Helminth Parasites of *Scorpaena brasiliensis* and *S. plumieri* (Perciformes: Scorpaenidae) from reefs of Veracruz, Mexico, Southern Gulf of Mexico

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ABSTRACT

Both *S. brasiliensis* and *S. plumieri* are relevant species in reef systems, but little is known about their parasitic helminths and community structure. This work describes such community in terms of species richness and diversity. A helminthological study was conducted on 33 specimens of *S. brasiliensis* and 36 of *S. plumieri*, captured in the Pájaros and Cabezo Reefs, in the Veracruz Reef System National Park (VRSNP), Ver., Mexico. The helminth community structure was analyzed in both hosts. A total of 10 parasitic species was registered for *S. brasiliensis* (trematodes, 5; nematodes, 3; cestodes, 1; acanthocephals, 1). *S. plumieri* hosted 11 species (trematodes, 4; nematodes, 4; monogeneans, 1; cestodes, 1; acanthocephals, 1), with 8 common species. Overall, parasites had prevalences < 20%, as *Pseudocapillaria* (*Icthyocapillaria*) sp., with 18.2% and 19.4% in *S. brasiliensis* and *S. plumieri*, respectively. Community component 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. The richness and diversity in the components community and infracommunity of parasitic helminths for both hosts are lower than in other parasite community of marine fish Southern Gulf of Mexico.

Keywords richness, diversity, infracommunity, component community

INTRODUCTION

Scorpenid fish are associated to rocky substrates and reef formations in the West Atlantic, and are distributed from the US to Brazil, including the Gulf of Mexico and the Caribbean Sea (*Amith-Vaniz et al., 1999*). Some species are popular due to sting injuries inflicted to bathers in tourist areas (*Field-Cortazares and Calderon-Campos, 2010*). Most species have no commercial relevance given their low capture volumes, for example, *Scorpaena plumieri* (*Haddad et al., 2003; Fuentes-Mata and Espinoza-Pérez, 2010*). Information related to infections of parasitic helminths on these hosts is scarce (*Cervigón et al., 1992*). Some records for Florida, US, are *Helicometrina nimia* in *Scorpena 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*; *Sterrhurs* sp., in *S. inermis*; *Bucephalus scorpaenae*, *H. nimia,* and *S. floridensis* in *S. plumieri* (*Overstreet et al., 2009*); *Pérez-Ponce de León et al. (2007)*, reported *Pseudopecoelus scorpenae* in *S. plumieri* from Quintana Roo, México. On the other hand, little is known on the community structure of helminth parasites of these hosts, as compared to other marine fish such as lutjanids and carangids from the Southern Gulf of Mexico (*Montoya-Mendoza et al., 2014; 2016, 2017*), 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.

MATERIALS AND METHODS

Sampling Procedures

From March to November, 2014; 33 specimens of *S. brasiliensis* and 36 *S. plumieri* were collected for helminthological examination. Fish were captured with spear and SCUBA diving at 5-10 m depth in Pájaros Reef (19°18'33"N, 96°08'33"W) and Cabezo Reef (19º03'07"N, 95º52'05"W), in the Veracruz Reef System National Park (VRSNP), state of Veracruz, Mexico, in the Southern Gulf of Mexico. In each organism, total length and weight was registered; then, the helminthological analysis was conducted, reviewing all tissues and organs, excepting blood and bones, under the stereoscopic microscope, following Lamothe's (1979) criteria. Helminths found were separated in Petri dishes with saline solution, 0.65%. They were fixed in hot formaline, 4%, and preserved in vial flasks with alcohol (70%), to be processed. For the morphological study and taxonomical determination of monogeneans, digeneans, cestodes and acanthocephals were dyed with Mayer's Paracarmin or Gomori's trichrome, and cleared with clove oil to mount total permanent preparations with Canada Balsam. Only nematodes were studied in temporary preparations cleared with pure glycerine (Vidal-Martínez et al., 2001). Specimens of each species were selected to be deposited in the National Helminths Collection of the Biology Institute *(Colección Nacional de Helmintos del Instituto de Biología)* (CNHE), UNAM. Following criteria proposed by Bush et al. (1997), parameters of prevalence (percentage of infected hosts), and mean intensity (mean of parasites per infected fish), for both host species were calculated.

