COMMUNITY ECOLOGY OF THE METAZOAN PARASITES OF ATLANTIC MOONFISH, *Selene setapinnis* (OSTEICHTHYES: CARANGIDAE) FROM THE COASTAL ZONE OF THE STATE OF RIO DE JANEIRO, BRAZIL

CORDEIRO, A. S.[1] and LUQUE, J. L.[2]

[1]Curso de Pós-graduação em Biologia Animal, Universidade Federal Rural do Rio de Janeiro, CEP 23851-970, Seropédica, RJ, Brazil

[2]Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, C.P. 74508, CEP 23851-970, Seropédica, RJ, Brazil

Correspondence to: José Luis Luque, Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, C.P. 74508, CEP 23851-970, Seropédica, RJ, Brazil, e-mail: jlluque@ufrrj.br

Received July 31, 2002 – Accepted April 17, 2003 – Distributed August 31, 2004

ABSTRACT

Eighty-nine specimens of *Selene setapinnis* (Mitchill, 1815) collected from the coastal zone of the State of Rio de Janeiro (21-23ºS, 41-45ºW and 23º05'S, 44º30'W), Brazil, from August 2001 to May 2002, were necropsied to study their metazoan parasites. Eighty-one (91%) specimens of *S. setapinnis* were parasitized by one or more metazoan species. Twenty-one species of parasites were collected: 8 digeneans, 3 monogeneans, 2 cestodes, 5 nematodes, and 3 copepods. The endoparasites (digeneans, cestodes, and nematodes) were 74.1% of total number of parasite specimens collected. The monogenean *Pseudomazocraes selene* (Hargis, 1957) was the most dominant species with the highest prevalence in the parasite community of *S. setapinnis*. The metazoan parasites of this host species showed the typical aggregated pattern of distribution. Only one parasite species (*Acanthocolpoides pauloi* Travassos, Freitas & Buhrnheim, 1955) showed positive correlation between the host total length and parasite abundance in *S. setapinnis*. *Caligus robustus* Bassett-Smith, 1898, *P. selene*, and *Terranova* sp. demonstrated positive correlation between the host total length and prevalence. Larvae of *Terranova* sp. showed influence of the host sex on its prevalence. A pair of ectoparasite species, *P. selene-C. robustus*, exhibited positive covariation between their abundances. Two pairs of endoparasite species, *L. microstomum-P. merus* and *A. pauloi-P. merus* showed significant covariation among their abundances; and the pair *Terranova* sp.-*Raphidascaris* sp. had positive co-ocorrence and covariation in the infracommunities of *S. setapinnis*. Like the parasite communities of the other carangid fishes from Rio de Janeiro, the parasite community of *S. setapinnis* is apparently only a slightly ordered species complex, characterized by dominance of endoparasite species.

Key words: parasite ecology, community structure, marine fish, Carangidae, *Selene setapinnis*, Brazil.

RESUMO

Ecologia da comunidade de metazoários parasitos do peixe-galo *Selene setapinnis* (Osteichthyes: Carangidae) do litoral do Estado do Rio de Janeiro, Brasil

Foram coletados 89 espécimes de *Selene setapinnis* (Mitchill, 1815) no litoral do Estado do Rio de Janeiro (21-23ºS, 41-45ºW e 23º05'S, 44º30'W), Brasil, de agosto de 2001 a maio de 2002, os quais foram necropsiados para o estudo de seus metazoários parasitos. Foram encontrados 81 (91%) espécimes de *S. setapinnis* parasitados por uma ou mais espécies de metazoários parasitos, sendo coletados 21 espécies de parasitos: 8 digenéticos, 3 monogenéticos, 2 cestóides, 5 nematóides e 3 copépodes. Os endoparasitos (digenéticos, cestóides e nematóides) somam 74,1% do número total de espécimes de parasitos coletados. O monogenético *Pseudomazocraes selene* (Hargis, 1957) foi a espécie mais dominante e com maior valor

