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Helminth Parasite Communities of Two *Scorpaena* spp. (Scorpaenidae) From Reefs of Veracruz, Mexico

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Abstract

Scorpaena brasiliensis and *S. plumieri* are relevant fish species in reef systems, but little is known about their parasitic helminth communities and their structure. This paper describes such community in terms of species richness and diversity. A helminthological study was conducted on 33 specimens of *S. brasiliensis* and 36 *S. plumieri*, captured in the Pajaros and Cabezo Reefs, in the Veracruz Reef System National Park (VRSNP), Veracruz, Mexico. The helminth community structure was analyzed in both host species. A total of 10 parasitic species was registered in *S. brasiliensis* (5 digeneans, 1 cestode, 3 nematodes, 1 acanthocephalan), while *S. plumieri* hosted 11 species (4 digeneans, 1 monogenean, 1 cestode, 4 nematodes, 1 acanthocephalan), with 8 common species. The species with the highest prevalence were *Pseudocapillaria* (*Icthyocapillaria*) sp., with 18.2% and 19.4% in *S. brasiliensis* and *S. plumieri*, respectively. Component community richness for *S. brasiliensis* was S = 10, with Shannon index diversity value of H' = 2.08. For *S. plumieri*, such values were of S = 11 and H' = 1.91. Richness and diversity in the component and infracommunity levels for both hosts are lower than in other parasite communities of marine fishes in the southern Gulf of Mexico.

Keywords: richness, diversity, infracommunity, helminthes, parasites, Mexico

1. Introduction

Scorpenid fish are associated to rocky substrates and reef formations in the West Atlantic Ocean, and are distributed from the US to Brazil, including the Gulf of Mexico and the Caribbean Sea (Smith-Vaniz et al., 1999). Some species are popular due to sting injuries inflicted to unwary bathers (Field-Cortazares & Calderon-Campos, 2010), but most species have no commercial relevance given their low capture volumes, *i.e.*, *S. plumieri* (Haddad et al., 2003; Fuentes-Mata & Espinoza-Pérez, 2010). Information related to parasitic helminths on these hosts is scarce (Cervigón et al., 1992). Available records include *Helicometrina nimia* in *S. agassizii*; *H. nimia, Neopecoelus scorpaenae* and *Sterrhurus floridensis* in *S. brasiliensis*; *Derogenes varicus*, *Opecoelina scorpaenae* and *Pseudopecoelus vulgaris* in *S. cristulata*; *N. scorpaenae* in *S. grandicornis*; *Sterrhurus* sp. in *S. inermis*; *B. scorpaenae*, *H. nimia*, *S. floridensis* in *S. plumieri*, all from Florida, USA (Manter, 1947); *B. scorpaenae* in *S. plumieri* from Louisiana, USA (Corkum, 1967); *Lecithochirium parvum* and *L. microcercus* in *S. plumieri* from Puerto Rico (Dyer et al., 1985); *H. nimia* in *S. plumieri* from Puerto Rico (Siddiqi & Cable, 1960) and Brazil (Travassos et al., 1967; Roumbedakis et al., 2014); *Pseudopecoelus scorpaenae* in *S. plumieri* from Mexico (Pérez-Ponce de León et al., 2007). On the other hand, little is known about the community structure of helminth parasites in these hosts, as compared to other marine fish, such as carangids and lutjanids from the Southern Gulf of Mexico (Montoya-Mendoza et al., 2014, 2016, 2017a), or other commercially relevant species from the Caribbean region (Aguirre-Macedo et al., 2007). In this report we describe the helminth community of *S. brasiliensis* and *S. plumieri*, in terms of species richness and diversity.

2. Method

2.1 Sampling Procedures

From March to November, 2014, 33 specimens of *S. brasiliensis* and 36 of *S. plumieri* were collected for helminthological examination. Fish were captured with spear and SCUBA diving at 5-10 m depth in Pajaros Reef (19°18′33″N, 96°08′33″W) and Cabezo Reef (19°03′07″N, 95°52′05″W), in the Veracruz Reef System National Park (VRSNP), state of Veracruz, Mexico. Fish specimens were kept in plastic containers with ice and transported to the lab for examination within 24 hours post-capture. Tissues and organs were reviewed using a stereomicroscope. The external examination included skin, scales, fins, gills, eyes, nostrils, mouth, and anus. Gills were removed and analyzed separately in Petri dishes with seawater. Internal examination included mesenteries, liver, kidney, and gonads. The whole digestive system was placed in Petri dishes with 0.75% saline for examination. Helminths were fixed with hot 4% formalin and preserved in 70% ethyl alcohol, according to Lamothe (1997). Monogeneans, digeneans, cestodes, and acanthocephalans were stained using Mayer's paracarmine and Gomori's triple stain, and then dehydrated in a graded alcohol series, cleared with clove oil, and mounted whole in Canada balsam. Nematodes were studied on temporary slides and cleared in glycerin, after which they were preserved in 70% alcohol (Vidal-Martínez et al., 2001). Voucher specimens were deposited at the National Helminths Collection (*Colección Nacional de Helmintos*) (CNHE), Institute of Biology of the National Autonomous University, Mexico City. Prevalence (percentage of infected hosts) and mean intensity (mean number of parasites per infected fish), were calculated following Bush et al. (1997).

