METAZOAN PARASITES OF CHUB MACKEREL, *Scomber japonicus* HOUTTUYN (OSTEICHTHYES: SCOMBRIDAE), FROM THE COASTAL ZONE OF THE STATE OF RIO DE JANEIRO, BRAZIL

DIMITRI R. ALVES[1]; JOSÉ L. LUQUE[2]; VANESSA D. ABDALLAH[3]

ABSTRACT: ALVES, D. R.; LUQUE, J. L.; ABDALLAH, V. D. **Metazoan parasites of chub mackerel,** *Scomber japonicus* **(Osteichthyes: Scombridae), from the coastal zone of the State of Rio de Janeiro, Brazil.** [Metazoários parasitos da cavalinha, *Scomber japonicus* (Osteichthyes: Scombridae), do litoral do Estado do Rio de Janeiro, Brasil.] *Revista Brasileira de Parasitologia Veterinária*, v. 12, n. 4, p. 164-170, 2003. Instituto de Veterinária, Departamento de Parasitologia Animal, Universidade Federal Rural do Rio de Janeiro, Caixa Postal 74.508, Seropédica, RJ 23851-970, Brazil. E-mail: jlluque@ufrrj.br

One hundred specimens of chub mackerel, *Scomber japonicus* Houttuyn, 1782 (Osteichthyes: Scombridae) collected from the coastal zone of the State of Rio de Janeiro, Brazil (21-23°S, 41-45°W), from June 2001 to April 2002, were necropsied to study their parasites. All fish were parasitized by one or more metazoan. Fifteen species of parasites were collected. Digeneans and the nematodes were the majority of the parasite specimens collected, with 70.5% and 20.4%, respectively. *Opechona* sp. was the dominant species with highest prevalence and abundance. The parasites of *S. japonicus* showed the typical overdispersed pattern of distribution. Three parasite species showed correlation between the host‘s total body length and abundance. *Kuhnia scombri* (Kuhn, 1829), *K. scombercolias* Nasir et Fuentes Zambrano, 1983 and *Raphidascaris* sp. showed differences in the prevalence and/ or abundance in relation to sex of the host. The mean parasite species richness was not correlated with the host‘s total body length. Two pairs of ectoparasites shared significant positive covariation and association; in the infracommunities of larval stages of endoparasites one pair show significant positive covariation and another pair show significant positive association between their abundance and prevalence, respectively. Quantitative and qualitative aspects of the parasite communities of *S. japonicus* from Brazil and Argentina reinforce the hypothesis of the existence of one fish populational stock in the Southwestern Atlantic Ocean.

KEY WORDS: Parasite ecology, community structure, Scombridae, *Scomber japonicus*, Brazil.

RESUMO

Entre junho de 2001 e abril de 2002 foram necropsiados 100 espécimes de *Scomber japonicus*, Houttuyn, 1782 (Osteichthyes: Scombridae) provenientes do litoral do Estado do Rio de Janeiro, Brasil (21-23°S, 41-45°W). Todos os peixes estavam parasitados por pelo menos uma espécie de metazoário. Foram coletadas quinze espécies de parasitos. Os digenéticos e nematóides constituíram a maioria dos espécimes coletados, com 70,5% e 20,4%, respectivamente. *Opechona* sp. foi a espécie dominante, com maiores valores de abundância e prevalência. Os parasitos de *S. japonicus* apresentaram um típico padrão de distribuição superdispersa. Três espécies de parasitos apresentaram correlação entre o comprimento total do hospedeiro e a abundância. *Kuhnia scombri* (Kuhn, 1829), *K. scombercolias* Nasir & Fuentes-Zambrano, 1983 e *Raphidascaris* sp. apresentaram diferenças na prevalência e/ou abundância em relação ao sexo do hospedeiro. A riqueza parasitária não apresentou correlação com o comprimento total do hospedeiro. Dois pares de ectoparasitos apresentaram covariação e associação positiva significativa. Nas infracomunidades de estágios larvais de endoparasitos, um par de espécies mostrou covariação positiva e um outro associação positiva entre suas abundâncias e

[1]Curso de Pós-Graduação em Ciências Veterinárias, Universidade Federal Rural do Rio de Janeiro (UFRRJ).

