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An ecological and comparative analysis of parasites in juvenile *Mugil liza* (Pisces, Mugilidae) from two sites in Samborombón bay, Argentina

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ABSTRACT. *Mugil liza* Valenciennes, 1836 is an economically important food fish and has been recommended for aquaculture in South America. A total of 278 fishes were collected in the spring and summer of 2009 and 2010. These fish were sorted into sample groups according to their size class. We used Bayesian statistics and 95% credible intervals for each parameter tested were calculated. Fish studied harbored a total of 15 different species of parasites. Diversity of parasite species found on *Mugil liza* was greatest at the S.R.C. collection site, but evidenced a lower species richness than at A.R. site. The 1st size fishes of both sites evidenced greater parasite diversity than either 2nd or 3rd size fish. Differences observed could be explained by the different use of habitat types at the two sites or differential susceptibility to infection by parasites. The dominance of *D. fastigata* influenced observed results of lower community diversity indexes. New works elucidating different parasite life cycles within juvenile and adults of *M. liza* in Argentina, promise to be important for determining the risk of the parasitism by zoonotic metacercariae *A. (P.) longa* and use of this fish as food and an economic resource, and the possible use of mullet parasites in other promising fields as indicators of biodiversity, and/ or water contamination.

KEYWORDS. Bayesian statistic, Ascocotyle, Dicrogaster, Hymenocotta, *Phyllodistomum*.

RESUMEN. Análisis ecológica y comparativa de parásitos en juveniles de *Mugil liza* (Pisces, Mugilidae) de dos sitios en la baía Samborombón, Argentina. *Mugil liza*, Valenciennes, 1836 es un pez de importancia comercial y ha sido recomendado en Sudamerica para la acuicultura. Los peces se distribuyeron en grupos de acuerdo con la talla. Usamos estadística Bayesiana e intervalos de credibilidad del 95% para cada parámetro calculado. Los peces alojaron un total de 15 especies parasitarias. La diversidad de las especies parasitas de *M. liza* fue mayor en el sitio de colecta S.R.C., pero evidencio una menor riqueza especifica que en A.R. La 1er talla de los peces de ambos sitios evidencio una mayor diversidad parasitaria que la 2da o 3er talla. Las diferencias observadas se pueden explicar por un uso diferente del hábitat en los dos sitios o a una susceptibilidad diferente a la infección por los parasitos. La influencia de la dominancia de *D. fastigata* resulta en el menor índice de diversidad de la comunidad. Nuevos trabajos que diluciden los diferentes ciclos de vida de los parásitos en los juveniles y adultos de *M. liza* en Argentina, prometen ser importantes para determinar el riesgo del parasitismo de la metacercaria zoonotica *A. (P.) longa* y el uso de este pez como alimento, una fuente económica y el posible uso de los parásitos de la lisa en otros promisorios campos como indicadores de biodiversidad y/o contaminación acuática.

PALABRAS CLAVE. Estadística Bayesiana, Ascocotyle, Dicrogaster, Hymenocotta, *Phyllodistomum*.

The Estuary of the Rio de la Plata is the second largest hydrologic basin of South America (Urien, 1967; Framiñan & Brown, 1996) and the most important within Argentina. Samborombón Bay, found within the estuary of the Rio de la Plata, was declared a RAMSAR site since 1997 (Ramsar Convention Bureau, 2015). Within the Bay of Samborombón it is evident that a north-south gradient in the concentrations of the nutrients, phosphorus, nitrogen exists (Schenone *et al*., 2008) due to the northern lotic systems receiving nutrients from the high basin where extensive agricultural and livestock activity has developed (Fernandez Cirelli *et al*., 2006). In the south of the Bay the oceanic influence is higher than in the north for two reasons, first, the proximity of the Ajó River to the sea and the great distance from the discharge of fresh water from the Parana and Uruguay Rivers into La Plata River (Schenone *et al*., 2007, 2008).

