009) reported *P. macracantha* in *Pastinachus areus* (= *P. sephen* Forsskål) from the northern coast of Australia. Our specimens identified as *P. macracantha* were isolated also from *P.* cf. *sephen* in the present study, and the scolex measurements of the specimens from the localities correspond. The occurrence of this species is extended from the northern coast of Australia and the north-western part of the Indian Ocean into the Persian Gulf.

Eutetrarhynchus platycephali
(Fig. 2)

(N=5): SL=3321 (2731–4058), SW at pbo=420 (270–673), SW at pb=376 (362-398), pbo=423 (320–497), TW=65 (57–72) basal, TW=71 (65–76) metabasal. TL=1953 (1811–2166), pv=1890 (1538–2471), TSW=71 (57–80), pb=1430 (1308–1541), ppb=18 (0–50), BL=1396 (1192–1512), BW=166 (142–199), BR=8.4, SP=1:4.5:1.3. Metabasal armature heteroacanthous typical, homeomorphous, in ascending half spirals of hollow hooks; metabasal hooks, L=13 (10–17), B=5 (4–8). Characteristic basal armature absent. Basal hooks on bothrial surface, L=10 (9–11), B=5 (4–8). Basal hooks on antibothrial surface, L=10 (9–12). Single enlarged uncinate hook on 8^{th} row on external surface, L=19, B=13. Long worm, L=21369 (10712–30989), with 37–65 segments. Strobila acraspedote. Cirrus unarmed, cirrus sac lateral, postequatorial, L=231 (178–284), W=163 (114–213), Genital pore marginal. Mature segment longer than wide, L=1208, W=875. Testes preovarian, L=29 (17–48), W=45 (27–67). Ovary bilobed from dorsoventral view and posterior, ovarian lobe, L=264 (135–391), W=161 (121–178). Uterus median, tubular, reaching anterior extremity.

Remarks: This is the first description of the adult worms of *Eutetrarhynchus platycephali* from the intestine of *Himantura* sp., *Rhinobatos* cf. *punctifer* and *Pastinachus* cf. *sephen*. The morphological characters of the scolex and armature correspond to those presented by Palm (2004), who recorded the plerocerci from the gills of an unidentified Platycephalidae from Pelabuhan Ratu, Indonesia. Beside the characteristic scolex shape and measurements, the single enlarged uncinate hook in the 8th row on external tentacle surface was clearly evident. The specimens from the Persian Gulf are slightly smaller than those from Indonesia. The occurrence of this species in the Gulf extends the known range of distribution from Indonesian waters to the north-western Indian Ocean.

TABLE 2. Dominance indices of parasite species.

Host species	Dominant parasite species	Dominance index
Himantura imbricata	*Dollfusiella* spp.	0.48
Aetomylaeus cf. *nichofii*	*Dollfusiella* spp.	0.75
Carcharhinus cf. *dussumieri*	*Otobothrium carcharidis*	0.68
Gymnura cf. *poecilura*	*Pterobothrium lesteri* and *Proemotobothrium southwelli*	0.5
Himantura sp.	*Dollfusiella* spp.	0.55
Pastinachus cf. *sephen*	*Dollfusiella* spp.	0.45
Aetomylaeus maculatus	*Dollfusiella* spp.	1
Carcharhinus cf. *sorrah*	*Otobothrium carcharidis*	0.78
Rhinobatos cf. *punctifer*	*Pseudochristianella southwelli*	0.70
Himantura cf. *uarnak*	*Parachristianella indonesiensis*	0.67
Rhynchobatus sp.	*Parachristianella monomegacantha*	0.51
Rhizoprionodon acutus	*Otobothrium carcharidis*	0.61

Superfamily Tentacularioidea Poche, 1926

The parasites belonging to the family Tentaculariidae Poche, 1926 included two specimens of *K. pronosoma* from the stomach of *H.* cf. *uarnak* and *Rhynchobatus* sp. One single specimen of an unidentified *Kotorella* sp. was isolated from the stomach of *H. imbricata*. Four specimens of *Nybelinia* Poche, 1926 with partly invaginated tentacles were recorded from the studied elasmobranchs. A single specimen of *Nybelinia* sp. I was isolated from the stomach of *R. acutus*, and three specimens of *Nybelinia* sp. II were isolated from the stomach of *H. imbricata* (Figure 3). Neither could be identified to the species level, lacking information on the metabasal armature. They could be distinguished according to the scolex measurements. They corresponded in TSW, hook length and hook base of the basal armature but differed in most other characters. Because of the poor condition of the strobila of *Nybelinia* sp. II, the total worm length, number of segments and size of the cirrus sac could not be compared.

For *Nybelinia* sp. I, the following measurements were made (n=1): SL=456, SW at pb=279, pbo=270, TL=201, TW=37 basal, pv=147, pb=189, vel=162, BL=159, BW=61, BR=2.6, TSW=27, SP=1:1.8:1.4. Falcate to uncinate solid hooks on base, L=11 (7–12), B=7 (5–10). Long worm, L=15732 with 80 segments; strobila acraspedote; final segment, L=1196, W=736, testes, L=74, W=44; ovary central, L=193, W=129; cirrus sac, W=51. For *Nybelinia* sp. II, the following measurements were made (n=3): SL=791 (736–828), SW at pb=573 (524–644), pbo=580 (524–644), pv=506 (414–598), pb=259 (239–282), TW=25 basal, TL=540 (432–649), vel=113 (101–129), BL=235 (225–248), BW=121 (110–130), BR=1.9, TSW=29, SP=1:2.2:1.1. Falcate solid hooks on base, L=12, B=7. Strobila acraspedote. Testes numerous, L=29, W=17; ovary central, L=202, W=147.

