Online ISSN: 0718-1957
RBMO
Revista de Biología Marina y Oceanografía
Vol. 57(2): 80-88, 2022
<https://doi.org/10.22370/rbmo.2022.57.2.3526>
ARTICLE

Parasitic fauna of the Peruvian moonfish *Selene peruviana* (Perciformes: Carangidae) from the north coast of Peru

Fauna parasitaria del pez espejo *Selene peruviana* (Perciformes: Carangidae) de la costa norte del Perú

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Resumen.- El pez espejo *Selene peruviana* es un recurso abundante en las costas del Pacífico, con una biología poco conocida. Respecto a su parasitofauna se han registrado solo dos especies de parásitos y ante tan poca información se realizó un estudio parasitológico en 80 especímenes de *S. peruviana*, capturados entre junio y octubre 2018, en la costa de Tumbes, norte del Perú. Se registró la longitud total (LT) y sexo de cada pez. Se calcularon los descriptores ecológicos de infección/infestación parasitaria, el grado de dispersión parasitaria, los índices de diversidad alfa y correlación entre los índices parasitológicos y las características biológicas de los peces (LT y sexo). Se registraron dos especies de monogeneos (*Oaxacotyle oaxacensis* y *Metamicrocotyla macracantha*), una especie de trematodo (*Lecithocladium cristatum*) y cuatro especies de copépodos (*Naobranchia* sp., *Lepeophtheirus* sp., *Caligus* sp. y *Lernanthropus* sp.). El monogeneo *O. oaxacensis* fue considerado como especie núcleo (*e.g.*, con prevalencia > 45%). La distribución de *O. oaxacensis* y *L. cristatum* fue agregada y no existió asociación entre la LT y el sexo con los índices parasitológicos. Los valores del índice de diversidad Margalef (D_{mg}), Shannon-Weaver (H´) y equidad de Pielou (J´) fueron mayores en hembras, pero la dominancia de Simpson (D) no mostró diferencias entre sexos. El índice de diversidad de H´ parasitario presentó un mayor valor en las tallas sobre la madurez sexual de *S. peruviana*, mientras que el índice de D parasitario presentó un patrón opuesto. Todas las especies de parásitos encontradas en este estudio son nuevos registros para *S. peruviana* y para el Perú.

Palabras clave: Carangidae, comunidad de parásitos, Copepoda, ecología, helmintos, ictioparasitología

Abstract.- Peruvian moonfish *Selene peruviana* is an abundant resource on the Pacific coasts, with a little-known biology. Regarding its parasitofauna, only two species of parasites have been registered and, given so little information, a parasitological study was carried out on 80 specimens of *S. peruviana* sampled from the coast of Tumbes, north of Peru, between June and October 2018. The total length (TL) and sex of each fish were recorded. The ecological descriptors of parasitic infection/infestation, the degree of parasitic dispersal, the alpha diversity indices and the correlation the parasitological indices and biological characteristics of the fish (TL and sex) were calculated. Two species of monogeneans (*Oaxacotyle oaxacensis* and *Metamicrocotyla macracantha*), one species of trematode (*Lecithocladium cristatum*) and four species of copepods (*Naobranchia* sp., *Lepeophtheirus* sp., *Caligus* sp. and *Lernanthropus* sp.) were recorded. The monogenean *O. oaxacensis* was considered the only core species (*e.g.,* with prevalence > 45%). The distribution found for *O. oaxacensis* and *L. cristatum* was aggregated and there was no association between TL and sex with the parasitological indices. In the case of alpha diversity indices, Margalef (D_{mg}), Shannon-Weaver (H´) and Pielou (J´) diversity index values were higher in females, but Simpson dominance (D) did not show differences between sexes. The diversity index of parasitic H' showed a higher value in the sizes over sexual maturity of *S. peruviana*. The parasitic D index presented an opposite pattern. All the parasite species found in this study are new records for *S. peruviana* and for Peru.

Key words: Carangidae, parasite community, Copepoda, ecology, helminths, ichthyoparasitology

INTRODUCTION

The Carangidae family is the most diversified of the order Perciformes. It includes 146 species in 32 genera that inhabit warm and temperate waters of the Atlantic, Pacific and Indian oceans (Jacobina *et al.* 2016, Camargo & Santos 2019). These fish are pelagic, found in the open sea where they feed on fish, crustaceans and other invertebrates (Fischer *et al.* 2011, Mukherjee *et al.* 2017).