Mugil liza Valenciennes, 1836, an economically important food fish has been recommended for aquaculture in South America (Godinho *et al*., 1988; OIA, 2007), is the only mullet that breeds in Argentina (Gonzalez Castro *et al*., 2011)

Many works have been published about lebranche mullet parasites (Chieffi, 1990; Chieffi *et al*., 1992; Knoff & Amato, 1992; Knoff & Boeger, 1994; Knoff *et al*., 1994; Amado & Rocha,1995; Martinez Okumura *et al*., 1999; Scholz, 1999; Suriano *et al*., 2000; Fernandes & Cohen, 2006; Aparecida de Oliveira *et al*., 2007; Abdallah *et al*., 2009; Failla Siquier & Ostrowski de Nuñez, 2009; Marcotegui *et al*., 2009; Marcotegui & Martorelli, 2009; Simões *et al*., 2010; Montes *et al*., 2013), but ecological papers have focused mainly on adult fish (Knoff *et al*., 1997; Ranzani-Paiva & Silva Souza, 2004; Alarcos & Etchegoin, 2010), only Carnevia & Speranza (2003) working with juvenile from Uruguay reported some population indices.

The main objective of this work is to compare the metazoan parasite populations and parasite communities, at the component and infracommunity levels, of juvenile lebranche mullet in two sites within Samborombón Bay and analyze the distribution of the zoonotic metacercariae of *A. (P.) longa*, recently reported by Martorelli *et al*. (2012), in juvenile mullet of different sizes.

MATERIAL AND METHODS

The samples were collected in two sites of the Samborombón Bay, one in the north of the bay (Salado River relief Channel – S.R.C., 35°50'10"S, 57°50'20"W) and other in the south (Ajó River – A.R., 36°20'12"S, 56°54'17"W). Both localities were clearly defined and described by Schenone *et al*. (2007, 2008).

Juvenile lebranche mullet were sampled in the spring and summer of 2009 and 2010 and collected from the coastal region using cast-nets, and fixed nets. The mullet sampled were divided into study groups (Tab. I) following the sizes established by Gonzalez Castro *et al*. (2011) and, as such, size corresponds to the age in the following manner; size 1 fish were (age 0-1 year), size 2 (age 2 yr) and size 3 (age 3 yr). The mean and 95% credibility interval for the weight (in grams), total length (in cm) and standard length, (in cm), were calculated using Bayesian statistics (Tab. II).

The samples for ecological studies were fixed in 10% buffered formalin. In the laboratory fish were examined for parasites following the protocol of Marcogliese (2007). All parasites were studied according to methods of Pritchard & Kruse (1982). The parasites studied were deposited in the helminthological (MLP) and in the crustacean collection of Museo de La Plata, Argentina (MLP-Cr).

Ecological terminology follows Bush *et al*. (1997). According with Magurran (1998) were calculated at the infracommunity level the species richness (S), number of parasites, Shannon-Wiener diversity index (H), Pielou evenness index (E), the Berger Parker dominance index (D), the dominant specie, the percent of uninfected fishes, and the percent of parasited fishes, and to the community component the prevalence of infection, the number of parasites (Ncc) , the species richness (Scc), the Shannon-Wiener diversity index (Hcc), Pielou evenness index (E) , and complement of Simpson dominance index (Simpson). The Shannon-Wiener index of diversity was calculated using base 10 logarithms. All parasites species were considered for the calculation of the community index.

The Shannon-Wiener diversity index, Pielou evenness index and complement of Simpson dominance index were calculated with the codes proposed by Golicher *et al*. (2006). It was calculated the DIC (deviance information criterion) for both codes (LogNorm and Gamma) being the latter smaller (233,32 vs 263,77 in S1, 228,61 vs 246,69 in S2) and used for the component community calculations.

