ECOLOGY OF METAZOANS PARASITES OF *MENTICIRRHUS AMERICANUS* (OSTEICHTHYES: SCIAENIDAE), COAST AREA FROM RIO DE JANEIRO STATE, BRAZIL

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SUMMARY: From January to December 1996, 115 specimens of *Menticirrhus americanus* (Linnaeus, 1758) (Osteichthyes: Sciaenidae) captured along the seashore of the state of Rio de Janeiro, Brazil (21°-23°S, 41°-45°W), were examined for metazoan parasites. The majority of specimens , 107 (93%), were parasitized by one or more species. A total of 1812 parasites were collected (an average of 17 parasites per fish). Fifteen species of metazoan parasites were found in this study, being the digeneans the more prevalent and those with greater biodiversity (seven species). *Rhamnocercus stichospinus* presented the highest value for mean intensity. Any species showed correlation between the total host length and parasite prevalence. Three species showed correlation between the total host length and parasite burden. Only for *R. stichospinus* occurred an influence of host sex on the prevalence and burden. *Bucephalus varicus* showed the higher dominant frequency in the parasite community of *M. americanus*. The Brillouin index for *M. americanus* presented an average value of H=0.562 ± 0.286. Uniformity index had an average value of 0.519 ± 0.413. Correlation between parasite diversity and host total length, as well as differences between the parasite diversity in male and female hosts, were not detected. To investigate possible parasite associations, the infracommunities were separate in two groups: ectoparasites (monogeneans and copepods) and endoparasites (digeneans and nematodes). Ectoparasite species did not show significant association or covariation. Among the endoparasite species one pair was observed : *Brachadena pyriformis* - *Opecoeloides polynemi* with positive association and covariation. Two pairs: *B. pyriformis* - *Contracaecum* sp. and *B. varicus* - *Contracaecum* sp. presented negative association and/or covariation. The parasite community of *M. americanus* showed a low number of species with high prevalence and intensity and scarce pairs of associated species, by these reasons it is considered more closer to isolationist type.

KEY WORDS: parasite ecology, community structure, marine fish, Sciaenidae, *Menticirrhus americanus*, Brazil.

INTRODUCTION

In the last years, the structure and composition of the parasitic communities from sea fishes of the Sciaenidae family have been studied (OLIVA *et alii*., 1990; THONEY, 1991, 1993; LUQUE & OLIVA, 1993; LUQUE, 1994; LUQUE, 1996; OLIVA & LUQUE, 1998). Sciaenideans from Pacific Ocean showed non organized parasitic communities, close to the isolationist type, and characterized by low number of endoparasites (LUQUE, 1996; OLIVA & LUQUE, 1998). A different pattern was observed for sciaenideans from north American Atlantic ocean, where the parasitic diversity and the number of inter species associations were greater, and the endoparasites were dominant (THONEY, 1993). Up now, the ecology of parasitic communities from south American Atlantic ocean sciaenideans have not been the subject of published pagers.

Menticirrhus genus include 9 bentonic species with neotropical distribution. *Menticirrhus americanus* is a common

species in the southeast Brazilian coast , and its known distribuiton covers from Cape Cod (USA) to Argentina (MENEZES & FIGUEIREDO, 1980; JARDIM, 1988).

The parasitic fauna of *M. americanus* in the Brazilian coast was scarcely studied. Only few descriptions of digenetic and nematodes (AMATO, 1982; FÁBIO, 1976; VICENTE & SANTOS, 1972, 1973). An analysis of the structure and composition of *M. americanus* parasitic community, with their inter species relationship and the diversity of the respective infracommunities, are presented in this paper. The dynamics of the parasitic infrapopulations was also evaluated as well as its relationship with some biotic factors as total host length and host sex.

MATERIALS AND METHODS

From January to December 1996, 115 *M. americanus* specimens, collected in the sea coast of Rio de Janeiro State, Brazil (21°-23°S, 41°-45°W), were necropsied. The examined fishes were 28.4 ± 7.7 (17.0-48.0) cm long and weighted 335.7 ± 329.5 (54.0-1580.0) g. The taxonomi determination was done according to MENEZES & FIGUEIREDO (1980).