Sample Size

In both host species, we analyzed the helminths species richness and diversity at component community level (all helminths of all species for each host fish), and infracommunity (total helminth species in each host examined, for each host fish species) (*Holmes and Price, 1986; Bush et al., 1997*). Richness observed in the community component for both host species was valuated using species cumulative curves, based on Clench's model equation (*Soberón and Llorente, 1993*), and estimate that, if the number of organisms examined enabled us to gather information on all – or most of – helminth species making the community up. For this valuation, we followed the procedure proposed by Jiménez-Valverde and Hortal (2003). Calculations were made by randomness (100x), sample-based species accumulation curves computed in EstimateS (*version 8.0 RK Colwell, http://viceroy.eeb. unconn.edu/estimates*) (*Moreno and Halffter, 2001*). When running Clench's model equation, it was considered that the last value of the curve was ≤0.1, indicating a sample size with records ≥80% of helminths integrating the community. Clench's model is described by the following function,

$V2 = (a \times V1)/[1 + (b \times V1)]$,

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. The slope of the accumulated species curve was calculated as $a/(1 + b \times n)^2$, where a and b are the previous values, and n is the number of hosts of the component examined (*Jiménez-Valverde and Hortal, 2003*). On the other hand, in both communities, the number of species left to be sampled with Clenchs' model equation, enabling estimating the total number of species in a component as a/b was estimated; and to determine the number of rare species missing at the component community level, the nonparametric species-richness estimator bootstrap was calculated from data observed (*Poulin, 1998)*. The species richness (*S*) and Shannon's diversity index (*H'*) were calculated at the community components level. At infracommunity level, it included the mean number of helminths species per fish, mean number of helminths individuals per fish, and mean of Brillouin diversity index (H) per fish. Also, the Jaccard similarity index between both parasite communities was calculated. (*Magurran, 2004*).

RESULTS

As it is summarized in Table 1, we examined 33 specimens of *Scorpaena brasiliensis* with total length from 15 to 35 cm (27.06±4.63), and weight ranging from 120 to 1091 gr (521.24±255.12); and 36 specimens of *S. plumieri* with total length from 20 to 41.3 cm (28.20±5.06), and weight ranging from 207 to 1499 g (553.25±312.23). In both hosts, 13 species of helminths were collected, 10 species for *S. brasiliensis*: trematodes, 5 (4 adults, 1 metacercaria); nematodes 3, (2 adults, 1 larva); cestodes, 1 (larva); and acanthocephals, 1 (juvenile). In *S. plumieri*, 11 species were found: trematodes, 4 (3 adults, 1 metacercaria); nematodes, 4 (2 adults, 2 larvae); monogeneans, 1; cestodes 1 (larva); and one acanthocephal (1 juvenile). Both species shared 8 species. Analysis of cumulative species curves for the component community suggested that the inventory of helminth species was nearly completed, and the slope of the cumulative species curve for *S. brasiliensis* was 0.06<0.1. Thus, an asymptote was reached (84.6 % of the species), and richness estimated by the Clench's model was 12 species (a=1.13, b=0.09; a/b=12.5). For *S. plumieri*, such value was 0.06<0.1, the asymptote was also reached (83.3 % of the species), and richness estimated by the Clench's model was 13 species (a=1.35, b=0.09; a/b=13.5). The value of nonparametric species-richness estimator bootstrap (*S. brasiliensis*, Sb=9; *S. plumieri*, Sb=13), indicated that, in both communities, we recovered most of all helminth parasites of the component community, but there are still others missing.