[2]Departamento de Parasitologia Animal, Instituto de Veterinária, UFRRJ, Caixa Postal 74.508, CEP 23851-970, Seropédica, RJ, Brasil. E-mail: jlluque@ufrrj.br

[3]Bolsista PIBIC (CNPq/UFRRJ).

prevalências, respectivamente. Aspectos quantitativos e qualitativos da comunidade parasitária de *S. japonicus* reforçam a hipótese da existência de apenas um estoque populacional desta espécie no Oceano Atlântico da América do Sul.

PALAVRAS-CHAVE: Ecologia parasitária, estrutura da comunidade, Scombridae, *Scomber japonicus*, Brasil.

INTRODUCTION

Scomber japonicus Houttuyn is a coastal pelagic species, to a lesser extent epipelagic to mesopelagic over the continental slope. This is a circumtropical species inhabiting warm water belt of Atlantic, Indian and Pacific oceans and adjacent seas. In America east coast is found from Nova Scotia to Argentina (COLLETTE; NAUEN, 1983; HAIMOVICI et al., 1994; FIGUEIREDO; MENEZES, 2000). In the Southern Brazilian littoral, chub mackerel populations are founded near to the shoalings of engraulid and clupeid fishes (ZAVALA-CAMIM; SECKENDORFF, 1985).

Some taxonomic papers on the parasites of *S. japonicus* from Brazil were published: Travassos et al. (1965), Rego and Santos (1983), and Fernandes et al. (1985) on digeneans; Rego and Santos (1983) and Eiras and Rego (1987) on didymozoids; Rego and Santos (1983) and Rohde and Watson (1985) on monogeneans; Rego (1987) on acanthocephalans; Vicente and Santos (1974) and Rego and Santos (1983) on nematodes. Studies on quantitative aspects of the parasites of *S. japonicus* from the Brazilian coastal zone were made by Rego and Santos (1983) and Rohde et al. (1995). Additional quantitative studies of parasites of *S. japonicus* from the South American Atlantic Ocean were made by Rohde et al. (1995) and Cremonte and Sardella (1997) from Argentina. Recently, Costa et al. (2003) recorded infection by larval stages of *Anisakis* spp. parasitic *S. japonicus* from Madeira island, Portugal.

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

MATERIALS AND METHODS

We examined 100 specimens of *S. japonicus* from June 2001 to April 2002. Local fishermen collected fish from coastal zone of the State of Rio de Janeiro (21-23ºS, 41-45ºW), Brazil. The fishes were identified according to Figueiredo and Menezes (2000) and measured 20 – 32 cm (mean = 25.7 ± 2.8 cm) in total length. The average total length of male (25.4 ± 2.7 cm, n = 76) and female (26.8 ± 2.9 cm, n = 24) fishes in the study sample were significantly different by the *t*-Student test (t= -2.114; P= 0.034).

The analysis included only parasite species with prevalence greater than 10% (BUSH et al., 1990). The variance to mean ratio of parasite abundance (index of dispersion) was used to determine distribution patterns and tested by the d statistical index (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 body length and abundance of parasites. Pearson's correlation coefficient r was used as an indication of the relationship between the host's total body length and the prevalence of parasites, with previous arcsine transformation of the prevalence data (ZAR, 1996). The possible influence of host sex on abundance and prevalence of parasites was tested using the Z normal approximation to the Mann-Whitney test and the chi-square test, respectively. 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 rank correlation coefficient. Parasite infracommunities were separated into three groups – ectoparasites (monogeneans and didymozoid), adult endoparasites (digeneans) and larval stages of endoparasites (cestodes, acanthocephalans and nematodes) – to determine possible interspecific associations. Ecological terminology follows BUSH et al. (1997). Statistical significance level was evaluated at $P \leq 0.05$.

Voucher specimens of helminths 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.