Ecological studies of the parasitic community were performed at the level of its components and its infracommunities (ESCH *et alii*, 1990). The constituents of the parasitic community were classified according to BUSH & HOLMES (1986), in central species (present in more than two thirds of the hosts), secondary species (present in one or two thirds of the hosts) and satellite species (present in less than one third of the hosts). The dominance of each parasitic community component was determined through the calculation of the dominance frequency and relative dominance (number of specimens of a given species divided by the total number of individuals from all species of the same infracommunitie), following the methodology of ROHDE *et alii* (1995). O quotient between the variance and the mean occurrence (dispersion index) was calculated for each parasite species as a manner to determine its distribution pattern. The degree of aggregation was obtained through the calculation of the Green index (LUDWIG & REYNOLDS, 1988). Spearman *rs* correlation coefficient was used to determine possible correlations between total host length and parasitic burden. The Pearson *r* correlation coefficient was used to verify possible correlation between host total length and the prevalence of parasite infections, after prevalence data being angular transformed (ZAR, 1996) and the separation of samples in four 10 cm class intervals. The influence of sex on prevalence and burden size of parasitic infections was tested by approximation of the Z normal, on a Mann-Whitney U test and by chi-square (χ^2), respectively.

The parasitic diversity of each infracommunity was calculated through the Brillouin (H) index, being determined its possible variation regarding to sex (c test) total length (Spearman *rs* correlation coefficients). It was also calculated for each infracommunity the uniformity index for the Brillouin index (J) (ZAR, 1996). Possible inter species associations between pairs of co-occurring species were determined through the chi-square test, using the Yates corrections whenever necessary. Possible covariation between parasitic burden for the species which formed associations were analyzed with the Spearman *rs* correlation coefficient (LUDWIG & REYNOLDS 1988).

The ecological terminology used is that recomended by BUSH *et alii* (1997). Analysis included only species with prevalence higher than 10% (BUSH *et alii* 1990). The level of significance adopted was $p < 0.05$.

RESULTS

Components of the parasitic community

One hundred and seven (93,0%) fishes were parasitized by some species of metazoans. A total of 1,812 parasite specimens of 15 species were collected, with an average of 17 parasite per host. Digenetic and monogenetic parasites represented 45.1% and 36.9% of the total amount of metazoans collected and the respective averages were 9.6 and17.6 parasites per host. *Menticirrhus americanus* presented two secondary species (1 digenetic, 1 nematode), 14 satellite species (6 digenetic, 2 monogenetic, 1 aspidobotreo, 1 nematode, and 3 copepods). No central species were found (Table 1). *Bucephalus varicus* presented the highest dominance frequency and the greater mean relative dominance (Table 2). All parasites of *M. americanus* presented the typical super disperse pattern observed in several parasitic systems. Endoparasites were more disperse than ectoparasites (Table 3).

Total length of males (28.8 ± 7.7 cm, N=41) and females (28.2 ± 7.8 cm, N=74) of *M. americanus* was not significantly different (t= 0.456, P= 0.648). Among the eight species of metazoans with prevalence higher than 10%, two species (1 monogenetic and 1 nematode) presented positive correlation between total host length and parasitic burden, and one species (digenetic) presented negative correlation. None species showed correlation between total host length and parasitic prevalence (Table 4). Only *Rhamnocercus stichospinus* (monogenetic) presented a relationship between sex and both prevalence and parasitic burden (males: 31.5 and 43.9%; females: 5.5 and 22.9%) (Z=-2.307, P=0.041; χ^2 = 5.460; P=0.019).

Parasitic infracommunities

Menticirrhus americanus presented a parasitic diversity of H=0.562 ± 0.286 and a maximal diversity of 1.196. Such diversity was not correlated with total host length (rs= 0.213, P=0.063) and showed no significative differences between male (H=0.589 + 0.314) and female (H=0.544 ± 0.299) hosts, (t=0.670, P=0.505). The average uniformity index was 0.519 ± 0.413. Mean parasitic diversity was 2.2 ± 1.331 being six the highest values. Thirteen hosts (26,0%) were infected by only one species and 33 (28.7%), 25 (21.7,%), 10 (8.7%), 6 (5.2%) and 3 (2.6%) presented multiple infections by 2, 3, 4, 5 and 6 species, respectively (Fig. 1).

To detect possible inter species relationships, parasitic

Table 1 - Prevalence, intensity amplitude, mean intensity, mean abundance and communitary status from metazoans parasites of *Menticirrhus americanus* captured in the coast area of Rio de Janeiro State, Brazil.

