Similarity Between Metazoan Parasite Communities of Two Sympatric Brackish Fish Species From Brazil

Luiz E. R. Tavares and José L. Luque*, Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74.508, Seropédica, RJ, CEP 23851-970, Brazil; *To whom correspondence should be addressed. *e-mail: jlluque@ufrrj.br*

ABSTRACT: Between March 2000 and February 2003, 63 specimens of *Genidens barbus* and 69 specimens of *Aspistor luniscutis* (Siluriformes: Ariidae), sympatric species from the coastal zone of Angra dos Reis (23°01′S, 44°19′W), RJ, Brazil, were necropsied to study their metazoan parasite communities. Parasite community descriptors were calculated and possible similarities statistically tested. Twenty-two species of metazoan parasites were identified, 15 species from *G. barbus* and 16 associated with *A. luniscutis*. Nine species were common to both host species; 4 of them exhibited significant differences in terms of abundance and prevalence. Mean total abundance, species richness, diversity, evenness, and Berger–Parker dominance values were not significantly different in the 2 species of fish. Similarity within parasite infracommunities showed highest homogeneity in *A. luniscutis*. The parasite infracommunities of *A. luniscutis* and *G. barbus* were characterized by ectoparasite dominance and scarcity of species with high prevalence. Nevertheless, low values of similarity were observed between infracommunities, and evidence for 2 distinct infracommunities groups was found.

Structure and composition of parasitic communities in each of sympatric host populations represent communities assembled from a pool of locally available parasite species (Valtonen et al., 2001; Poulin, 2007). This structure and composition may be related to various features of hosts themselves (feeding, reproductive behavior, etc.), host phylogenetic relationships, and to the physicochemical and biological characteristics of the habitat (Bush et al., 2001; Poulin, 2006, 2007). Thus, short phylogenetics and geographical distances between host species affect the similarities between their parasite communities once exchanges of parasite species over evolutionary time are facilitated among phylogenetically related species and among geographically adjacent, or sympatric, host populations (Poulin and Morand, 1999; Poulin, 2007). Among the most important host traits with respect to the structure and composition of parasite communities are host size and vagility, or migratory habits (Polyanski, 1961; Bush et al., 2001; Poulin, 2007). Recently, Luque et al. (2004) examined a data set from metazoan parasites of 50 fish species from the same general area (coastal waters of Rio de Janeiro, Brazil) and found that parasite biodiversity was not distributed randomly among marine fish species with respect to host characteristics. They concluded that fish body size proved to be a main predictor of structure and composition in their fishes and suggested host feeding habitat also may influence parasite species richness.

Based on these observations, similarity between structure and composition of parasite communities of sympatric and related host species is somewhat expected when hosts share habitat and exhibit similar behavior (Goater et al., 1987; Poulin, 1995; Poulin and Morand, 1999; Bush et al., 2001; Poulin, 2007). Sympatric fish species may totally overlap in habitat and feeding behavior, which seems to disagree with Gause's hypothesis, i.e., the concept of competitive exclusion, and the problem is to determine where, when, and how overlapping occurs (Lowe-McConnell, 1999). A number of studies have been undertaken to answer these questions and some have shown a high degree of specialization with regard to shared habitat without a spatial and temporal overlap; several ariid fish species from Brazilian coastal waters exhibit these characteristics (Mishima and Tanji, 1982; Azevedo, Araújo, Cruz-Filho, Gomes, and Pessanha, 1998; Lowe-McConnell, 1999).