RESULTS

Component community - Fifteen species of metazoan parasites were collected (Table 1). The majority of the parasites specimens collected were digeneans (70.5%), followed by the nematodes (20.4%). *Opechona* sp. was the predominant species, with 3,711 specimens collected (52.5% of all parasites); and showed the highest values of mean relative dominance and frequency of dominance (Table 2). *Opechona* sp., *Nematobothrium scombri* (Taschenberg, 1879) and *Raphidascaris* sp. showed correlation between the host's total body length and abundance (Table 3). *Kuhnia scombri*, *K. scombercolias* and *Raphidascaris* sp. showed differences in the prevalence and/or abundance in relation to sex of the host. The abundance and the prevalence of *K. scombri*, *K. scombercolias* and *Raphidascaris* sp. were significant higher in the female (0.6 and 25%; 8; 25.3 and 71%) than the male (0.1 and 6.5%; 2.4; 10.7 and 46%) hosts, respectively (Table 4).

Infracommunities – All fish were parasitized by at least one parasite species. A total of 7,069 individual parasites was collected, with mean of 70.6 parasites/fish. The values of the dispersion for the ectoparasites and endoparasites were 16.911 (d = 43.828) and 184.167 (d = 176.915), respectively. Relationships between the total parasite abundance and the

Table 1**.** Prevalence, intensity, mean intensity, mean abundance, and site of infection of the metazoan parasites of *Scomber japonicus* from the coastal zone of the State of Rio de Janeiro, Brazil.

Parasites	Prevalence (%)	Intensity	Mean intensity	Mean abundance	Site of infection
Digenea					
Lecithocladium harpodontis (CHIOC 36239)	80	1-131	12.7±16.8	10.2±15.8	Stomach
Nematobothrium scombri (CHIOC 36240)	55	1-30	4.6±4.9	2.5±4.3	Operculum
Opechona sp. (CHIOC 36241)	85	1-568	43.6±89.3	37.1±83.8	Intestine
Monogenea					
Grubea cochlear (CHIOC 36242)	18	1-5	1.6±1	0.3±0.7	Gills
Kuhnia scombercolias (CHIOC 36243)	46	1-53	8.2±12	3.7±9.1	Gills
Kuhnia scombri (CHIOC 36244)	11	1-7	2.1±1.7	0.2±0.8	Gills
Cestoda					
Scolex pleuronectis (CHIOC 36245)	30	1-26	5.1±5.8	1.5±3.9	Intestine
Acanthocephala					
Corynosoma australe (cystacanth) (CHIOC 36246)	12	1-4	1.4±0.9	0.1±0.5	Mesenteries
Corynosoma sp. (cystacanth) (CHIOC 36247)	10	1-4	2.1±0.9	0.2±0.7	Mesenteries
Rhadinorhynchus pristis (CHIOC 36248)	7	1-4	1.8±1.2	0.1±0.5	Intestine
Nematoda					
Anisakis sp. (larval) (CHIOC 35232)	4	1-8	3.5±3.3	0.1±0.8	Mesenteries
Contracaecum sp. (larval) (CHIOC 35233)	2	1-4	2.5±2.1	<0.1	Mesenteries
Raphidascaris sp. (larval) (CHIOC 35234)	52	1-159	27.4±36.8	14.2±29.8	Mesenteries
Copepoda					
Caligus pelamydis (MNRJ 19196)	2	1-2	1.5±0.7	<0.1	Gills
Clavellisa scombri (MNRJ 19197)	2	-	1	<0.1	Gill rakers

host's total body length (r_s = 0.142, *P* = 0.156) of fish were not observed. The mean parasite species richness 4.8 ± 1.7 (1-9), was not correlated with the host's total body length (r_s = 0.190, *P* = 0.068). Five hosts were infected by one parasite species and 11, 21, 23, 17, 15, 6, 1 and 1 had multiple infections with 2, 3, 4, 5, 6, 7, 8 and 9 parasite species, respectively.