Parasites	Prevalence (%)	intensity amplitude	mean intensity	mean abundance	communitary status
ASPIDOBOTHREA					
Lobatostoma sp.	1.7	1-2	1.5	0.03	Sa
DIGENEA					
Brachadena pyriformis	18.3	1-11	2.0	0.4	Sa
Gonocercella pacifica	2.6	1-6	3.3	0.1	Sa
Lecithochirium microstomum	22.6	1-12	3.0	0.7	Sa
Sclerodistomum prevesiculatum	2.6	1-2	1.3	0.03	Sa
Bucephalus varicus	35.6	1-71	12.0	4.3	S
Prosorhynchus ozakii	10.4	1-16	4.1	0.4	Sa
Opecoeloides polynemi	28.7	1-16	4.2	1.2	Sa
MONOGENEA					
Encotyllabe spari	4.3	---	1.0	0.04	Sa
Rhamnocercus stichospinus	30.4	1-282	18.8	5.8	Sa
NEMATODA					
Capillaria sp.	2.6	3-5	4.3	0.1	Sa
Contracaecum sp.(larva)	39.1	1-37	5.5	2.2	S
COPEPODA					
Bomolochus paucus	8.7	1-10	3.7	0.3	Sa
Caligus haemulonis	12.2	1-3	1.1	0.1	Sa
Caligus praetextus	0.9	---	1.0	0.01	Sa

*(S): secondary species, (Sa) Satellite species

Table 2 - Dominance frequency, dominance frequency shared with one and two species, and mean relative dominance of the components from the community of metazoans parasites found in *Menticirrhus americanus* do captured in the coast area of Rio de Janeiro Sate, Brazil.

Parasites	Dominance frequency shared with one species	Dominance frequency shared with two species	Dominance frequency and standard deviation	Mean relative dominance
Brachadena pyriformis	10	2	2	0.076±0.209
Lecithochirium microstomum	11	2	2	0.077±0.180
Bucephalus varicus	32	5	0	0.222±0.359
Prosorhynchus ozakii	6	0	0	0.048±0.174
Opecoeloides polynemi	17	5	1	0.118±0.251
Rhamnocercus stichospinus	19	4	0	0.139±0.261
Contracaecum sp.	22	3	1	0.175±0.302
Caligus haemulonis	5	2	0	0.042±0.174

infracommunities were separated in two groups: ectoparasites (monogenetic and copepods) and endoparasites (digenetic, cestodes, acantocephalids and nematodes). Ectoparasites did not presented pairs of associates species. Among endoparasites, one pair of species showed association and positive covariation, and two presented association and/or negative covariation (Table 5).

DISCUSSION

The results obtained indicate that digenetic are the major constituents of *M. americanus* parasitic community. Studies regarding *M. americanus* feeding habits, showed that this fish has a varied diet, that includes crustaceans, equinoderms, ofiuroids, bivalve mollusks, poliquets and small fishes

Table 3 - Dispersion index (DI) and Green aggregation index (GI) for metazoans parasites of *Menticirrhus americanus* do captured in the coast area of Rio de Janeiro Sate, Brazil.

Parasites	DI	IG
Brachadena pyriformis	3.858	0.069
Lecithochirium microstomum	4.708	0.047
Bucephalus varicus	36.879	0.072
Prosorhynchus ozakii	7.702	0.139
Opecoeloides polynemi	7.303	0.045
Rhamnocercus stichospinus	150.518	0.226
Contracaecum sp.	12.026	0.044
Caligus haemulonis	1.246	0.016

Table 4 - Values for Spearman correlation coefficient (*rs*) and for Pearson correlation coefficient (*r*) to evaluate the relationship between total *Menticirrhus americanus* length and either the parasitic burden and prevalence among the components of their parasitic community (P= significance level).

Parasites	*rs*	*P*	*r*	*P*
Brachadena pyriformis	-0.098	0.294	-0.804	0.405
Lecithochirium microstomum	0.070	0.454	0.760	0.450
Bucephalus varicus	-0.243	0.008	-0.967	0.162
Prosorhynchus ozakii	-0.047	0.616	-0.934	0.231
Opecoeloides polynemi	-0.175	0.060	0.586	0.601
Rhamnocercus stichospinus	0.452	<0.001	0.918	0.258
Contracaecum sp.	0.597	<0.001	0.973	0.148
Caligus haemulonis	-0.100	0.285	-0.823	0.384

Table 5 - Pairs of species for co-occurring endoparasites in *Menticirrhus americanus* do captured in the coast area of Rio de Janeiro Sate, Brazil.