de prevalência na comunidade parasitária de *S. setapinnis*. Os metazoários parasitos deste hospedeiro mostraram o típico padrão agregado de distribuição. Apenas uma espécie de parasito (*Acanthocolpoides pauloi* Travassos, Freitas & Bührnheim, 1955) mostrou correlação positiva entre o comprimento total do hospedeiro e a abundância parasitária. *Caligus robustus* Bassett-Smith, 1898, *P. selene* e *Terranova* sp. tiveram correlação positiva entre o comprimento total do hospedeiro e a prevalência parasitária. Larvas de *Terranova* sp. mostraram influência do sexo do hospedeiro sobre sua prevalência parasitária. Apenas um par de espécies de ectoparasitos, *P. selene*-*C. robustus*, mostraram covariação positiva entre suas abundâncias. Dois pares de espécies de endoparasitos, *L. microstomum*-*P. merus* e *A. pauloi*-*P. merus* mostraram covariação positiva entre suas abundâncias; e o par *Terranova* sp.-*Raphidascaris* sp. teve co-ocorrência e covariação positiva nas infracomunidades de *S. setapinnis*. Como nas outras comunidades parasitárias de peixes carangídeos do Rio de Janeiro, a comunidade parasitária de *S. setapinnis* aparentemente é um complexo de espécies pouco ordenado, caracterizado pela dominância de endoparasitos.

Palavras-chave: ecologia parasitária, estrutura comunitária, peixes marinhos, Carangidae, *Selene setapinnis*, Brasil.

INTRODUCTION

The Atlantic Moonfish, *Selene setapinnis* (Mitchill, 1815) is a demersal carangid, with known distribution from New Scotia to North Argentina. These fishes are basically carnivorous predators, feeding on fishes, crustacean, and planktonic invertebrates. In the life cycle, the young specimens are found in waters with low salinity, and on sandy substrates in marine coastal zones, while the adults are found until 54 m depth, constituting schools close to the water surface (Menezes & Figueiredo, 1980; Cervigón *et al.*, 1992).

Another species of *Selene* which is abundant in the southern Brazilian coastal zone is *S. vomer* (Linnaeus, 1758), which can easily be differentiated from *S. setapinnis* because of the size of the first ray of the dorsal and anal fins and by the body height (Menezes & Figueiredo, 1980).

Some taxonomic papers about the parasites of *Selene* spp. from Brazil were published by Vicente & Santos (1973) (nematodes); Fabio (1981), Amato (1982, 1983), and Wallet & Kohn (1987) (digenean); Kohn *et al.* (1992) (monogenean); and Palm (1997) (cestodes).

Recently, Cezar *et al.* (2000) in a quantitative study about infracommunities of metazoan ectoparasites of *S. vomer* from the State of Rio de Janeiro, concluded that the monogenean was the dominant parasite group. Other papers about quantitative aspects of parasite fauna of carangid fishes from Rio de Janeiro were done on *Oligoplites* spp. by Takemoto *et al.* (1996) and for *Caranx hippos* and *C. latus* by Luque & Alves (2001).

In this report, we analyze the metazoan parasite community of *S. setapinnis*, from the coastal zone of the State of Rio de Janeiro, at the component and infracommunity levels, and compare our results with those on the parasite communities of other carangid fishes.

MATERIAL AND METHODS

From August 2001 to May 2002, 89 specimens of *S. setapinnis* were examined from Copacabana and Barra de Guaratiba, State of Rio de Janeiro (22º55'S, 43º12'W and 23º05'S, 44º30'W), Brazil. Fishes were identified according to Menezes & Figueiredo (1980) and measured 20-44.5 cm (mean = 29.4 ± 6.2) in total length. The average total length of male (24-40.5 cm; mean = 31.4 ± 5.6; n = 47) and female (24-44.5 cm; mean = 32.1 ± 7.1; n = 42) fishes were not significantly different ($t = -0.392$, $p = 0.212$). The analysis included only parasite species with prevalence 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 relative dominance (number of specimens of one species/total number of specimens of all species in the infra-community) of each parasite species were calculated according to Rohde *et al.* (1995). Spearman's rank correlation coefficient r_z 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, 1996) and partition of host samples into five 5 cm length intervals (20-25 cm, 25.5-30 cm, 30.5-35 cm, 35.5-40 cm, and 40.5-45 cm). 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 Chi-square test, respectively. Parasite species diversity was calculated using the Brillouin index (*H*) because each fish analysed corresponded to a fully censused community (Zar, 1996). The possible 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 determined using the chi-square test. Possible covariation among the abundance of concurrent species was analyzed using the Spearman's rank correlation coefficient. Ecological terminology follows Bush *et al.* (1997). Statistical significance level was evaluated at p = 0.05. Voucher specimens of helminths were deposited in the Coleção Helmintológica do Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, RJ, Brazil; copepods were deposited in the Coleção de Crustacea do Museu Nacional (MNRJ), Quinta da Boa Vista, Rio de Janeiro, RJ, Brazil.