WinBUGS was used to generate 100,000 samples from the posterior distributions for each of the analyses after discarding the initial 10,000 samples as a 'burn in'. The mean and the 2,5th and 97,5th percentiles of the distribution of each parameters was calculated with the statistic programs Epidat 4.0 and WinBUGS software (http://www.sergas.es) and (http://www2.mrc-bsu.cam.ac.uk/bugs/winbugs).This interval was used to represent a 95% Bayesian credible interval. The first year sampled was used as "prior" of the second year. A significance level (α) of 5 % or less was considered significant ($P <= 0.05$).

RESULTS

Fish studied harbored a total of 15 species of parasites (Tab. III), of which five were digeneans [*Dicrogaster fastigata* Thatcher & Sparks, 1958, *Hymenocotta manteri* Overstreet, 1969, *Ascocotyle (Phagicola) longa* Ransom, 1920, *Phyllodistomum mugilis* Knoff & Amato, 1992 and Metacercariae Hemiuridae gen. sp.]; three species were monogeneans (*Ligophorus* sp., *Macrocotyle macracantha* Koratha, 1955 and *Microcotyle pseudomugilis* Hargis, 1957); four species were copepods (*Ergasilus versicolor* Wilson, 1911, *Ergasilus atafonensis* Amado & Rocha, 1997, *Parabrachiella* sp. 1, *Parabrachiella* sp. 2); one species of acanthocephalan (*Floridosentis mugilis* Machado, 1951); and, one species of hirudinean (*Myzobdella uruguayensis* Mañe Garzon & Montero, 1977).

Tab. I. Number of juvenile lebranche mullet in each size from both sites, Samborombón bay, Argentina (A.R., Ajó River; S.R.C., Salado River relief Channel).

	S.R.C.		A.R.			Total
Sample year	Size 1	Size 2	Size 1	Size 2	Size 3	
2009	59	6	93	3	0	161
2010	60	5	17	29	6	117
Total	119	11	110	35	6	278

Tab. II. Weight (in gr.), Total and Standard Length (in mm) of lebranche mullets (A.R., Ajó River; ds, standard deviation; S1, size 1; S2, size 2; S3,size 3; S.R.C., Salado River relief Channel).

		Weight		Total length		Standard length	
		Mean and range	ds	Mean and range	ds	Mean and range	ds
S1	AR	7,93 (5,95-9,89)	1	8,89 (6,86-10,87)	1,01	7,4 (5,65-9,16)	0,89
	SRC	6,1 (4,66-7,54)	0,73	6,6 (5,68-7,52)	0,47	4,99 (4,2-5,79)	0,4
S2	AR	170,9 (170,7-171,1)	0,09	25,02 (24,04-25,69)	0,34	21,05 (20,37-21,72)	0,34
	SRC	58,14 (57,11-59,15)	0,52	18,79 (17,33-20,23)	0,74	15,62 (14,28-16,94)	0,68
S3	AR	308,4 (231,3-381,8)	39,05	32,83 (30,76-34,88)	1,05	27,15 (25,91-28,39)	0,63

Tab. III. Population parameters and microhabitat of parasites in lebranche mullet size from both sites, Samborombón bay, Argentina: Part A, Salado River Relief Channel; Part B, Ajó River [A.(P.) longa, Ascocotyle (Phagicola) longa; c, coelom; D. fastigata, Dicrogaster fastigata; E. atafonensis, Ergasilus atafonensis; E. versicolor, Ergasilus versicolor; f, fins; F. mugilis, Floridosentis mugilis; g, gill; H. manteri, Hymenocotta manteri; in, intestine; m, mesentery; MA, median abundance; MI, median intensity; M. macracantha, Metamicrocotyle macracantha; M. pseudomugilis, Microcotyle pseudomugilis; msc, muscle; M. uruguayensis, Myzobdella uruguayensis; n, nostrils; P, prevalence; P. mugilis, Phyllodistomum mugilis].