Two pairs of ectoparasites shared significant positive covariation and associations (Table 5). One pair of larval stages of endoparasites (*Scolex pleuronectis* - *Raphidascaris* sp.) showed significant positive covariation (r_s = 0.240, *P* = 0.015) and another pair of larval stages of endoparasites (*Scolex pleuronectis* - *Corynosoma* sp.) showed significant positive associations (χ^2 = 4.76, *P*= 0.029).

DISCUSSION

Scomber japonicus showed a parasite community with dominance by endoparasites. The digeneans *Lecithocladium*

Table 2. Frequency of dominance and mean relative dominance of the metazoan parasites of *Scomber japonicus* 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
Lecithocladium harpodontis	31	5	0.283±0.261
Nematobothrium scombri	5	3	0.087±0.141
Opechona sp.	36	9	0.342±0.267
Grubea cochlear	1	0	0.019±0.109
Kuhnia scombercolias	2	0	0.057±0.122
Kuhnia scombri	0	0	0.001±0.005
Scolex pleuronectis	2	1	0.032±0.087
Corynosoma australe	1	0	0.023±0.105
Corynosoma sp.	0	0	0.011±0.089
Raphidascaris sp.	13	1	0.137±0.201

Table 3. Spearman's rank correlation coefficient (r_s) and Pearson's correlation coefficient (r) values used to evaluate possible relationships among the total length of *Scomber japonicus*, 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*
Lecithocladium harpodontis	-0.060	0.552	-0.592	0.407
Nematobothrium scombri	-0.222*	0.026	-0.687	0.313
Opechona sp.	0.201*	0.044	-0.674	0.325
Grubea cochlear	-0.129	0.200	-0.843	0.156
Kuhnia scombercolias	-0.025	0.802	-0.554	0.445
Kuhnia scombri	0.002	0.978	-0.049	0.950
Scolex pleuronectis	-0.126	0.208	-0.272	0.728
Corynosoma australe	0.127	0.205	0.778	0.221
Corynosoma sp.	0.215	0.278	0.097	0.902
Raphidascaris sp.	0.466*	0.001	0.097	0.902

(*) significant values, *P*: significance level.

harpodontis Srivastava, 1942, *N. scombri* and *Opechona* sp., were the more prevalent and abundant species. Dominance of endoparasites has been recorded in other fishes from Rio de Janeiro (SILVA et al., 2000; ALVES; LUQUE, 2001), and this situation would be related with the feeding behavior of *S. japonicus* which have a diet composed by fishes, euphausiids and cephalopods. (COLLETTE; NAUEN, 1983; HAIMOVICI et al., 1994, FIGUEIREDO; MENEZES, 2000), which are possible intermediate hosts of digeneans (NIKOLAEVA, 1985; BRAY; GIBSON, 1990; KØIE, 1991). Moreover, *Opechona* spp. are considered stenoxenic species and were recorded parasitic in species of *Scomber* (BRAY; GIBSON 1990, 1997).

The presence of larval stages of cestodes, acanthocephalans and nematodes suggesting that *S. japonicus* might be occupy an intermediate trophic level at the marine

Table 4. Normal approximation *Zc* of Mann-Whitney test and chi-square (χ^2) test values used to evaluate possible relationships between the sex of *Scomber japonicus* and abundance and prevalence of the components of its parasites community from the coastal zone of Rio de Janeiro, Brazil.

Parasites	*Zc*	*P*	χ^2	*P*
Lecithocladium harpodontis	-0.758	0.448	0.49	0.482
Nematobothrium scombri	-0.178	0.858	0.01	0.985
Opechona sp.	-1.914	0.055	0.15	0.694
Grubea cochlear	-0.338	0.735	0.04	0.845
Kuhnia scombercolias	-2.465*	0.013	3.46	0.063
Kuhnia scombri	-2.482*	0.013	6.32*	0.012
Scolex pleuronectis	-1.883	0.059	1.36	0.244
Corynosoma australe	-0.034	0.972	0.40	0.526
Corynosoma sp.	-0.058	0.931	0.22	0.639
Raphidascaris sp.	-2.542*	0.011	6.14*	0.013

(*) significant values, *P*: significance level.

