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Metazoan Parasites of the Atlantic Spadefish *Chaetodipterus faber* (Teleostei: Ephippidae) from the Coastal Zone of the State of Rio de Janeiro, Brazil

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ABSTRACT: One hundred ten Atlantic spadefish *Chaetodipterus faber* (Broussonet, 1782) (Teleostei: Ephippidae) collected from the coastal zone of the State of Rio de Janeiro, Brazil (21–23°S, 41–45°W) between February 1995 and March 1996 were necropsied to study their metazoan parasites. The majority of the fish (82.7%) were parasitized by 1 or more metazoan species. Ten species of parasites were collected: 4 digeneans, 2 monogeneans, and 4 copepods. The copepods were the majority (53.1%) of the total number of parasite specimens collected. The caligid *Anuretes anurus* was the most dominant species with highest prevalence and abundance. *Prosogonotrema labiatum* and *A. anurus* showed a positive correlation between the host's total length and parasite abundance, while *Parancylodiscoides* sp. showed a negative correlation between the host's total length and parasite prevalence and abundance. The sex of hosts did not influence prevalence and abundance of any parasite species. The mean diversity in the infracommunities of *C. faber* was $H = 0.659 \pm 0.280$, with no correlation with the host's total length and with no significant difference between male and female fish. *Chaetodipterus faber* had 4 pairs of parasite species with significant positive association, 3 pairs of endoparasites, and 1 pair of ectoparasites. Negative associations were not found. The low diversity and parasite richness observed might be linked to the low dietary variation of *C. faber*.

KEY WORDS: parasite ecology, community structure, marine fish, Ephippidae, *Chaetodipterus faber*, Brazil.

Chaetodipterus faber (Broussonet, 1782) is a benthic fish distributed from New England, U.S.A., to southern Brazil (Ditty et al., 1994). This species is very common in the southern Brazilian coastal zone (Couto and Vasconcelos, 1980; Menezes and Figueiredo, 1985). The literature on parasites of *C. faber* from Brazil is taxonomic in scope. Kohn (1966), Fernandes et al. (1985), and Wallet and Kohn (1987) recorded digenean parasites of *C. faber* from the state of Rio de Janeiro and Amato (1983a, b) from Florianópolis, state of Santa Catarina. Recently, Cezar and Luque (1998) redescribed *Anuretes anurus* (Bere, 1936), a copepod parasitic on the gills of *C. faber* from the coastal zone of Rio de Janeiro.

In this report, we analyzed the metazoan parasite community of *C. faber* at the component and infracommunity levels and compared our results with those on parasite communities of other marine fishes from the Neotropical region.

Materials and Methods

From February 1995 to March 1996, 110 *C. faber* were examined. Local fishermen collected fish from the coastal zone of the state of Rio de Janeiro (21–23°S, 41–45°W). The fish measured 14.0–46.0 cm (mean = 27.7 ± 7.1 cm) in total length and weighed 150–2,430 g (817.5 ± 462.8 g). Fish were identified according to Menezes and Figueiredo (1985). The ecological approximation of the metazoan parasite community was made to component and infracommunity levels (Esch et al., 1990). The dominance frequency and the relative dominance (number of specimens of 1 species/total number of specimens of all species in the infracommunity) of each parasite species were calculated according to Rohde et al. (1995). Spearman's rank correlation coefficient r_s was calculated to determine possible correlations between the total length of hosts and the abundance of parasites. Pearson's correlation coefficient r was used as an indication of the relationship between the host's total length and the prevalence of parasites, with previous arcsine transformation of the prevalence data (Zar, 1996) and partitioning of host samples into four 10-cm (total length) intervals. The effect of host sex on abundance and prevalence of parasites was tested using the Z normal approximation to the Mann–Whitney test and the chi-square test, respectively. Parasite species diversity was calculated using the Brillouin index (H), because each fish analyzed corresponded to a fully censused community (Zar, 1996). The probable variation of diversity in relation to host sex (Mann–Whitney test) and to host total length (Spearman's rank correlation coefficient) were tested. For each infracommunity, the Pielou evenness index (J') was calculated (Ludwig and Reynolds, 1988). The possible interspecific association between concurrent species was determined using the chi-

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Table 1. Prevalence, intensity, mean intensity, and mean abundance of infection of the metazoan parasites of *Chaetodipterus faber* from the coastal zone of the state of Rio de Janeiro, Brazil.