Part A - Salado River Relief Channel

		Size 1			Size 2		
	Microhabitat	P	MI	MA	P	MI	MA
DIGENEA							
D. fastigata	in	50 (40-59)	12 (6-18)	0.53 (0-1.1)	68 (50-85)	149 (9-289)	44 (0.7-88)
H. manteri	in	21 (14-29)	42 (19-65)	31.6 (11.7-51.5)	60 (41-78)	24 (9-39)	7.7 (1.3-14)
A. (P.) longa	m, msc.	14 (8-20)	13 (3-23)	0.5 (0-1)	64 (46-82)	19 (1-42)	12.5 (0-26.6)
P. mugilis	c	-----	-----	-----	-----	-----	-----
Hemiuridae gen. sp.	c	3 (1-10)	2	0.04 (0-0.11)	-----	-----	-----
MONOGENEA							
Ligophorus sp.	g	46 (36-55)	9 (5-12)	4.5 (2.5-6.5)	60 (41-78)	12 (4-20)	7 (2-11.8)
M. macracantha	g	-----	-----	-----	-----	-----	-----
M. pseudomugilis.	g	5 (1.1-8.5)	1	0.03 (0.01-0.06)	-----	-----	-----
COPEPODA							
E. versicolor	g	-----	-----	-----	-----	-----	-----
E. atafonensis	g	4 (0.7-7.2)	1.5 (1-2)	0.03 (0-0.06)	20 (6-36)	2 (1-14)	0.36 (0-0.92)
Parabrachiella sp. 1	n	5 (1-11)	2 (1-18)	0.07 (0-0.17)	12 (2-24)	1.8 (1-3)	0.69 (0.1-1.29)
Parabrachiella sp. 2	f	-----	-----	-----	-----	-----	-----
ACANTOCEPHALA							
F. mugilis	in	6 (2-10)	1.7 (1-4)	0.05 (0-0.1)	32 (15-50)	1	0.63 (0.2-1.08)
HIRUDINEA							
M. uruguayensis	g	23 (4-45)	1	0.2 (0-0.46)	-----	-----	-----

Part B - Ajó River

	Size 1			Size 2			Size 3		
	P	MI	MA	P	MI	MA	P	MI	MA
DIGENEA									
D. fastigata	71 (62-79)	80 (58-102)	57.7 (40.6-74.8)	44 (28-61)	91 (6-289)	76.4 (5-147.8)	63 (32-92)	205 (1-715)	137 (0-395.89)
H. manteri	23 (16-31)	2 (1-5)	0.1 (0-0.18)	18 (7-30)	2 (1-7)	0.4 (0-1)	-----	-----	-----
A. (P.) longa	30 (22-39)	12 (6-18)	0.9 (0.1-2)	46 (31-62)	9 (2-16)	6 (1-11)	25 (1-53)	4	0.7 (0-2.7)
P. mugilis	11 (0-24)	1	0.07 (0-0.18)	-----	-----	-----	-----	-----	-----
Hemiuridae gen. sp.	-----	-----	-----	-----	-----	-----	-----	-----	-----
MONOGENEA									
Ligophorus sp.	54 (44-63)	5 (3-6)	1.6 (0.9-2.2)	28 (14-42)	1 (1-3)	4.8 (0.1-9.5)	25 (1-53)	16	2.7(0-10.8)
M. macracantha	6 (2-11)	1	0.05(0.01-0.09)	23 (11-36)	1 (1-2)	0.08(0.05-0.3)	-----	-----	-----
M.pseudomugilis.	6 (2-10)	2 (1-4)	0.01 (0-0.02)	-----	-----	-----	-----	-----	-----
COPEPODA									
E. versicolor	14 (8-21)	1.5 (1-2)	0.15(0.05-0.25)	8 (1-16)	3 (0-9)	0.34 (0-1.03)	-----	-----	-----
E. atafonensis	-----	-----	-----	-----	-----	-----	-----	-----	-----
Parabrachiella sp. 1	46 (37-56)	2.5 (2-3)	0.93 (0.66-1.2)	20 (9-33)	2.3 (0-4.35)	0.33 (0-0.65)	-----		0.02 (0-0.03)
Parabrachiella sp. 2	8 (3-13)	1.3 (1-2)	0.06 (0-0.12)	10 (2-20)	1 (1-4)	0.14 (0-0.3)	-----	-----	-----
ACANTOCEPHALA									
F. mugilis	21 (5-39)	1	0.29 (0-0.64)	56 (41-72)	1	0.31 (0-0.61)	75 (47-99)	4 (1-10)	3.5 (0-7.93)
HIRUDINEA									
M. uruguayensis	-----	-----	-----	-----	-----	-----	-----	-----	-----