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). For five parasite species, only one specimen was registered per host organism, as follows: *S. brasiliensis*: Didymozoidae and *Gorgorhynchus*; *S. plumieri*: *Benedenia*, *Bucephalus scorpaena,* and *Anisakis*. Together with *Bucephalus scorpaena* and *Serrasentis sagittifer*, these parasites make slight differences between both hosts (Table 1). No significant correlation was found between the total number of species (S) or the total number of helminths (N), when comparing 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)], 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 when comparing prevalence and abundance of helminth species of *S. brasiliensis*, while no significant correlation was found in *S. plumieri* (r=0.53).

Components community and Infracommunity

Considering both host species, a total of 181 helminths was collected. Out of these, 73 were found in *S. brasiliensis*. Infections ranged from 1 to 9 parasite individuals per infected host. Richness of the component community was S=10, and the Shannon index diversity value was H'=2.08. Infracommunities richness ranged from 1 to 3 species of helminths per fish. But 12/33 (36.3%) hosts were parasite-free. 11 host had a single species; 8 hosts were infected by 2, y 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 value of 0.19±0.23. The other 108 helminths were found in *S. plumieri*. Infections ranged from 1 to 31 individuals per infected host. Richness of the component community was *S*=11, and the Shannon index diversity value was *H'*=1.91. Infracommunities richness ranged from 1 to 6 species of helminths per fish. It was also found that 16/36 (44.4 %) hosts were parasite-free; 10 hosts had 1 parasite species; 4 hosts 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. On the other hand, among community components, we found a high similitude index between parasitic communities of *S. brasiliensis* and *S. plumieri*, with rate of 61.5% (I_J=0.615), as they have 8 common species (Table 1).

DISCUSSION

Adding the previous known parasites records for *S. brasiliensis* (*D. varicus* and *O. scorpaenae*) (6) and those reported in this study, the updated inventory of helminths for these fish reached 13 helminth species. This work added 10 new host records. In the species update for *S. plumieri* (*B. scorpaenae*, *H. nimia*, *S. floridensis* and *Pseudopecoelus scorpenae*) (*Pérez-Ponce de León et al., 2007; Overstreet et al., 2009*), the number raised to 11 helminth species, 9 new records from this research, and the species list for both communities, we have 4 new local records. These results are attributed to the species accumulation curve suggesting an almost complete inventory concerning the location studied. Now, richness registered in both communities (*S*=10, *S. brasiliensis*; *S*=11, *S. plumieri*), is considered low, and abundance as well, when comparing communities found in other hosts in this area, for example, carangids and lutjanids (*Montoya-Mendoza et al., 2014; 2016; 2017)*, and even to marine-estuarine fish from the Caribbean, such as *Symphurus plagiusa* (*S*=8) (*Rodríguez-González and Vidal-Martínez, 2008*); *Eugerres plumieri* (*S*=10) and *Scomberomorus maculatus* (*S*=10) (*Aguirre-Macedo et al., 2007*). and they are also similar to records for communities of scorparnid species from other sites, e.g. *S. notate*, *S. porcus* and *S. scrofa* (Sasal et al., 1997), and *S. scrofa* (Tepe et al, 2013).Low parasites richness and abundances in these communities are related to the scorpenids feeding habits, based on penaeids, stomatopods, crabs, and fish by *S. brasiliensis*; and crab, fish and octopuses in *S. plumieri* (*Randall, 1967*). From the host-parasite relationship perspective, endoparasites depend on intermediate hosts to be distributed, and to infect the definitive hosts throughout the trophic web, and complete their life cycle. Probably, these distribution and infection processes could not occurred given the limited distribution of the parasite or intermediate hosts (*Aguirre-Macedo et al., 2007*; *Busch et al., 2012*). On the other hand, presence of larval stages of digeneans, cestodes, nematodes y acanthocephals suggest that both scorpenids species act as intermediate hosts, and small-sized organisms are predated by fish such as *Dasyatis americana* and some lutjandis, in which they will complete their life-cycle (*Randall, 1967*). Another significant factor to be highlighted on the parasites community structure, is the species interchange between both scorpaenids, as they share 61.5% of species found; which is similar to the record among parasite communities of sympatric carangids species in the area of study, *Caranx crysus* and *C. hippos*, with similarity of 60% (*Montoya-Mendoza et al., 2017*). On the other hand, these data show that helminth communities of *S. brasiliensis* and *S. plumieri* have low richness and diversity as components community and infracommunities than those found in other marine fish from area, possibly due to their benthic habits and low vagility, unlike other fish as *C. crysos* (S =21, $\overline{X}S$ = 3.8±2.7, $\overline{X}H$= 1.01±0.44), *C. hippos* (S =18, $\overline{X}S$ = 34.1±2.8, $\overline{X}H$= 0.85±0.4), *T. carolinus* (S =19, $\overline{X}S$ = 4.5±2.1, $\overline{X}H$= 0.66±0.44) (*Montoya-*