2.2 Sample Size

Helminth communities were analyzed at component community (all helminths in all individuals examined), and infracommunity (helminths in each single fish examined) levels (Holmes & Price, 1986; Bush et al., 1997). Sampling adequacy for the component community was evaluated with a procedure similar to that of the helminth parasites community as *L. campechanus* and *L. synagris* (Montoya-Mendoza et al., 2014; 2016), using a randomized (100x) sample-based species accumulation curve computed in EstimateS (version 8.0 RK Colwell, http://viceroy.eeb.unconn.edu/estimates) (Moreno & Halffter, 2001). To determine the component community, we examined the asymptotic richness based on the Clench's model equation (Soberón & Llorente, 1993), as well as the final slope of the randomized species accumulation curve (Jiménez-Valverde & Hortal, 2003). Clench's model is described by the following function:

$$V2 = (a \times V1)/[1 + (b \times V1)] \tag{1}$$

where, *V2* is observed richness, *V1* is the number of hosts examined; *a* and *b* are curve parameters: *a* equals the new species adding rate, and *b* is a parameter related to the curve shape. These values were calculated iteratively using the EstimateS and Statistica (StatSoft, Inc., Tulsa, Oklahoma) software, as in Jiménez-Valverde and Hortal (2003). The slope of the cumulative species curve was calculated as $a/(1 + b \times n)^2$, where *a* and *b* are parameters above, and *n* is the number of hosts examined from a given component. Clench's model equation allows estimating the total number of species in a component as *a*/*b*. To determine the number of rare species missing at the component community level, the nonparametric species-richness estimator bootstrap was calculated from data observed, as recommended by Poulin (1998). The Shannon index of diversity (*H*'), was calculated for the component community as in Magurran (2004). Descriptors of infracommunity included the mean number of helminth species per fish, the mean number of helminth individuals per fish, and the mean value of the Brillouin's diversity index per fish (*H*). Similarity among two parasite communities was estimated using the Jaccard similarity index (Magurran, 2004).

3. Results

We examined 33 specimens of *Scorpaena brasiliensis* (total length: 15-35 cm, mean: 27.06±4.63; weight: 120-1091 gr, mean 521.24±255.12); and 36 *S. plumieri* (total length: 20-41.3 cm, mean: 28.20±5.06; weight: 207-1499 gr, mean: 553.25±312.23). In both hosts, a total of 13 species of helminths were collected, 10 in *S. brasiliensis*: 5 digeneans (4 adults, 1 metacercaria), 1 cestode (larva), 3 nematodes (2 adults, 1 larva), and 1 acanthocephalan (juvenile). In *S. plumieri*, 11 species were found: 4 digeneans (3 adults, 1 metacercaria), 1 monogenean, 1 cestode (larva), 4 nematodes (2 adults, 2 larvae), and 1 acanthocephalan (juvenile). Both species shared 8 helminth species (Table 1).

The analysis of cumulative species curves for the component community suggested that the inventory of helminth species, when collecting 80% of the species, and the slope of the cumulative species curve for *S. brasiliensis* was 0.06. Thus, an asymptote was reached, and richness estimated by the Clench's model was 12 species (*a* = 1.13, *b* = 0.09; *a*/*b* = 12.5). For *S. plumieri*, when collecting 84% of the species, such value was 0.06, an asymptote was also reached, and richness estimated by the Clench's model was 13 species (a = 1.35, b = 0.09; a/b = 13.5). The value of the nonparametric species-richness estimator bootstrap (*S. brasiliensis*, *Sb* = 9; *S. plumieri*, *Sb* = 13) confirms that most, if not all, helminth species from the component community were recovered from both host species.