Table 5. Concurrent species pairs of ectoparasites on *Scomber japonicus* from the coastal zone of the State of Rio de Janeiro, Brazil.

Species pairs	r_s	*P*	χ^2	*P*
Grubea cochlear - Kuhnia scombercolias	0.189	0.058	0.99	0.320
G. cochlear – K. scombri	0.328*	<0.001	11.18*	<0.001
K. scombercolias – K. scombri	0.453*	<0.001	10.04*	0.001
Nematobothrium scombri - G. cochlear	0.086	0.391	1.21	0.271
N. scombri – K. scombercolias	0.126	0.209	2.06	0.151
N. scombri - K. scombri	0.033	0.740	0.56	0.453

(r_s) Spearman rank correlation coefficient; (χ^2) chi-square test; (*) significant values; *P*: significance level.

food web confirming chub mackerel as part of the diet of other teleosts as *Coryphaena hippurus* Linnaeus and *Thunnus albacares* (Bonnaterre) (ZAVALA-CAMIN; SECKEN-DORFF, 1985). For instance, Navone et al. (1998) described the life cycle of *Hysterothylacium aduncum* (Rudolphi, 1802) and suggested that *S. japonicus* is an intermediate and definitive host of this nematode. In addition, one of the main food items of *S. japonicus* are planktivorous fishes, mainly the anchovies (Engraulidae). Recent papers showed the parasite communities of anchovies from Argentina as hosts of numerous larval stages of parasites of carnivorous fishes, including the chub mackerel (TIMI et al., 1999). This situation could be an example of the importance of the food web structure as determinant of parasite species richness and diversity in the marine ecosystem (MARCOGLIESE, 2001).

A preliminary study made by Rego and Santos (1983) recorded parasites from a sample of 50 specimens of *S. japonicus* from Rio de Janeiro, and given information on the prevalence of 13 helminth parasites. The parasite fauna described by Rego and Santos (1983) showed similarity with the species of Digenea and Monogenea but differences in Cestoda and Acanthocephala. Copepods were not included in Rego and Santos (1983). Also, prevalence values detected in the present work were higher than those determined by Rego and Santos (1983). Also, Rohde et al. (1995) recorded six ectoparasite species (three monogenean and three copepod) parasitic on 98 *S. japonicus* from an unspecified Brazilian locality, from these species only *Caligus productus* Dana, 1852 was not recorded in the present work.

Cremonte and Sardella (1997) studied the parasite fauna of 173 specimens of *S. japonicus* from two localities from Argentina. In this case, a quantitative analysis was made in order to determine the possible presence of two populational stocks of *S. japonicus* in this region. The number of species recorded by Cremonte and Sardella (1997) was lower than the recorded in the present paper. This is not the first case where the parasite richness of the fishes from the Brazilian coastal zone is higher than the fishes from Argentina (SARDELLA et al., 1995; 1998). Alves and Luque (2001) and Alves et al. (2002) showed similar pattern for *Micropogonias furnieri* (Desmarest) and *Genypterus brasiliensis* Regan. This situation could be an indicator of a possible latitudinal gradient of the parasitism in marine fishes from South American Atlantic, in concordance with the hypothesis of a higher biodiversity in the regions near to equatorial line, stated with reserves by Rohde (1999).

By other hand, Cremonte and Sardella (1997) stated that the qualitative differences between the component parasite communities of *S. japonicus* from Brazil and Argentina might be explained by the presence of different populational stocks in both regions. Nevertheless, Seckendorff and Zavala-Camin (1985) proposed the existence of an unique migratory population or stock of *S. japonicus* between Brazil and Argentina. Although Perrota et al. (1990) were found morphometric differences between the Brazil and Argentine specimens of *S. japonicus*, the quantitative similarity of the parasite communities of *S. japonicus* from these two regions reinforce the hypothesis of the existence of one stock only in the Southwestern Atlantic.