The Ariidae (Siluriformes) is comprised of species of catfishes inhabiting mainly brackish and marine waters, with just a few species adapted to freshwater (Nelson, 2006). The majority of the species occur in multispecific assemblages in coastal waters, mainly estuaries and tidal rivers of warm-temperate and tropical regions. Generally, the ariids are found at shallow depths, with sandy or muddy substrata, although some marine species are restricted to depths greater than 100 m. In the spawning season, these fishes frequently search for lagoons or the mouths of rivers to reproduce; males commonly incubate eggs in the oral cavity

until they hatch. Some species have a high potential for aquaculture and are of great economic value (Mishima and Tanji, 1982; Araújo, 1984, 1988; Azevedo et al., 1999; Marceniuk and Ferraris, 2003). *Aspistor luniscutis* (Valenciennes, 1840) and *Genidens barbus* (Lacépède, 1803), commonly referred to as sea catfishes, are the largest species of Ariidae found along the Brazilian coast, where they may reach up to 1.2 m in total length; both species represent an important fishery resource. *Aspistor luniscutis* occurs from Guyanas to southeastern Brazil and *G. barbus* from northeastern Brazil to Argentina. In the spawning season, adults migrate to estuaries, where juveniles reside during the first 2 yr, after which *A. luniscutis* return to the open areas of coastal bays and *G. barbus* return to the sea (Mishima and Tanji, 1983a, 1983b; Azevedo, Araújo, Cruz-Filho, Gomes, and Pessanha, 1998).

According to Mishima and Tanji (1981, 1982), Reis (1986), and Azevedo, Araújo, Cruz-Filho, Gomes, and Pessanha (1998), these 2 fish species share habitat and feeding habits (generalist–opportunist), although they also exhibit spatial separation. Recruits of *A. luniscutis* (specimens with total length <180 mm), and recruits and juvenile specimens of *G. barbus* (total length <150 mm and 150–250 mm, respectively) are more abundant near the mouths of rivers. *Aspistor luniscutis* juveniles (total length = 180–300 mm) are widespread in the inner bays. *Aspitor luniscutis* adults (total length <300 mm) are distributed just outside bay areas, and *G. barbus* adults (total length <250 mm) migrate to the open sea. Additionally, specimens of *A. luniscutis* were found at greater depths than *G. barbus*.

Parasitological records associated with *G. barbus* have been summarized by Tavares and Luque (2004). Recently, Tavares and Luque (2005) described a copepod species parasitic on *A. luniscutis*, and Domingues and Fehlauer (2006) recently described new species of monogenean parasitic on both *G. barbus* and *A. luniscutis*. Otherwise, no additional parasite records have been published for *A. luniscutis*. Studies on ecological and quantitative features of the parasite faunas of ariid fishes from the Brazilian coast, up to the present study, have been restricted to Pereira and Costa (1986), São Clemente et al. (1991), and Tavares and Luque (2004). Additionally, studies comparing component or infracommunities of sympatric fish species from Brazilian coastal waters are scarce and restricted to Luque et al. (1996), Takemoto et al. (1996), and Luque et al. (2008).

In this report, we analyzed the possible similarity between the metazoan parasite community of the 2 sympatric ariid fishes, *A. luniscutis* and *G. barbus*, from the coastal waters of the State of Rio de Janeiro, Brazil, at the component and infracommunity levels. In total, 132 specimens of sea catfishes were examined for metazoan parasites. Sixty-three specimens of *G. barbus* measuring 43.9 ± 9.9 (31–80) cm in total length were caught between March 2000 and April 2001 and 69 specimens of *A. luniscutis* measuring 35.4 ± 2.2 (30.8–42) cm in total length were taken between November 2002 and February 2003, from the coast of Angra dos Reis (23°01′S, 44°19′W), State of Rio de Janeiro, Brazil. Fishes were identified according to Figueiredo and Menezes (1978); host identification followed Marceniuk and Ferraris (2003). The average total length of *G. barbus* and *A. luniscutis* specimens was significantly different ($t = 7.7$; $P < 0.01$). All fish examined were considered adults (total length >25 cm [*G. barbus*] and total length >30 cm [*A. luniscutis*]) (see Azevedo, Araújo, Cruz-Filho, and Gomes, 1998). Parasites were recovered from the body surface, gills, branchial chambers, body cavities, and viscera after examination with stereomicroscopy. Prevalence, mean abundance, and mean intensity of infection were calculated for each parasite species in each host following Bush et al. (1997). The subsequent data analysis included only parasite species with prevalences ≥10% (Bush et al. 1990). Chi-square analysis was used to test differences in prevalence; a 2-sample *t*-test on $\log(x + 1)$-transformed data was employed to analyze differences in abundance of parasite species that occurs in the 2 host species (Zar, 1999). Numerical dominance was calculated using the Berger–Parker dominance index. Parasite species diversity was calculated by means of

TABLE I. Site of infection (SI), prevalence (P), mean intensity (MI), and mean abundance (MA) of the metazoan parasites of *Aspistor luniscutis* and *Genidens barbus* from the coastal zone of the State of Rio de Janeiro, Brazil. SD = standard deviation.

