COMMUNITY ECOLOGY OF METAZOAN PARASITES OF THE LATER JUVENILE COMMON SNOOK *Centropomus undecimalis* (OSTEICHTHYES: CENTROPOMIDAE) FROM THE COASTAL ZONE OF THE STATE OF RIO DE JANEIRO, BRAZIL

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ABSTRACT

Between April and December 2000, seventy-nine specimens of *Centropomus undecimalis* from Angra dos Reis, coastal zone of the State of Rio de Janeiro (23°01'S, 44°19'W), Brazil, were necropsied to study their infracommunities of metazoan parasites. Nine species of metazoan parasites were collected: 1 digenean, 1 monogenean, 1 acantocephalan, 1 nematode, 4 copepods, and 1 isopod, and 96.2% of the fishes were parasitized by one or more metazoan, with mean of 85.3 ± 122.9 parasite/fish. The digenean *Acanthocollaritrema umbilicatum* Travassos, Freitas & Bührnheim represented the majority of the parasites specimens collected, totaling, 94.7%. This species was the most abundant, prevalent, and dominant, showing positive correlation with the host's total body length and parasite abundance. The copepod species *Acantholochus unisagittatus* Tavares & Luque presented differences in abundance in relation to sex of host. The mean diversity in the infracommunities of *C. undecimalis* was $H' = 0.095 \pm 0.116$, with no correlation with the host's total body length but correlated with the host's sex. No pair of parasite species showed positive or negative association or covariation. The dominance of digenean *A. umbilicatum* in the later juvenile common snook parasite community could be related with the predatory food habits of common snook and an apparent feeding transition period which might occasion great exposure to infective forms.

Key words: parasite ecology, community structure, marine fish, Centropomidae, *Centropomus undecimalis*, Brazil.

RESUMO

Ecologia da comunidade de metazoários parasitos de *Centropomus undecimalis* do litoral do Estado do Rio de Janeiro, Brasil

Entre abril e dezembro de 2000, 79 espécimes de *C. undecimalis*, provenientes de Angra dos Reis, litoral do Estado do Rio de Janeiro (23°01'S, 44°19'W), Brasil, foram necropsiados para o estudo de suas infracomunidades de metazoários parasitos. Foram coletadas nove espécies de metazoários parasitos: 1 digenético, 1 monogenético, 1 acantocéfalo, 1 nematóide, 4 copépodes e 1 isópode; e 96,2% dos peixes estavam parasitados por um ou mais metazoários parasitos, com média de 85,3 ± 122,9 parasitos/peixe. O digenético *Acanthocollaritrema umbilicatum* Travassos, Freitas & Bührnheim foi o táxon maioritário, representando 94,7% do total de parasitos coletados. Esta espécie foi a mais abundante, prevalente e dominante, apresentando correlação positiva entre o comprimento total dos hospedeiros e a abundância parasitária. O copépode *Acantholochus unisagittatus* Tavares & Luque apresentou diferenças em sua abundância em relação ao sexo dos hospedeiros. A diversidade média das infracomunidades de *C. undecimalis* foi de $H' = 0,095 \pm 0,116$ sem correlação com o comprimento

total dos hospedeiros e com diferenças em relação ao sexo dos hospedeiros. Nenhum par de espécies demonstrou associação e covariação positiva ou negativa. A dominância do digenético *A. umbilicatum* na comunidade parasitária dos robalos jovens pode estar relacionada ao hábito predador e ao aparente período de transição alimentar, que pode levar a uma grande exposição às formas infectantes.

Palavras-chave: ecologia parasitária, estrutura comunitária, peixes marinhos, Centropomidae, *Centropomus undecimalis*, Brasil.

INTRODUCTION

The common snook, *Centropomus undecimalis* (Bloch, 1792) is a demersal species that spends much of its life in estuaries, but migrates to ocean inlets or just offshore to spawn (Tucker & Campbell, 1988). This is a euryhaline and diadromous fish, with known distribution from Pamlico Sound, North Carolina, USA, southward to Rio de Janeiro, Brazil (Rivas, 1986). *Centropomus undecimalis* is predaceous and occupies high levels in the trophic web (Figueiredo & Menezes, 1980). Centropomid fishes are commercially important and widely used in aquaculture as a food fish and also as recreational fish (Vasconcelos-Filho & Galiza, 1980; Bórquez & Cerqueira, 1998; Kennedy *et al.*, 1998; Tolley & Peebles, 1998).