Parasites	% Prevalence	Intensity	Mean intensity	Mean abundance
Digenea				
Prosogonotrema bilabiatum CHIOC No. 33962a, b	27.3	1–10	2.3	0.6
Lecithocladium chaetodipteri CHIOC No. 33965	20.9	1–39	8.1	1.7
Multitestis (*Multitestis*) *inconstans* CHIOC No. 33963a, b	27.3	1–45	7.9	2.1
M. (*Multitestoides*) *brasiliensis* CHIOC No. 33964a, b	11.8	1–11	4.0	0.5
Monogenea				
Parancylodiscoides sp. CHIOC No. 33960	21.8	1–47	6.9	1.5
Sprostoniella sp. CHIOC No. 33961	8.2	1–3	1.2	0.1
Copepoda				
Caligus haemulonis MNRJ No. 7237–7238	4.5	1–5	2.4	0.1
Caligus mutabilis MNRJ No. 7289	5.4	1–2	1.3	0.1
Anuretes anurus MNRJ No. 7284–7285	65.4	1–68	10.1	6.6
Lernanthropus pupa MNRJ No. 12874	30.0	1–7	2.2	0.7

square test, with the Yates correction. Possible covariation among the abundance of concurrent species was analyzed using the Spearman rank correlation coefficient. Ecological terminology follows Bush et al. (1997). The analysis included only parasite species with prevalence greater than 10% (Bush et al., 1990). Statistical significance level was evaluated at $P \leq 0.05$. Voucher specimens of collected helminths were deposited in the Coleção Helmintológica do Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil; copepods were deposited in the Coleção Carcinológica do Museu Nacional (MNRJ), Quinta da Boa Vista, Rio de Janeiro, Brazil.

Results

Component community

Ten species of metazoan parasites were collected (Table 1). Copepods were the most abundant, with 4 species, and they accounted for 53.1% of the total parasites collected. Copepods parasitized 72 (65.4%) of the hosts, with mean abundance of 6.6. *Anuretes anurus* was the dominant species, with 726 specimens collected (52.0% of all parasites), and had the highest values of mean relative dominance and frequency of dominance (Table 2). Digeneans and monogeneans represented 35.3% and 11.5%, respectively, of all parasites collected.

The average total lengths of male (26.45 ± 6.55, n = 55) and female (29.0 ± 7.710, n = 55) fish in the study sample were not significantly different ($t = -1.892$, $P = 0.06$). Abundances of *Prosogonotrema bilabiatum* and *A. anurus* were each positively correlated with host total length, while the abundance of *Parancylodiscoides* sp. was negatively correlated with host total length (Table 3). The sex of the hosts did not influence parasite prevalence and abundance of any species (Table 4).

Infracommunities

Ninety-one (82.7%) spadefish were parasitized by at least 1 parasite species. A total of 1,545 individual parasites were collected, with a mean abundance of 14.0 ± 21.178 (1–169). No relationship between total parasite abundance and total body length ($r_s = 0.133$, $P = 0.166$) and sex ($Z = -0.260$, $P = 0.794$) of fish was observed. The mean parasite species richness 2.29 ± 1.683 (1.0–6.0) was not correlated with total body length ($r_s = 0.091$, $P = 0.342$) and sex ($Z = -0.115$, $P = 0.908$) of fish. Twenty-one hosts (19.1%) showed infection with 1 parasite species, and 25 (22.7%), 18 (16.4%), 20

Table 2. Frequency of dominance and mean relative dominance of the components of the community of metazoan parasites of *C. faber* from the coastal zone of the state of Rio de Janeiro, Brazil.