Parasites	SI	*A. luniscutis* (n = 69)			*G. barbus* (n = 63)		
		P (%)	MI ± SD	MA ± SD	P (%)	MI ± SD	MA ± SD
Digenea							
*Dinosoma clupeola**	Stomach	8.7	4.8 ± 8.9	0.4 ± 2.8	38.1	7.4 ± 17.8	2.8 ± 11.4
Hysterolecitha sp.	Intestine	1.5	<0.1	<0.1	–	–	–
Opecoeloides sp.	Intestine	2.9	<0.1	<0.1	–	–	–
*Pseudoacanthostomum floridensis**	Stomach	4.4	1.3 ± 0.6	<0.1	19.1	1.3 ± 0.9	0.3 ± 0.6
Monogenea							
Chauhanellus neotropicalus	Gills	43.5	6.7 ± 9.2	2.9 ± 6.9	–	–	–
Hamatopeduncularia sp.	Gills	—	–	–	9.5	2.7 ± 2.3	0.2 ± 1
Cestoda							
Scolex polymorphus	Intestine	5.8	1.3 ± 0.5	<0.1	6.4	1	<0.1
Pterobothrium crassicolle (plerocercoid)	Body cavity	11.6	1.1 ± 0.4	0.1 ± 0.4	–	–	–
Nomimoscolex arandasregoi	Intestine	—	–	–	4.8	40.7 ± 43.4	1.9 ± 11.7
Acanthocephala							
Polymorphus sp. (cystacanth)	Intestine	—	–	–	1.6	1	<0.1
Nematoda							
Hysterothylacium sp. (larval)	Mesenteries	—	–	–	7.9	6.2 ± 6.5	0.5 ± 2.4
Philometra fariaslimai	Intestine	—	–	–	12.7	3.4 ± 3.7	0.4 ± 1.7
Copepoda							
Bomolochus sp.	Gills	1.5	1	<0.1	–	–	–
Caligus haemulonis	Gills; body surface	5.8	1.8 ± 1.5	0.1 ± 0.5	1.6	1	<0.1
Caligus praetextus	Body surface	1.5	1	<0.1	4.8	1	<0.1
*Ergasilus youngi**	Gills	88.4	7.8 ± 8.2	6.7 ± 8.1	4.8	1	<0.1
Lepeophtheirus bagri	Gills	14.5	1.2 ± 0.4	0.2 ± 0.5	14.3	1.7 ± 0.9	0.2 ± 0.7
*Lepeophtheirus monacanthus**	Gills	1.5	1	<0.1	66.7	5.2 ± 5.1	3.5 ± 4.8
Taeniastrotos brasiliensis	Gills	—	–	–	1.6	1	<0.1
Branchiura							
Argulus sp.	Body surface	1.5	1	<0.1	–	–	–
Isopoda							
Gnathia sp. (larval)	Gills	1.5	1	<0.1	–	–	–
Hirudinea							
Piscicolidae gen. sp.	Gills	1.5	1	<0.1	7.9	2 ± 2.2	0.2 ± 0.8

* Significant difference between parasitic abundance (*t*) and prevalence (χ^2); $P < 0.05$.

