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Metazoan parasites of *Mycteroperca bonaci* (Epinephelidae) off the coast of Yucatán, Mexico, with a checklist of its parasites in the Gulf of Mexico and Caribbean region

Parásitos metazoarios de *Mycteroperca bonaci* (Epinephelidae) de las costas de Yucatán, México, con una lista de sus parásitos registrados en el golfo de México y la región del Caribe

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Abstract. Samples of black grouper, *Mycteroperca bonaci*, totalling 161 specimens, were collected at 3 protected natural areas in Yucatán, Mexico: Reserva de la Biosfera Ría Celestún (RBRC), Reserva Estatal de Dzilam (RED), and the Parque Nacional Arrecife Alacranes (PNAA). In this study, we present the results of a survey of the metazoan parasite fauna of these fishes, together with a checklist of the metazoan parasites recorded previously from black grouper in the Gulf of Mexico and the Caribbean Sea. Twenty five taxa were found in the survey (21 adults and 4 larval stages). Nineteen taxa represent new host records for *M. bonaci,* increasing the total number of parasite taxa recorded for this host species to 59 in the geographic area referred above. Differences in species composition and infection parameters of each group of parasites are presented and discussed.

Key words: ectoparasites, endoparasites, marine fish, arrecife Alacranes, black grouper, Caribbean Sea, *Dollfustrema* sp.

Resumen. En este trabajo se presentan los resultados del estudio parasitológico de 161 "negrillos" *Mycteroperca bonaci* recolectados en 3 áreas naturales protegidas del estado de Yucatán, México: Reserva de la Biosfera Ría Celestún (RBRC), Reserva Estatal de Dzilam (RED) y el Parque Nacional Arrecife Alacranes (PNAA). Asimismo, se presenta la lista de metazoarios parásitos registrados en este hospedero hasta el momento en la región del golfo de México. Como resultado de este estudio, se reportan 25 taxa parasitando esta especie de pez, de los cuales 21 se encontraron en fase adulta y 4 en etapa larvaria. Diecinueve de los taxa encontrados son reportados por primera vez para este hospedero, incrementándose a 59 el número total para este hospedero en la región.

Palabras clave: ectoparasitos, endoparasitos, peces marinos, arrecife Alacranes, negrillos, mar Caribe, *Dollfustrema* sp.

Introduction

The black grouper, *Mycteroperca bonaci* (Poey, 1960), is one of the most important species for commercial fisheries in Bermuda, Gulf of Mexico, Cuba and Venezuela (Heemstra and Randall, 1993). In the Yucatán Peninsula, all the serranid species are included in the "mero" fishery (Sánchez-Salazar et al., 1999). By both number of individuals and weight of landings, *M. bonaci* is one of the 3 most important species in this fishery (Brulé et al., 2008). Unfortunately, information on the parasite fauna of this species in the Southeast of Mexico is limited to a few taxonomic records. In spite of the economic and ecological importance of *M. bonaci* in the region, only 3 parasite species have previously been recorded: 1 monogenean (Vidal-Martínez and Mendoza-Franco, 1998) and 2 nematodes (González-Solís et al., 2002; Mejía-Madrid and Guillén-Hernández, 2011).

Fish parasites can be important from the economic and medical point of view; they are also potentially useful as indicators of human impact on the environment, of possible phylogenetic relationships between host and parasite, of host diet and migrations, and can be used as biological tags in fish stock identification (Williams et al., 1992; Williams and Jones, 1994; Lafferty, 1997; MacKenzie and Abaunza, 2005; Marcogliese, 2005; Sasal et al., 2007). In the Gulf of Mexico and the Caribbean Sea, 40 taxa have previously

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been reported as parasites of *M. bonaci*: 3 monogeneans, 4 cestodes, 15 digeneans, 5 nematodes, 7 copepods, and 6 isopods.

The main goals of this paper are to present the results of a survey of metazoan parasites recorded from *M. bonaci* in 3 localities in the state of Yucatán, and to update the checklist of metazoan parasites reported for this fish species in the Gulf of Mexico and the Caribbean Sea.