Parasitos	*O. polynemi*	*B. pyriformis*	*B. varicus*	*P. ozakii*	*L. microstomum*	*Contracaecum sp*
Opecoeloides polynemi	———	0.227*	0.156	0.069	-0.031	-0.116
Brachadena pyriformis	7.044*	——-	-0.064	-0.025	0.016	-0.249*
Bucephalus varicus	3.322	-0.060	——-	-0.136	-0.068	-0.212
Prosorhynchus ozakii	0.141	-0.023	-2.105	——-	-0.031	-0.116
Lecithochirium microstomum	-0.052	1.689	-0.349	0.044	——-	-0.068
Contracaecum sp.	-0.653	-6.658*	-4.048*	0.036	-0.986	——-

rs: values for the Spearman correlation coefficient
χ^2: values for the chi-square test.
*: Significative values.

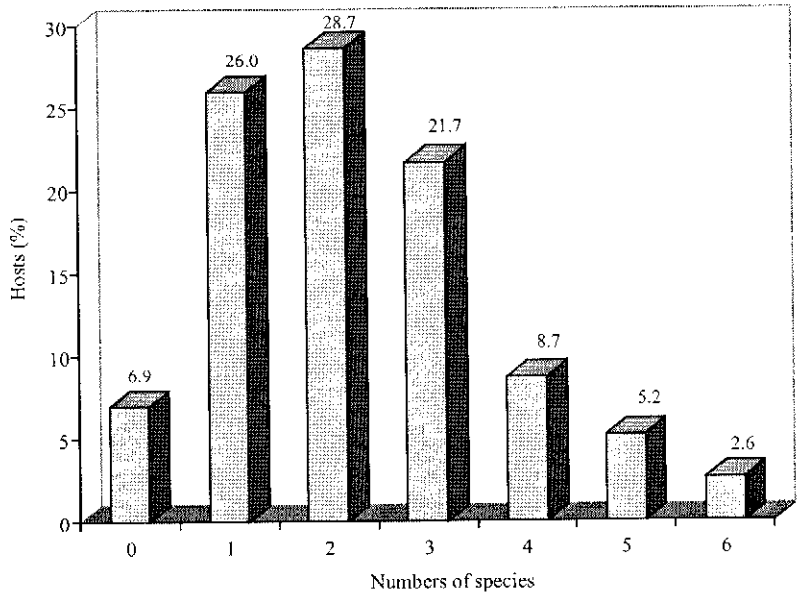

Figure 1 - Parasitic diversity of *Menticirrhus americanus* do captured in the coast area of Rio de Janeiro State, Brazil.

(LUNARDON & SILVA, 1990; LUNARDON *et alii*, 1991). Such *M. americanus* trait gives to this species a huge potential to act as intermediate or definitive host in trophically transmitted parasitic systems. A large part of their diet (mainly crustaceans and poliquets) can act as intermediate hosts in the life cycle of some sea fishes digenetic parasites. Such result are in agreement with previous work conducted with other fish species in the Rio de Janeiro State (LUQUE *et alii*, 1996a; TAKEMOTO *et alii*, 1996; KNOFF *et alii*, 1997) which showed the dominance of digenetics, being also independent from the bentonic or pelagic characteristic of their hosts.

The lack of absolute dominance for all species in the parasitic community *M. americanus* reinforces the statement of ROHDE *et alii* (1995), which use ectoparasites as model and postulate that parasitic communities of sea fishes are not well ordered complexes of species, going away from the established patterns already proved to be useful for other host groups, mainly for aquatic birds (BUSH, 1990).

According to SHOTTER (1973), the fish length can, under certain conditions, be considered as a biological reflex of age, being then one of the most influent factors on the variations of the parasitic infrapopulations and in the parasite accumulation during the host life. Age increase leads to several changes in fish biology, mainly regarding to trophic levels and several physiological conditions, which has direct impact on the composition of parasitic fauna, mainly on parasites acquired by trophic pathway (POLYANSKI, 1961). Such statements apparently do no apply to the present study, were only three species showed correlation between parasitic burden and total host length. Regarding to parasite prevalence, any species presented statistically significant correlation. Thus, other factors that could explain the influence of host age on the size of parasitic infrapopulations should be considered, as migrations during breeding season, that could lead to changes on the diet affecting thereby parasitism levels (BURN, 1980; MOSER & HSIEH, 1992).

