COMMUNITY ECOLOGY OF THE METAZOAN PARASITES OF WHITE SEA CATFISH, *Netuma barba* (OSTEICHTHYES: ARIIDAE), FROM THE COASTAL ZONE OF THE STATE OF RIO DE JANEIRO, BRAZIL

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ABSTRACT

Between March 2000 and April 2001, 63 specimens of *N. barba* from Angra dos Reis, coastal zone of the State of Rio de Janeiro (23°0'S, 44°19'W), Brazil, were necropsied to study their infracommunities of metazoan parasites. Fifteen species of metazoan parasites were collected: 2 digeneans, 1 monogenean, 2 cestodes, 1 acantocephalan, 2 nematodes, 6 copepods, and 1 hirudinean. Ninety-six percent of the catfishes were parasitized by at least one metazoan parasite species. A total of 646 individual parasites was collected, with mean of 10.3 ± 16.6 parasites/fish. The copepods were 37.5% of the total parasite specimens collected. *Lepeophtheirus monacanthus* was the most dominant species and the only species with abundance positively correlated with the host total length. Host sex did not influence parasite prevalence or mean abundance of any species. The mean diversity in the infracommunities of *N. barba* was $H = 0.130 \pm 0.115$ with no correlation with host's total length and without differences in relation to sex of the host. One pair of endoparasites (*Dinosoma clupeola* and *Pseudoacanthostomum floridensis*) showed positive association and covariation between their abundances and prevalences. The parasite community of *N. barba* from Rio de Janeiro can be defined as a complex of species with low prevalence and abundance and with scarcity of interspecific associations. However, because of both the presence of assemblages of sympatric ariid species as well as the spawning behavior characteristic of these fishes, additional comparative studies of the parasite component communities of ariids are necessaries to elucidate this pattern.

Key words: parasite ecology, community structure, marine fish, Ariidae, *Netuma barba*, Brazil.

RESUMO

Ecologia da comunidade de metazoários parasitos de *Netuma barba* do litoral do Estado do Rio de Janeiro, Brasil

Entre março de 2000 e abril de 2001, 63 espécimes de *N. barba*, provenientes de Angra dos Reis, litoral do Estado do Rio de Janeiro (23°0'S, 44°19'W), Brasil, foram necropsiados para estudo de suas infracomunidades de metazoários parasitos. Foram coletadas 15 espécies de metazoários parasitos: 2 digenéticos, 1 monogenético, 2 cestóides, 1 acantocéfalo, 2 nematóides, 6 copépodes e 1 hirudíneo. Constatou-se que 96% dos bagres estavam parasitados por, no mínimo, uma espécie de parasito. Um total de 646 parasitos foram coletados, com média de 10,3 ± 16,6 parasitos por peixe. Os copépodes representaram 37,5% do total de espécies coletadas. *Lepeophtheirus monacanthus* foi a espécie dominante e a única com abundância correlacionada positivamente com o comprimento total dos hospedeiros,

cujo sexo não influenciou a prevalência e a abundância média parasitária de nenhuma espécie. A diversidade média das infracomunidades de *N. barba* foi de $H = 0{,}130 \pm 0{,}115$, sem apresentar correlação com o comprimento total dos hospedeiros e sem diferenças em relação ao sexo destes. Um par de endoparasitos (*Dinosoma clupeola* e *Pseudoacanthostomum floridensis*) apresentou associação e covariação positiva entre suas abundâncias e prevalências. A comunidade parasitária de *N. barba* do litoral do Estado do Rio de Janeiro pode ser definida como um complexo de espécies com baixa prevalência e abundância e escassez de associações interespecíficas. Entretanto, em razão da presença de assembléias de espécies simpátricas de arídeos e do comportamento reprodutivo característico desses peixes, são necessários estudos comparativos adicionais das comunidades parasitárias componentes dos arídeos para confirmar esse padrão.

Palavras-chave: ecologia parasitária, estrutura comunitária, peixes marinhos, Ariidae, *Netuma barba*, Brasil.