Some recently published taxonomic papers on the parasites of *Centropomus* species from Brazil are: Wallet & Kohn (1987); Rodrigues *et al.* (1990); Robaldo & Padovan (1998) on digenean; Bravo-Hollis (1986) and Kritsky *et al.* (2001) on monogeneans; and Tavares & Luque (2003) on copepods.

Studies on quantitative aspects of the parasites of *C. undecimalis* from the Brazilian coastal zone were restricted to the digenean *A. umbilicatum* (Tavares & Luque, 2001a) and to the copepod *Caligus praetextus* Bere, 1936 (Tavares & Luque, 2001b). Studies on ecological aspects of parasite infracommunities of *C. undecimalis* are unknown.

In this report, we analyzed at the component and infra-community levels the metazoan parasite community of *C. undecimalis* from the coastal zone of the State of Rio de Janeiro.

MATERIALS AND METHODS

From April to December 2000, 79 specimens of *C. undecimalis* were examined from Angra dos Reis, coastal zone of the State of Rio de Janeiro, Brazil (23°01'S, 44°19'W). Fishes, identified according to Rivas (1986), measured 18.5-47.0 cm (mean = 35.2 ± 3.4 cm) in total length. The average total length of male (35.8 ± 4.1 cm, n = 39) and female (35.3 ± 1.9 cm, n = 27) fishes in the study sample were not significantly different (t = 0.569, p = 0.575); thirteen specimens measuring 33.7 ± 5.1 cm were not differentiated as male or female and not included in this analysis. The term "later juvenile common snook" was used according to Peters *et al.* (1998) to classify the common snook specimens with body size similar to the sample studied in the present report.

The analysis included only parasite species with prevalence higher than 10% (Bush *et al.*, 1990). The quotient between variance and mean of parasite abundance (index of dispersion) was used to determine distribution patterns, and its significance was tested using d statistical test. 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 total length of hosts and 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, 1999) and partition of host samples into four 5 cm length intervals. 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 to 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 analyzed using the chi-square test. Possible

covariation among the abundance of concurrent species was analyzed using the Spearman rank correlation coefficient. Ecological terminology follows Bush *et al.* (1997). Statistical significance level was evaluated at $p \leq 0.05$.

Voucher specimens from representative species of helminths were deposited in the Coleção Helmintológica do Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil; copepods and isopods were deposited in the Coleção de Crustacea do Museu Nacional (MNRJ), Rio de Janeiro, Brazil.

RESULTS

Component community

Nine species of metazoan parasites were collected (Table 1). The digenean *A. umbilicatum*, the most abundant and dominant species, accounted for 94.7% of total parasites collected and showed the highest values of mean relative dominance and frequency of dominance (Table 2). All parasites of *C. undecimalis* had the typical aggregated pattern of distribution observed in many parasite systems. *Acanthocollaritrema umbilicatum* showed the highest values of dispersion indices (Table 3). Abundance of *A. umbilicatum* was positively correlated with host total length, although prevalence of no specieswassignificantly correlated with host's total length (Table 4). The mean abundance and prevalence of *A. unisagittatus* were significant higher in the male (95.7 and 81.5%) than in the female (56.3 and 76.9%) hosts ($Z_c = -2.15$, $p = 0.03$; $F = 0.05$).

Infracommunities

Ninety-six percent of common snooks were parasitized by at least one parasite species. A total of 6,741 individual parasites was collected, with mean of 85.3 ± 122.9 parasite/fish. The value of dispersion indices for the total individual parasites was 75.573. Relationships between total parasite abundance and total body length of fish were observed ($r_s = 0.233$, $p = 0.03$). Mean parasite species richness 1.9 ± 1 (1-4) was not correlated with total body length of fish ($r_s = 0.063$, $p = 0.581$). Twenty-eight hosts (36%) showed infection with one parasite species and 31 (39%), 12 (15%), and 5 (6%) had multiple infections with 2, 3, and 4 species, respectively. Mean parasite species diversity (H) was 0.095 ± 0.116 and maximum diversity was 0.391. The Brillouin-based evenness index (J) had a mean of 0.295 ± 0.358. Parasite diversity was not correlated to host total length ($r_s = -0.01$, $p = 0.93$) and significant differences ($t = -2.35$, $p = 0.03$) in parasite diversity were observed between male ($H = 0.127 \pm 0.126$) and female common snooks ($H = 0.077 \pm 0.105$).