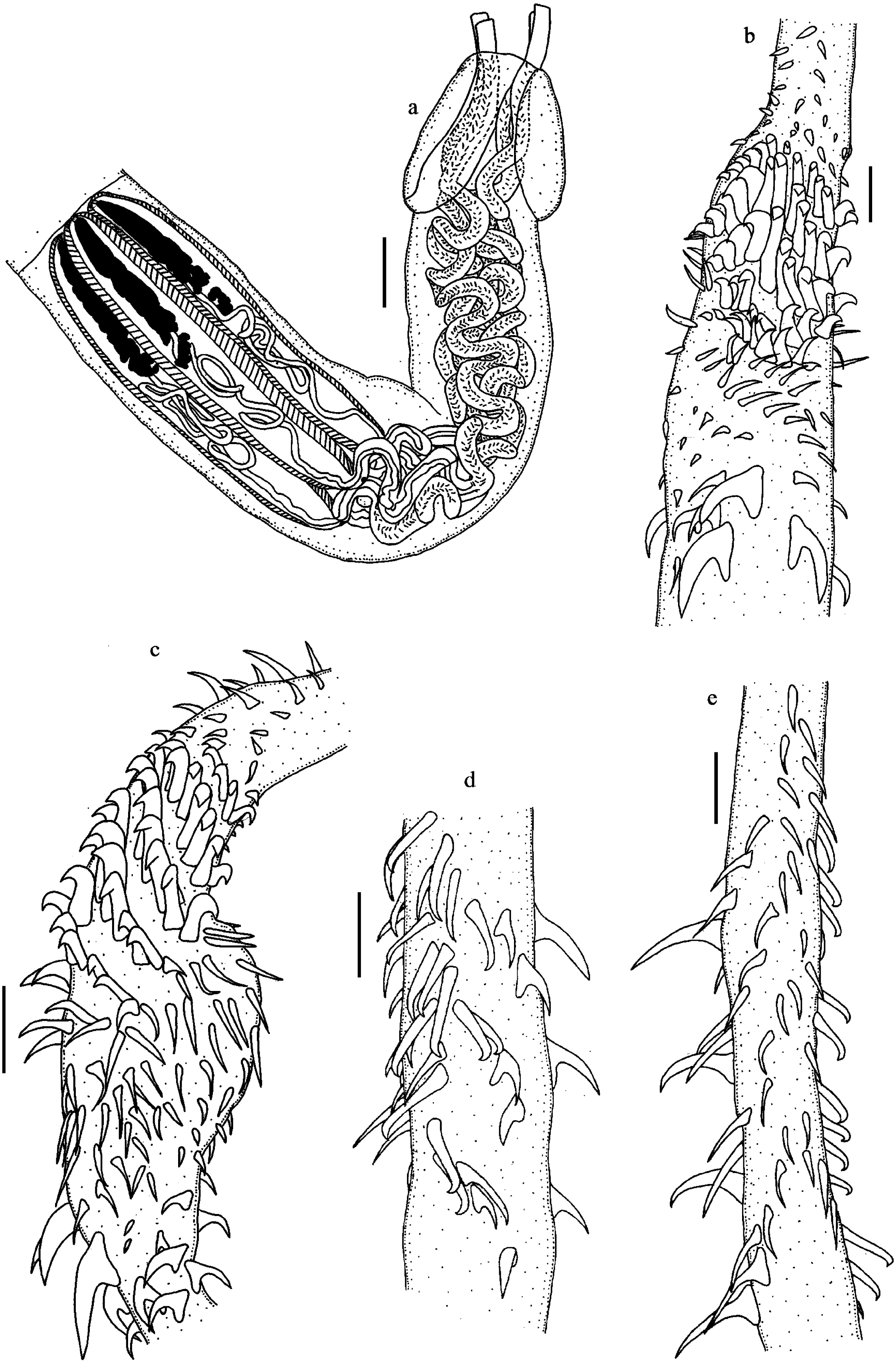

FIGURE 1 a–e. *Prochristianella macracantha*. **a.** Scolex. **b.** Bothrial surface, basal armature. **c.** External surface, basal armature. **d.** Internal surface, metabasal armature. **e.** Bothrial surface, metabasal armature. Scale bars: a, 100; b–e, 10.