INTRODUCTION

Netuma barba (Lacépède, 1803) is a demersal, benthic, brackish marine fish with known distribution from Bahia, Brazil to Argentina (Figueiredo & Menezes, 1978). Within the life cycle of *N. barba*, in the spawning season, the adult specimens migrate to estuarine areas where juvenile stay during the two first years, when they migrate to the sea (Mishima & Tanji, 1983a, b; Araújo, 1988).

Netuma barba is very common in the southern Brazilian coastal zone and constitutes an important local fishery resource (Mishima & Tanji, 1981, 1982; Araújo *et al.*, 1998a; Azevedo *et al.*, 1998a, 1999).

Some taxonomic papers on parasites of *N. barba* from Brazil exist: Amato (1974), Pereira-Junior & Costa (1986), Fernandes & Goulart (1989) on digeneans; Fortes (1981) on nematodes; Fortes (1981), São Clemente *et al*. (1991) on cestodes; Luque *et al.* (1998), and Luque & Cezar (2000) on copepods.

Studies on quantitative aspects of parasites of *N. barba* from the Brazilian coastal zone up to now have been restricted to digenean (Pereira-Junior & Costa, 1986) and larval stages of trypanorhynch cestodes (São Clemente *et al.*, 1991).

In this report, we analysed the metazoan parasite community of *N. barba*, from the coastal zone of the State of Rio de Janeiro, at the component and infracommunity levels.

MATERIALS AND METHODS

From March 2000 to April 2001, 63 specimens of *N. barba* were examined from Angra dos Reis, coastal zone of the State of Rio de Janeiro (23°01'S, 44°19'W), Brazil. Fishes was identified according to Figueiredo & Menezes (1978) and measured 31-80 cm (mean = 43.9 ± 9.9 cm) in total length. The average total length of male (43.7 ± 3.9 cm, n = 36) and female (47.3 ± 13.1 cm, n = 27) fishes was not significantly different ($t = -1.405$, $p = 0.172$). All fish specimens were considered as adults (total body length > 25 cm) (Azevedo *et al.*, 1998b). The analysis included only parasite species with prevalences higher than 10% (Bush *et al.*, 1990). The index of dispersion (quotient between variance and mean of parasite abundance) and *d* test were used to determine distribution patterns (Ludwig & Reynolds, 1988). The dominance frequency and the relative dominance (number of specimens of one 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 host's total length and abundance of parasites. Pearson's correlation coefficient *r* was used as an indication of the relationship between the total length of hosts and the prevalence of parasites, with previous arcsine transformation of the prevalence data (Zar, 1999) and partition of host samples into five 10 cm length intervals, according to Pereira-Junior & Costa (1986) and São Clemente *et al.* (1991). The effect of host sex on abundance and prevalence of parasites was tested using the Z_c normal approximation to the Mann-Whitney test and the Fisher exact test, respectively. Parasite species diversity was calculated using the Brillouin index (*H*), because each fish analyzed corresponded to a fully censused community (Zar, 1999). The probable variation of diversity in relation to host

sex (Mann-Whitney test) and host total length (Spearman's rank correlation coefficient) was tested. For each infracommunity, evenness (Brillouin-based evenness index) was calculated. The possible interspecific association between concurrent species was determined using the chi-square test. Possible covariation among abundance of concurrent species was analyzed using Spearman's rank correlation coefficient. Ecological terminology follows Bush *et al.* (1997). Statistical significance level was evaluated at $p \leq 0.05$. Voucher specimens of helminths and hirudineans were deposited in the Coleção Helmintológica do Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil; copepods were deposited in the Coleção de Crustacea do Museu Nacional (MNRJ), Quinta da Boa Vista, Rio de Janeiro, RJ, Brazil. Voucher specimens of *N. barba* were deposited in the Coleção Ictiológica do Museu Nacional, Quinta da Boa Vista, Rio de Janeiro, RJ, Brazil.