The genus *Selene* (Lacépède, 1802) includes seven species distributed in the western Atlantic such as *Selene brownii* (Cuvier, 1816), *S. setapinnis* (Mitchill, 1815) and *S. vomer* (Linnaeus, 1816); in the eastern Atlantic, *S. dorsalis* (Gill, 1862) and, finally, *S. peruviana* (Guichenot, 1866), *S. brevoortii* (Gill, 1863) and *S. orstedii* (Lütken, 1880) in the eastern Pacific (Reed *et al.* 2001, Jacobina *et al.* 2013, Jun *et al.* 2016). The Peruvian moonfish *S. peruviana* is a benthopelagic fish that forms schools and inhabits the sandy bottoms of the coasts of America, specifically from the Gulf of California (USA) to the coast of Peru, and occasionally in the north of Chile. The young specimens are distributed from the superficial zone to 50 m depth (Froese & Pauly 2019, Walker *et al.* 2020).

Selene peruviana has little commercial value and is marketed as a third class fish in some countries (Tripp-Valdez *et al.* 2012), it is one of the seven most caught fish in artisanal fisheries and marketed in Tumbes in the northern coast of Peru that is part of the coastal fishing ecosystem of the southeast Pacific (De la Puente *et al*. 2020). There are few studies on *S. peruviana*; an eco-morphology study has been carried out in relation to feeding (Bohórquez-Herrera *et al.* 2014) and other was about the weight-length relationship (Coello *et al.* 2020). A few parasitological studies have been done in Peruvian moonfish which reported two species of monogeneans, *Ahpua piscicola* Caballero & Bravo-Hollis, 1973 in Mexico (Lamothe-Argumedo *et al.* 1997, Mendoza-Garfias *et al.* 2017) and *Pseudomazocraes monsivaeisae* Caballero & Bravos-Hollis, 1955 in Costa Rica (Rodríguez-Ortíz *et al.* 2004). There are no records regarding the parasitic fauna of *S. peruviana* in Peru (Luque *et al.* 2016, Alves *et al.* 2017, Eiras *et al.* 2017, Londoñe-Bailón *et al.* 2020), despite the fact that it plays an important role in the marine ecosystem and is used for human consumption (Tripp-Valdez *et al.* 2012). Therefore, the objective of this research was to characterize the parasitic fauna of *S. peruviana* from the north coast of Peru and to determine its ecological descriptors of parasitic infection/infestation, the degree of parasitic dispersal, the alpha diversity indices and the correlation of the total length and sex of the Peruvian moonfish with these indices.

Materials and methods

Eighty specimens of *S. peruviana* were collected between June and October 2018 from the north coast of Peru at Puerto Zorritos (03°40'04.1"S; 80°39'14.9"W), Tumbes. The selected period did not involve maximum spawning period of *S. peruviana*, which is between March and May.

Fish were identified using the taxonomic keys of Chirichigno (1974) and catalog of Chirichigno & Cornejo (2001). Subsequently, measurements of the total length (TL) and the sex of each fish were taken. A necropsy of each individual was performed to search for parasites and the skin, eyes, fins, gills, oral cavity, stomach, intestine, mesentery, coelomic cavity, liver, kidney, heart and gonad were examined with the help of a stereoscopic microscope. The collected metazoan parasites were preserved in 70% ethyl alcohol according to the recommendations described by Eiras *et al.* (2006).

For the preparation of the slides *in toto*, the monogeneans and digeneans were processed with the staining techniques of acetic acid carmine, Mayer's paracarmine and Gomori trichome (aqueous, alcoholic and hematoxylin-trichome), dehydrated in increasing concentrations of ethanol (70, 80, 90 and 100%), cleared in eugenol and mounted in balsam of Canada. In the case of copepods, they were cleared in glycerin (Salgado 2009, Almeida & Almeida 2014, Oyarzún-Ruiz & González-Acuña 2020).

The parasitological indices of prevalence (P%), mean abundance (MA) and mean intensity (MI) of infection/infestation were calculated according to Bush *et al.* (1997) and Bautista-Hernández *et al.* (2015). The specific importance (I) was calculated considering the influence of each species of parasite in the ecological group, evaluated based on P% plus mean abundance (MA) x 100. Finally, species were classified by type of strategy as "core" (P > 45%), "secondary" (10% < P > 45%) and "satellite" (P < 10%) (Bursey *et al.* 2001, Iannacone & Alvariño 2012, Minaya *et al.* 2020a, b).