Some patterns were detected in the parasite community of *S. japonicus*: the total parasite abundance and the parasite richness were not correlated with size of the host. The correlation among the total length of the fishes and the prevalence and abundance of parasite species is possibly originated by accumulative infection and it is a pattern anteriorly found in other marine fishes from Rio de Janeiro (LUQUE et al., 1996; KNOFF et al., 1997; CHAVES; LUQUE, 1999). Exceptions are expected because this type of relationship is strongly influenced by changes in the feeding habits of the fish correlated with the age (SAAD-FARES; COMBES, 1992).

Moreover, the ectoparasites *K. scombri* and *K. scombercolias* and the larval of *Raphidascaris* sp. showing differences in their prevalences and/or abundances in relation to the host sex. These correlations were surprising because differences in biological conditions of male and female chub mackerel are unknown. However, this pattern can be explained at least for *Raphidascaris* sp. because the abundance of this parasite was positively correlated with host's total length. Moreover, the lengths of male and female chub mackerel were significantly different; thus, this relationship is confounded with the apparent inequalities between female and male infection levels. Quantitative relationships of the sex of the host with the infection levels of some components of the parasite infracommunities were also detected in other marine fishes from Brazil (LUQUE et al., 1996; KNOFF et al., 1997; CHAVES; LUQUE, 1999; ALVES; LUQUE, 2001).

Acknowledgments:- J.L. Luque was supported by a Research fellowship from CNPq (Conselho Nacional de Pesquisa e Desenvolvimento Tecnológico). D. R. Alves and V. D. Abdallah were supported by student fellowships from CNPq.

REFERENCES

ALVES D.R.; LUQUE, J.L. Community ecology of the metazoan parasites of the white croaker *Micropogonias furnieri* (Osteichthyes: Sciaenidae) from the coastal zone of the State of Rio de Janeiro,Brazil. *Memórias do Instituto Oswaldo Cruz,* v. 96, n. 2, p. 145-153, 2001.

ALVES, D.R.; LUQUE, J.L.; PARAGUASSÚ, A.R. Community Ecology of the Metazoan Parasites of Pink Cusk-eel, *Genypterus brasiliensis* (Osteichthyes: Ophidiidae), from the Coastal Zone of the State of Rio de Janeiro, Brazil. *Memórias do Instituto Oswaldo Cruz*, v. 97, n. 5, p. 683-689, 2002.

BRAY, R.A.; GIBSON, D.I. The Lepocreadiidae (Digenea) of fishes to the north-east Atlantic: review of the genera *Opechona* Looss, 1907 and *Prodistomum* Linton, 1910. *Systematic Parasitology,* v. 15, n. 3, p. 159-202, 1990.

BRAY, R.A.; GIBSON, D.I. The Lepocreadiidae Odhner, 1905 (Digenea) of fishes from the north-east Atlantic: summary paper, with keys and checklists. *Systematic Parasitology,* v.36, n. 3, p. 223-228, 1997.

BUSH, A.O.; AHO J.M.; KENNEDY,C.R. Ecological versus phylogenetic determinants of helminth parasite community richness. *Evolutionary Ecology,* v. 4, n. 1, p. 1-20, 1990.

BUSH, A.O.; LAFFERTY, K.D.; LOTZ, J.M.; SHOSTAK, A.W. Parasitology meets ecology on its own terms: Margolis et al. revisited. *Journal of Parasitology,* v. 83, n. 4, p. 575-583, 1997.

CHAVES, N.D.; LUQUE, J.L. Ecology of metazoans parasites of *Menticirrhus americanus* (Osteichthyes: Sciaenidae), coast area from Rio de Janeiro State, Brazil. *Revista Brasileira de Parasitologia Veterinária,* v. 8, n. 2, p. 137-144, 1999.

COLLETTE, B.B.; NAUEN, C.E. FAO species catalogue. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. *FAO Fisheries Synopses*, v. 125, n. 2, p. 1-137, 1983.