Some parasites were found only in one location (Hemiuridae gen. sp., *E. atafonensis* and *M. uruguayensis* in S.R.C. and *P. mugilis*, *M. macracantha*, *E. versicolor* and *Parabrachiella* sp. 2 in A.R.), those parasites were not used for the population comparisons.

Population parameters

Prevalence. When analyzed, the size 1 (S1) mullets from both sites, evidenced a significant higher prevalence of *D. fastigata*, *A (P.) longa* and *Parabrachiella* sp. 1 in A.R. For size 2 (S2) mullets, the digenean *H. manteri* evidenced a significant higher prevalence in the S.R.C. samples. In A.R. samples the prevalence of *D. fastigata*, and *Ligophorus* sp. were significant bigger in the size 1 (S1) compared with S2 fishes, but within size 3 (S3) fishes prevalence was not statistically significant different to both sizes (S1 and S2). The copepod *Parabrachiella* sp. 1 was more prevalent in S1 fish, *M. macracantha* was more prevalent in S2 fish and *F. mugilis* was more prevalent in S2 and S3 than in S1 fish at the A. R. sample site. In the Salado River relief Channel (S.R.C.) the prevalence of *H. manteri*, *A. (P.) longa* and *F. mugilis* were significant higher in S2 than in S1 fish.

Mean intensity. When analyzed the S1 from both sites *D. fastigata* evidenced significant higher mean intensity of parasite species observed in the A.R. samples. In S2 class juvenile mullets from S.R.C. the mean intensity of both *H. manteri* and *Ligophorus* sp. were significantly greater than observed in A.R. samples. In A.R. the mean intensity of *Ligophorus* sp. was significant higher in S3 fishes compared with S1 and S2 size classes, while intensity within S1 and S2 classes were not statistically significant different. The mean intensity of *Ascocotyle (P.) longa* was not statistically significant different in S1 and S2 size classes, but significant lower for S3 than S1 size class. In the S.R.C. there is no difference observed between sizes.

Mean abundance. When analyzed the S1 fishes from both sites *D. fastigata* and *Parabrachiella* sp. 1 were significant greater mean abundance in the A.R. samples. In the S.R.C. samples, *H. manteri* and *Ligophorus* sp. evidenced significant higher mean abundance. The comparison of the S2 size classes of the two sample sites, indicated a significant higher mean abundance of *H. manteri* was observed in S.R.C. than in the A. R. In A.R. samples, only *Parabrachiella* sp. 1 was significant more abundant in the S1 size fish than o S2. In S.R.C. samples *F. mugilis* was significant more abundant in S2 size fish than in S1 fish.

Infracommunity level. The Table IV reflects the community indexes for both sites, S.R.C and A.R. The most dominant parasite species observed in all the sizes of juvenile mullet samples at both sites was *D. fastigata*. The S and the Shannon-Wiener diversity index were similar in both sites in all the sizes. The number of parasites sowed no meaning differences inside the S1 of mullets from both sizes. In A.R. the S1 have more parasites than the others sizes.

Evenness was bigger and significant in S1 and S2 from S.R.C than the A.R. In this latter site, the evenness of S1 was bigger and significant than S2, and this last two were not significant different than S3. The S1 from S.R.C. have a bigger and significant percent's of uninfected fishes than same sizes in A.R.