For parasites with prevalence greater than 10%, the dispersion indices were calculated: variance-mean ratio (Id), Poulin's discrepancy (IDP) and k from the negative binomial equation, using Quantitative Parasitology 3.0 statistical package (Rózsa *et al.* 2000, Reiczigel *et al.* 2019). It allows the classification of the distribution into contagious or aggregate (> 1), uniform (< 1) and random (= 0) (Iannacone & Alvariño 2013). IDP quantifies aggregation as the discrepancy between the observed parasite distribution and the hypothetical distribution, taking values from 0 (no aggregation) to 1 (maximum theoretical aggregation) [*i.e.*, all parasites are found in a single host (Poulin 1993)]; and the k of the binomial equation varies between the values of 0 and + ∞, the smaller the value of k (up to close to 8), the greater the aggregation (Villalba 2018).

The following alpha diversity indices were determined: species richness (S), individuals, Margalef richness (D_{mg}), Shannon-Weaver diversity (H'), Pielou equity (J), Simpson dominance (D), and the Chao-1 estimator, for the parasitic community component in males and females; as well as for the length below and on the sexual maturity of *S. peruviana*, considering the value of 21.5 cm for the length for first sexual maturity, based on the criteria indicated by Tripp-Valdez *et al.* (2012). The analysis of the diversity indices and the parasite richness estimator was carried out with PAST software (Paleontological Statistics) v. 4.03 (Hammer *et al.* 2001, Iannacone & Alvariño 2013).

Prior to the use of differential statistical analyses, the data was evaluated for compliance with homoscedasticity of variances with Levene test and normality with Shapiro-Wilk test. It was verified whether there were differences in the TL of *S. peruviana* between the sexes using Student's t test. TL of the fish was divided into five ranges of 2.7 cm each, following Sturges rule (Zar 2014): (1) less than 22.5 (20.83, n= 22), (2) 23-25.4 (23.97, n= 17), (3) 26-28 (27, n= 16), (4) 29-30.4 (29.8, n= 14), (5) greater than 31 (32.26, n= 11). Spearman correlation coefficient (r_s) was used to determine if there was a relationship between TL and prevalence (P%). Previously, these values were transformed to the square root of arcsine. The same criterion was used to find the association between MA and MI with fish TL using Pearson's coefficient (r_p) (Zar 2014). Finally, 2x2 contingency tables, through χ^2 statistic, were used to calculate the degree of association between sex of the host and prevalence (> 10%) for each parasite species. To compare MA and MI between sexes, Student t test was used (Esch *et al.* 1990). This statistical test was also used to compare parasitic H' and D between both sexes and between sizes regarding sexual maturity of *S. peruviana*.

The non-metric multi-dimensional scaling (NMDS) technique was used to evaluate the structure of the parasite infracommunity as a function of the abundance of infection/infestation of each parasite species. The similarity matrix was constructed using Bray-Curtis index. The abundance of infestation of each parasite species in each host and its relationship with length of sexual maturity, and the host sex were analyzed using a one-way analysis of variance with a non-parametric multivariate statistical permutation test (PERMANOVA), with ten thousand permutations (Minaya *et al.* 2020a).

The parasites collected from *S. peruviana* were deposited in the Helminths and Related Invertebrates Collection of the Zoology Collection (HPIA), Museo de Historia Natural of Universidad Nacional Federico Villarreal (MHN-UNFV), Lima. The codes for each specimen are shown in Table 1.

Results

The *S. peruviana* sample consisted of 47 males and 33 females. The mean total length (TL) of the Peruvian moonfish was 24.56 ± 6.81 cm for the whole sample. No differences in TL were observed between males (24.57 ± 7.68) and females fish (24.53 ± 5.44) (t = 0.02, *P* = 0.98).

Of out 80 individuals of *Selene peruviana* examined, 66 (82.50%) were parasitized with at least one species; 44 individuals had only one parasite species (55%), 20 individuals had biparasitism (25%) and 2 individuals had triparasitism (2.5%). A total of 326 parasite specimens of seven species and three taxa (Monogenea, Trematoda and Copepoda) were collected. Six ectoparasite species and only one endoparasite were found in *S. peruviana* (Table 1).