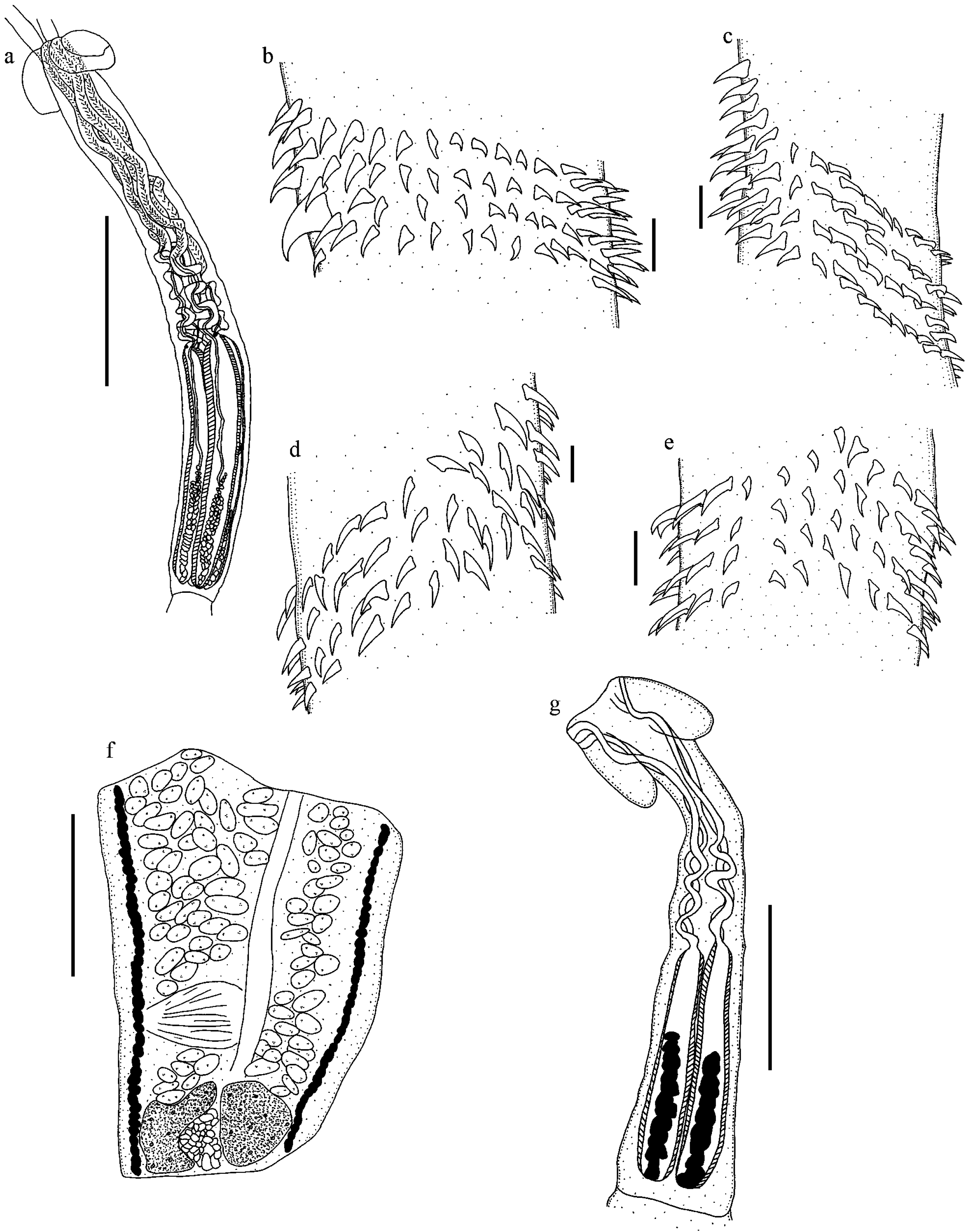

FIGURE 2 a–f. *Eutetrarhynchus platycephali*. **a.** Scolex. **b.** External surface, basal armature. **c.** Internal surface, metabasal armature. **d.** Bothrial surface, metabasal armature. **e.** External surface, metabasal armature. **f.** Mature segment. **Fig. 2 g.** *Eutetrarhynchus* sp. Scale bars: a, 1000; b–e, 10; f, 500; g, 100.

