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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

HELMINTHIC ASSEMBLAGES OF *SERIOLELLA POROSA* GUICHENOT 1848 (PISCES: CENTROLOPHIDAE) FROM SAN MATÍAS GULF (ARGENTINA)

ENSAMBLES HELMÍNTICOS DE *SERIOLELLA POROSA* GUICHENOT 1848 (PISCES: CENTROLOPHIDAE) DEL GOLFO SAN MATÍAS (ARGENTINA)

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Abstract

No previous studies were carried out on aspects of the helminth assemblages of *Seriolella porosa*. The present study aims to analyze the metazoan parasite of *S. porosa* and establish the relationship between the parasitic variations and both fish size and sex. A total of 101 specimens of *S. porosa* from San Matías Gulf, Argentina were examined between September and October 2006. Thirteen species were reported with a total of 3366 parasites. *Lecithocladium cristatum* was the most prevalent, dominant and abundant species. The average species richness was 3.2 ± 1.20. The evenness showed an inverse correlation with the total number of parasites and did not reveal differences between host sexes. None of the parasite species showed interspecific associations with each other. The average richness of the infracommunity was significantly less than the component community. The helminth community of the silver warehou shows little diversity with many satellite species and only two core species (*Anisakis* sp. and *L. cristatum*). Further studies, using parasites as stock indicators, would indicate whether the San Matías population represents a reproductive aggregation that penetrates the gulf seasonally in winter or whether it is a permanent stock isolated from the continental shelf.

Keywords: Fish - helminthic assemblages - parasite ecology - *Seriolella porosa*.

Resumen

Hasta el momento no se llevaron a cabo estudios sobre aspectos de los ensambles de helmintos de *Seriolella porosa*. El presente estudio se propone analizar el ensamble de metazoos parásitos de *S. porosa* y establecer las interrelaciones entre variaciones en la estructura parasitaria y el sexo y tamaño del hospedador. Se examinó un total de 101 especímenes de *S. porosa* capturados entre septiembre y octubre de 2006 en el Golfo San Matías, Argentina. Trece especies y un total de 3366 parásitos fueron registrados. La especie más prevalente, dominante y abundante fue *Lecithocladium cristatum.* La riqueza específica fue de 3.2 ± 1.20. La equitatividad mostró una correlación inversa con el número total de parásitos y no reveló diferencias entre sexos. Ninguna de las especies parásitas mostró asociación interespecífica con otras especies del ensamble. La riqueza promedio de la infracomunidad fue significativamente menor que aquella del componente comunitario. La comunidad de helmintos del savorín mostró poca diversidad con varias especies satélites y solo dos especies centrales (core) (*Anisakis* sp. and *L. cristatum*). El presente podría constituir la base para identificar stocks poblacionales, empleando parásitos, para demostrar si la población del Golfo San Matías es un conjunto reproductivo que penetra estacionalmente al Golfo en invierno, o si se trata de un stock propio del Golfo y separado física y reproductivamente de los savorines de la Plataforma Continental Argentina.

Palabras clave: Ecología parasitaria, ensambles helmínticos, peces, *Seriolella porosa*,

INTRODUCTION

Knowledge of helminth fish parasite communities from commercial fisheries reveals basic information as well as applicable data for studies on population stocks (Timi, 2007; Braicovich & Timi, 2008), the health of ecosystems (Palm & Rückert, 2009) and the sanitary state of the fish (Valero *et al.*, 2006; Jakob & Palm, 2006).

In view of recent studies, the parasitic fauna of fish appears to be governed by the trophic habits and availability of the hosts, as well as the range of depth and migration processes (Rhode, 1984; Kennedy *et al.*, 1986; Poulin, 1995; Klimpel *et al.*, 2003, 2006a, b). This implies that parasites are important indicators of the habitat and trophic status of fish in marine ecosystems (Klimpel *et al.,* 2003). Many studies consider that the host size is a factor that influences the formation of parasitic assemblages (Thoney, 1993; Sardella *et al.*, 1995; Balboa & George-Nascimento, 1998), being a more influential parameter than host sex (Luque *et al.,* 1996; Knoff *et al.,* 1997; González & Acuña, 2000; Ramos Alves & Luque, 2001; Iannacone & Alvariño, 2008). *Seriolella porosa* Guichenot 1848 (silver warehou) is an important fish resource of the Argentine Sea (Sánchez & Bezzi, 2004). Its distribution extends from 35° to 55° S (Garciarena & Perrotta, 2002). Commercial landings of this resource underwent a growing trend over the last 20 years as "by catch" in the hake fishery (Cousseau & Perrota, 1998). It was described by Perier & Di Giácomo (2002) as “a seasonal fish resource which uses the area as a spawning ground and nursery” in the San Matías Gulf fishery. Up to the present only two studies have been made on the parasitological status of this fish in the South Atlantic Ocean (Guagliardo *et al.,* 2009, 2010).