The monogenean *Oaxacotyle oaxacensis* (Caballero & Hollis, 1963) Lebedev, 1984 had the highest prevalence of infestation (P%= 56.25) and abundance (n= 159 parasites). The trematode *Lecithocladium cristatum* (Rudolphi, 1819) Looss, 1907 was the second most prevalent species (P%= 40) and considered as secondary. The remaining five species were considered as satellite or rare (P < 10%). The highest mean intensity (MI) corresponded to *L. cristatum* (4.84) followed by *O. oaxacensis* (3.55) (Table 1).

Table 1. Parasitological descriptors for *Selene peruviana* from northern Peru / Descriptores parasitológicos para *Selene peruviana* en el norte del Perú

Parasite species	nPH	PH	P%	MA	MI	I	Strategy	MUFV
MONOGENEA								
Oaxacotyle oaxacensis	35	45	56.25	1.99	3.53	255	Core	HPIA:189
Metamicrocotyla macracantha	79	1	1.25	0.01	1	2.5	Satellite	HPIA:190
TREMATODA								
Lecithocladium cristatum	48	32	40	1.94	4.84	233.76	Secondary	HPIA:191
COPEPODA								
Naobranchia sp.	78	2	2.5	0.03	1	5	Satellite	HPIA:192
Lepeophtheirus sp.	78	2	2.5	0.03	1	5	Satellite	HPIA:193
Caligus sp.	79	1	1.25	0.01	1	2.5	Satellite	HPIA:194
Lernanthropus sp.	75	5	2.5	0.08	1.2	13.75	Satellite	HPIA:195

nPH= non-parasitized host, PH= parasitized host, P%= prevalence, MA= mean abundance, MI= mean intensity, I= specific importance, MUFV= code of the Museo de Historia Natural (CZMHN) (Facultad de Ciencias Naturales y Matemática from Universidad Nacional Federico Villarreal, Lima)

The spatial dispersion of *O. oaxacensis* and *L. cristatum*, indicated that these parasite species were not homogeneously distributed in the population of *S. peruviana*, on the contrary, they had aggregate (contagious) distribution (> 1). Likewise, Poulin's discrepancy (PDI) index indicated that *L. cristatum* presented a higher degree of aggregation than *O. oaxacensis* (Table 2).

Table 2. Aggregation indices of the two most prevalent ichthyoparasite species found in *Selene peruviana* from northern Peru / Índices de agregación de las dos especies de ictioparásitos más prevalentes encontradas en *Selene peruviana* del norte del Perú

Parasite species	Id	PDI	k	Distribution
MONOGENEA				
Oaxacotyle oaxacensis	5.15	0.69	0.51	aggregate
TREMATODA				
Lecithocladium cristatum	16.17	0.84	0.20	aggregate

Id= variance-mean ratio dispersion index, PDI= Poulin discrepancy and k of the negative binomial equation

Table 3. Alpha diversity indices of the community component of parasites according to sample of the total population, sex and size at sexual maturity of *Selene peruviana* / Índices de diversidad alfa del componente comunitario de parásitos según muestra de la población total, sexo y talla de madurez sexual de *Selene peruviana*

Alpha diversity indices of the parasite component community	Total	Males	Females	Below the size at sexual maturity	Size at sexual maturity
Richness (S)	7	5	5	2	7
Individuals	326	218	108	86	240
Margalef (D_{mg})	1.03	0.74	0.85	0.22	1.09
Shannon-Weaver (H')	0.87	0.79	0.97	0.63	0.91
Equity of Pielou (J´)	0.45	0.49	0.60	0.94	0.47
Dominance of Simpson (D)	0.46	0.48	0.44	0.54	0.46
Chao-1	7	5	6	7	2

Parasite richness in both male and female of *S. peruviana* was five species. However, there was a higher abundance of parasites in male fish than in female (Table 3). The indices of alpha parasitic diversity of D_{mg} and J' were higher in female fish than in males. The parasite diversity index H´ was higher in females fish than in males (t= 2.15; *P* = 0.03). However, the value of the D index did not differ between sexes (t= 1.84; *P* = 0.06). Chao-1 estimator for the total number of hosts indicated the number of species that should have been found and this was a value of seven, the same number found in the present study, which is why the level of sampling effort was optimal (Table 3).