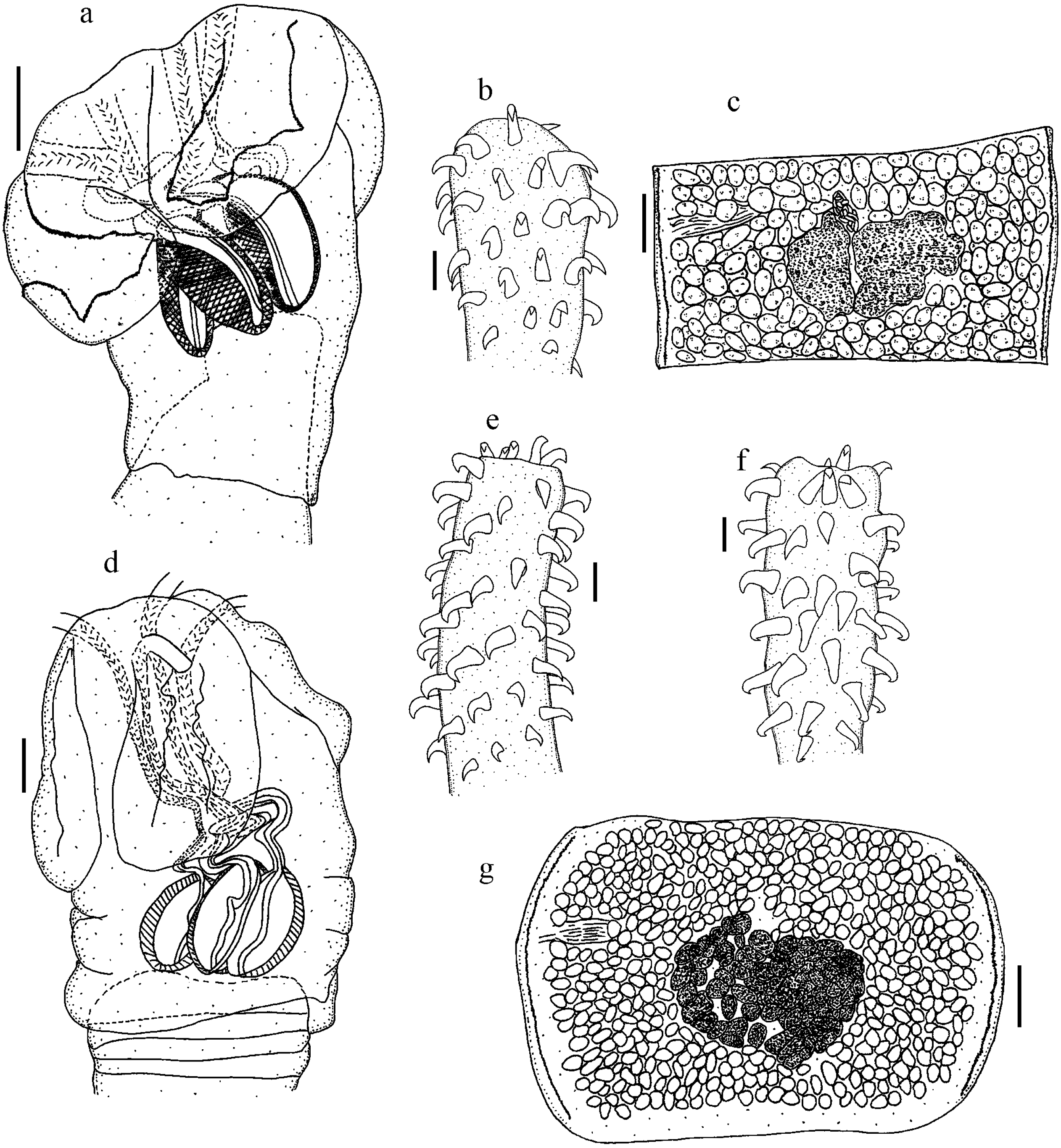

FIGURE 3 a–d. *Nybelinia* sp. I from the stomach of *R. acutus*. **a.** Scolex. **b.** Bothrial surface, basal armature. **c.** Mature segment. **Fig. 3 d–g**. *Nybelinia* sp. II from the stomach of *Himantura imbricata*. **d.** Scolex. **e.** Bothrial surface, basal armature. **f.** Antibothrial surface, basal armature. **g.** Mature segment. Scale bars: a, c, d, g, 100; b, e, f, 10.