RESULTS

Component community

Fifteen species of metazoan parasites were collected (Table 1). Copepods were the most abundant with six species, accounting for 37.5% of the total parasites collected. *Lepeophtheirus monacanthus* Heller, 1865, was the dominant species, with 219 specimens collected (33.9% of all parasites), and showed the highest values of mean relative dominance and frequency of dominance (Table 2). All parasites of *N. barba* showed the typical aggregated pattern of distribution observed in many parasite systems. *Dinosoma clupeola* Fernandes & Goulart, 1989, showed the highest values of dispersion indices (Table 3). Abundance of *L. monacanthus* was positively correlated with host's total length, with which prevalence was not significantly correlated (Table 4). The mean abundance and prevalence of all parasite species were not significant different in female and male hosts.

Infracommunities

Ninety-six percent of *N. barba* were parasitized by at least one parasite species. A total of 646 individual parasites were collected, with mean of 10.3 ± 16.6 (1-88) parasites/fish. The value of dispersion index for the total individual parasites was 114.3. Relationships between total parasite abundance and total body length of fish ($r_s = 0.235$, $p = 0.062$) were not observed. Parasite species richness 2.0 ± 1.0 (1-5) was correlated with total body length of fish ($r_s = 0.252$, $p = 0.046$). Eighteen hosts (29%) showed infection with one parasite species and 22 (35%), 16 (25%), 3 (5%), and 1 (2%) had multiple infections with 2, 3, 4, and 5 parasite species, respectively. The mean parasite species diversity (H) was 0.130 ± 0.115 and the maximum diversity was 0.387. The Brillouin-based evenness index (J) had a mean of 0.416 ± 0.350. Parasite diversity was not correlated with host total length ($r_s = 0.187$, $p = 0.143$) and no significant differences ($t = -0.052$, $p = 0.959$) in parasite diversity were observed between male (H = 0.121 ± 0.113) and female fishes (H = 0.140 ± 0.118).

Parasite infracommunities were separated into two groups: ectoparasites (copepods) and adult endoparasites (digeneans and nematode), to determine possible interspecific associations. Larval stages were not included in this analysis because no species showed a prevalence higher than 10%. Among the ectoparasites, species did not share significant covariation. The infracommunities of endoparasites had one pair of species which showed significant positive association and covariation, *D. clupeola* and *Pseudoacanthostomum floridensis* Nahhas & Short, 1965 (Table 5).

DISCUSSION

The present study detected some patterns in the infracommunity structures of metazoan parasites of *N. barba* from Rio de Janeiro, Brazil: (1) ectoparasite dominance; (2) correlation of parasite abundance with the size of the host; (3) low number of parasite interspecific relationships.

The dominance of copepod ectoparasites has been recorded for some parasite communities of marine fishes from the coastal zone of southeastern Brazil (Cezar & Luque, 1999; Tavares *et al.*, 2001). Several factors might give rise to this pattern, but the typical schooling behavior of *N. barba* in the spawning season described by Mishima & Tanji (1983a) could strongly favor the direct transmission of ectoparasites, whose dominance must be carefully observed in mariculture activity involving *N. barba*.

TABLE 1

Prevalence, intensity, mean intensity, mean abundance, and site of infection of the parasites of *Netuma barba* from the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	Prevalence (%)	Intensity	Mean intensity	Mean abundance	Site of infection
DIGENEA					
Dinosoma clupeola CHIOC 34703 a, b	38.1	1-88	7.4 ± 17.8	2.8 ± 11.4	Stomach
Pseudoacanthostomum floridensis CHIOC 34706 a, b	19.1	1-4	1.3 ± 0.9	0.3 ± 0.6	Stomach
MONOGENEA					
Hamatopeduncularia sp. CHIOC 34707	9.5	1-7	2.7 ± 2.3	0.2 ± 1.0	Gills
EUCESTODA					
Tetraphyllidean larval CHIOC 34947	6.4	–	1	< 0.1	Intestine
Nomimoscolex arandasregoi CHIOC 34944	4.8	1-87	40.7 ± 43.4	1.9 ± 11.7	Intestine
ACANTOCEPHALA					
Polymorphus sp. (cystacanth) CHIOC 34946	1.6	–	1	< 0.1	Mesenteries
NEMATODA					
Contracaecum sp. (larval) CHIOC 34671	7.9	1-17	6.2 ± 6.5	0.5 ± 2.4	Mesenteries
Philometra fariaslimai CHIOC 34690	12.7	1-11	3.4 ± 3.7	0.4 ± 1.7	Intestine
HIRUDINEA					
Piscicolid not identified CHIOC 34684	7.9	1-6	2 ± 2.2	0.2 ± 0.8	Gills
COPEPODA					
Caligus haemulonis MNRJ 15419	1.6	–	1	< 0.1	Gills
Caligus praetextus MNRJ 15420	4.8	–	1	< 0.1	Body surface
Ergasilus sp. MNRJ 15423	4.8	–	1	< 0.1	Gills
Lepeophtheirus bagri MNRJ 15421	14.3	1-3	1.7 ± 0.9	0.2 ± 0.7	Gills
Lepeophtheirus monacanthus MNRJ 15422	66.7	1-27	5.2 ± 5.1	3.5 ± 4.8	Gills
Taeniastrotos brasiliensis MNRJ 15424	1.6	–	1	< 0.1	Gills