The comparisons of diversity indices (richness, abundance, D_{mg} index and parasitic H´ between groups, < 22.5 cm, 23-25.4 cm, 26-28 cm, 29-30.4 cm and > 31 cm of *S. peruviana* showed that greater values of index of parasitic H´ in higher fish TL (t= 4.31; *P* < 0.001). In contrast, the value of the parasitic D index was greater in immature than mature hosts (t= 2.38; *P* = 0.01) (Table 3).

There were no correlation of the TL of *S. peruviana* with P%, MA and MI of the parasites *O. oaxacensis* and *L. cristatum*. Regarding sex, there was no association with P%, MA and MI of the two parasites mentioned above (Table 4).

Table 4. Correlation between total length of the fish (TL) and parasitological indices (P%, MA, MI) of two parasitic species and the association of the sex of *S. peruviana* with the same parasitological descriptors / Correlación entre la longitud total del pez (LT) y los índices parasitológicos (P%, MA, MI) de dos especies de parásitos y la asociación del sexo de *S. peruviana* con los mismos descriptores parasitológicos

Correlations/associations		Parasite species	
		Oaxacotyle oaxacensis	*Lecithocladium cristatum*
TL *vs.* P%	r_s (Spearman)	0.39	0.38
	P	0.52	0.52
TL *vs.* MA	r_p (Pearson)	0.86	-0.39
	P	0.06	0.51
TL *vs.* MI	r_p (Pearson)	0.73	-0.40
	P	0.16	0.51
Sex *vs.* P%	X^2	1.38	0.01
	P	0.24	0.93
Sex *vs.* MA	t	1.42	0.36
	P	0.14	0.71
Sex *vs.* MI	t	1.00	0.35
	P	0.32	0.73

r_s= Spearman correlation, r_p= Pearson's correlation, *P*= level of significance, X^2= Chi-square test, t = Student's t

PERMANOVA analysis showed a low heterogeneity between parasite infracommunities and host's sexual maturity size (Pseudo-F= 1.08, P = 0.34) (Fig. 1), also between parasite infracommunities and host sex (Pseudo-F= 1.36, P = 0.23). NMDS evaluated the structure of parasite species abundance with respect to sex, and suggested a high degree of homogeneity between parasite infracommunities, despite there being two outlier points of male hosts (Fig. 2).

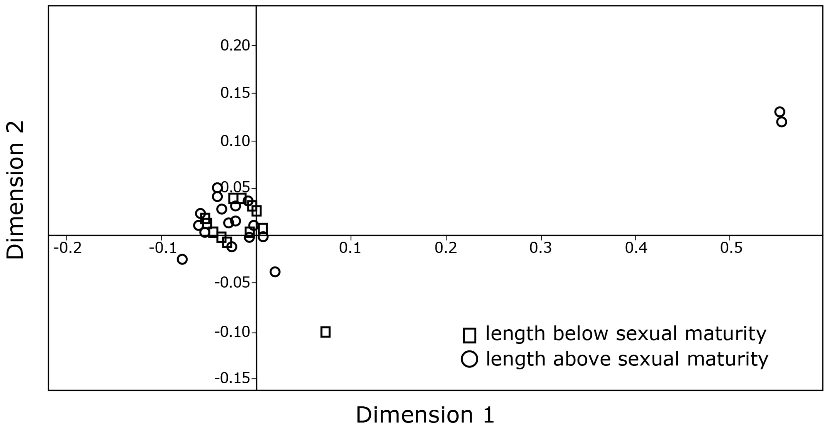

Figure 1. Non-metric multidimensional scaling (NMDS) plotting sexual maturity size scores in terms of their parasitic abundance in *Selene peruviana*. Bray Curtis similarity / Escalamiento multidimensional no métrico (NMDS) trazando los resultados de la talla de madurez sexual en términos de su abundancia parasitaria en *Selene peruviana*. Similitud de Bray Curtis