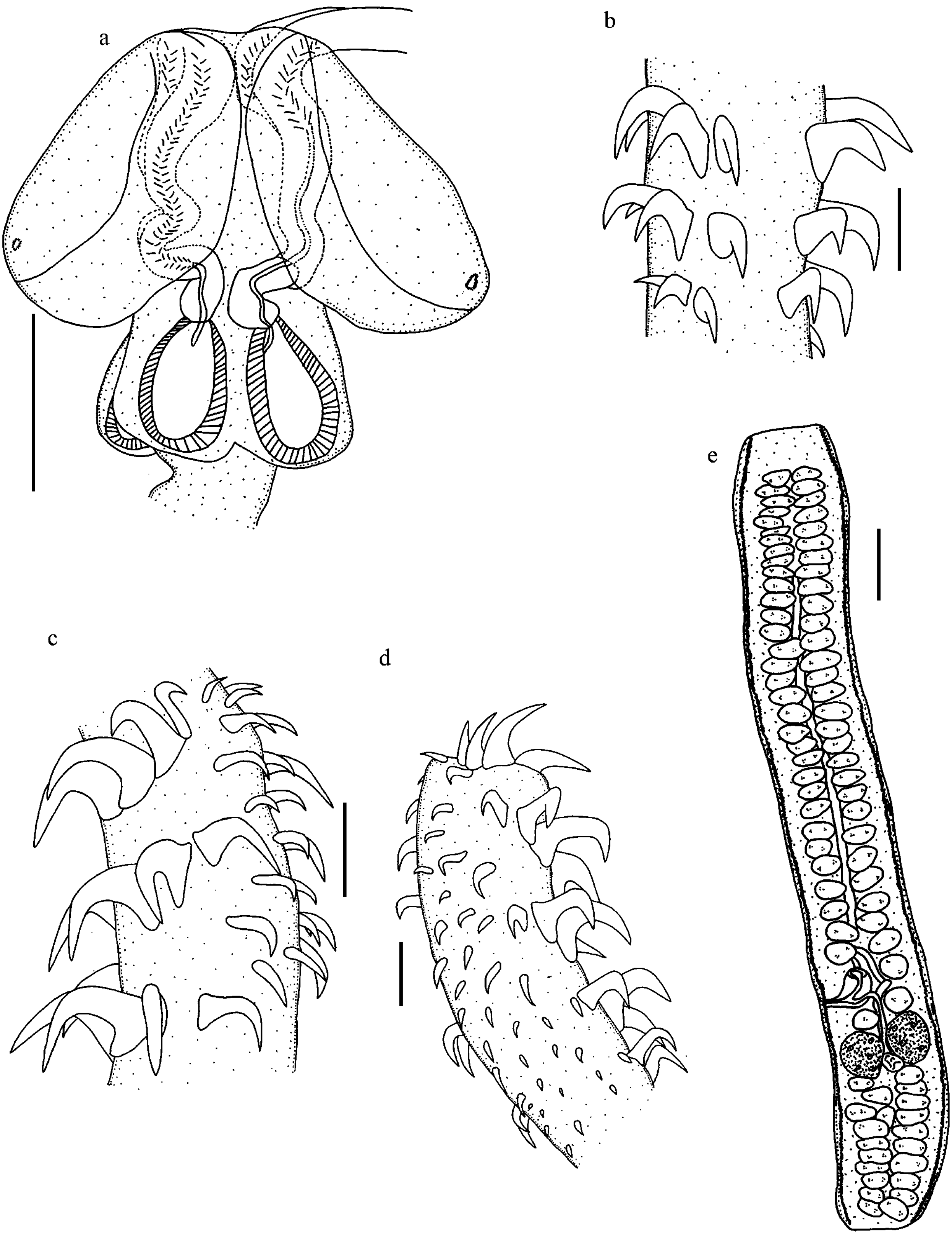

FIGURE 4 a–e. *Otobothrium* sp. **a.** Scolex. **b.** Internal surface, basal armature. **c.** Bothrial surface, basal armature. **d.** External surface, basal armature. **e.** Mature segment. Scale bars: a, e, 100; b–d, 10.

Superfamily Lacistorhynchoidea Guiart, 1927

A single specimen of *Pterobothrium lesteri*, family Pterobothriidae Pintner, 1931, from the intestine of *G*. cf. *poecilura*, was found. Two species, *Pseudogrillotia perelica* and *Callitetrarhynchus gracilis*, belonged to the family Lacistorhynchidae Guiart, 1927.

P. lesteri from the Persian Gulf corresponded to the morphological characters described by Campbell and Beveridge (1996). The characters used included: acraspedote scolex, 4 oval bothria, elongate bulbs, metabasal armature heteroacanthous, multiatypical heteromorphous, principal rows with 5 hollow hooks, single intercalary row of 3–4 spiniform hooks, a band of hooks on the external surface and an acraspedote strobila. The specimen found in *G.* cf. *poecilura* was smaller than that described by Campbell and Beveridge (1996) (SL=1343 vs. 2600–4800, SW at pbo 189 vs. 500–700, SW at pb 225 vs. 500–840, bothrium length 233 vs. 280–460 and bothrium width 56 vs. 210–270).

Superfamily Otobothrioidea Dollfus, 1942

Three distinct species belonged to the family Otobothriidae Dollfus, 1942, including *Otobothrium carcharidis*, *Proemotobothrium southwelli* and *Otobothrium* sp. from *C*. cf. *dussumieri* and *R*. *acutus* (Figure 4).

For *Otobothrium* sp., the following measurements were made (n=5): SL= 231 (208–255), SW at pb=122 (103–145), pbo=191 (172–208), bothrium length=191 (179–213), bothrium width=129 (120–137), TW=22 (17–27) basal, TL=181 (172–184), bothrial pit diameter=12 (10–12), pv=172 (147–196), pb=104 (93–113), BL=85 (81–91), BW=49 (44–56), BR=1.7, SP=1:1.8:1.1. Metabasal armature heteroacanthous atypical, heteromorphous, in ascending half spirals of 6 or 7 hollow hooks; Hooks 1(1′), L=15 (14–17), B=9 (7–10). Hooks 2 (2′), L=15 (14–17), B=7 (6–8). Hooks 3 (3′), L=12 (10–13), B=7 (6–8). Hooks 4 (4′), L=10, B=4 (3–5). Hooks 5(5′), L=6 (5–7), B=2. Hooks 6 (6′), L=5 (4–6), B=0.1. Single intercalary row of 3 hooks between each principal row, L=7 (5–9), B=2. Characteristic basal armature absent. Small worm, L=4743 (3146–5976), with 12–16 segments. Strobila acraspedote. Mature segment, L=1538 (1122–1748), W=205 (175–244). Genital pore 478 (350–598) from posterior end of proglottid. Hermaphroditic sac, L=91 (74–110) W=69 (49–86). Internal seminal vesicle small, L=38 (29–54), W=15 (12–17). Number of testes 76–85, arranged in 2 longitudinal rows; testes L=32 (25–37), W=74 (61–93). Ovarian lobe, L=89 (61–122), W=74 (61–101). Mehli’s' gland, 44 (37–49) in diameter. Vitelline follicles, L= 27 (22–32), W= 15 (12–20).

This species corresponds closely with *Otobothrium curtum* (Linton, 1909) Dollfus, 1942 as redescribed by Beveridge and Justine (2007). However, the present specimens of *Otobothrium* sp. differ from *O*. *curtum* in possessing bothrial pits and a different number of testes. *Otobothrium curtum* lacks any bothrial pit. The number of testes in *Otobothrium curtum* is higher than for *Otobothrium* sp. (289–345 per segment vs. 76–85).