TABLE 2

Frequency of dominance and mean relative dominance of the metazoan parasites of *Netuma barba* 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
Dinosoma clupeola	10	8	0.183 ± 0.311
Pseudoacanthostomum floridensis	1	5	0.037 ± 0.114
Philometra fariaslimai	3	3	0.049 ± 0.171
Lepeophtheirus bagri	2	5	0.041 ± 0.125
Lepeophtheirus monacanthus	30	4	0.464 ± 0.411

TABLE 3

Dispersion index (DI) and *d* test of the metazoan parasites of *Netuma barba* from the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	DI	*d*
Dinosoma clupeola	46.5	64.8
Pseudoacanthostomum floridensis	1.6	3.2
Philometra fariaslimai	6.6	17.5
Lepeophtheirus bagri	1.9	4.1
Lepeophtheirus monacanthus	6.7	17.7

TABLE 4

Spearman's rank correlation coefficient (r_s) and Pearson's correlation coefficient (r) values used to evaluate possible relationships among the total length of *Netuma barba*, abundance and prevalence of the components of its parasite community from the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	r_s	p	r	p
Dinosoma clupeola	–0.056	0.664	0.006	0.968
Pseudoacanthostomum floridensis	0.167	0.190	0.003	0.928
Philometra fariaslimai	–0.028	0.828	0.184	0.471
Lepeophtheirus bagri	0.118	0.359	0.251	0.390
Lepeophtheirus monacanthus	0.378*	0.002	0.284	0.355

* = significant values; p = significance level.

TABLE 5

Concurrent species pairs of endoparasites in *Netuma barba* from the coastal zone of the State of Rio de Janeiro, Brazil.

Species pairs	c^2	p	r_s	p
Dinosoma clupeola–Pseudoacanthostomum floridensis	5.13*	0.024	0.269*	0.033
P. floridensis–Philometra fariaslimai	0.21	0.646	0.052	0.688
P. fariaslimai–D. clupeola	0.55	0.458	0.096	0.456

χ^2 = Chi-square test; r_s = spearman rank correlation coefficient; * = significant values; p = significance level.

In environments under cultivation, with high fish population density, increase of ectoparasite prevalence and abundance is routine (Euzet & Raibaut, 1985). Moreover, the ectoparasite fauna of *N. barba* from Rio de Janeiro is composed of species with high pathogenic potential such as caligid and ergasilid copepods. We emphasize the occurrence of species of sea lice (*Caligus* and *Lepeophtheirus*). Caligid species are responsible for great economic losses in world fish farming (Boxshall & Defaye, 1993; Tavares & Luque, 2001). The influence of the host total length on the abundance of parasitism at the infracommunity level was strongly influenced by the relationship between *L. monacanthus* and host total length. The other parasite species did not show this relationship.