3.1 Parasitic Parameters

In general, parasitic parameters were low for all helminths found in both host species, with prevalence values < 20%; for example, *Pseudocapillaria* (*Icthyocapillaria*) sp., (18.2%) in *S. brasiliensis* and (19.4%) in *S. plumieri*. Mean intensity was < 5 helminths per infected fish, with exception of *Neopecoelus scorpaenae* in *S. plumieri* (9.75). Five parasite species had only one specimen per host, as follows: *S. brasiliensis*: Didymozoidae gen. sp., and *Gorgorhynchus* sp.; *S. plumieri*: *Benedenia* sp., *Bucephalus scorpaena,* and *Anisakis* sp., these five species, together with *Bucephalus scorpaena* and *Serrasentis sagittifer*, made the difference in the species composition of parasite communities in both hosts (Table 1). No significant correlation was found between the total number of species (*S*) or the total number of helminths (*N*), with size and weight of *S. brasiliensis* [(total host length vs. *S*, r = 0.1; vs. *N*, r = 0.2), (weight vs. *S*, r = 0.2; vs. *N*, r = 0.2)]; nor with *S. plumieri* [(total host length vs. *S*, r = 0.3; vs. *N*, r = 0.3), (weight vs. *S*, r = 0.2; vs. *N*, r = 0.04)]. However, a highly significant correlation (r = 0.84) was found between prevalence and mean intensity of helminth species of *S. brasiliensis*, while no significant correlation was found in *S. plumieri* (r = 0.53).

Table 1. Prevalence and mean intensity of parasitic helminths in scorpaenids from El Cabezo and Pájaros reefs, VRSNP, Veracruz, México

Specie[+]	CNHE	Site	*Scorpaena brasiliensis*			*Scorpaena plumieri*		
			n (% p)	mi±SD	range	n (% p)	mi±SD	range
Monogenea								
Benedenia sp.	-	gill				1(2.77)*	1±0	1
Digenea								
Lecithochirium floridense	10679, 10686	int	5(15.1)	2.4±1.3	1-4	4(11.1)	2.3±0.5	2-3
*Pseudopecoelus scorpaenae***	10680, 10687	int	6(18.2)	1.8±1.3	1-4	4(11.1)	9.8±7.9	1-20
Bucephalus scorpaenae **	10681, 10688	int	1(3)*	5±0	5	1(2.77)	1±0	1
Derogenes sp.	10682	int	1(3)*	3±0	3			
Didymozoidae gen. sp. [(mt)]	10683, 10689	int	1(3)*	1±0	1	3(8.3)*	1.3±0.5	1-2
Cestoda								
Tetraphyllidea gen. sp. [(p)]	10684, 10694	int	4(12.1)*	3.5±3.1	1-8	9(25)*	1.7±1	1-4
Nematoda								
Pseudocapillaria (*Pseudocapillaria*) sp.	10696, 10694	int	5(15.1)*	1.4±1	1-3	6(16.6)*	2.1±2	1-6
Pseudocapillaria (*Icthyocapillaria*) sp.**	10697, 10695	int	6(18.2)*	1.8±1.6	1-5	7(19.4)*	1.7±1.2	1-4
Anisakis sp. [(l)]	10692	mes				1(2.8)*	1±0	1
Contracaecum sp. [(l)]	10698, 10693	int	3(9)*	2.6±2	1-5	4(11.1)*	2.3±2.5	1-6
Acanthocephala								
Gorgorhynchus sp. [(j)]	10685	mes	1(3)*	1±0	1			
Serrasentis sagittifer [(j)]	10691	int				2(5.5)*	1.5±0.7	1-2
Total species			**10**			**11**		

Note. [+]Specie. Life stages: *j*, juvenile; *l*, larva; *mt*, metacercarie; *p*, plerocercoid.

Abbreviations: int, intestine; mes, mesenteries; mi, mean intensity; n, number of infected hosts; % p, prevalence; SD, standard deviation; *, new host record; **, new record for Mexico.

3.2 Component Community and Infracommunity

A total of 181 helminths was collected in both host species. Out of these, 73 were found in *S. brasiliensis*. Infections ranged from 1 to 8 individuals per infected host. Richness of the component community was *S* = 10, and the Shannon index diversity value was *H*' = 2.08. For the infracommunity in *S. brasiliensis*, 12 hosts were parasite-free (36.3%), and richness ranged from 1 to 3 species of helminths per fish. Eleven hosts had a single helminth species; 8 hosts had 2, and 2 had 3. The average number of parasites species per individual host was 1.57±0.67, while the average number of helminth individuals per host was 3.47±2.33. The value of Brillouin's index for each infracommunity ranged from 0 to 0.76 with an average of 0.19±0.23. The other 108 helminths were found in *S. plumieri*. Infections ranged from 1 to 20 individuals per infected host. Richness of the component community was S = 11, and the Shannon index diversity value was H' = 1.91. The infracommunity for *S. plumieri*, 16 hosts were parasite-free (44.4%), richness ranged from 1 to 6 species of helminths per fish. 10 hosts had 1 parasite species; 4 were infected by 2; 3 had 3; 1 had 4; 1 had 5; and 1 had 6. The average number of parasites species per individual host was 2.1±1.48, while the average number of helminth individuals per host was 5.4±6.9. The value of Brillouin's index for each infracommunity ranged from 0 to 1.15 with an average value of 0.31±0.38. In the community components, we found a high similarity (Jaccard similarity index, IJ = 0.615), among the parasite communities of *S. brasiliensis* and *S. plumieri*, as they share eight species (Table 1).