In A.R. (Tab. V) the fishes of S1 and S2 were infected with three and the S3 only with two parasite species. In S.R.C, in contrast with A.R., some fishes had 6-7 parasite species. In this site the fishes were parasitized more frequently with two parasite species.

The correlation (Tab. VI) between LT of mullets and S was negative in the S1 from A.R. and positive in S.R.C. The correlation with the N was positive in S1 and S2 from A.R. and S1 from the S.R.C. The correlation with the Shannon-Wiener diversity index was negative in S1 and S2 from A.R. but both sizes in the S.R.C were positive.

Component community. The Berger Parker dominance index is plotted in Figs 1-3. In the S1 from R.A. the species with significant higher dominance after *D. fastigata* were *Ligophorus* sp., *A. (P.) longa* and *Parabrachiella* sp. In the S1 class samples of S.R.C. the dominance of *D. fastigata* wasn't so overwhelmed as in the A. R. and secondarily dominant species were *Ligophorus* sp., *H. manteri* and *A. (P.) longa*. For S2 class fish sampled in A.R. found *A. (P.) longa* to be the second most dominant species after *D. fastigata*. In the S2 of S.R.C. the most dominant species after *D. fastigata* were *A. (P.) longa*, *H. manteri* and *Ligophorus* sp. The S3 size class samples of A.R. the most dominant species after *D. fastigata* was *F. mugilis.*

The parasite samples of S1 size fish of S.R.C. were compared with S2 size there and found to evidence significantly great species richness (Scc), Shannon-Wiener diversity index (Shannon) and complementary of Simpson equitability index (Simpson). In the A.R. the S1 size class was compared with S2 and S3 in the same site and found the S1 fish had the highest values of species richness, number of parasites, and Shannon and Simpson indices. The S2 had a significant great species richness of parasites than S3 fish sampled in the same site.

When comparing parasite loads between the same fish sizes at the two sites, found the S1 class samples of S.R.C. had a significant higher prevalence (Pcc), Shannon-Wiener and Simpson index, but evidenced significant lower counts of parasites and significant lower species richness than the S1 from A.R. The S2 sample class of S.R.C. indicated greater Shannon and Simpson indices than S2 of A.R. The prevalence of parasites in both sites was not significant different than in S2 samples, but the species richness was greater for parasites in S2 samples of A.R.

DISCUSSION

The high number of parasite species found in comparison with past studies may be explained by the fact that here were analyzed juvenile mullets that could be more susceptible to infection by parasites, or alternately, there may have been other factors such as behavior differences, lower immunological competence, or environmental changes (Khan, 2012).

We agree with Alarcos & Etchegoin (2010) who stated *M. liza* as definitive host because the parasites here found were monoxenous cycles (*Ligophorus* sp., *M. macracantha*, *M. pseudomugilis*, *Parabrachiella* sp. 1, *Parabrachiella* sp. 2, *E. versicolor*, *E. atafonensis* and *M. uruguayensis*) or adults of heteroxenous cycles (*D. fastigata*, *H. manteri*, *P. mugilis*, *F. mugilis*) demonstrating *M. liza* as a definitive host even when they are juveniles.

There was evidence that reported differences between the environments of the two sites (Schenone *et al*., 2007, 2008) studied may affect and/or alter the parasite fauna present in each. Schenone *et al*. (2007, 2008) clustered the sites in the north end of the Bay based in similar pH values, dissolved oxygen, high concentrations of nutrients, phosphorus and nitrogen and also containing the same kinds of contaminants, such as lead, zinc, copper and arsenic. In the south of the bay, the group of streams and channels present share similar values of pH, concentration of oxygen and conductivity due to being near the ocean and lack many of the contaminants and agricultural sourced nutrients as a factor of being far away from the discharge of Parana and Uruguay Rivers into the La Plata River. In A. R. the saline waters allow the development of parasites normally found in adults mullets (*P. mugilis*, *M. macracantha*, *E. versicolor*) of Argentina (Alarcos & Etchegoin, 2010) and Brazil (Knoff & Amato, 1992;

Tab. IV. Community parameters of each lebranche mullet size in both environments, Samborombón bay, Argentina (A.R., Ajó River; Evenness, Pielou evenness index; Ncc, number of parasite; Pcc, prevalence of parasitic infection; S, species richness; S1, size 1; S2, size 2; S3, size 3; Scc, species richness of the community component; Shannon, Shannon-Wiener diversity index; Simpson, complement of Simpson dominance index; S.R.C., Salado River relief Channel).