The absence of correlations of parasite infrapopulations with the sex of the host fish is another pattern widely documented in marine fishes and generally is considered a consequence of the absence of sexual differences in some biological aspects of fish (Alves *et al*., 2002). Male specimens of *N. barba* after spawning season show incubating behaviour (Araújo, 1988; Chaves, 1994; Araújo *et al.*, 1998b; Azevedo *et al.*, 1998b). Egg and larvae mouth breeding last for three months and during this time adult fish do not feed. This period of empty stomach may protect the fish from further ingesting intermediate hosts. According to Araújo *et al.* (1998a), at this time the male specimens show a lower condition factor, which can indicate a physiological deficiency. Possibly influencing the level of infection, however, no differences relative to parasite abundance, intensity, and diversity among male and female hosts were found. Additional parasitological studies of seasonal samples of *N. barba* could elucidate this point further.

The feeding habits and wide diet spectrum of demersal fishes puts them in to contact with several potential intermediate hosts of acanthocephalan, digenean, and nematodes. This might be increasing the presence of endoparasites in these fishes (Alves & Luque, 2001). *Netuma barba* feed mainly on crustaceans, polychaetes, small fishes, and detritus, without selectivity, suggesting that it is an opportunist species (Mishima & Tanji, 1982; Araújo, 1984; Reis, 1986). The diet of the host species is the main factor affecting the parasite community structure, specially for the digenean trematodes transmitted to their final host through a predator-prey relationship (Sasal *et al.*, 1999). In spite of the migratory habits of *N. barba*, their parasite richness and diversity are lower than expected, owing perhaps to a limiting factor constitued by their spawning migration and mouthbreeding habits. In addition, the biology of brackish water fishes allows the exchange of parasite species between marine and freshwater fish, because marine parasite species can utilize both freshwater and marine fish species as intermediate or final hosts, and marine fish can harbor freshwater parasite species (Valtonen *et al*., 2001). For instance, other brackish fishes from the coastal zone of Rio de Janeiro showed a higher parasite richness for the parasite communities of *Mugil platanus* and *Micropogonias furnieri* (Knoff *et al*., 1997; Alves & Luque, 2001). However, additional comparative studies on the parasite components of juvenile and adult *N. barba* specimens are necessary to clarify this feature of their biology.

Pereira-Junior & Costa (1986) recorded the digenean *Pelorohelmis moniliovata* (Freitas & Kohn, 1967) parasitic in the swim bladders of *N. barba* from southern Brazil, with a 10.3% prevalence of infection. São Clemente *et al.* (1991) recorded the trypanorhynch *Callitetrarhynchus gracilis* (Rudolphi, 1819), *C. speciosus* (Linton, 1897), and *Pterobothrium crassicolle* (Diesing, 1850) with a 23% prevalence of infection. In relation to the studies of Pereira-Junior & Costa (1986) and São Clemente *et al*. (1991), qualitative and quantitative differences of infections might be explained by the opportunist feeding habits of *N. barba* associated with local changes in distribution of hosts and availability of prey items over time.

Scarcity of interspecific associations in the parasite infracommunities is a common pattern in the majority of studied marine fishes (Rohde *et al*., 1995). According to Poulin (2001), experimental evidence from concomitant infections of captive hosts under laboratory conditions, and field evidence on patterns of richness and co-occurrence of parasite species from wild-caught hosts are necessary for determining the real role of interspecific interactions in parasite community structures. Some authors have cited the occurrence of spatial segregation among sympatric ariid species (Mishima & Tanji, 1981, 1983a; Araújo, 1988; Azevedo *et al.*, 1998a, 1999). Azevedo *et al.* (1998b) recorded spatial overlapping between *N. barba*, *Cathorops spixii* (Agassiz, 1829), and *Genidens genidens* (Valenciennes, 1839)

juveniles in Sepetiba Bay, Rio de Janeiro, Brazil. This fact reinforces the possibility that these ariid fishes would show high similarity in their parasite infracommunities.

The parasite community of *N. barba* from Rio de Janeiro can be defined as a complex of species with low prevalence and abundance and with scarcity of interspecific associations. This situation is in concordance with that observed by Valtonen *et al*. (2001) in relation to marine brackish fish species. However, because of the presence of assemblages of sympatric ariid species and the characteristic spawning behavior of these fishes, additional comparative studies of the parasite component communities in Rio de Janeiro are necessary to confirm this pattern.

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