It would be expected that *S. porosa* carries several parasite species to upper levels of the food chain because it occupies an intermediate level in the food web. Since there are no records of aspects of the helminthic assemblages of the silver warehou, the aims of this study were to analyze them at the component and infracommunity levels and to evaluate the relationship between the parasitic burden and fish size and sex.

MATERIALS AND METHODS

A total of 101 specimens of *S. porosa* (68 males, 32 females and 1 undetermined) were examined between September and October 2006. The area of capture was the northern sector of San Matías Gulf (41°00'S, 64°00'W), Argentina. The fish were caught by commercial fleet trawlers from San Antonio Oeste port. Host size (cm), weight (g) and sex were determined. The gonad/somatic index was estimated as GSI= (gonad weight/total weight)*100. Parasites were extracted from the gills, body cavity and digestive lumen. They were subsequently relaxed in hot saline solution, fixed in 5% formalin and stored in 70% alcohol. Part of the helminth sample was stained with Langeron's hydrochloric carmine cleared in clove oil and mounted in Canada balsam. Nematodes and acanthocephalans were made transparent in hot alcohol-glycerine. Parasite prevalence, abundance and the intensity of infection were calculated following Bush *et al.* (1997). Specimens of digenean trematodes were deposited in the collection of the Museum of La Plata (Argentina) under the following numbers of collection: *Lecithocladium cristatum* (Voucher MLP 5935), *Elytrophalloides oatesi* (Voucher MLP 5936), *Gonocerca cfr. phycidis* (Voucher MLP 7937) & *Aponurus laguncula* (Voucher MLP 5938).

The community structure was analyzed at the component community and infracommunity levels. Species with prevalences ⩾ 10 % were considered as component species in the infracommunities (Bush *et al.*, 1990).

The variance/mean ratio (coefficient of dispersion) was used to determine the distribution patterns at the level of infrapopulations. In order to quantify the influence of parasite species in the community, the specific importance (IE = (relative prevalence + relative abundance) x 100) was estimated according to Bursey *et al.* (2001). At the infracommunity level, the richness, mean diversity and evenness when richness was higher than four species (Brillouin based evenness index) were calculated (Mouillot *et al.*, 2005). The qualitative association between pairs of parasite species was estimated by using the correlation Φ coefficient (Combes, 1983). At the component community level, the relative dominance (number of specimens of one species in respect of the total number of specimens of all species in the infracommunity) of each parasite species was calculated according to Morales & Pino de Morales (1987). The dominance frequencies and the co-dominances were also calculated. The ecto/endoparasite ratio was determined as the number of ectoparasite species/number of endoparasite species.

The species richness, the total number of parasites, the Simpson index of diversity (Pielou, 1975; Krebs, 1989), the Shannon-Wiener index of diversity and evenness were calculated after Magurran (1988). The correlations between the total number of parasites, richness, diversity and evenness in relation to host weight and total length were tested using Spearman's rank correlation coefficient (Siegel & Castellan, 1995). Evenness was also correlated with the total number of parasites. This latter parameter was compared with host sex using the nonparametric Mann-Whitney U test (Siegel & Castellan, 1995). The strategy of colonization, allogenic or autogenic species, was assessed according to Bush *et al.* (2001).

RESULTS

The mean total body length and weight of fish were 39.60 ± 4.68 and 514.55 ± 264.25 respectively. The mean GSI was 0.052 (0.009 – 0.230) in females. Most of the females (75%) had not reached the first sexual maturity length (< 45 cm). A total of 3366 helminths, mostly endoparasites, were recorded and a total of thirteen taxa were identified. The ectoparasite versus endoparasite relationship was low (R= 0.18). The helminth assemblage was highly dominated by digenean (2309 or 68.6% of the specimens). All component community species (prevalence 10%) had an aggregated pattern of distribution. Table 1 shows that *Lecitochladium cristatum* was not only dominant but also the

Table 1. Prevalence, abundance, mean intensity and specific importance of the parasitic helminths of *Seriolella porosa* from the San Matías Gulf (Argentina). 95% confidence interval. SD: standard deviation.