TABLE II. Characteristics of the metazoan parasites infracommunities in *Aspistor luniscutis* and *Genidens barbus* from the costal zone of the State of Rio de Janeiro, Brazil. SD = standard deviation. No significant differences were found.

| Community descriptors	*A. luniscutis*	*G. barbus*	*t*	*P*
Mean total abundance ± SD	10.93 ± 12.02	10.25 ± 16.56	0.52	0.52
Mean species richness ± SD	2.09 ± 1.08	2.02 ± 1.04	−0.40	0.69
Total species richness	17	15	–	–
Ectoparasites	11	8	–	–
Endoparasites (adult)	4	4	–	–
Endoparasites (larval)	2	3	–	–
Mean diversity ± SD	0.13 ± 0.13	0.13 ± 0.12	−0.02	0.98
Mean evenness ± SD	0.40 ± 0.37	0.43 ± 0.36	−0.39	0.70
Numerical dominance ± SD	0.78 ± 0.24	0.76 ± 0.26	0.24	0.81
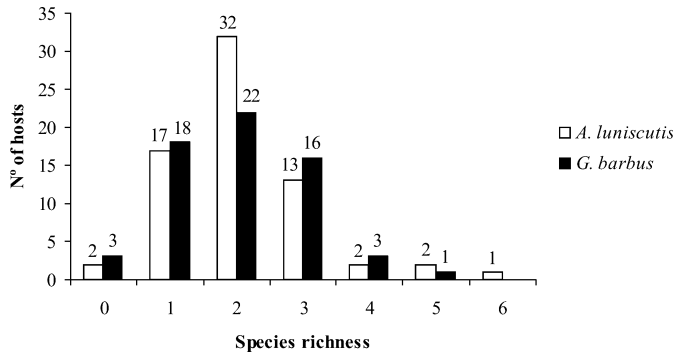
FIGURE 1. Distribution of species richness in the parasite infracommunities of *Aspistor luniscutis* and *Genidens barbus* from the coastal zone of the State of Rio de Janeiro, Brazil.

FIGURE 3. Similarity indexes between parasite infracommunities of *Aspistor luniscutis* and *Genidens barbus* from the costal zone of the State of Rio de Janeiro, Brazil.

the Brillouin index (H) and evenness using the evenness associated to Brillouin's index of diversity (Zar, 1999). Possible differences in community descriptors were tested with a 2-sample t-test on log(x + 1)-transformed data. The Jaccard qualitative and Sorensen quantitative similarity indexes were calculated among infracommunities within, and between, fish samples. Discriminate analysis on square-root–transformed data was used to classify different infracommunities, showing which parasite species are responsible for differences and to display the infracommunities within a coordinate system graphically (Ludwig and Reynolds, 1988).