Materials and methods

Samples were taken from 3 protected natural areas (Table 1): Reserva de la Biosfera Ría Celestún (RBRC) (20°51'34" N and 90°24'69" W), Reserva Estatal de Dzilam (RED) (21°24'00" N and 88°50'52" W), and Parque Nacional Arrecife Alacranes (PNAA) (22°22'41" N and 89°30'57" W). The RBRC is located in the east region and RED in the west region of the state; both areas are coastal and include 2 of the main ports of the state. On the other hand, PNAA is a reef located at 130 km from the coast and is an important fishing area.

Fish were provided by the artisanal fishermen or caught with hook and line. When fish were obtained by artisanal fishermen, only the viscera were examined. During 2008 and 2009 only viscera were examined (see Table 1); during 2010 and 2011 further samples were collected and each entire fish was examined for both ecto- and endoparasites. A total of 161 hosts were examined from the 3 natural protected areas. Fish obtained by artisanal fishermen were not measured or weighed, but those caught with hook and line were measured (total length and standard length) and weighed (P). At PNNA 63 fish were collected and 23 were measured (TL= 40.14 ± 8.25; SL= 34.15 ± 7. 54; P= 873.44 ± 656. 08), at RBRC 54 fishes were examined and 38 were measured (Lt= 35.75 ± 7.52; Le= 31.17 ± 6.63; P= 605.59 ± 734.74) and finally at RED 44 fish were examined but none was measured or weighed.

Samples were transported to the laboratory in containers with ice and examined under microscopes. All parasites were studied fresh, counted *in situ* and then preserved in 70% alcohol and processed for subsequent identification by means of conventional helminthological methods (Lamothe-Argumedo, 1997). Parasitic copepods and isopods were fixed and stored in 70% alcohol. Voucher specimens of helminth species were deposited at Coleccion Nacional de Helmintos, Instituto de Biología, Universidad Nacional Autónoma de México, México City. Ecological parameters such as prevalence, mean intensity, and mean abundance were calculated following Bush et al. (1997).

Results

A total of 28 654 individual parasites belonging to 25 taxa, 9 of which were identified to species level, were found in the 161 fish examined (Table 2). Twenty-one taxa were found as adults and only 4 as larvae. Digeneans and nematodes were the groups with the highest number of taxa (8 each); monogeneans, acanthocephalans, isopods,

Table 1. Collection dates and number of hosts collected per month in each locality studied

Collection dates		*Number of hosts per locality*		
Year	*Month*	*PNAA*	*RBRC*	*RED*
2008	July	28	—	19
	August	—	13	25
	November	—	3	—
2009	May	3	—	—
2010	April	16	—	—
	September	10	—	—
	October	—	10	—
	November	—	5	—
	December	—	12	—
2011	January	—	11	—
	February	6	—	—
Total hosts revised for intestinal and ectoparasites		26	38	—
Total hosts revised for intestinal helminths only		63	54	44

PNAA= Parque Nacional Arrecife Alacranes, RBRC= Reserva de la biosfera Ria Celestun, RED= Reserva Estatal de Dzilam.

Table 2. Infection levels of the metazoan parasites of *M. bonaci* in 3 different localities of Yucatán, Mexico