COSTA, G.; PONTES, T.; MATTIUCCI S.; D'AMÉLIO, S. The occurrence and infection dynamics of Anisakis larvae in the black-scabbard fish, Aphanopus carbo, *chub mackerel,* Scomber japonicus, *and oceanic horse mackerel,* Trachurus picturatus *from Madeira, Portugal.* Journal of Helminthololgy, v. 77, n. 2, p. 163-166, 2003.

CREMONTE, F.; SARDELLA, N.H. The parasito fauna of *Scomber japonicus* Houttuyn, 1782 (Pisces: Scombridae) in two zones of the Argentine Sea. *Fisheries Research,* v. 31, n. 1-2, p. 1-9, 1997.

EIRAS, J.C.; REGO, A.A. The histopathology of *Scomber japonicus* infection by *Nematobothrium scombri* (Trematoda: Didymozoidae) and of larval anisakid nematode infections in the liver of *Pagrus pagrus. Memórias do Instituto Oswaldo Cruz,* v. 82, n. 2, p. 155-159, 1987.

FERNANDES, B.M.M.; KOHN, A.; PINTO, P. Aspidogastrid and digenetic trematodes parasites of marine fishes of the coast of Rio de Janeiro State, Brazil. *Revista Brasileira de Biologia,* v. 45, n. 1-2, p. 109-116, 1985.

FIGUEIREDO, J.L.; MENEZES, N.A. *Manual de Peixes Marinhos do Sudeste do Brasil VI. Teleostei (5),* Museu de Zoologia, Universidade de São Paulo, São Paulo, 2000. 116 p.

HAIMOVICI, M.; MARTINS, A.S.; FIGUEIREDO, J.L.; VIEIRA, P.C. Demersal bony fish of the outer shelf and upper slope of the southern Brazil Subtropical Convergence Ecosystem. *Marine Ecology Progress Series,* v. 108, n. 1, p. 59-77, 1994.

KNOFF, M.; LUQUE, J.L.; AMATO, J.F.R. Community ecology of the metazoan parasites of grey mullets, *Mugil platanus* (Osteichthyes: Mugilidae) from the littoral of the State of Rio de Janeiro, Brazil. *Revista Brasileira de Biologia,* v. 57, n. 3, p. 441-454, 1997.

KØIE, M. Aspects of the morphology and life cycle of *Lechithocladium excisum* (Digenea, Hemiuridae), a parasite of *Scomber* spp. *International Journal for Parasitology,* v. 21, n. 5, p. 597-602, 1991.

LUDWIG, J.A.; REYNOLDS, J.F. *Statistical Ecology: A Primer on Methods and Computing.* New York: Wiley-Interscience Publications, 1988. 337 p.

LUQUE, J.L.; AMATO, J.F.R.; TAKEMOTO, R.M. 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,* v. 56, n. 2, p. 279-292, 1996.

MARCOGLIESE, D.J. Pursuing parasites upon the food chain: Implications of food web structure and function on parasite communities in aquatic systems. *Acta Parasitologica,* v. 46, n. 2, p. 82-93, 2001.

NAVONE, G.T.; SARDELLA, N.H.; TIMI, J.T. Larvae and adults of *Hysterothylacium aduncum* (Rudolphi, 1802) (Nematoda: Anisakidae) in fishes and crustaceans in the South West Atlantic. *Parasite,* v. 5, n. 2, p. 127-136, 1998.

NIKOLAEVA, V.M. Trematodes – Didymozoidae fauna, distribution and biology.In: W. Hargis, Jr. (ed.) *Parasitology and Pathology of Marine organisms of the world ocean. NOAA Techniques Reports*, 1985. p. 67-72.

PERROTA, R.G.; AUBONE, A.; SÁNCHEZ, A. Estudio comparado de los caractéres morfométricos y merísticos de la caballa (*Scomber japonicus* Houttuyn, 1782) (Teleostei, Scombridae) del sur de Brasil y del área marplatense (Mar Argentino). *Scientia Marina,* v. 54, n. 1, p. 47-53, 1990.