Parasites	Frequency of dominance	Frequency of dominance shared with one or more species	Mean relative dominance
Prosogonotrema bilabiatum	2	0	6.330 ± 14.303
Lecithocladium chaetodipteri	7	2	7.984 ± 17.185
Multitestis (Multitestis) inconstans	10	2	11.218 ± 19.723
M. (Multitestoides) brasiliensis	1	2	3.610 ± 12.082
Parancylodiscoides sp.	9	2	10.764 ± 25.934
Anuretes anurus	46	7	48.816 ± 35.397
Lernanthropus pupa	3	2	8.325 ± 17.696

(18.2%), 2 (1.8%), and 5 (4.5%) had multiple infections with 2, 3, 4, 5, and 6 parasite species, respectively. Mean parasite species diversity (H) was 0.659 ± 0.280; the maximum diversity was 1.307. The Pielou evenness index (J') had a mean of 0.824 ± 0.536. Parasite diversity was not correlated to host total length ($r_s = 0.194$, $P = 0.107$), and no significant differences ($Z < 0.01$, $P > 0.50$) in parasite diversity were observed between male ($H = 0.650 \pm 0.258$) and female spadefish ($H = 0.670 \pm 0.306$).

Parasite infracommunities were separated into two groups, ectoparasites (monogeneans and copepods) and endoparasites (digeneans), to determine interspecific associations. Among the ectoparasites, only 1 copepod species pair, *Lernanthropus pupa* and *A. anurus,* shared significant positive association and covariation (Table 5). The infracommunities of endoparasites had 3 pairs of digeneans that exhibited significant positive associations and covariations: *Multitestis (Multitestis) inconstans* and *P. bilabiatum, M. (M.) inconstans* and *Lecithocladium chaetodipteri,* and *M. (Multitestoides) brasiliensis* and *P. bilabiatum* (Table 6).

Discussion

The present study detected some patterns in the structure of the metazoan parasites of *C. faber:* (1) ectoparasite dominance, (2) low parasite richness and diversity, and (3) absence of correlation of parasite abundance, at the infracommunity level, with the size or sex of the host. These patterns were somewhat different from those recorded for other benthic marine fishes from the coastal zone of the state of Rio de Janeiro (Luque et al., 1996a, b; Knoff et al., 1997; Chaves and Luque, 1998). The parasite community of *C. faber* was dominated by ectoparasites, and this was in disagreement with results on other Brazilian marine fishes where digeneans were the dominant parasites. This difference might be explained by the diet of *C. faber.* According to Couto and Vasconcelos (1980) and Hayse (1990), the diet of *C. faber* showed few ontogenetic changes and was restricted to some species of isopods, hydroids, and polychaetes, potential intermediate hosts for digeneans. Bittencourt (1990) gave evidence of the herbivorous habits of *C. faber.* The monoxenic life cy-

Table 3. Spearman's rank correlation coefficient (r_s) and Pearson's correlation coefficient (r) values used to evaluate possible relationships between the total length of *C. faber* and abundance and prevalence of the components of its parasite community from the coastal zone of the state of Rio de Janeiro, Brazil. (P = significance level).

Parasites	r_s	P	r	P
Prosogonotrema bilabiatum	0.221	0.023	−0.312	0.602
Lecithocladium chaetodipteri	0.023	0.832	−0.633	0.254
Multitestis (Multitestis) inconstans	0.182	0.495	0.712	0.172
M. (Multitestoides) brasiliensis	0.042	0.653	0.141	0.821
Parancylodiscoides sp.	−0.293	0.002	−0.891	0.043
Anuretes anurus	0.244	0.015	0.482	0.412
Lernanthropus pupa	0.065	0.520	−0.763	0.131

Table 4. Normal approximation *Z* of the Mann–Whitney test and chi-square (χ^2) test values used to evaluate possible relationships between the sex of *C. faber* and abundance and prevalence of the components of its parasite community from the coastal zone of the state of Rio de Janeiro, Brazil. (*P* = significance level).