In the case of ectoparasites, the mechanisms of parasitism increase related to host length are based upon a cumulative process. When infestation took place in a site as the gills, which increase in surface area as the fish grows longer and offers thereby higher chances and higher oxygen levels to larval stages of copepods and monogenetics (FERNANDO & HANEK, 1976). Another factor that could influence infestations is the aggregation level (either temporary or permanent) of the host communities, what could ease the contact with the larvae (a free living stage) (ROUBAL, 1990). *Menticirrhus americanus* swims in shoals in the low depth coast areas, what is a particular trait of this fish (LUNARDON *et alii*, 1991), and is know in the Unites States for occupy a area know as surf zone, propitiating in this way the biological cycle for ectoparasites that have a direct cycle.

The influence of host sex, despite its widely citation on the pertinent literature, is usually minimized in papers dealing with communitary analysis (POULIN, 1996). Data banks on sea fishes indicates that many parasites did not present quantitative variations caused by host sex. This is considered to be a reflex of the lack of differences in the biology and populational dynamics of male and female hosts (LUQUE *et alii*, 1996a). Nevertheless, further research is needed in order to visualize the influence of other factors that already proved to play a role for other host groups (such as hormonal, immunologic, morphological and behavioral) (BUNDY, 1988; LADLE, 1992; POULIN, 1996). The same pattern found for other fishes from the Rio de Janeiro state is repeated in this work (LUQUE *et alii*, 1996a; TAKEMOTO *et alii*, 1996; KNOFF *et alii*, 1997), where the majority of species did not present differences in either parasitic prevalence or burden that could be related to host sex. LUQUE *et alii* (1996a) stated that studies on seasonally and breeding seasons could shed a light upon such aspect, since it should be verified if changes on either male or female hosts behavior occur regarding breeding seasons, feeding habit, hormonal levels, migrations and sexual dimorphism which could change the ecological niche.

Studies on the parasitic diversity of sea fishes are scarce and were done considering only one part of the infracommunities (*i.e.* ecto or endoparasites). POULIN (1995) concluded that for fishes, the variety of endoparasites is proportional t the increase of animal feed portion of host diet. Results obtained in recent research conducted in Rio de Janeiro State (LUQUE *et alii*, 1996b; TAKEMOTO *et alii*, 1996; KNOFF *et alii*, 1997) and in the present work, demonstrate a lack defined standards for parasitic diversity. Such heterogeneity should be analyzed considering the ecological profile of the Brazilian coast, an area were cold and hot sea streams encounters each other, with areas of resurgence and emergence (VALENTIN, 1994). All this factors can influence the ecology of both definitive and intermediate host populations.

The low number of endoparasites species associated species may suggest the participation of differentiate intermediate hosts, which belong to the wide feed spectrum of *M. americanus* and could be offered with variated intensity following a seasonally. The influence of the parasitic community in this seasonal pattern was demonstrated by LUQUE (1994), who explained the parasite prevalence oscillations as caused by several factors, including seasonal availability of intermediate hosts (although that is hardly demonstrable for the Rio de Janeiro State, where a diverse seasonally did not occur.

HOLMES (1990) stated that for sea fishes, isolationist communities are the most usual due several reasons: 1) ectotermia, individuals with this trait have lees need of food; 2) alimentary duct with a simple structure, offering thereby less niches; 3) lower trophic spectrum, and 4) wider alimentary spectrum. For *M. americanus*, due the presence generalist species, the lack of central species and the few evidences of interactions between the infracommunities components, one can consider this community of metazoan parasites as typically isolationist.

LUQUE (1994) analyzed the structure parasitic community of *Menticirrhus ophicephalus* from the coast of Peru and found some patterns very different form the parasitic community of *M. americanus*, as for example the almost complete absence of endoparasites and the absolute dominance of monogenetic diplectanideans. Furthermore, the values for parasitic burden are much higher than those for *M. ophicephalus* (in a ratio of 10:1). It was demonstrated for both hosts that only few parasite species had their prevalence and burden size influenced neither positively nor negatively by total host length. Regarding sex influence, a similar result was found for both species, where only the diplectanideans showed variations. According to LUQUE (1996) ectoparasites communities from Peru sciaenedeans were characterized by the absence of associations and correlations between the constituent species, what could suggest the lack of competitive processes in their respective infestation sites. A similar situation was found for *M. americanus* in the present paper. Many of the patterns found for *M. ophicephalus* in south American Pacific ocean are shared by other sciaenideans species from the same area (genera *Stellifer*, *Sciaena* and *Paralonchurus* (OLIVA & LUQUE, 1998)). Further studies are needed to investigate other sciaenideans species in south American Atlantic ocean, in order to compare the trends found for *M. americanus* in Rio de Janeiro State.