Twenty-two metazoan parasite species were collected from the 2 host species, 16 in *A. luniscutis* and 15 in *G. barbus*. Nine species were common to both. Four of the common species exhibited significant differences in prevalence and abundance (Table I). In total, 740 metazoan parasites were collected from *A. luniscutis*, with an overall mean abundance of 10.7 ± 12.1 parasites/fish (range 1–63) and 646 specimens from *G. barbus*, with a mean abundance of 10.3 ± 16.6 (range 1–88). Sixty-seven (97%) of the *A. luniscutis* sample and 60 (95.2%) of the *G. barbus* sample were parasitized by at least 1 metazoan species (Fig. 1). Mean values of community descriptors for both host species are given in Table II. No differences were observed between community descriptors of *A. luniscutis* and *G. barbus*. Similarities index within fish samples showed higher homogeneity in *A. luniscutis* infracommunities (Fig. 2). A high degree of variability was observed in the analysis of both Jaccard and Sorensen similarity indexes (Fig. 3) (see standard deviation). The first discriminant variable explained 100% of the variance (eigenvalue = 1.94). A significant overall group effect was observed (Wilks's lambda = 0.34, $F_{8,123}$, $P < 0.01$). Infracommunities were distributed mainly along the first discriminant axis (Fig. 4) and constituted 2 distinct groups (χ^2 = 135.71, $P < 0.01$). Each infracommunity was 96% correctly classified into 2 host species groups (*A. luniscutis* 94%, n = 64 and *G. barbus* 98%, n = 62). *Ergasilus youngi* and *Chauhanellus neotropicalis* were the species that contributed most in determin-
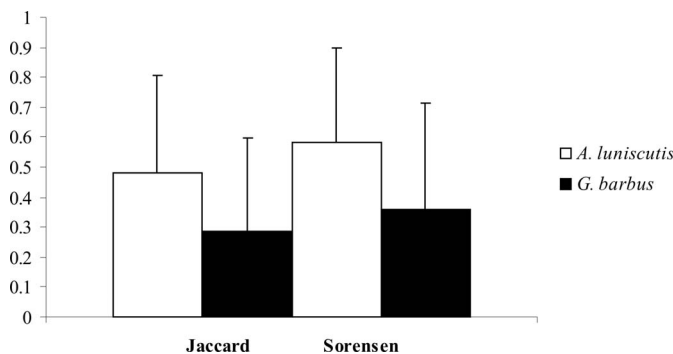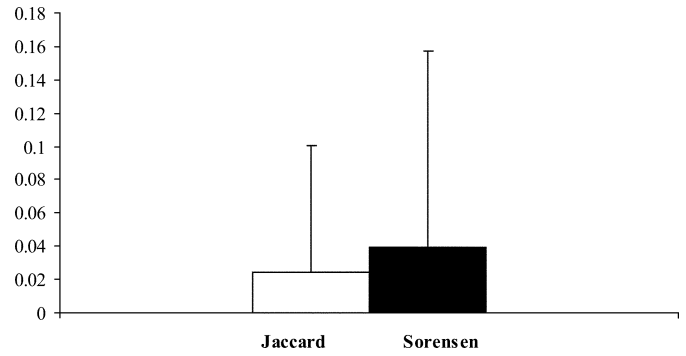
ing the position of infracommunities on the first 2 discriminant axes, and accounted for 82.7% and 47.2% of the values, respectively.

The parasite communities of these sea catfishes studied are characterized by the presence of species with low prevalence and abundance, and are composed mostly of ectoparasites, mainly copepod species. The high prevalence values recorded for some ectoparasite species may be related to the typical reproductive pattern of these catfishes that usually includes large schools during the spawning season (Mishima and Tanji, 1983a), which probably facilitates transmission of parasites with direct life cycles. In total, 9 parasite species were common to both fish species, 6 of them ectoparasites. Although Mishima and Tanji (1983b), Azevedo, Araújo, Cruz-Filho, Gomes, and Pessanha (1998), and Azevedo, Araújo, Cruz-Filho, and Santos (1998) suggested a cleared spatial separation among populations of adults of *A. luniscutis* and *G. barbus*, these authors also recognized a spatial overlapping among younger fishes.

Concomitant occurrence of direct life cycle parasite species among *A. luniscutis* and *G. barbus* reinforces the notion to habitat overlap. If we look only for species with prevalences >10% in each fish sample, 4 species were collected from *A. luniscutis* and 5 species were collected from *G. barbus*; of these, only 1 species, an ectoparasite *Lepeophtheirus bagri*, was common to both host species.

After spawning season, male fishes exhibit incubating behavior, with egg and larval brooding, which lasts for 3 mo; during this time, adult fishes do not feed (Araújo, 1988; Chaves, 1994; Araújo et al., 1998; Azevedo, Araújo, Cruz-Filho, and Santos, 1998). This behavior may protect the fish from the ingestion of potential intermediate hosts, preventing recruitment of internal parasites. Specimens of *A. luniscutis*
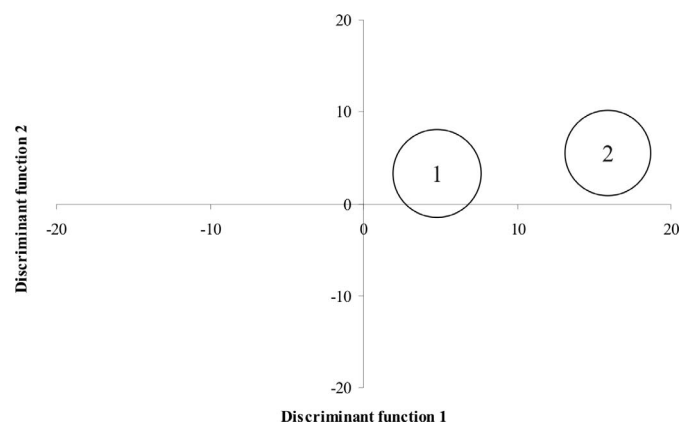

FIGURE 2. Similarity indexes within parasite infracommunities of *Aspistor luniscutis* and *Genidens barbus* from the costal zone of the State of Rio de Janeiro, Brazil.