Species	Developmental stage	Site	Prevalence (%) ± CI	Abundance ± SD	Mean intensity ± SD	Specific importance	Frequence of Dominance single	Frequence of Dominance 3 species	Previous records from South Atlantic Ocean (*)
Nematoda									
Anisakis sp.	LIII	Body cavity	75.25 ±8.5	7.22 ±10.96	9.59 ±11.71	797.25	25	1	1,2,3,4,5,6,7, 8, 9,10
Pseudoterranova sp.	LIII	Body cavity	1.98 ±8.68	0.02 ±0.14	1 ±0	21.98	0	0	5,6,10,11, 12,13
Hysterothylacium sp.	LIV	Body cavity	2.97 ±10.57	0.03 ±0.17	1 ±0	32.97	1	0	1,2,3,4,5,6,7, 8,10, 14,15,16
Philometra cf. seriolellae	Adult	Ovary	2.97 ±10.57	0.05 ±0.30	1.67 ±0.58	52.97	0	0	---
Acantocephala									
Corynosoma cetaceum	Juvenile	Body cavity	2.97 ±10.57	0.03 ±0.17	18 ±0	32.97	0	0	1,7,8,10,17,18
Corynosoma australe	Juvenile	Body cavity	1.98 ±8.68	0.04 ±0.31	2 ±1.41	41.98	0	0	1,3,4,6,7,8,13, 17,18,20,22,23
Cestoda									
Nybelinia sp.	Plerocercus	Body cavity	0.99 ±1.95	0.01 ±0.10	1	10.99	0	0	3,6,7,8

Table 1. Continuation.

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Species	Developmental stage	Site	Prevalence (%) ± CI	Abundance ± SD	Mean intensity ± SD	Specific importance	Frequence of Dominance single	Frequence of Dominance 3 species	Previous records from South Atlantic Ocean (*)
Monogenea									
Neogrubea seriolellae	Adult	Gills	63.4 ±9.49	2.65 ±3.98	4.19 ±4.32	328.4	6	2	---
Eurysorchis australe	Adult	Gills	28.7 ±8.91	0.42 ±0.80	1.44 ±0.87	70.7	2	0	---
Digenea									
Lecithocladium cristatum	Adult	Stomach	80.19 ±7.85	17.90 ±24.63	22.32 ±25.74	1870.2	56	2	7,24
Aponurus laguncula	Adult	Stomach	19.8 ±7.85	0.40 ±1.08	2 ±1.65	59.8	0	1	7,10,24,25,26
Ellytrophaloides oatesi	Adult	Stomach	31.68 ±9.16	4.55 ±13.88	14.38 ±21.81	486.68	8	0	7,11,12,15, 24,25,27,28,29,30
Gonocerca. cf. phycidis	Adult	Stomach	0 ±1.95	0.01 ±0.10	1	0.09	0	0	15,24,28,29,31

(*) References: 1- Guagliardo (2003). 2- Tanzola & Guagliardo (2004). 3- Timi *et al.* (2005). 4- Timi & Poulin (2003). 5- Sardella *et al.* (1998). 6- Sardella & Timi (2004). 7- Braicovich (2008). 8- Braicovich & Timi (2008). 9- Guagliardo *et al.* (2009). 10- Timi *et al.* (2008). 11- Gaevskaya *et al.* (1990). 12- Sardella & Timi (1996). 13- Cremonte & Sardella (1997). 14- Navone *et al.* (1998). 15- Mackenzie & Longshaw (1995). 16- Incorvaia & Díaz de Astarloa (1998). 17- Timi & Lanfranchi (2009). 18- Sardella *et al*. (2005). 19- Tanzola & Guagliardo (2000). 20- Timi *et al.* (2001). 21- Zdzitowiecki (1989). 22- Tanzola *et al*. (1997). 23- Braicovich *et al.* (2005). 24- Guagliardo *et al.* (2010). 25- Szidat (1950). 26- Szidat (1961). 27- Brickle *et al.* (2006). 28- Suriano & Sutton (1981). 29- Szidat (1955). 30- Szidat & Graefe (1968). 31- Laskowski & Zdzitowiecki (2005).

Table 2. Community descriptors of *Seriolella porosa* in San Matías Gulf (Argentina).