Data analyses

The prevalence, mean abundance, mean intensity, intensity and site of infection with the results of the statistical analyses are given in Table 1. Prevalence and Mean abundance of *O*. *carcharidi*s in *R*. *acutus* were significantly higher than in *C*. cf. *dussumieri*. Mean abundance of *H*. *macrocephalus* in *Rhynchobatus* sp. was significantly higher than in *P*. cf. *sephen*. Prevalence and mean abundance of *T. macropora* in *R*. cf. *punctifer* and *H*. cf. *uarnak* were significantly higher than in *Himantura* sp. and prevalence of *T. macropora* in *P.* cf. *sephen* was also significantly higher than in *Himantura* sp.. Mean abundance of *P. indonesiensis* in *Himantura* sp. was significantly higher than in *P.* cf. *sephen*. Prevalence and mean abundance of *Prochristianella* spp. in *H*. *imbricata* and *Himantura* sp. were significantly higher than in *A*. cf. *nichofii*. Prevalence of *Prochristianella* spp. in *P.* cf. *sephen* was significantly higher than in *A*. cf. *nichofii*, but mean abundance in *A*. cf. *nichofii* was significantly higher than in *P.* cf. *sephen.* Mean abundance of *Dollfusiella* spp. in *Himantura* sp. was significantly higher than in *A*. cf. *nichofii* and *R*. cf. *punctifer*, respectively. Dominance indices were calculated for the dominant parasite species in each host species (Table 2). *Dollfusiella* was the predominant parasite taxon at a prevalence of 50% to 80%. It must be kept in mind that this most probably is a composite of different species.

Host specificity values were calculated for the parasites identified to the species level. For each trypanorhynch, two values were calculated. The first value describes the host specificity index for elasmobranchs from the Persian Gulf, and the second updates the dataset published by Palm (2004) and Palm and Caira (2008) (Table 3). The host specificity index of *Oncomegoides celatus* was calculated by using Beveridge and Campbell (2005). Host specificity values of *Kotorella pronosoma*, *Pseudogrillotia perelica*, *Callitetrarhynchus gracilis* and *Proemotobothrium southwelli* were updated according to Palm and Caira (2008).

Discussion

The present study is the first large-scale investigation on adult trypanorhynch cestodes of elasmobranchs from the Persian Gulf. Previous studies identified a variety of larval trypanorhynchs from the region (Mirzayans 1970; Ghiasi 1988; Kardousha 1991; El Naffar *et al*. 1992; Saif *et al*. 1994; Sheini mandani 1994; Kardousha 1999; Hassan *et al*. 2002; Peighan *et al*. 2004), but only Haseli (2005) identified adult trypanorhynchs. A total of 23 new host and new locality records are established.

With the description of 22 different trypanorhynch taxa and the earlier records from the Persian Gulf and the Gulf of Oman region, as many as 47 trypanorhynch taxa (including taxa not identified to the species level) are known from this northwestern tip of the Indian Ocean (Mirzayans 1970; Tirgari *et al*. 1975; El Naffar *et al*. 1992; Saif *et al*. 1994; Kardousha 1999; Hassan *et al*. 2002; Palm 2004; Peighan *et al*. 2004; Haseli 2005; present study). Most abundant are the lacistorhynchids such as *Callitetrarhynchus gracilis*, where both the hosts of the adults and the plerocerci have been reported. A variety of teleosts are intermediate hosts for *Callitetrarhynchus* Pintner, 1931 (Kardousha 1999; Hassan *et al*. 2002; Palm 2004; Peighan *et al*. 2004; Abdou & Palm 2008) and *Floriceps* Cuvier, 1817 (Palm 2004; Abdou & Palm 2008) in the region, with carcharhinids being the typical final hosts, *Carcharhinus* cf. *dussumieri*, *Carcharhinus* cf. *sorrah*, and *Rhizoprionodon acutus* in the Persian Gulf.

Other common parasites of carcharhinid sharks were *Otobothrium carcharidis*, *Otobothrium* sp. and the grillotiid *Pseudogrillotia perelica*. The life cycle suggested for the superfamilies Lacistorhynchoidea Guiart, 1927 and Otobothrioidea Dollfus, 1942 includes either three hosts with copepods as the first intermediate, teleosts as second intermediate and elasmobranchs as the final hosts, or with four hosts including copepods as the first intermediate, schooling fish as second and larger predatory fish as the third intermediate and elasmobranchs as the final hosts (Palm *et al*. 1994; Palm 2004). We suggest that as is the case with *C. gracilis*, the entire life cycles of the other recorded lacistorhynchids and otobothriids also occur within the Persian Gulf. The most species-rich group of trypanorhynchs was the eutetrarhynchoids, common parasites of rajiforms (Palm *et al*. 2009). This is most probably biased by the higher number of ray species that were studied. However, because all elasmobranchs were obtained with trawl fisheries, the studied species might be representative for the region. The life cycle of the eutetrarhynchoids includes three hosts, with copepods as the first, benthic or coastal invertebrates, e.g. penaeids as second intermediate and elasmobranchs as the final hosts (Palm 2004).