REGO, A.A. *Rhadinorhynchus pristis* (Rudolphi, 1802) acanthocephalan parasite of fishes, *Scomber scombrus* and *S. japonicus*. Some observations on the scanning eletron microscope. *Memórias do Instituto Oswaldo Cruz,* v. 82, n. 2, p. 287-288, 1987.

REGO, A.A.; SANTOS, C.P. Helmintofauna de cavalas, *Scomber japonicus* Hoult, Rio de Janeiro. *Memórias do Instituto Oswaldo Cruz,* v. 78, n. 4, p. 443-448, 1983.

ROHDE, K. Latitudinal gradients in species diversity and Rapoport´s rule revisited: a review of recent work and what can parasites teach us about the causes of the gradients?. *Ecography,* v. 22, n. 6, p. 593-613, 1999.

ROHDE, K.; HAYWARD, C.; HEAP, M. Aspects of the ecology of metazoan ectoparasites of marine fishes. *International Journal for Parasitology,* v. 25, n. 8, p. 945-970, 1995.

ROHDE, K.; WATSON, N. Morphology, microhabitats and geographic variation of *Kuhnia* spp. (Monogenea: Polyopisthocotylea). *International Journal for Parasitology,* v. 15, n. 5, p. 569-586, 1985.

SAAD-FARES, A.; COMBES, C. Abundance/host size relationships in a fish trematode community. *Journal of Helminthology,* v. 66, n. 3, p. 187-192, 1992.

SARDELLA, N.H.; ETCHEGOIN, A.J.; MARTORELLI, S.R. Las comunidades parasitárias de *Micropogonias furnieri* (Corvina) en Argentina. *Boletin del Instituto de Oceanografia de la Universidad de Oriente,* v. 34, n. 1-2, p. 41-47, 1995.

SARDELLA, N.H.; AVENDAÑO, J.; TIMI, J.T. Parasite communities of *Genypterus blacodes* and *G. brasiliensis* (Pisces: Ophiidae) from Argentina. *Helminthologia,* v. 35, n. 4, p. 209-218, 1998.

SECKENDORFF, R.W.; ZAVALA-CAMIN, L.A. Reprodução, crescimento e distribuição da cavalinha (*Scomber japonicus*) no sudeste e sul do Brasil. *Boletim do Instituto de Pesca,* v. 12, n. 2, p. 1-13, 1985.

SILVA, L.G.O.; LUQUE, J.L.; ALVES, D.R.; PARAGUASSÚ, A.R. Ecologia da comunidade parasitária do peixe-espada *Trichiurus leptur*us (Osteichthyes: Trichiuridae) do litoral do estado do Rio de Janeiro, Brasil. *Revista Brasileira de Zoociências,* v. 2, n. 2, p. 115-133, 2000.

TIMI, J.T.; MARTORELLI, S.R.; SARDELLA, N. Digenetic trematodes parasitic on *Engraulis anchoita* (Pises: Engraulidae) from Argentina and Uruguay. *Folia Parasitologica*, v. 46, n. 2, p. 132-138, 1999.

TRAVASSOS, L.; FREITAS, J.F.T.; BUHRNHEIN, P.F. Trematódeos de peixes do litoral capixaba *Acanthocolpoides pauloi* gen. n. sp. n. *Atas da Sociedade de Biologia do Rio de Janeiro*, v. 4, n. 4, p. 57-59, 1965.

VICENTE, J.J.; SANTOS, E. Alguns helmintos de peixes do litoral norte Fluminense – II. *Memórias do Instituto Oswaldo Cruz*, v. 72, n. 3-4, p. 173-179, 1974.

ZAR, J.H. *Biostatistical Analysis*. 3rd ed., Upper Saddle River: Prentice-Hall, 1996. 662 p.

ZAVALA-CAMIN, L.A.; SECKENDORFF, R.W. Identificação e distribuição de juvenis de Scombridae (Osteichthyes – Perciformes) no Sudeste e Sul do Brasil. *Boletim do Instituto de Pesca*, v. 12, n. 3, p. 139-151, 1985.

Recebido em 25 de novembro de 2003.
Aceito para publicação em 22 de dezembro de 2003.