	PNAA				*RBRC*				*RED*			
Parasites	*N*	*P (%)*	*AM ± DS*	*IM ± DS*	*N*	*P (%)*	*AM ± DS*	*IM ± DS*	*N*	*P (%)*	*AM ± DS*	*IM ± DS*
Monogenea												
Pseudorhabdosynochus sp.	26	6.45	0.28 ± 1.27	4.5 ± 3.53	38	—	—	—		—	—	—
Pseudorhabdosynochus capurroi (Vidal-Martínez and Mendoza-Franco, 1998)	26	45.16	6.78 ± 17.81	15.5 ± 24.71	38	50	7.57 ± 26.47	15.15 ± 36.32		—	—	—
Digenea												
Prosorhynchus atlanticus (Manter, 1940)	63	51.56	50.3 ± 148.4	96.1 ± 195.3	54	70.37	27.2 ± 83.13	38.5± 97.17	44	63.64	176.7± 416.70	170.7± 317.76
Prosorhynchus sp.	63	12.9	0.81 ± 3.89	12 ± 10.81	54	11.11	5.22 ± 21.72	47 ± 51.45	44	79.55	163.9 ± 405.61	199.4 ± 448.54
Bucephalidae gen. sp.	63	6.25	0.47 ± 2.72	7.5 ± 9.14	54	—	—	—	44	—	—	—
Paracryptogonimus sp.	63	—	—	—	54	1.85	0.12 ± 0.95	7.0 ±	44	—	—	—
Lepidapedoides epinepheli (Sogandares-Bernal, 1959)	63	17.18	1.17 ± 3.64	6.72 ± 6.42	54	51.85	7.85 ± 15.73	15.14 ± 19.26	44	43.18	1.89 ± 5.51	3.89 ± 7.72
Hamacreadium mutabile (Linton, 1910)	63	29.68	5.9 ± 17.65	19.6 ± 28.74	54	5.55	0.12 ± 0.70	2.33 ± 2.30	44			
Unidentified digeneans	63	3.4	0.06 ± 0.41	2 ± 1.41	54	—	—	—	44	—	—	—
Dollfustrema sp.	23	80	14.3 ± 17.83	20.9 ± 18.1	38	100	149.0 ± 121.81	153.0 ± 120.9		—	—	—
Cestoda												
Tetraphyllidea gen. sp.	63	—	—	—	54	1.85	0.04 ± 0.27	2 ± 0	44	2.27	0.07 ± 0.45	3.00
Acanthocephala												
Gorgorhynchus sp.	63	4.68	0.04 ± 0.21	1 ± 0	54	18.51	1.37 ± 4.14	7.30 ±7.14	44	59.09	4.89 ± 11.44	5.85 ± 6.14
Serrasentis sp.	23	—	—	—		5.26	0.07 ± 0.35	1.50 ± 0.70	—	—	—	—
Nematoda												
Pseudoterranova sp.	23	1.56	0.18 ± 1.06	6		12.96	0.28 ± 0.69	1.57 ± 0.78	—	—	—	—
Hysterothylacium fortalezae (Klein, 1973)	63	—	—	—	54	1.85	0.12 ± 0.95	7 ± 0	44	15.91	0.70 ± 2.68	4.43 ± 5.68
Hysterothylacium sp.	63	20.31	0.79 ± 2.24	3.84 ± 3.74	54	16.6	1.22 ± 4.99	7.33 ± 10.71	44	2.27	0.05 ± 0.30	2.00
Cucullanus mycteropercae (Mejía-Madrid and Guillén-Hernández, 2011)	63	—	—	—	54	—	—	—	44	20.45	1.07 ± 3.45	5.22 ± 6.30

Table 2. Continues

	PNAA				*RBRC*				*RED*			
Parasites	*N*	*P (%)*	*AM ± DS*	*IM ± DS*	*N*	*P (%)*	*AM ± DS*	*IM ± DS*	*N*	*P (%)*	*AM ± DS*	*IM ± DS*
Raphidascaris sp.	63	12.5	1 ± 3.67	7. 87 ± 7.6	54	—	—	—	44	2.27	0.02 ± 0.15	1.00
Dichelyne bonacii (González-Solís et al., 2002)	63	—	—	—	54	1.85	0.12 ± 0.95	7 ± 0	44	—	—	—
Philometra salgadoi (Vidal-Martínez et al., 1995)	26	42.42	2.65 ± 5.97	6.07 ± 7.92	38	10.52	0.28 ± 1.03	2.75 ± 2.06		—	—	—
Philometra sp.	26	27.27	0.87 ± 2.88	3.11 ± 4.93	38	26.31	0.65 ± 1.27	2.5 ± 1.26		—	—	—
Copepoda												
Lernanthropus sp.	26	—	—	—	38	55.26	1.52 ± 2.07	2.76 ± 2.09		—	—	—
Hatschekia insolita (Wilson, 1913)												
Syn. *Hatschekia serrana* (Pearse, 1952)	26	36.36	0.96 ± 1.92	2.5 ± 2.43	38	10.52	0.73 ± 2.94	7.0 ± 6.97		—	—	—
Isopoda												
Gnathia sp.	26	21.21	1.06 ± 2.46	4.85 ± 3.13	38	60.52	3.55 ± 5.26	5.86 ± 5.69		—	—	—
Tridentella sp.	26	9.09	0.09 ± 0.29	1 ± 0	38	13.15	0.42 ± 1.38	3.20 ± 2.58		—	—	—