Only a few specimens belonging to the family Tentaculariidae including *Kotorella pronosoma*, *Kotorella* sp. and four specimens of *Nybelinia* were recorded from the studied elasmobranchs. According to Palm *et al*. (1997) and Palm (2004), the life cycle proposed for the Tentacularioidea Poche, 1926, especially for the genus *Nybelinia*, includes four or more hosts, with copepods as first, euphausiids or schooling fish as second intermediate hosts and fish as third intermediate or paratenic hosts. As stated by Palm *et al*. (1994) and Palm (2004), the intermediate hosts play an important role in the completion of the life cycle of trypanorhynchs. In comparison to other localities such as the Indonesian coast, the occurrence of tentaculariids in the Persian Gulf seems to be scarce. Jakob and Palm (2006) studied six different teleost species from the southern Java

TABLE 3. Host specificity values for adult trypanorhynchs

Trypanorhynch family	Trypanorhynch species	Adult hosts from the Persian Gulf					Rank	Adult HS_S (The Persian Gulf)	Adult hosts in the world					Rank	Adult HS_S (total)	Category of host specificity (globally)
		No. Species	No. Genera	No. Families	No. Orders	No. Classes			No. Species	No. Genera	No. Families	No. Orders	No. Classes			
Tentaculariidae	*Kotorella pronosoma*	2	2	2	1	1	375251	5.57432185	14	7	4	2	1	46414297	7.66665177	Euryxenous
Pterobothriidae	*Pterobothrium lesteri*	1	1	1	1	1	1	0.00000000	2	1	1	1	1	2	0.3010299956	Mesostenoxenous
Lacistorhynchidae	*Pseudogrillotia perelica*	1	1	1	1	1	1	0.00000000	3	2	1	1	1	1002	3.0008677215	Metastenoxenous
Lacistorhynchidae	*Callitetrarhynchus gracilis*	5	3	2	1	1	376252	5.57547881	20	8	4	2	1	46415296	7.666661124	Euryxenous
Otobothriidae	*Proemotobothrium southwelli*	4	3	2	2	1	45664801	7.65958156	6	4	3	2	1	46039051	7.6631263629	Euryxenous
Otobothriidae	*Otobothrium carcharidis*	4	2	1	1	1	1003	3.00130093	5	2	1	1	1	1004	3.0017337128	Metastenoxenous
Mixodigmatidae	*Halysiorhynchus macrocephalus*	2	2	2	1	1	375251	5.57432185	6	5	3	1	1	751497	5.8759272512	Euryxenous
Mixodigmatidae	*Trygonicola macropora*	4	3	2	1	1	376251	5.575477662	8	5	3	1	1	751499	5.8759284070	Euryxenous
Eutetrarhynchidae	*Eutetrarhynchus platycephali*	3	3	2	1	1	376250	5.575476508	3	3	2	1	1	376250	5.575476508	Euryxenous
Eutetrarhynchidae	*Oncomegoides celatus*	1	1	1	1	1	1	0.000000000	3	2	1	1	1	1002	3.0008677215	Metastenoxenous
Eutetrarhynchidae	*Parachristianella monomegacantha*	3	3	2	1	1	376250	5.575476508	18	9	5	2	1	46787542	7.6701302299	Euryxenous
Eutetrarhynchidae	*Parachristianella indonesiensis*	4	3	2	1	1	376251	5.575477662	5	4	2	1	1	377249	5.5766280972	Euryxenous
Eutetrarhynchidae	*Pseudochristianella southwelli*	1	1	1	1	1	1	0.000000000	3	2	2	2	1	45663802	7.6595720683	Euryxenous
Eutetrarhynchidae	*Prochristianella macracantha*	1	1	1	1	1	1	0.000000000	1	1	1	1	1	1	0.0000000000	Oioxenous

coast, Indonesia, and isolated six tentacularioids at a high prevalence between 2.5-100%. Also the elasmobranchs such as thresher sharks and the rajiform were highly infected (Palm 2000, 2004). The infection of 16 different teleost fish species off the Mozambique coast with six tentacularioids was even higher, ranging mainly from about 30 to 100% (Palm *et al*. 1997). This contrasts the very few specimens of tentacularioids in the sampled 194 elasmobranchs in the present study. In teleosts, only El Naffar *et al*. (1992) reported *Nybelinia* sp. from *Upeneus tragula* Richardson at a prevalence of 11.4% and from *Saurida tumbil* (Bloch) at a prevalence of 2.7% along the coast of the United Arab Emirates. Kardousha (1999) reported *Nybelinia indica* Chandra, 1986 from *Alepes djedaba* (Forsskål) and *Tentacularia coryphaenae* Bosc, 1797 from *Euthynnus affinis* (Cantor) at a prevalence of 6.7% along the coasts of the United Arab Emirates, and Palm (2004) reported *Nybelinia indica* from *Epinephelus tauvina* (Forsskål) and *Nemipterus japonicus* (Bloch) from the southern part and northern side of the Persian Gulf. Haseli (2005) recorded *Heteronybelinia heteromorphi* from *Carcharhinus* cf. *dussumieri*.