		S.R.C.		A.R		
		S1	S2	S1	S2	S3
Infracomunity	Nº Fishes	119	11	110	32	6
	S	2.26 (1.99-2.53)	3.57 (2.22-4.93)	2.72 (2.48-2.97)	2.8 (2.46-3.13)	2.2 (1.49-2.91)
	Nº Parasites	32.41 (17.20-47.62)	78.56 (1-169.87)	75.8 (57-95)	29.63 (5.27-53.99)	32.35 (8-57)
	Shannon	0,31 (0,24-0,37)	0,59 (0,19-0,98)	0,35 (0,28-0,43)	0,26 (0,16-0,36)	0,32 (0-0,47)
	Evenness	0,64 (0,58-0,71)	0,67 (0,5-0,85)	0,45 (0,39-0,51)	0,27 (0,19-0,36)	0,65 (0,2-1,1)
	Berger parker	0,74 (0,73-0,75)	0,82 (0,81-0,83)	0,87 (0,86-0,88)	0,93 (0,93-0,94)	0,95 (0,94-0,96)
	Dominant specie	*D. fastigata*	*D. fastigata*	*D. fastigata*	*D. fastigata*	*D. fastigata*
	Uniffected fish	26 (19-35)	17 (4-45)	10 (5-16)	9 (1-34)	22 (1-53)
Community Component	Pcc	74 (65-81)	83 (55-96)	90 (84-95)	91 (66-99)	78 (47-99)
	Ncc	5448	3289	7099	29578	863
	Scc	10	6	11	10	4
	Shannon	0.99 (0.92-1.07)	0.62 (0.58-0.65)	0.58 (0.48-0.68)	0.29 (0.28-0.30)	0.24 (0.19-0.30)
	Simpson	2.29 (2.19-2.41)	1.39 (1.36-1.43)	1.34 (1.21-1.27)	1.14 (1.13-1.15)	1.1 (1.07-1.14)

Tab. V. Number of parasite species in the lebranche mullet sizes from both sites, Samborombón bay, Argentina (A.R., Ajó River; S1, size 1; S2, size 2; S3, size 3; S.R.C., Salado River relief Channel).

		S1	S2	S3
A.R	1 species	18 (11,6-26,10)	8,7 (2-19)	-----
	2 species	17,1 (10,8-25,10)	30,33 (20,70-49,7)	56 (31,5-92)
	3 species	32,37 (24,8-42,6)	23,8 (14,3-41,3)	22 (1,3-52,7)
	4 species	15,3 (9,6-22,9)	19,47 (10,4-35,4)	-----
	5 species	7,23 (2,9-12,5)	8,7 (2-19)	-----
S.R.C.	1 species	23,6 (17,3-32,5)	11,03 (0,6-34,1)	-----
	2 species	22,84 (16,6-31,6)	11,11 (0,6-34,1)	-----
	3 species	12,56 (7,5-19,3)	22,22 (8-54,8)	-----
	4 species	8,66 (4,3-14,3)	16,66 (3,6-45)	-----
	5 species	3,14 (0,6-6,5)	11,03 (0,6-34,1)	-----
	6 species	1,6 (0-3,9)	11,03 (0,6-34,1)	-----
	7 species	1,6 (0-3,9)	-----	-----