PNAA= Parque Nacional Arrecife Alacranes, RBRC= Reserva de la biosfera Ria Celestun, RED= Reserva Estatal de Dzilam. N= number of hosts examined; P(%)= prevalence; AM= mean abundance; IM= mean intensity; SD= standard deviation.

and copepods had 2 each and only one taxon of cestodes was found. Twenty out of the 25 taxa are new host records for *M. bonaci*.

The greatest number of taxa were found at Celestún (20) followed by Arrecife Alacranes (18) and Dzilam de Bravo (9). Arrecife Alacranes and Celestún share 58.3% (14 out of 24 species) of the parasite species, while Arrecife Alacranes and Dzilam share 6 (46.1%) and Celestun and Dzilam 7 (53.8%) of the 13 species found in the intestine of this host species.

The intestine was the site of infection where the largest number of different parasite taxa (13) was found. This was followed by the gills with 7 taxa. Gills were examined only in fish samples from Arrecife Alacranes and Celestun; 4 parasite taxa were shared between those samples.

Overall, digeneans showed the highest prevalence values, particularly *Prosorhynchus* sp., and *P. atlanticus* as adults. As larval stages (metacercariae), *Dollfustrema* sp. showed high prevalences at both Alacranes and Celestún, but mean abundance and mean intensity values were higher in samples collected from Celestún. Parasites with direct life cycles such as monogeneans, copepods, and isopods also showed high prevalences, but with lower mean abundances values than digeneans.

Discussion

Prior to this study, 40 metazoan parasite taxa were known to parasitize *M. bonaci* in the Gulf of Mexico and throughout the Caribbean Sea, but no data on infection levels were given in any of those studies. Previous records in Mexico showed the presence of 1 monogenean (Vidal-Martínez and Mendoza-Franco, 1998) and 2 nematodes in this host (González-Solís et al., 2002; Mejía-Madrid and Guillén-Hernández, 2011). Our data show that 19 out of the 25 species found at the 3 study sites in Yucatán are new records for *M. bonaci*, increasing the total number of parasite taxa recorded for this host species to 59 (Table 3).

Three species of monogeneans have been previously reported from *M. bonaci*: *Pseudorhabdosynochus capurroi* in Mexico and Puerto Rico (Vidal-Martínez and Mendoza-Franco, 1998; Medina-Ríos, 2008), *P. kritskyi* in Puerto Rico (Medina-Ríos, 2008) and *Diplectanum* sp. in Venezuela (Fuentes et al., 2009). It is possible that the monogeneans identified as *Pseudorhabdosynochus* sp. in this study belong to the species *P. kritskyi,* but the small number of collected individuals and the poor condition of the material precludes it specific determination.

Eight out of the 15 digenean taxa previously reported in *M. bonaci* were found in the present study. Bucephalids were the best represented with 4 taxa which constitute 50% of the taxa found. The high number of species belonging to this family recorded in the present survey, and the previous record of at least 37 species of the genus *Prosorhynchus* as parasites of *Mycteroperca* spp., may be an indication of a close phylogenetic relationship between this group of hosts and their parasites (Cribb et al., 2002).

Four taxa of cestodes had been previously reported in *M. bonaci* (Table 3). Since the cestode found in the present survey is a larval form, it was not possible to identify it to species level. Tetraphyllidean cestodes exhibit a narrow specificity to their final hosts (Williams and Jones, 1994; Marcogliese, 1995) and it is known that the elasmobranchs *Carcharhinus plumbeus* and *Sphyrna mokarran* prey on serranids (Jory and Iversen, 1989), so it is possible that adults of this parasite are present in those hosts.