Component community		**Infracommunity**	
Total number of species	13	Mean species per host (±SD)	3.12 ± 1.20
Total number of helminths	3366	Mean helminth per host (± SD)	33.3 ± 27.6
Diversity indices		Mean diversity (Brillouin) (±SD, rank)	
- Shannon-Wiener	1.28		0.23 ± 0.13 [0.00-0.56]
- Simpson	0.64		
Evenness (Shannon-Wiener)	0.50	Mean evenness (Brillouin) (± SD, rank)	
			0.40 ± 0.19 [0.127-0.96]
Dominance		Percentage of infracommunities dominated by	
(Berger-Parker)	0.53	the dominant species	55.45 %

Tabla 3. Relationships (Spearman correlation) between infracommunities descriptors and the size and weigth of *Seriolella porosa* from Golfo San Matías(Argentina). r_s: Spearman's coefficient; critical p-value = 0.05.

Infracommunity descriptor	**Size**		**Total weigth**	
	r_s	p	r_s	p
Total number of parasites	0.31	0.002**	0.18	0.062
Richness	0.23	0.022*	0.18	0.074
Diversity (Brillouin)	0.16	0.098	0.35	0.00**
Evenness (Brillouin)	-0.13	0.21	0.04	0.73

most abundant and prevalent species and it was also of greater relative influence in the community (IE= 1870.2).

Only one fish was free of parasites, five fishes (4.95 %) harboured a single species while 95 hosts (94.05 %) showed multiple infestations, with a richness range of two to six parasite species. The average infracommunity species richness was 3.2 ± 1.20. Co-dominances were not frequent. All parasite species were autogenic in their colonization strategy, completing their life-cycles in aquatic hosts within the same ecosystem.

Both the infracommunity and the component community descriptors are shown in Table 2.

The richness and total number of parasites showed significant correlation with the size of the hosts, while only diversity was correlated with body weight (Table 3). The evenness showed an inverse correlation with the total number of parasites.

No significant differences were observed between males and females (U= 1057, p= 0.82) in the total parasite burden and none of the species showed any strong interspecific associations.

DISCUSSION

Two species of *Seriolella* reported from the Southwestern Atlantic are: *S. porosa* Guichenot 1848 and *S. caerulea* Guichenot 1848. Although there is a latitudinal overlap between these two species, they are rarely found together as they live at different levels in the water column (Cousseau & Díaz de Astarloa, 1993). In the San Matías Gulf, *S. porosa* is the species that has undergone rising and sustained catches, so it is an important fishery resource in its distribution area (Garciarena & Perrota, 2002; Perier & Di Giácomo, 2002).

This study is the first comprehensive approach on silver warehou helminth assemblages. Our records barely coincide with any previous studies of *Seriolella* spp.; in *S. violacea* Guichenot, 1848 from the Peruvian coast there were no species in common with the present survey. The monogenean *Paraeurysorchis sarmientoi* (Tantalean, 1974) Tantalean, Martinez & Escalante, 1985 and the cestode *Neobothriocephalus aspinosus* Mateo & Bullock, 1966 are the only two species reported from this South Pacific host (Iannacone 2003). Additionally, *S. porosa* showed no similarities with the endoparasites of *S. brama* (Günther, 1860) from New Zealand although the monogenean species were the same (Rhode *et al.,* 1980). None of the digeneans in this work were recorded for *S. punctata* in Tasmania (Bray & Cribbs, 2003).

According to Cortés & Muñoz (2008) infracommunity studies constitute the first step to any parasitological analysis within or between species of hosts through their parasitological descriptors. In the present study, all component species of *S. porosa* follow the typical aggregated pattern of distribution. As stated by several authors, aggregation is common behavior in parasitic life (Crofton, 1971; Esch & Fernández, 1993). A wide range of biological processes generates this type of distribution (Morales & Pino de Morales, 1987). According to Janovy (1992) the structures of parasite populations and their frequency distributions would be the result of mostly ecological processes. The prey of the fishes could be considered as carriers of these infracommunities, in agreement with the concept of "instant infracommunities" (Bush *et al.*, 1993), perhaps transmiting many parasites with the intake of few intermediate hosts and vice versa, thus determining the distribution pattern of parasites.

In our study ectoparasites species were scarce. This fact agrees with the parasitism present in teleosts from the South Atlantic coast (Sardella & Timi, 1996; Tanzola *et al.,* 1997; Tanzola & Guagliardo, 2000; Sardella & Timi, 2004; Timi *et al.*, 2005; Timi & Lanfranchi, 2009). In the north Bonaerense region of the Argentine Sea, the dominance of larval parasites, in terms of parasite prevalence and abundance, seems to be the rule (Timi & Lanfranchi, 2009). The fact that we have reported a dominance of adult stages at higher latitude in our study, probably reflects a particular biogeographic region where the ecology component governs the parasitic assemblages of the silver warehou in a different way. It was noted that the mean richness of the infracommunities was significantly less than the total number of species from the component community. This situation agrees with the idea that the infracommunities rarely include all species present at the component community level (Poulin, 1998).