4. Discussion

Adding the previous known parasites records for *S. brasiliensis*, which are: *H. nimi*a, *L. floridense*, *P. scorpaenae*, *S. musculus* (Overstreet et al., 2009), and those reported in this investigation, the updated inventory of helminths for this host reached 12 helminth species. For *S. plumieri*, parasites known were: *B. scorpaenae*, *H. nimia*, *L. floridense*, *P. scorpaenae*, and *S. musculus* (Overstreet et al., 2009), and with those found in this work, the inventory of helminths for this host reached 13 helminth species. This investigation added 8 new host records for each host species, and 3 new locality records. In addition, both hosts share parasites with other scorpaenids, *e.g.*, *L. floridense* in *S. agassizii*; *B. scorpaenae* and *P. scorpaenae* in *S. grandicornis*; and *Derogenes* sp. in *S. maderensis* (Overstreet et al., 2009). It has to be noted that they even share parasites records (*L. floridense*, metacercarie of Didymozoidae, larva of Tetraphyllidea, and *Pseudocapillaria* sp.), with the invasive scorpaenid *Pterois volitans*, the red lionfish, from the same locality (Montoya-Mendoza et al., 2017b). These observations showed that most adult parasites registered infest local scorpaenids, and that may be related to their distribution area, but now they can also be found in invasive scorpaenids, probably due to the transfaunal phenomenon displayed by larval forms.

On the other hand, our records of both parasite communities revealed that they are almost complete, but richness registered in both communities (S = 10, *S. brasiliensis*; S = 11, *S. plumieri*), is considered low, when compared to other hosts in this area, for example, carangids (*Caranx crysos*, S = 21; *C. hippos*, S = 18; *Trachinotus carolinus*, S = 18) (Montoya-Mendoza et al., 2017a), or lutjanids (*Lutjanus campechanus*, S = 21; *L. synagris*, S = 25) (Montoya-Mendoza et al., 2014, 2016). Now, when these species richnesses and abundances are compared with parasite communities of local hosts such as *Chloroscombrus chrysurus* (S = 12), *Oligoplites saurus* (S = 7) (Montoya-Mendoza et al., 2017a), or others from the southeast of the Gulf of Mexico, *i.e.*, *Symphurus plagiusa* (S = 8) (Rodríguez-González & Vidal-Martínez, 2008), or the Caribbean *Eugerres plumieri* (S = 10) and *Scomberomorus maculatus* (S = 10) (Aguirre-Macedo et al., 2007), where they have not reached their maximum size (Aguirre-Macedo et al., 2007), samples are quite similar as related to the number of parasite species, therefore, they can be identified as communities with mean richness and abundance.

Low richness values of parasite species are usually associated with the host vagility, given that fish with high vagilities, such as *C. crysos*, *C. hippos* or *L. campechanus*, have higher species richness, and those with low vagility, like our hosts, have lower values. However, low richness in parasite communities of hosts studied here, could be associated to parasitic-host relationships, considering that richness and abundance records for parasite communities in scorpaenids from other latitudes have been low, as in *S. guttata* (Love & Moser, 1983), *S. notata*, *S. porcus* and *S. scrofa* (Sasal et al., 1997; Öktener, 2014).

Another aspect that should be pointed out due to its effects on the parasite community richness, is the presence and distribution of intermediate hosts, and the definitive host itself, especially those who are a part of the host diet, based on prey such as penaeids, stomatopods, crabs, fish, and octopuses (Randall, 1967). They may be infected with larval stages of parasites, and considering that hosts have similar food sources, the similarity of 61.5% of the parasite species composition between both communities, could be explained (Deardoff & Overstreet, 1981; Sasal et al., 1997; Aguirre-Macedo et al., 2007). On the other hand, the presence of parasite larvae suggests that both scorpaenid species are at an intermediate level in the marine food web, as smaller sizes are captured by predators, such as *Dasyatis americana* and some lutjanids (Randall, 1967).

Finally, data show that helminth communities of *S. brasiliensis* and *S. plumieri* have lower richness and diversity values than those found in other marine fish from the Southern Gulf of Mexico and the Caribbean (Randall, 1967; Sánchez-Ramírez & Vidal-Martínez, 2002; Espínola-Novelo et al., 2013; Montoya-Mendoza et al., 2014, 2016, 2017a). The composition, richness, and diversity of helminth communities in *S. brasiliensis* and *S. plumieri* could be mainly associated to their distribution, intermediate and definitive hosts, feeding habits and low host vagility.

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