This is the first time that the acanthocephalans *Gorgorhynchus* sp. and *Serrasentis* sp. have been reported as parasites of *M. bonaci*. Prevalence and mean abundance values for *Gorgorhynchus* sp. were lowest at Arrecife Alacranes, probably as a consequence of the intermediate host distribution. Prior to this report, *Gorgorhynchus gibber* was found in *Mycteroperca venenosa* (see Amin, 1998) and *G. clavatus* in *Epinephelus morio* (see Moravec et al., 1997). *Serrasentis* sp. infection in *M. bonaci* may be accidental or the parasite may use this fish as a paratenic host, since the parasites were found encysted in the mesenteries.

After digeneans, nematodes are the second group with most species parasitizing *M. bonaci*. Previous records in Mexico and the Yucatán Peninsula include *Dichelyne bonacii* (González-Solís et al., 2002) and *Cucullanus mycteropercae* (Mejía-Madrid and Guillén-Hernández, 2011). *Raphidascaris anchoviellae* has been found in *M. bonaci* from Florida (Linton, 1908), *Philometra lateolabracis* in Bermuda (Rees, 1970), and *Anisakis simplex* in Puerto Rico (Medina-Ríos, 2008), but they have not been found previously in Mexico. This last species uses cetaceans as natural final hosts but also can infect humans (Anderson, 2000).

Both *Lernanthropus* sp. (Copepoda) and *Gnathia* sp. (Isopoda) are new records for *M. bonaci*. Species of the genus *Gnathia* are not parasitic as adults, but their praniza larvae are (Kabata, 1970). Rohde (2005) reported that the Caribbean region shows a high diversity of ectoparasites; the small number of those parasites reported in Mexico could be a consequence of the lack of parasitological studies on those groups.

Previous studies on marine fish parasites off Yucatán had shown a pattern where the intestinal helminth-fauna was dominated by digenean species (Moravec et al., 1997; Sánchez-Ramírez and Vidal-Martínez, 2002; Argáez-García et al., 2010). The present study shows a

Table 3. Checklist of metazoan parasites reported from *Mycteroperca bonaci* in the Caribbean Sea and Gulf of Mexico, including records from the present study, localities and sites of infection

Parasite taxa	*Site of infection*	*Locality*	*Catalogue number #*	*Reference*
Monogenea				
Diplectanum sp.	G	Venezuela		Fuentes et al., 2009
Pseudorhabdosynochus capurroi	G	Yucatán, Mexico	8207	Vidal-Martínez and Mendoza-Franco 1998; Present study
Pseudorhabdosynochus kritskyi (Dyer et al., 1995)	G	Puerto Rico		Medina-Ríos, 2008
Pseudorhabdosynochus sp. *	G	Yucatán, Mexico	8206	Present study
Digenea				
Postporus epinepheli (Manter, 1947)		Florida, USA		Overstreet, 1969
Prosorhynchus atlanticus (Manter, 1940)	St, In, Pc	Florida, USA, Yucatán, Mexico	8208	Manter, 1947 Present study
*Prosorhynchus pacificum (*Manter 1940)	In	Florida, USA, Apalachee Bay, USA, Curacao, Jamaica, and Belice		Manter, 1940; Overstreet, 1969 Nahhas and Short, 1965 Nahhas and Short, 1965 Fischthal, 1977
*Prosorhynchus ozakii (*Manter 1934)		Curacao and Jamaica		Nahhas and Cable, 1964
Prosorhynchus promicropsi (Manter 1940)		Curacao		Yamaguti 1971
Prosorhynchus sp.*	St, In, Pc	Yucatán, Mexico	8209	Present study
Dollfustrema sp. *	F	Yucatán, Mexico	8214	Present study
Bucephalidae gen. sp. *	In	Yucatán, Mexico	8210	Present study
Paracryptogonimus sp. *	In	Yucatán, Mexico	8211	Present study
Didymozoidea gen. sp.		Puerto Rico		Medina-Ríos, 2008
Brachyphallus parvus (Manter, 1947) (as *Lecithochirum parvum*)	In	Florida, USA, Puerto Rico		Overstreet, 1969 Medina-Ríos, 2008
Lecithochirium microstomum (Chandler, 1935)	In	Florida, USA		Overstreet, 1969
Lecithochirium sp.	St	Puerto Rico		Medina-Ríos, 2008
Lepidapedoides nicolli (Manter,1934)		Venezuela		Nasir and Gómez, 1977
Lepidapedoides epinepheli (Sogandares-Bernal, 1959)*	St, In, Pc	Yucatán, Mexico	8212	Present study
Neolepidapedon mycteropercae (Siddiqi and Cable, 1960)		Curacao and Jamaica		Nahhas and Cable, 1964
Stephanostomum dentalum (Linton,1901)	In	Jamaica		Nahhas and Cable, 1964
Stephanostomum imparispine (Linton, 1905)	In	Puerto Rico		Medina-Ríos, 2008
Deretrema fusillus (Linton, 1940)	In	Curacao, Jamaica		Nahhas and Cable, 1964
Rhipidocotyle adbaculum (Manter,1940)	In	Puerto Rico		Medina-Ríos, 2008