RESULTS

Component community

Twenty-one species of metazoan parasites were collected (Table 1): eight digenean, 3 monogenean, 2 cestodes, 5 nematodes, and 3 copepods. *Selene setapinnis* is a new host record for all these species, with exceptions made for *Nybelinia* sp. and *Tergestia selenei* (Table 1). The monogenean *P. selene* was the most prevalent species with greatest values of frequency of dominance and mean relative dominance (Table 2). The endoparasites (digenean, cestodes, and nematodes) made up 74.1% of the total parasites collected, with 39.5% of helminth larval stages and 34.6% of adult digenean. All parasites of *S. setapinnis* had the typical aggregated pattern of distribution observed in many parasite systems (Table 3). Only *Acanthocolpoides pauloi* showed positive correlation between host total length and parasite abundance. *Caligus robustus*, *P. selene*, and *Terranova* sp. showed parasite prevalence correlated with the host total length (Tab. 4). Only *Terranova* sp. showed correlation between sex and parasite prevalence ($\chi^2 = 5.110$, p = 0.023).

Infracommunities

Ninety-one percent of *S. setapinnis* studied were parasitized by at least one parasite species. A total of 1,208 individual parasites was collected, with mean of 13.4 ± 20.1 parasites/fish. A relationship between total parasite abundance and total body length of fish ($r_s = 0.310$, $p = 0.003$) was observed. Parasite species richness 3.2 ± 2.2 (1-10) was correlated with total body length of fish ($r_s = 0.317$, $p = 0.002$), but not with host sex ($Z_c = -0.619$, $p = 0.535$). Nine hosts (10.1%) showed infection with one parasite species, and 22 (24.7%), 16 (17.9%), 12 (13.4%), 6 (6.7%), 7 (7.8%), 5 (5.6%), 2 (2.2%), 1 (1.1%), and 1 (1.1%) had multiple infections with 2, 3, 4, 5, 6, 7, 8, 9, and 10 parasite species, respectively. Mean parasite species diversity (*H*) was = 0.325 ± 0.154 and maximum diversity was 0.712. The Brillouin-based evenness index (*J*) had a mean of 0.506 ± 0.365. Parasite diversity was not correlated with host total length ($r_s = 0.132$, $p = 0.293$) and no significant differences ($Z_c = -0.835$, $p = 0.403$) in parasite diversity were observed between male ($H = 0.424 \pm 0.429$) and female fishes ($H = 0.296 \pm 0.152$).

Parasite infracommunities were separated into three groups – ectoparasites (monogenean and copepods), helminth larval stages (cestodes and nematodes), and adult endoparasites (digeneans and nematodes) – to determine possible interspecific associations. Only one pair of ectoparasite species *P. selene*-*C. robustus* showed positive covariation ($\chi^2 = 21.12$, $p < 0.001$). Two pairs of species of helminth larval stages, *Nybelinia* sp.-*Terranova* and *Terranova* sp.-*Raphidascaris* sp., showed positive covariation (Table 5). Two pairs of endoparasite species, *L. microstomum*-*P. elongatus* and *L. microstomum*-*P. merus*, showed positive covariation (Table 6).

DISCUSSION

In the present report was detected quantitative dominance of endoparasite species in the parasite community of *S. setapinnis*. Carvalho-Filho (1999) mentioned the moonfish as a carnivorous species feeding on small fishes and benthic crustacean, which might act as an intermediate host of the endo-parasites. This pattern was also detected in other

studied carangid species from the coastal zone of the State of Rio de Janeiro, e.g., *Oligoplites saliens*, *O. palometa*, *O. saurus*, *Caranx hippos*, and *C. latus* (Takemoto *et al*., 1996; Luque & Alves, 2001). The highest prevalence and parasite abundance values of the anisakid larvae suggest that *S. setapinnis* occupies an intermediate level in the marine trophic web, being part of marine bird and mammal diets (definitive hosts of anisakids). This characteristic was also observed in other demersal marine fishes from Rio de Janeiro (Takemoto *et al.*, 1996; Luque *et al.*, 1996; Silva *et al.*, 2000). The anisakids were found only on the mesenteries of *S. setapinnis*, which apparently reduces the zoonotic potential.