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Mendoza et al., 2017) or *L. campechanus* (S =21, $\overline{X}\,S$ = 5.1±2.2, $\overline{X}\,H'$= 0.92±0.4) and *L. synagris* (S =25, $\overline{X}\,S$ = 6.27±2.5, $\overline{X}\,H'$= 1.07±0.42) (*Montoya-Mendoza et al., 2014; 2016)*.

CONCLUSION

Composition, richness and diversity of helminth communities of *S. brasiliensis* and *S. plumieri* can be associated to their feeding habits as benthonic residents with low vagility in the reefs, and distribution of their intermediate hosts as relevant parameters. Fish feed on the most abundant preys available, therefore feeding habits and mean abundance of infected or non-infected hosts are significant factors that can delimit the parasite community structure.

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Table 1 (on next page)

Prevalence and mean intensity of parasitic helminths in scorpenids from El Cabezo and Pájaros reefs, VRSNP, Veracruz. Mexico.

Parasitic parameters of the helminth species are presented for each host species

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

			Scorpaena brasiliensis (n = 33)			*Scorpaena plumieri* (n= 36)		
Specie	CNHE	site	n (% p)	mi (±ES)	range	n (% p)	mi (±ES)	range
Monogeneans								
Benedenia sp.		gill				1(2.77)*	1 ± -	1
Digeneans								
Lecithochirium floridense (Manter, 1934)	10679 10686	int	5(15.1)*	2.4 ± 1.3	1-4	4(11.1)	2.25 ± 0.5	2-3
Pseudopecoelus scorpaenae (Manter, 1934)**	10680 10687	int	6(18.2)*	1.8 ± 1.3	1-4	4(11.1)*	9.75 ± 7.9	1-20
Bucephalus scorpaena (Manter, 1934)**	10681 10688	int	1(3)*	5 ±	5	1(2.77)	1 ±	1
Derogenes sp.	10682	int	1(3)*	3 ±	3			
Didymozoidae	10683 10689	int	1(3)*	1 ±	1	3(8.3)*	1.33 ± 0.5	1-2
Cestodes								
Tetraphyllidea	10684 10694	int	4(12.1)*	3.5 ± 3.1	1-8	9(25)*	1.7 ± 1	1-4
Nematodes								
Pseudocapillaria (*Pseudocapillaria*)**	10696 10694	int	5(15.1)*	1.4 ± 1	1-3	6(16.6)*	2.1 ± 2	1-6
Pseudocapillaria (*Icthyocapillaria*)**	10697 10695	int	6(18.2)*	1.8 ± 1.6	1-5	7(19.4)*	1.7 ± 1.2	1-4
Anisakis sp.	10692	mes				1(2.77)*	1 ±	1
Contracaecum sp.	10698 10693	int	3(9)*	2.6 ± 2	1-5	4(11.1)*	2.25 ± 2.5	1-6
Acanthocephals								
Gorgorhynchus sp.	10685	mes	1(3)*	1 ±	1			
Serrasentis sagittifer (Linton, 1889)	10691	int				2(5.5)*	1.5 ± 0.7	1-2
Total Species			**10**			**11**		

Data key. int, intestine; mes, mesenteries; n, number of infected hosts; % p, prevalence; mi, Mean intensity.

Note.*, new host record; **, new locality record.

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