Parasites	*Z*	*P*	χ^2	*P*
Prosogonotrema bilabiatum	−0.343	0.733	0.182	0.662
Lecithocladium chaetodipteri	−0.202	0.831	0.212	0.645
Multitestis (Multitestis) inconstans	−0.355	0.723	0.421	0.514
M. (Multitestoides) brasiliensis	−0.543	0.592	0.793	0.373
Parancylodiscoides sp.	−0.262	0.792	0.213	0.645
Anuretes anurus	−0.782	0.943	0.162	0.684
Lernanthropus pupa	−0.191	0.842	0.182	0.672

cles of copepods and monogeneans, in addition to possible permanent or temporarily aggregated patterns within *C. faber* populations, might increase the probability of successful parasite transmission by the free-living larval stages of these ectoparasites (Roubal, 1990).

Another difference of the parasite community of *C. faber* from other fishes of the Brazilian coastal zone was the absence of correlation between parasite abundance and diversity and the host size. As pointed out in the classic study by Polyanski (1961), quantitative and qualitative changes in parasitism are expected with fish growth. According to Saad-Fares and Combes (1992), in the case of the digeneans, this correlation might be influenced by changes in the diet of the fish. Regarding ectoparasites, changes in levels of the parasitism with changing host size are expected because the surface area of the infection site increases with growth, and this provides more space to larval monogeneans and copepods (Fernando and Hanek, 1976). However, at the component community level, some digeneans and monogeneans did show correlations between host size and parasite abundance, with some heterogeneity in the population features of the spadefish's parasite community. This situation is clear in the ectoparasites. Abundance and prevalence of the copepod *A. anurus* were each positively correlated with host total length, while the abundance and prevalence of the monogenean *Parancylodiscoides* sp. were negatively correlated with host total length. Better explanation of these patterns will only be possible when the life cycles of the parasites and their relationship with spadefish feeding patterns and population dynamics become known.

Absence of correlation between the sex of the host and the prevalence and abundance of components of the parasite community of marine fishes is common. An exception was seen in *Mugil platanus* from Rio de Janeiro, in which 30% of the components of its parasite community showed differences in their prevalences and abundances relative to host sex (Knoff et al., 1997). In *C. faber,* the lack of such correlation might be attributed to similarity in ecological relationships (behavior, habitat, and diet) of males and females as stated by Luque et al. (1996a) and Takemoto et al. (1996). According to Poulin

Table 5. Concurrent species pairs of ectoparasites on *C. faber* from the coastal zone of the State of Rio de Janeiro, Brazil. Significant values are underlined.

	Parancylodiscoides sp.	*A. anurus*	*L. pupa*
		r_s*	
Parancylodiscoides sp.	—	−0.059	0.104
Anuretes anurus	−0.598	—	0.283
Lernanthropus pupa	0.624	8.566	—
	χ^2†		

* r_s = Spearman rank correlation coefficient.
† χ^2 = chi-square test.

Table 6. Concurrent species pairs of endoparasites in *C. faber* from the coastal zone of the State of Rio de Janeiro, Brazil. Significant values are underlined.

	P. bilabiatum	*L. chaetodipteri*	*M. (M.) inconstans*	*M. (M.) brasiliensis*
		r_s*		
Prosogonotrema bilabiatum	—	0.081	0.337	0.279
Lecithocladium chaetodipteri	0.081	—	0.302	0.003
Multitestis (Multitestis) inconstans	10.742	5.332	—	0.118
M. (Multitestoides) brasiliensis	5.248	0.014	0.930	—
		χ^2†		

* r_s = Spearman rank correlation coefficient.
† χ^2 = chi-square test.