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

Parasites	Prevalence (%)	Intensity	Mean intensity	Mean abundance	Site of infection
Digenea					
Acanthocolpoides pauloi (CHIOC N. 35001, 35002)	20.2	1-11	3.6 ± 3.2	0.8 ± 2.2	Intestine
Dinurus sp. (CHIOC N. 35000)	4.5	1-4	1	< 0.1	Intestine
Lecithochirium microstomum (CHIOC N. 34988, 34989)	47.1	1-13	3.1 ± 2.8	1.5 ± 2,5	Intestine
Parahemiurus merus (CHIOC N. 34992, 34993)	28.0	1-10	2.5 ± 2.0	0.7 ± 1.5	Intestine
Podocotyle sp. (CHIOC N. 34996, 34997)	6.7	1-6	1	< 0.1	Intestine
Pseudopecoelus elongatus (CHIOC N. 34998, 34999)	19.10	1-35	6.1 ± 8.2	1.1 ± 4.2	Intestine
Stephanostomum sp. (CHIOC N. 34994)	6.8	1-3	1.3 ± 0.8	< 0.1	Intestine
Tergestia selenei (CHIOC N. 34995a, b)	9.0	1-2	1	< 0.1	Intestine
Monogenea					
Benedenia sp. (CHIOC N. 35007)	1.1	---	1	< 0.1	Gills
Encotyllabe sp. (CHIOC. N. 35006)	1.1	---	1	< 0.1	Gills
Pseudomazocraes selene (CHIOC N. 34990, 34991a, b)	65.0	1-17	4.6 ± 4.1	2.9 ± 3.9	Gills
Cestoda					
Callitetrarhynchus gracilis (CHIOC N. 35005)	1.1	---	1	< 0.1	Mesenteries
Nybelinia sp. (larva) (CHIOC N. 35003, 35004)	11.2	1-4	1.6 ± 0.9	0.1 ± 0.5	Mesenteries
Nematoda					
Anisakis sp. (larval) (CHIOC N. 34820)	9.0	1-6	2.3 ± 1.8	0.2 ± 0.8	Mesenteries
Contracaecum sp. (larval) (CHIOC N. 34821)	7.8	1-15	2.5 ± 1.5	0.1 ± 0.7	Mesenteries

TABLE 1 (*Continued*.)

Parasites	Prevalence (%)	Intensity	Mean intensity	Mean abundance	Site of infection
Hysterothylacium sp. (larval) (CHIOC N. 34822)	7.8	1-127	32.5 ± 43.6	2.5 ± 14.4	Mesenteries
Terranova sp. (larval) (CHIOC N. 34823)	21.3	1-25	5 ± 5.6	1.0 ± 3.2	Mesenteries
Raphidascaris sp. (larval) (CHIOC N. 34824)	12.3	1-31	8.3 ± 8.9	1.0 ± 4.1	Mesenteries
Copepoda					
Caligus longipedis (MNRJ N. 18616)	1.1	---	1	< 0.1	Gills
Caligus robustus (MNRJ N. 18617)	36.0	1-7	2.0 ± 1.7	0.7 ± 1.4	Gills
Lernaeenicus sp. (MNRJ N. 18618)	1.1	---	1	< 0.1	Body surface

TABLE 2
Frequency of dominance and mean relative dominance of metazoan parasites of *Selene setapinnis* 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
Acanthocolpoides pauloi	0	3	0.076 ± 0.204
Caligus robustus	0	4	0.158 ± 0.310
Lecithochirium microstomum	2	7	0.142 ± 0.235
Nybelinia sp.	0	2	0.009 ± 0.032
Parahemiurus merus	0	4	0.054 ± 0.123
Pseudomazocraes selene	7	8	0.243 ± 0.283
Pseudopecoelus elongatus	4	5	0.072 ± 0.200
Terranova sp.	3	5	0.053 ± 0.133
Raphidascaris sp.	3	3	0.030 ± 0.110

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

Parasites	DI	*d*
Acanthocolpoides pauloi	5.855	18.874*
Caligus robustus	2.856	9.192*
Lecithochirium microstomum	4.258	14.148*
Nybelinia sp.	1.967	5.379*
Parahemiurus merus	3.807	11.618*
Pseudomazocraes selene	5.400	17.600*
Pseudopecoelus elongatus	15.633	39.226*
Terranova sp.	10.497	29.754*
Raphidascaris sp.	18.378	43.645*

(*) significant values.

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 *Selene setapinnis*, 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*
Acanthocolpoides pauloi	0.343*	0.0009	0.465	0.430
Caligus robustus	–0.032	0.761	–0.900*	0.037
Lecithochirium microstomum	0.153	0.150	–0.097	0.876
Nybelinia sp.	0.241*	0.022	0.863	0.059
Parahemiurus merus	0.024	0.819	–0.128	0.837
Pseudomazocraes selene	0.574*	< 0.001	0.967*	0.007
Pseudopecoelus elongatus	–0.120	0.259	–0.165	0.790
Terranova sp.	0.196*	0.064	0.958*	0.010
Raphidascaris sp.	0.120	0.259	0.784	0.116

(*) significant values.