Some of the patterns found by THONEY (1991, 1993) for the sciaenideans *Leiostomus xanthurus* and *Micropogonias undulatus* from the north American Atlantic ocean, are close to those presented here for *M. americanus*. For the species studied by THONEY (1991, 1993) the majority of the parasite species found are digenetic, followed by copepods and monogenetic. Young hosts have almost the same diversity of adults, presenting a regional variations consequence of alimentary resources availability.

Historic - geographical differences with an anfi-oceanic profile are the less studied aspect among the possible determinants for sea fishes parasitic communities structure (POULIN & ROHDE, 1997). Since both Pacific and Atlantic oceans have their own species of *Menticirrhus*, this genus can act as a model to test the ROHDE (1986) hypothesis, who propose that parasitic diversity would be greater in Pacific rather than in Atlantic ocean, due to Atlantic greater geological age and their wide areas that freeze during the glacial ages. In a first sight, *Menticirrhus* parasitic communities follow this hypothesis (only for monogenetics). For endoparasites however, this hypothesis fail since they present greater diversity for *M. americanus*. A comparative analysis of parasitic communities should be done with adult samples of *M. americanus* and *M. ophicephalus* captured in areas with a close latitude (to minimize the effect of host age and of water temperature on the composition of parasitic communities (ROHDE, 1993; POULIN & ROHDE, 1997)), and considering also the totality of the components of their parasitic communities (ecto and endoparasites).

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SUMÁRIO

Durante janeiro e dezembro de 1996, 115 espécimes de *Menticirrhus americanus* (Linnaeus, 1758) (Osteichthyes: Sciaenidae) provenientes do litoral do Estado do Rio de Janeiro, Brasil (21-23°S, 41-45°O), foram examinados para o estudo dos seus metazoários parasitos. A maioria dos peixes estudados, 107 (93%), estavam parasitados por uma ou mais espécies. Um total de 1812 parasitos foram coletados, com uma média de 17 parasitos/peixe. Quinze espécies de metazoários parasitos foram identificadas, os digenéticos foram os mais diversos e abundantes com sete espécies. *Rhamnocercus stichospinus* mostrou o maior valor de intensidade média.. Nenhuma espécie apresentou correlação entre o comprimento total do hospedeiro e a prevalência parasitária.. Três espécies mostraram correlação entre o comprimento total do hospedeiro e a abundância parasitária. Apenas *R. stichospinus* apresentou influência do sexo do hospedeiro sobre sua prevalência e abundância. *Bucephalus varicus* apresentou a maior frequência de dominância na comunidade parasitária de *M. americanus*. O índice de Brillouin teve em *M. americanus* um valor médio de H=0.562+0.286. O índice de uniformidade teve um valor médio de 0.519±0.413. Não foi detectada correlação entre a diversidade parasitária e o comprimento total do hospedeiro, nem diferença entre a diversidade parasitária dos hospedeiros machos e fêmeas. Para analisar possíveis associações parasitárias, as infracomunidades foram separadas em dois grupos: ectoparasitos (monogenéticos e copépodes) e endoparasitos (digenéticos e nematóides). As espécies de ectoparasitos não apresentaram associação ou covariação significativa enttre suas abundâncias. Entre as espécies de endoparasitos foram observados um par, *Brachadena pyriformis- Opecoeloides polynemi*, com correlação e covariação positivas e dois pares, *B. pyriformis - Contracaecum sp.* e *B. varicus - Contracaecum sp.* com associação e/ou covariação negativas. A comunidade parasitária de *M. americanus* mostrou um baixo número de espécies com alta prevalência e abundância e escassos pares de espécies associadas, por estas razões é considerada mais próxima do tipo isolacionista.

PALAVRAS-CHAVE: ecologia parasitária, estrutura comunitária, peixes marinhos, Sciaenidae, *Menticirrhus americanus*, Brasil.

REFERENCES

AMATO, J.F.R. (1982). Digenetic trematodes of Percoid fishes of Florianópolis, southern Brasil - Bucephalidae. *Revista Brasileira de Biologia*, *42*:667-680.

BUNDY, D.A.P. (1988). Sexual effects on parasite infection. *Parasitology Today*, *4*:186-189.

BURN, P.R. (1980). Density dependent regulation of a fish trematode population. *Journal of Parasitology*, *66*:173-174.

BUSH, A.O. (1990). Helminth communities in avian hosts: determinants of pattern. *In*: *Parasite communities: patterns and processes*. G. Esch, A. O. Bush & J. Aho (eds.), Chapman & Hall, New York, p. 197-232.