Table 3. Continues

Parasite taxa	*Site of infection*	*Locality*	*Catalogue number #*	*Reference*
Hamacreadium mutabile (Linton, 1910) *	In	Yucatán, Mexico	8213	Present study
Helicometrina exacta (Linton, 1910)	In	Florida, USA		Manter, 1933
Cestoda				
Otobothrium curtum (Linton, 1909) Syn *Rhynchobothrium curtum*	In	Florida, USA		Linton, 1908
Scolex pleuronectis (Müller, 1788) Syn *Scolex polymorphus* Rudolphi	In	Florida, USA, Puerto Rico		Linton, 1908 Medina-Ríos, 2008
Callitetrarhynchus gracilis (Rudolphi, 1819) Syn *Rhynchobothrium speciosum* (Linton, 1897)	In	Florida, USA		Linton, 1908
Tetraphyllidea	In			Jensen, 2009
Tetraphyllidea gen. sp. *	Pc	Yucatán, Mexico		Present study
Acanthocephala				
Gorgorhynchus sp.	In	Yucatán, Mexico	8215	Present study
Serrasentis sp.	In	Yucatán, Mexico	8216	Present study
Nematoda				
Dichelyne bonacii (González-Solís Argáez-García and Guillén-Hernández, 2002)	In	Yucatán, Mexico Yucatán, Mexico	8222	González-Solís et al., 2002; Present study
Cucullanus mycteroperae (Mejía-Madrid and Guillén-Hernández, 2011)	In	Yucatán, Mexico	8220	Mejía-Madrid and Guillén-Hernández, 2011; Present study
Pseudoterranova sp. *	Me	Yucatán, Mexico	8217	Present study
Hysterothylacium fortalezae (Klein, 1973) *	In	Yucatán, Mexico	8219	Present study
Hysterothylacium sp. *	In, Pc	Yucatán, Mexico		Present study
Raphidascaris anchoviellae (Chandler, 1935)		Florida, USA		Linton, 1907 cited by Chandler, 1954
Raphidascaris sp. *	In	Yucatán, Mexico	8221	Present study
Philometra lateolabracis (Yamaguti, 1935)	Te	Bermuda		Rees, 1970
Philometra salgadoi (Vidal-Martínez Aguirre-Macedo and Moravec 1995) *	Oc	Yucatán, Mexico	8223	Present study
Philometra sp. *	Op, Ma	Yucatán, Mexico	8224	Present study
Copepoda				
Lepeophtheirus bonaci Pearse 1952	G			Williams, cited by Bullock and Smith, 1991