Seven species, with prevalences lower than 10% were not included in the component community analysis (*Pseudoterranova* sp., *Hysterothylacium,* sp., *Philometra cf. seriolellae, Corynosoma australe, C. cetaceum, Nybelinia* sp. and *Gonocerca cf. phycidis*).

The average richness of the infracommunities (3.12 ± 1.20) represents a common value in other host/parasite systems, ranging from two to five species per host (Cordeiro & Luque, 2004; Mouillot *et al.*, 2005; Jacob & Palm, 2006; Rodríguez-González & Vidal-Martínez, 2008; Timi & Lanfranchi, 2009). In comparison, it should be noted that the average richness of *S. porosa* was slightly less than the value recorded for *S. violacea* in Chilean waters (4.60 ± 1.54) (Mouillot *et al.* 2005). In this study, the most recruited species with prevalence > 50% were *L. cristatum*, *N. seriolellae* and *Anisakis* sp.

The richness was positively correlated with the size of the hosts. In larger fish more food is consumed, so consequently an increase in the exposure to the infective stages of the parasites is expected (Poulin, 1995).

When both the Shannon-Wiener and Simpson indexes were compared in respect of the Brillouin values, the mean values for the infracommunities were lower than the component community.

Until the present time, the most common mean value of helminth diversity in marine fish infracommunities is less than two. Based on previous records (Ramos Alves *et al.,* 2002; Cordeiro & Luque, 2004; Sardella & Timi, 2004; Timi & Lanfranchi, 2009; Palm & Rückert, 2009) the parasite assemblage of silver warehou shows little diversity, with many satellite species and only two central ones (*Anisakis* sp. and *L. cristatum*).

The evenness is a measure of the unequal representation of species in a hypothetical community in which all species are equally common (Krebs 1989). In this work, the evenness was 0.50, while the mean value of evenness in the infracommunities was lower (0.40) showing an unequal distribution of the specific abundance. These values can perhaps be explained by the high dominance of *L. cristatum.* Evenness was not correlated with either size or weight of the host but showed a highly significant inverse correlation with the total number of parasites. We have noted that the greatest number of helminths were *L. cristatum* and *Anisakis* sp., both of them with the highest dominances.

None of the species showed any interspecific association with each other (Table IV). A common pattern in many host species is the absence of sexual differences in the prevalence and/or parasitic intensities (Ramos Alves & Luque, 2001; Knoff *et al.,* 1997; Luque *et al.*, 1996; Iannacone, 2003). Accordingly, no differences in the total number of parasites were reported here, discarding selective parasitism or differential trophic behavior between sexes.

In respect of the colonizing ability in the Argentine Sea of cestodes, nematodes and acanthocephalans recorded in the silver warehou, they may be considered as generalists, as they have previously been recorded in several hosts in the South Atlantic. It is likely that some infect *S. porosa* accidently, especially those with low prevalences, due to the trophic behavior of this host (Forciniti & Pérez Macri, 1992; Sánchez & Prenski, 1996). However it should be noted that both, monogeneans and digeneans, have demonstrated selective colonization strategies in the Atlantic Ocean.

Previous studies on the use of parasites as biological tags of South Atlantic fish stocks have been able to discriminate populations of *Merluccius hubbsi* Marini, 1933 (Sardella & Timi, 2004), *Scomber japonicus* (Houttuyn, 1782) (Cremonte & Sardella, 1997); *Engraulis anchoita* HUbbs & Marini, 1935 (Timi, 2003), *Cynoscion guatucupa* Cuvier 1830 (Timi *et al.,* 2005), *Eleginops maclovinus* (Valenciennes, 1839) Dollo, 1904 (Brickle & MacKenzie, 2007) *Percophis brasiliensis* Quoy & Gaimard, 1824 (Braicovich & Timi, 2008) and *Pinguipes brasilianus* Cuvier, 1829 (Timi *et al.,* 2008). The only information about seasonal migration in the area of distribution of the silver warehou in the Argentine Sea is in the San Matías Gulf (Perier & Di Giácomo, 2002). Further studies, using parasites as stock indicators, might show whether the San Matías Gulf population represents a reproductive aggregation that enters the gulf in winter, looking for better environmental conditions or whether it is a permanent stock isolated from the continental shelf.

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