BUSH, A.O. & J.C. HOLMES. (1986). Intestinal helminths of lesser scaup ducks: an interactive community. *Canadian Journal of Zoology*, *64*:142-152.

BUSH, A.O., J.M. AHO & C.R. KENNEDY. (1990). Ecological versus phylogenetic determinants of helminth parasite community richness. *Evolutionary Ecology*, *4*:1-20.

BUSH, A.O., K.D. LAFFERTY, J.M. LOTZ & A.W. SHOSTAK. (1997). Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *Journal of Parasitology*, *83*:575-583.

FÁBIO, S.P. (1976). Estudo de dois trematódeos parasitos de peixes marinhos. *Memórias do Instituto Oswaldo Cruz, Rio de Janeiro*, *74*:71-76.

FERNANDO, C.H. & C. HANEK. (1976). Gills. *In*: *Ecological aspects of Parasitology*, C. R. Kennedy (ed.). North-Holland Publishing Company, Amsterdam, p. 209-226.

HOLMES, J.C. (1990). Helminth communities in marine fishes. *In*: *Parasite communities: patterns and processes*. G. Esch, A. O. Bush & J. Aho (eds.), Chapman & Hall, N. Y., p. 101-130.

JARDIM, L.F.A. (1988). Sinopse das espécies de *Menticirrhus* Gill, 1861 (Osteichthyes: Sciaenidae) do Atlântico ocidental. *Revista Brasileira de Zoologia*, *5*:179-187.

KNOFF, M., J.L. LUQUE & J.F.R. AMATO. (1997). Community ecology of the metazoan parasites of grey mullets, *Mugil platanus* (Osteichtyes:Mugilidae) from the littoral of the State of Rio de Janeiro, Brazil. *Revista Brasileira de Biologia*, *57*:441-454.

LADLE, R.J. (1992). Parasites and sex: catching the Red Queen. *Trends in Ecology and Evolution*, *7*:405-408.

LUDWIG, J.A. & J.F. REYNOLDS. (1988). *Statistical Ecology: A primer on methods and computing*. Wiley-Interscience Publications, New York, 337 p.

LUNARDON, M. J. & J. L. SILVA. (1990). A sazonalidade e o comportamento alimentar de *Menticirrhus litoralis* Holbrook, 1860 (Perciformes: Sciaenidae) na região de Pontal do Sul, Paraná, Brasil. *Arquivos de Biologia e Tecnologia, Curitiba*, *33*: 835-842.

LUNARDON, M.J., J.L. SILVA, J.R. VERANI & J.O. BRANCO. (1991). Comportamento alimentar de *Menticirrhus americanus* (Linnaeus, 1758) (Perciformes: Sciaenidae) no litoral do Paraná, Brasil. *Arquivos de Biologia e Tecnologia, Curitiba*, *34*:487-502.

LUQUE, J.L. (1994). Dinámica poblacional y estructura de la comunidad de metazoarios parásitos de *Menticirrhus ophicephalus* (Pisces: Sciaenidae) en la costa peruana. *Revista de Biologia Tropical*, *42*:21-29.

LUQUE, J.L. (1996). Distribución y asociaciones interespecíficas en las comunidades de metazoarios ectoparásitos de peces esciénidos del Perú. *Revista de Biologia Tropical*, *44*:387-394.

LUQUE, J.L. & M.E. OLIVA. (1993). Análisis cuantitativo y estructura de la comunidad parasitaria de *Paralonchurus peruanus* (Pisces: Sciaenidae) en la costa peruana. *Parasitologia al Dia*, *17*:107-111.

LUQUE, J.L., J.F.R. AMATO, & R.M. TAKEMOTO. (1996a). Comparative analysis of the communities of metazoan parasites of *Orthopristis ruber* and *Haemulon steindachneri* (Osteichthyes: Haemulidae) from the southeastern Brazilian littoral: I. structure and influence of the size and sex of hosts. *Revista Brasileira de Biologia*, *56*:279-292.

LUQUE, J.L., J.F.R. AMATO & R.M. TAKEMOTO. (1996b). Comparative analysis of the metazoan parasite communities of *Orthopristis ruber* and *Haemulon steindachneri* (Osteichthyes: Haemulidae) from the southeastern Brazilian littoral: II. diversity, interspecific associations, and distribution of the gastrointestinal parasites. *Revista Brasileira de Biologia*, *56*:293-302.