Only one group, ectoparasites (copepods), was used to determine possible interspecific associations. Adult endoparasites and larval stages were not included in this analysis because only one species of each group showed prevalence higher than 10% (*A. umbilicatum* as an adult and *Contracaecum* sp. in the larval stage). The copepod species pair *A. unisagittatus* and *C. praetextus* did not share significant association and covariation ($\chi^2 = 2.47$, $p = 0.116$; $r_s = 0.130$, $p = 0.253$).

DISCUSSION

We detected some patterns in the structure and composition of the community of metazoan parasites of *C. undecimalis* from Brazil: (1) endoparasite dominance; (2) correlation of parasite abundance with host size; and (3) lack of parasite interpecific relationships.

The dominance of digenean endoparasites has been described for several parasite communities of marine fishes from the coastal zone of southeastern Brazil (Luque *et al.*, 1996; Takemoto *et al.*, 1996; Knoff *et al.*, 1997; Luque & Chaves, 1999; Silva *et al.*, 2000; Luque & Alves, 2001). Feeding habits and broad diet spectrum of demersal fishes, which bring them in contact with several potential intermediate hosts of marine acanthocephalan, digenean, and nematodes, might increase the presence of endoparasites in these fishes (Alves & Luque, 2001). The later juvenile *Centropomus undecimalis* shows predatory habits and an apparent feeding transition period (Vasconcelos-Filho & Galiza, 1980; Teixeira, 1997), thus, great exposure to infective stages of parasites trophically transmitted is possible.

According Sasal *et al.* (1999), the diet of the host species is the main factor affecting parasite community structure, specially for digenean trematodes that are transmitted to their final host through a predator-prey relationship. These authors proposed that hosts with a more diversified diet should encounter more intermediate host species and, consequently, harbor more parasite species. Despite parasite abundance and prevalence shown in the common snook, in the present report parasite species richness was lower than expected. Many authors have

reported diversified predatory feeding habits for this fish species (Harrington & Harrington, 1961; Vasconcelos-Filho & Galiza, 1980; Lau & Shafland, 1982; Gilmore *et al.*, 1983; McMichael *et al.*, 1989; Teixeira, 1997; Peters *et al.*, 1998). However, as reported by Teixeira (1997) and Peters *et al.* (1998), although as nursery grounds estuaries represent the most important habitat for common snook, because they are near urban areas these ecosystems suffer great anthropic pressure resulting from organic and industrial discharges. This leads to eutrophication, followed by increased biological oxygen demand which subsequently produces mortalities of many forage species (Khan & Thulin, 1991).

TABLE 1
Prevalence, intensity, mean intensity, mean abundance, and site of infection of the metazoan parasites of *Centropomus undecimalis* from the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	Prevalence (%)	Intensity	Mean intensity	Mean abundance	Site of infection
DIGENEA					
Acanthocollaritrema umbilicatum (CHIOC 34702 a, b)	83.5	1-618	96.7 ± 129.1	80.8 ± 123.2	Intestine
MONOGENEA					
Rhabdosynochus hargisi (CHIOC 34708)	8.9	1-8	2.9 ± 2.7	0.3 ± 1.1	Gills
ACANTOCEPHALA					
Corynosoma sp. (cystacanth) (CHIOC 34710)	2.5	---	1	< 0.1	Intestine
NEMATODA					
Contracaecum sp. (larval) (CHIOC 34670)	12.7	1-8	3.8 ± 2.9	0.5 ± 1.6	Mesenteries
COPEPODA					
Acantholochus unisagittatus (MNRJ 15425)	53.2	1-19	6.2 ± 4.9	3.3 ± 4.7	Gills
Caligus praetextus (MNRJ 15341)	11.4	1-5	1.8 ± 1.4	0.2 ± 0.7	Body surface
Ergasilus sp. (MNRJ 15426)	3.8	3-4	3.7 ± 0.6	0.1 ± 0.7	Gills
Lernanthropus gisleri (MNRJ 15342)	3.8	---	1	< 0.1	Gills
ISOPODA					
Cymothoid not identified (MNRJ 15427)	5.1	1-2	1.3 ± 0.5	< 0.1	Body surface