(1996), the influence of host sex on parasite prevalence and abundance is a topic hardly touched upon in discussions of community analysis, and it is necessary to conduct experiments that show the influence of other factors, mainly on physiology and behavior of the fish.

Ecological disturbances are determining factors in the structure of parasite communities (Holmes, 1990). In this study, we collected fewer digeneans than in the studies by Amato (1983a, b) of fishes from Florianópolis, Santa Catarina, Brazil, which is influenced by the subtropical convergence (meeting of the warm Brazilian Current with the cold Falkland Current). According to Luque et al. (1996a), this situation is also seen regarding the digeneans of the haemulid fish *Orthopristis ruber*. This suggests that the subtropical convergence might provide variation in ecological conditions that could affect the population dynamics and diversity of parasites. This situation is mentioned in other papers on the ecology of parasites of marine fishes from the South American Pacific Ocean, a region dominated by an upwelling system and the aperiodic El Niño–Southern Oscillation (ENSO) phenomenon (Oliva et al., 1996; Oliva and Luque, 1998). Additional studies are needed to quantify the impact of ecological disturbances on the structure and composition of parasite communities of marine fishes of the Neotropical region.

Another characteristic of the parasite community of *C. faber* was the absence of larval digeneans, cestodes, and acanthocephalans, which are generally common in marine teleost fishes (George-Nascimento, 1987). This could suggest that the limited diet of *C. faber* does not favor its participation as intermediate or transport host in the life cycle of these parasites. The absence of larval helminths has also been seen regarding the sciaenid fishes from the Peruvian coastal zone, and it will be fully explained only by additional information on the population features of the potential intermediate and definitive hosts.

Four pairs of positively associated species were detected. Associations among parasites suggested that infective stages occurred in the same habitat or at least, in some cases, with the occurrence of cumulative infection of the fish by another species (Rohde et al., 1994). In the congeneric digeneans *Multitestis (M.) inconstans* and *M. (M.) brasiliensis*, the absence of association showed that possibly the intermediate hosts belong to different items of the diet of *C. faber*. This situation may be a function of the diet of *C. faber*. Negative associations were not found. However, according to Rohde et al. (1994), the detection of interspecific associations between parasites must be confirmed by experiments on the biology of the parasite species to provide conclusive evidence for the presence or absence of interspecific competition.

Rohde et al. (1995) stated that the metazoan ectoparasite communities of marine fish live in nonsaturated, little-ordered assemblages. This postulate apparently is also valid for endoparasite communities of marine fish from South America. Data obtained from other neotropical marine fish also showed the low degree of competitive interactions and, in some cases, the dominance of generalist species (George-Nascimento and Iriarte, 1989; Luque, 1996; Luque et al., 1996b; Oliva et al., 1996; Takemoto et al., 1996; Knoff et al., 1997; Chaves and Luque, 1998; Oliva and Luque, 1998). The parasite community of *C. faber* can be included as yet another example of this.

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A Message from the Editors

In the last issue Sherman Hendrix announced his retirement from 5 years of outstanding editorship and our assumption of the role. We will strive to build on the foundation of excellence that Sherm and all of our predecessors have laid down. The successful production of a journal such as ours depends not only on editors, but on the support of society officers, editorial board members, an outstanding publisher, and most of all the general membership who serve both as authors and peer reviewers. We have been blessed with the unqualified support of all of you in these respects. While the historical "helminthological" element of the Society's name implies a restriction to "worm parasitologists", in reality the term does not truly represent the membership as it is, a diverse group of parasitologists engaged in the study of all aspects of host/parasite relationships. As we move into the next millennium, our discipline will be faced with a whole new array of challenges and one, biodiversity through biological survey, is already emerging as an exciting and rewarding opportunity. We look forward to continuing to provide through the *Journal* a forum for the presentation of your accomplishments in meeting these challenges.

Willis A. Reid, Jr.
Janet W. Reid
Editors