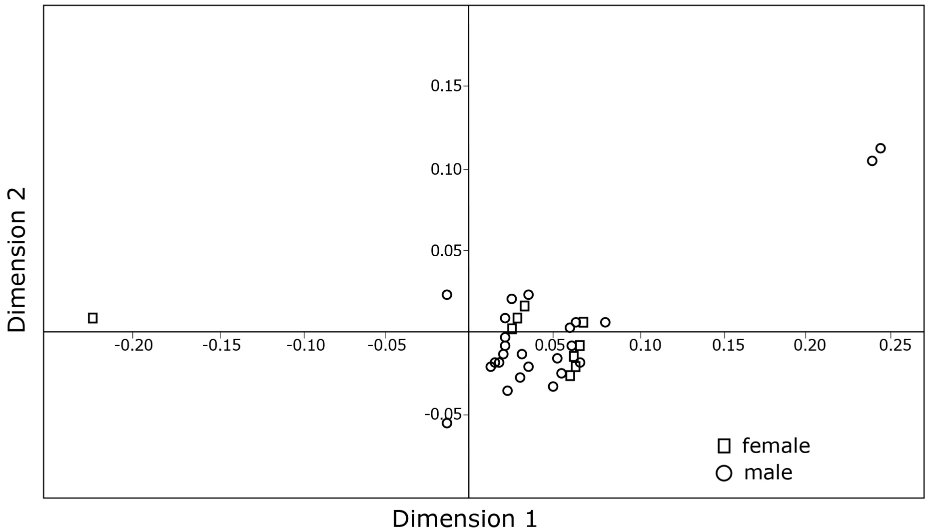

Figure 2. Non-metric multidimensional scaling (NMDS) plotting sex score in terms of their parasitic abundance in *Selene peruviana*. Bray Curtis similarity / Escalamiento multidimensional no métrico (NMDS) trazando los resultados del sexo en términos de su abundancia parasitaria en *Selene peruviana*. Similitud de Bray Curtis

Discussion

Previous studies of *S. peruviana* parasitic communities of are limited and there are only two parasitic records; the monogenean *P. monsivaeisae* in Costa Rica, which also parasitizes to other species within the Carangidae family; and another monogenean, *A. piscicola,* which was recorded in *S. peruviana* from Mexico. Particularly, *A. piscicola* has been found on several other genus of Carangidae, including species of *Caranx*, which have characteristics in common with *S. peruviana,* such as the depth range inhabited (maximum 350 m) and habitat (Pacific and Atlantic Ocean) (Lamothe-Argumedo *et al.* 1997, Rodríguez-Ortíz *et al.* 2004, Mendoza-Garfias *et al.* 2017).

In the present study, Chao-1 estimator indicates that the species richness found was adequate based on the level of sampling effort for the total number of sampled hosts. Therefore, the evaluation of 80 specimens of *S. peruviana* was optimal. This agreed with Shvydka *et al.* (2018), who pointed out that the sample size equal to 80 or more hosts and for fish parasites with a highly aggregated dispersal pattern, allow an accurate estimation of the ecological descriptors. Seven species and three taxa were collected in *S. peruviana*. However, Cordeiro & Luque (2004) recorded 21 parasite species (eight trematodes, three monogeneans, two cestodes, five nematodes and three copepods) in a congeneric host, *S. setapinnis* from the coast of the State of Rio de Janeiro in Brazil. This difference is due to the host species, geographical distribution that includes different ecosystems. Thus, temperatures and marine fauna of different localities influence the trophic behavior that consequently affects the parasite communities of the hosts, even they are congeneric species (Soto *et al.* 2016).

The monogenean *O. oaxacensis*, parasite that presented the highest prevalence, mean abundance and intensity is a monoxenic species that easily parasitizes schools of fish (Ñacari & Sánchez 2014), which is a typical characteristic of the Carangidae family (Gallegos-Navarro *et al.* 2018). In contrast, the monogenean *Metamicrocotyla macracantha* was recorded in a single male host. This parasite only has records on *Mugil cephalus* Linnaeus, 1766 (Vásquez-Ruiz & Jara-Campos 2012, Luque *et al.* 2016) from Peru. This monogenean has been found on other species of Mugilidae family from South America and Mexico (Cohen *et al.* 2013, Mentz *et al.* 2016, Vidal-Martínez *et al.* 2017).