TABLE 2
Frequency of dominance and mean relative dominance of the metazoan parasites of *Centropomus undecimalis* 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
Acanthocollaritrema umbilicatum	60	2	0.708 ± 0.381
Contracaecum sp. (larval)	2	1	0.027 ± 0.118
Acantholochus unisagittatus	11	6	0.171 ± 0.278
Caligus praetextus	1	2	0.023 ± 0.120

TABLE 3
Dispersion index (DI) and *d* test of the metazoan parasites of *Centropomus undecimalis* from the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	DI	*d*
Acanthocollaritrema umbilicatum	187.9	158.8
Contracaecum sp. (larval)	5.33	36.5
Acantholochus unisagittatus	6.7	19.9
Caligus praetextus	2.6	7.7

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 *Centropomus undecimalis*, abundance and prevalence of the components of its parasite community in the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	r_s	*p*	*r*	*p*
Acanthocollaritrema umbilicatum	0.223	0.048*	0.780	0.117
Contracaecum sp. (larval)	0.029	0.799	0.202	0.550
Acantholochus unisagittatus	< 0.01	0.998	0.302	0.450
Caligus praetextus	0.062	0.586	0.541	0.264

*: significant values; *p*: significance level.

Also, the schooling behavior related for juvenile and adult common snook (Peters *et al.*, 1998) might favor direct ectoparasite transmission. Some ectoparasite species showed prevalence higher than 10% on *C. undecimalis* from Rio de Janeiro. In mariculture activities with high fish population density, ectoparasite prevalence and abundance increase is possible (Euzet & Raibaut, 1985). The ectoparasite fauna of common snook from Rio de Janeiro is composed by species with high pathogenic potential such as caligid and ergasilid copepods. We emphasize sea lice occurrence since *Caligus* species are responsible for great economic losses in world fish farming *Caligus praetextus* (Tavares & Luque, 2001b).

The correlation among total length of *C. undecimalis* and abundance of *A. umbilicatum*, might originate in accumulative infection. Sasal *et al.* (1999) observed that large fish are supposed to eat more and, therefore, ingest more intermediate hosts. This is a pattern previously found in other marine fishes from Rio de Janeiro (Luque *et al.*, 1996; Knoff *et al.*, 1997; Luque & Chaves, 1999; Luque & Alves, 2001; Alves & Luque, 2001; Tavares *et al.*, 2001). According to Polyanski (1961), quantitative and qualitative changes in parasitism are expected with fish growth. In the case of digeneans, this relationship is strongly influenced by changes in feeding habits of the fish correlated with age (Saad-Fares & Combes, 1992). Juvenile common snook have a preliminary pelagic stage followed by a longer demersal stage (Peters *et al.*, 1998) and show an apparent feeding transition period associated to this ontogenetic change in habitat. Early juvenile common snook feed mainly on copepods, other microcrustaceans, and insect larvae, while later juvenile and adult common snook feed on a wider range of food items, specially finfishes and shrimps (Harrington & Harrington, 1961; Vasconcelos-Filho & Galiza, 1980; Teixeira, 1997), which can be intermediate hosts of digenean parasites in marine fishes.

The correlation of the sex of *C. undecimalis* with abundance and prevalence of copepod *A. unisagittatus* was surprising because biological differences in male and female common snook are unclear. Snooks are protandrous and size at maturity is somewhat confusing (Peters *et al.*, 1998). Moreover, Poulin (1996) stated that high testosterone levels can cause immunosuppression in males and could lead in some cases to males suffering more from parasites than do females, although many parasite surveys have reported no significant differences in infection abun-

dance and prevalence between female and male hosts. Quantitative relationships of the sex of the host with infection levels of some components of the parasite communities were also detected in other marine fishes from Rio de Janeiro (Luque *et al.*, 1996; Knoff *et al.*, 1997; Alves & Luque, 2001) and may suggest ecological and behavioral differences between female and male hosts.

The lack of parasite species associated pairs shown in *C. undecimalis* is in agreement with the data obtained on other marine fishes, where the presence of a low number of associated species is a common pattern (Rohde *et al.*, 1995). However, these data from quantitative associations between parasite species could be used with caution to explain the parasite community structure. According to Rohde *et al.* (1995) and Poulin (2001), interspecific relationships can only be considered valid when tested under experimental conditions. These results reinforce the postulate of Rohde *et al.* (1995) according to which the parasite community structure in marine fishes constitutes a confused and unsaturated species complex, unlike the interactive patterns related for other host groups.

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