TABLE 5
Concurrent species pairs of larval stages of helminth endoparasites in *Selene setapinnis* from the coastal zone of the State of Rio de Janeiro, Brazil.

Pairs of species	$\mathbf{c}^2$	*p*	r_s	*p*
Nybelinia sp.-*Terranova* sp.	0.26	0.607	0.360*	< 0.001
Nybelina sp.-*Raphidascaris* sp.	0.03	0.874	0.069	0.516
Terranova sp.-*Raphidascaris* sp.	2.30	0.130	0.475*	< 0.001

(χ^2) Chi-square test; (r_s) values of Spearman's rank correlation coefficient. (*p*) significant level (*) significant values.

TABLE 6
Concurrent species pairs of endoparasites in *Selene setapinnis* from the coastal zone of the State of Rio de Janeiro. Brazil.

Pairs of species	÷²	*p*	r_s	*p*
Acanthocolpoides pauloi-Lecithochirium microstomum	2.19	0.138	0.114	0.286
A. pauloi-Parahemiurus merus	2.15	0.142	-0.112	0.295
A. pauloi-Pseudopecoelus elongatus	0.32	0.570	0.015	0.888
L. microstomum-P. merus	2.15	0.142	0.309*	0.003
L. microstomum-P. elongatus	0.33	0.566	0.217*	0.041
P. elongatus-P. merus	0.21	0.650	0.130	0.225

(χ^2) Chi-square test; (r_s) values of Spearman's rank correlation coefficient. (*p*) significant level (*) significant values.

The ectoparasite infracommunities in *S. setapinnis* showed dominance by the monogenean *P. selene*. These results are in agreement with data provided by Cezar *et al.* (2000) for *S. vomer*. On the other hand, Luque & Alves (2001) recorded lower values of parasite prevalence and abundance of *P. selene* in *C. latus*, which suggested the preference of *P. selene* for moonfishes, confirming

the high host specificity expected for Monogenea. In addition, among the carangid species studied in Rio de Janeiro, qualitative similarity in the copepod infracommunities was observed. For instance, *C. robustus* was collected from *Selene* spp., *Oligoplites* spp., and *Caranx* spp. (Takemoto *et al.*, 1996; Luque & Alves, 2001; Cezar *et al.*, 2000).

An analysis of the possible relationships between body size and parasite prevalence and abundance showed heterogeneous patterns. As observed for other carangids, the main difficulty in interpreting these results is the scarcity of information about the biology and populational aspects of *S. setapinnis* and the other regional carangids. According to Luque & Alves (2001), correlation between the host total length and parasite prevalence and abundance is a pattern widely recorded in marine fishes from Rio de Janeiro and documented with numerous cases in freshwater and marine fishes from other latitudes (Luque *et al.*, 1996). However, according to some authors (Saad-Fares & Combes, 1992; Poulin, 2000) this pattern cannot be generalized because in many host-parasite species systems the correlation is positive but weak and non-significant. Nevertheless, some qualitative and quantitative differences detected in the size classes studied for *S. setapinnis* could originate in a possible heterogeneity in feeding behavior in young and adult fishes. The absence of correlations in the size of the parasite infrapopulations with the sex of the fish host is another widely documented pattern, generally interpreted as a consequence of sexual differences absent in some biological aspects of the fish (Luque & Alves, 2001). More knowledge about parasite and host biology is needed to improve the interpretation of these parasitological patterns, in an ecological framework incorporating pertinent environmental and biological information, as recommended by Marcogliese (2001).

Selene setapinnis showed a little-ordered parasite assemblage offering scarce quantitative evidence of interspecific association. Previous studies about the parasite community of carangid fishes and others from the State of Rio de Janeiro also showed this type of parasite assemblage (Cezar *et al.*, 2000; Luque & Alves, 2001; Takemoto *et al.*, 1996), in agreement with the postulates of Rohde *et al.* (1995) and Morand *et al.* (2002).

Acknowledgements — J. L. Luque was supported by a Research fellowship from CNPq (Conselho Nacional de Pesquisa e Desenvolvimento Tecnológico). A. Cordeiro was supported by student fellowships from CAPES (Coordenação de Aperfeiçoamento do Pessoal de Ensino Superior).

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