FIGURE 4. Sample scores of first 2 discriminant axes for parasite infracommunities of *Aspistor luniscutis* and *Genidens barbus* from the costal zone of the State of Rio de Janeiro, Brazil. Numbers represent group of species—(1) *A. luniscutis*, (2) *G. barbus*; circles around group means represent the 95% tolerance region, e.g., 95% of the observations in a group are expected to lie in this region.

were collected during the mouth brooding period and showed lower values of prevalence for the trophically transmitted species *Dinosoma clupeola* and *Pseudoacanthostomum floridensis*.

According to Poulin (1997, 2007), component communities have greater homogeneity in vagile hosts and *G. barbus* seems to be the more vagile species of the 2. However, greater homogeneity observed within parasitic infracommunities of *A. luniscutis* could also be correlated with the same length class of the specimens studied. In other words, this group of fishes was composed of individuals sharing the same habitat and feeding behavior, which might influence the similarity in parasite prevalence and abundance within a specific host length (Saad-Fares and Combes, 1992). The *G. barbus* sample was composed of specimens with different length classes, suggesting an influence of these biological characteristics with respect to host size classes and the composition and structure of the metazoan parasite communities.

Sympatric and phylogenetically related host species are expected to show similarities in their parasite communities, mainly when they also overlap spatially and temporally (Poulin and Morand, 1999). Discriminant analysis, based on abundance and species richness, showed 2 distinct groups of hosts. *Ergasilus youngi* was the species that most contributes to the differences between *A. luniscutis* and *G. barbus* infracommunities. Another ectoparasite species, *Chauhanellus neotropicalis*, which also contributes to these differences, occurs only in *A. luniscutis*. According to Valtonen et al. (2001), separate communities often share parasite species, but rarely will have identical composition; they can also be merely stochastic assemblages of available parasite species at a single point in time. In the present report, time is clearly a confounding factor, i.e., the *G. barbus* collection was made between March 2000 and April 2001 and *A. luniscutis* between November 2002 and February 2003. This temporal difference could also explain quantitative and qualitative variations in parasite species populations infecting the 2 host species. However, when considering only those parasite species with prevalences >10%, *L. bagri* exhibited no difference in prevalence or abundance between *A. luniscutis* and *G. barbus* samples.

Luque et al. (1996) and Takemoto et al. (1996) used a comparative approach to examine the metazoan parasite communities of related marine fish species from the same locality (state of Rio de Janeiro, Brazil). They observed a high degree of similarity and attributed this pattern to shared behavior and feeding habits of the host species. However, although a representative number of parasite species were shared by related host species, these species showed marked differences between their prevalences and intensities. Possibly, however, these differences in a more thorough analysis might indicate lower similarity than observed; thus, similarity indexes were used just for the component community and discriminate analysis was not employed by Luque et al. (1996) or Takemoto et al. (1996). Moreover, Luque et al. (2008) observed low similarity values among parasite infracommunities of *Pseudopercis numida* and *Pseudopercis semifasciata* and suggested their sedentary habits and restricted geographic distribution of the hosts as a determinant of this finding.

Further parasitological studies including more ariid species are necessary; the ariid assemblage from Rio de Janeiro is composed of at least 4 species sharing the same habitat in a fixed period of their life cycle (Azevedo, Araújo, Cruz-Filho, Gomes, and Pessanha, 1998; Azevedo, Araújo, Cruz-Filho, and Santos, 1998). These studies should contribute to elucidate possible patterns in the composition and structure of parasite communities in sympatric fish species.

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