The only trematode collected was *Lecithocladium cristatum* (Hemiuridae). The genus *Lecithocladium* is widely distributed, their dominant species *L. cristatum* being in the digestive tract of several species of marine fish around the world (Cribb *et al.* 2002, Akmirza 2012, Guagliardo *et al.* 2010, 2014; Indaryanto *et al.* 2015, Abdel-Gaber *et al.* 2019). In Peru, this parasite has been found in the intestine of the following hosts: *Peprilus snyderi* Gilbert & Starks, 1904 (Ñacari & Sánchez 2014); *Seriolella violacea* Guichenot, 1848 (Luque & Oliva 1993) and *Stromateus stellatus* Cuvier, 1829 (Iannacone *et al.* 2010, Luque *et al.* 2016). It has been classified as a secondary species due to its prevalence of 40%, with an average abundance of 1.94 and a high average intensity of 4.84. Køie (1991) argues that the host's feeding type would to help explain the biological cycle of this trematode, since *Lecithocladium* spp. require two intermediate hosts: a gastropod and a polychaete, in the case of *S. peruviana* (Guagliardo *et al.* 2010, 2014). Tripp-Valdez *et al.* (2012) point out that the food of *S. peruviana* includes spionid polychaetes that act as intermediate host of this trematode. The prevalence of this parasite, in relation to other trematodes, may be due to the fact that it generally parasitizes detritivorous hosts, changing according to the maturity of the host, from a zooplanktophagous to a phytobenthic diet (Navarrete *et al.* 2017).

TL and sex of the host did not influence parasite populations and communities of *S. peruviana*. It is usual that the abundance and prevalence of several parasite species of a community are unrelated to host length, in fact Cordeiro & Luque (2004) showed that the abundance of *Acanthocolpoides pauloi* Travassos, Texeiras de Freitas & Buhrnheim, 1965, was the only one positively correlated to host TL among 21 species of parasites found in *S. setapinnis*, whereas the prevalence of infestation of three parasite species [*Caligus robustus* Bassett-Smith, 1898, *Pseudomazocraes selene* (Hargis, 1957) and *Terranova* sp.] showed a positive correlation with the total length of this fish. Another study, found absence of associations between ecto-parasitological indices (Minaya *et al.* 2020c) and morphological parameters of the spotted grouper *Hyporthodus niphobles* (Gilbert & Starks, 1897). Usually, local ecological factors (abiotic and biotic factors) may be important in regulating the parasite community, in this study it was not possible to identify which factor may explain the correlations or lack of thereof between parasitological descriptors and host length.

Copepoda was the group with the highest richness of parasites; four species, *Naobranchia* sp., *Caligus* sp., *Lernanthropus* sp. and *Lepeophtheirus* sp. but all of them were considered as satellite species. In Peru, one species of *Naobranchia*, 12 species of *Caligus*, seven species of *Lernanthropus* and three species of *Lepeophtheirus* have been registered parasitizing different marine fishes mainly Sciaenidae, Scombridae, Mugilidae and Carangidae families (Luque *et al*. 2016).

Parasite species diversity (H') showed a higher value in females compared to males and the D index showed no differences between fish of both sexes. Considering that TL was similar between male and female of *S. peruviana*, H' diversity could be affected by other variables. Polyanski (1961) suggested five factors that could explain the diversity of parasites in marine fish, diet as the main factor, life span, vagility or mobility, gregarious habits and host size (Espinola-Novelo *et al.* (2020). Diet and vagility in *S. peruviana* could vary between both sexes and influence parasite diversity, being higher in females than in males

Diversity index of parasitic H′ observed a higher value in the sizes on sexual maturity of *S. peruviana*. The parasitic D index showed differences between below the size and size at sexual maturity of *S. peruviana*. Sexual maturity in a congeneric *Selene dorsalis* (Gill, 1862) species has been observed to be related to an increase in the gonadosomatic and hepatosomatic index, in response to changes in temperature, upwelling events, primary productivity, or a combination of these factors. These upwelling periods were the periods of greatest feeding intensity in *S. dorsalis* (Arra *et al.* 2018). All these factors that explain sexual maturity in *S. dorsalis* could explain the differences in sexual maturity in *S. peruviana*. Santoro *et al.* (2020) found that factors related to the reproductive cycle of fish were the most important predictors of parasite richness, suggesting that larger and sexually mature individuals harbor a greater number of parasite species, which is the result of complex interactions between environment, host fish populations, and free-living larval stages or populations of their intermediate hosts.

Studies of ichthyoparasitic fauna in natural marine coastal environments contribute to the knowledge of the functioning of aquatic ecosystems (Lane *et al.* 2020). All the species of metazoan parasites documented in this work are considered as new records of parasites for the host *S. peruviana* and for Peru.

Acknowledgments

This work was supported by Vicerrectorado de Investigación, Universidad Nacional Federico Villarreal, Lima, Peru. We also thank Universidad Científica del Sur, Lima, Peru for technical support.

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Received 5 July 2021
Accepted 15 May 2022