Possible reasons for less abundance of tentacularioids in the Persian Gulf might be linked to the abundance of some required intermediate hosts, such as the euphausiids, or the absence of oceanic shark species, e.g. thresher sharks. Another explanation might be the characteristics of the Persian Gulf. The dominant water current in the Persian Gulf is a counter clockwise movement with less saline water entering the Strait of Hormuz at the surface, flowing northwards along the Iranian coast. The salinity of this northern current is strongly influenced by some rivers in the north, such as Tigris, Euphrates, Karun, Hendijan, Hileh and Mand (Hunter 1983; Reynolds 1993). While the bottom of the Persian Gulf is mostly muddy in the northern part, the southern part especially around Qatar and the United Arab Emirates is mostly sandy (Emery 1956). Food resources, depth, salinity and temperature mainly influence the distribution and species composition of the copepod first intermediate hosts (Islam *et al*. 2005; Gaard *et al*. 2008). According to Zhaoli (2007) and Yoon *et al*. (2000), temperature, salinity and chlorophyll *a* concentration are main important ecological factors for the spatial distribution of euphausiids. Therefore, ecological differences in the north and south of the Persian Gulf may influence the abundance and species composition of the required intermediate and available final hosts, promoting especially the lacistorhynchoids and eutetrarhynchoids.

Palm (2004) suggested that the Indonesian archipelago is at the centre of trypanorhynch distribution, with more than 50 species recorded from a single locality alone, from Pelabuhan Ratu at the southern Java coast. Indonesia has the highest marine biodiversity respective to the number of elasmobranch and teleost fish species, offering a species rich host fauna for these cestodes. According to the Australian Biological Resources Study, over 100 trypanorhynch species have been described from Australian waters, and also the Indian waters are known for a high number of trypanorhynchs (Beveridge & Campbell 1998). With the present record of *Eutetrarhynchus platycephali*, *Parachristianella indonesiensis* and *Prochristianella macracantha*, species formerly known only from Indonesia and Australia also occur in the Persian Gulf. Other components of the trypanorhynch fauna, such as *Kotorella pronosoma*, *Nybelinia indica*, *Tentacularia coryphaenae*, *Callitetrarhynchus gracilis*, *Otobothrium carcharidis* and *Halysiorhynchus macrocephalus* have been described from the Indian coast, Indonesia and Australia (Zaidi & Khan 1976; Chandra 1986; Bilqees & Khurshid 1988; Bates 1990; Arthur & Ahmed 2002; Palm 2004). It seems as if the Indian Ocean through the Bay of Bengal links the Persian Gulf to the waters of the Indonesian archipelago, suggesting the whole region from the northwestern Indian Ocean to the Australian coastal waters being connected and most important for the trypanorhynch distribution, and possibly evolution. This is supported by the fact that many trypanorhynchs have restricted host specificity, enabling them to explore a wide range of hosts and habitats (Palm *et al*. 2007, 2009).

Based on the existing data, we cannot conclude so far that the parasite distribution patterns in the Indo-West Pacific directly match those of their final hosts. According to Kellermanns *et al*. (2007) and Palm *et al*. (2008), factors such as a) extensive final host migrations, b) overlapping distribution patterns of different final host populations, c) low host specificity and large population sizes in the intermediate and final hosts, and d) extensive final combined with intermediate host migrations influence the gene flow in fish parasitic helminths, such as the cosmopolitan *Tentacularia coryphaenae*. Low host specificity in trypanorhynchs allows exploitation of new hosts and habitats, increasing a possible range of distribution. Palm and Caira

(2008) demonstrated that the host specificity Hs for the final larval stages of 63 trypanorhynchs was 6.29 and the average value for the corresponding adult trypanorhynchs was 3.86. This together with a diverse elasmobranch fauna can explain the extension of the species distribution for species from the Austral-Indonesian region into the Persian Gulf. For the first time, the host specificity index Hs (Caira *et al*. 2003) was calculated for a diversity of trypanorhynch from a single ecosystem, the Persian Gulf (Table 3). Two out of the five locally oioxenous species are metastenoxenous globally (Palm & Caira 2008). This might be explained by the fact that the elasmobranchs from the Persian Gulf constitute a small portion of the known species, and some elasmobranchs were not sampled in the present investigation. *Pseudochristianella southwelli* was oioxenous locally but euryxenous globally. According to the parasite host checklist of Palm (2004), this parasite species can infest *Carcharhinus* sp. and *Rhinobatos halavi* (Forsskål), synonym of *Glaucostegus halavi* (Forsskål), as well. Similarly *Oncomegoides celatus* is oioxenous locally and metastenoxenous globally. *Prochristianella macracantha* was isolated from *P.* cf. *sephen* and is considered oioxenous locally and globally as well.

Most interestingly, the host specificity category for the rest of the trypanorhynch species identified is often similar for the Persian Gulf and globally. This supports the observation by Palm and Caira (2008), and demonstrates the ability of many trypanorhynchs to infect a wide range of different hosts. According to Palm *et al*. (2009), a similar feeding ecology enabled host switching from carcharhiniforms into rajiforms in trypanorhynch evolution, suggesting that host ecology is more important for the trypanorhynch occurrence than its phylogeny. The present study extends the known range of distribution for a variety of trypanorhynchs from the Indian Ocean into the Persian Gulf, demonstrating a species rich community within the region. We are aware that some of the taxa could not be identified to the species level, due to partly invaginated tentacles that did not reveal most of their important taxonomic features. Further collections however, will reveal an even richer trypanorhynch fauna in the Gulf region. For the first time, the host specificity index was applied for a trypanorhynch community within a distinct ecosystem, mainly supporting the statements by Palm and Caira (2008). This can explain the extensive range of distribution for many species, and also the species richness within the semi-enclosed ecosystem of the Persian Gulf.

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