Table 3. Continues

Parasite taxa	*Site of infection*	*Locality*	*Catalogue number #*	*Reference*
Lepeophtheirus curtus (Wilson 1913) Syn. *Dentigyrps curtus* (Wilson, 1913)	G Bs	Colombia Brasil		Bunkley-Williams et al., 1999 Luque et al., 1998
Lepeophtheirus dissimulatus (Wilson 1905)	G	Colombia		Bunkley-Williams et al., 1999
Lepeophtheirus bermudensis (Heegaard 1943	G	Puerto Rico		Medina-Ríos, 2008
Hatschekia insolita (Wilson, 1913) valida Syn. *Hatschekia serrana* (Pearse, 1952)	G	Florida, USA, Yucatán, Mexico.		Pearse, 1952 Present study
Lernanthropus wilsoni Pearse 1952	G			Pearse, 1952
Lepeophtheirus bonaci Pearse 1952	G			Pearse, 1952
Lernanthropus sp. *	G	Yucatán, Mexico		Present study
Isopoda				
Aega tenuipes Schioedte & Meinert, 1880	No	Florida, USA		Williams, cited by Bullock and Smith, 1991
Alcirona krebsii, Hansen, 1890	No	Florida, USA		Williams, cited by Bullock and Smith 1991
Anilocra haemuli (Williams and Williams, 1981)	G	Colombia		Bunkley-Williams et al., 1999
Excorallana costata (Lemos de Castro, 1960)	G	Colombia		Bunkley-Williams et al., 1999
Tridentella virginiana (Richardson, 1905)	No G G	Florida, USA, Colombia, Puerto Rico		Williams, cited by Bullock and Smith, 1991 Bunkley-Williams et al., 1999 Medina-Ríos, 2008
Tridentella sp.*	G	Yucatán, Mexico		Present study
Gnathia sp.*	No G	Puerto Rico Yucatán, Mexico		Medina-Ríos, 2008 Present study
Cymothoa oestrum (Linnaeus, 1793)	G	Puerto Rico		Medina-Ríos, 2008

F= fins; G= gills; In= intestine; Ma= mandíble; Me= mesenteries; No= nasal cavity; Oc= ocular cavity; Op= operculum; Pc= pyloric caeca; St= stomach; GO= Gonad; *= new host record; #= reference number in National Collection of Helminths, UNAM.

similar pattern for *M. bonaci,* where 7 digenean taxa vs 4 nematode taxa were found in this organ.

The high number of parasites in adult stages in this host is probably a result of its role as a predator in the ecosystem (Parrish, 1987). The larval taxa found in this host comprised 1 cestode (Tetraphyllidea gen. sp.), 1 digenean (*Dollfustrema* sp.) and 1 nematode (*Pseudoterranova* sp.), which complete their life cycles in large predatory fishes or sea mammals.

Differences in the number of taxa and their infection levels found between localities may be related to sample size, season or the biotic and abiotic conditions at each locality. Dzilam de Bravo was the site with the lowest sample size and only fish intestines were examined, also samples were collected during only 2 months of the year. However, samples from Arrecife Alacranes and Celestún were larger, ecto and endoparasites were obtained, and samples were caught at different times of the year. These factors increased the probability of finding parasite taxa with strong seasonality or low prevalence values.

Differences in parasite abundances between localities, mainly those which infect the intestine, can be a result of the abundance and geographical distribution of the intermediate hosts, since most of these reach their final

hosts via a predator-prey relationship. Ectoparasites such as monogeneans and copepods, on the other hand, are strongly influenced by external environmental conditions. Previously 2 species belonging to the genus *Pseudorhabdosynochus* had been reported off the coast of Yucatán (*P. capurroi* in *M. bonaci* by Vidal-Martínez and Mendoza-Franco [1998] and *P. yucatanensis* in *E. morio* by Vidal-Martínez et al. [1997]). In the present survey, however, just 1 species was found at Celestún and 2 at Arrecife Alacranes. This difference may be related to the geographical distribution of the parasites, rather than a seasonal pattern, since that samples from Celestún were collected at different times of the year, which would rule out seasonality as an explanation for the difference. Prevalence and mean abundance values for *Gorgorhynchus* sp. were lower at Arrecife Alacranes, probably as a consequence of the intermediate host distribution.

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