MENEZES, N.A. & J.L. FIGUEIREDO. (1980). *Manual de Peixes Marinhos do Sudeste do Brasil. IV. Teleostei (3)*. Museu de Zoologia, Universidade de São Paulo, São Paulo, SP, 96 p.

MOSER, M. & J. HSIEH. (1992). Biological tags for stock separation in Pacific herring *Clupea harengus pallasi* in California. *Journal of Parasitology*, *78*: 54-60.

OLIVA, M.E. & J.L. LUQUE. (1998). Metazoan parasite infracommunities in five sciaenid fishes from the central Peruvian littoral. *Memórias do Instituto Oswaldo Cruz*, *93*:175-180.

OLIVA, M., J.L. LUQUE & J. IANNACONE. (1990). The metazoan parasites of *Stellifer minor* (Tschudi, 1844): An ecological approach. *Memórias do Instituto Oswaldo Cruz*, *85*:271-274.

POLYANSKI, Y.I. (1961). Ecology of parasites of marine fishes. *In*: *Parasitology of Fishes*, V.A. Dogiel, G.K. Petrushevski & Y.I. Polyanski (eds.), Oliver & Boyd, Edinburgh & London, p. 1-47.

POULIN, R. (1995). Phylogeny, ecology, and the richness of parasite communities in vertebrates. *Ecological Monographs*, *65*:283-302.

POULIN, R. (1996). Sexual inequalities in helminth infections: a cost of being a male. *American Naturalist*, *147*:287-295.

POULIN, R. & K. ROHDE. (1997). Comparing the richness of metazoan ectoparasite communities of marine fishes: controlling for host phylogeny. *Oecologia*, *110*: 278-283.

ROHDE, K. (1986). Differences in species diversity of Monogenea between the Pacific and Atlantic oceans. *Hydrobiologia*, *137*:21-28.

ROHDE, K. (1993). *Ecology of marine parasites. An introduction to marine parasitology*. Second ed., CAB International, United Kingdom, 298 p.

ROHDE, K., C. HAYWARD & M. HEAP. (1995). Aspects of the ecology of metazoan ectoparasites of marine fishes. *International Journal for Parasitology*, *25*:945-970.

ROUBAL, F.R. (1990). Seasonal changes in ectoparasite infection of juvenile yellowfin bream, *Acanthopagrus australis* (Günther) (Pisces: Sparidae), from a small estuary in northern New South Wales. *Australian Journal of Marine and Freshwater Research*, *41*:411-427.

SHOTTER, R.A. (1973). Changes in the parasite fauna of whiting, *Odontogadus merlangus* L. with age and sex of host, season, and from different areas in the vicinity of the Isle of Man. *Journal of Fish Biology*, *5*:559-573.

TAKEMOTO, R.M., J.F.R. AMATO.& J.L. LUQUE. (1996). Comparative analysis of the metazoan parasite communities of leatherjackets, *Oligoplites palometa, O. saurus* and *O. saliens* (Osteichthyes: Carangidae) from Sepetiba Bay, Rio de Janeiro, Brazil. *Revista Brasileira de Biologia*, *56*:639-650.

THONEY, D.A. (1991). Population dynamics and community analysis of the parasite fauna of juvenile spot, *Leiostomus xanthurus* (Lacepede), and Atlantic croaker, *Micropogonias undulatus* (Linnaeus) (Sciaenidae) in two estuaries along the middle Atlantic coast of the United States. *Journal of Fish Biology*, *39*:515-534.

THONEY, D.A. (1993). Community ecology of the parasites of adult spot, *Leiostomus xanthurus*, and Atlantic croaker, *Micropogonias undulatus* (Sciaenidae) in the Cape Hatteras region. *Journal of Fish Biology*, *43*:781-804.

VALENTIN, J.L. (1994). A ressurgência - fonte de vida dos oceanos. *Ciência Hoje*, *18*:19-25.

VICENTE, J.J. & E. SANTOS. (1972). Sobre um novo nematódeo camalanídeo parasito de peixe marinho (Nematoda, Camallanoidea). *Atas da Sociedade de Biologia do Rio de Janeiro*, *15*:145-147.

VICENTE, J.J. & E. SANTOS. (1973). Alguns helmintos de peixes do litoral Norte-Fluminense. *Memórias do Instituto Oswaldo Cruz*, *71*:95-113.

ZAR, J.H. (1996). *Biostatistical Analysis*. Third ed., Prentice-Hall, Inc., Upper Saddle River, New Jersey, 662 p.

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