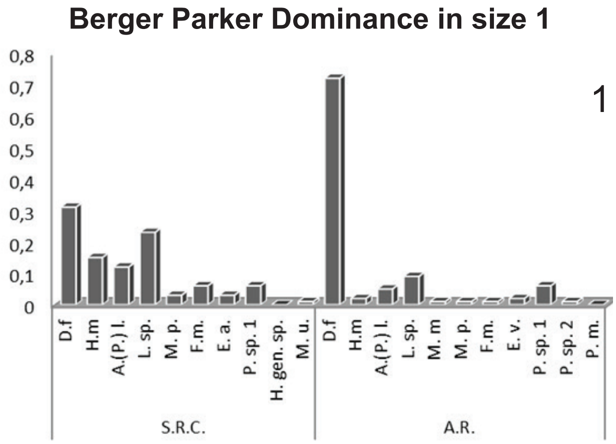
Tab. VI. Correlation index between total length and species richness (S), number of parasites (N) and Shannon-Wiener diversity index (A.R., Ajó River; S1, size 1; S2, size 2; S3, size 3; S.R.C., Salado River relief Channel).

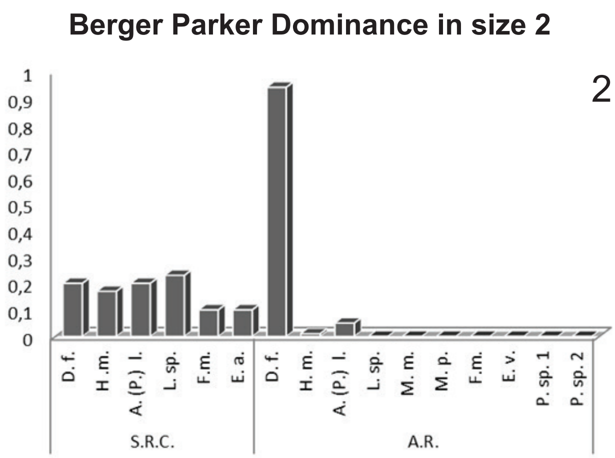
		S.R.C.	A.R.
Species Richness	S1	0,54 (0,48-0,61)	-0,97((-0,95)-(-0,99))
	S2	0,18 ((-0,4)-0,76)	0,03 ((-0,14)-0,21)
	S3	-----	0,11 ((-0,7)-0,81)
Number of Parasites	S1	0,56 (0,53-0,58)	0,16 (0,04-0,21)
	S2	0,05 ((-0,01)-0,12)	0,15 (0,08-0,22)
	S3	-----	-0,07 ((-0,74)-0,67)
Shannon-Wiener Diversity Index	S1	0,17 (0,05-0,29)	-0,98 ((-0,99)-(-0,95))
	S2	0,22 (0,12-0,32)	-0,63 ((-0,83)-(-0,44))
	S3	-----	-0,17 ((-0,84)-(0,65))

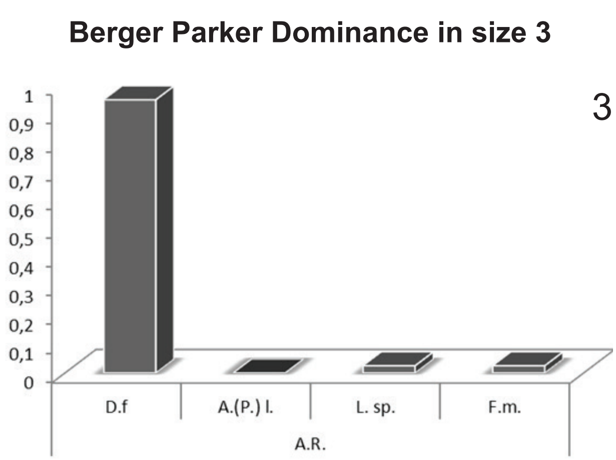
Knoff *et al.*, 1994, 1997). Also we found that in A.R sample sites some species, such as *A. (P.) longa*, *D. fastigata*, and *Parabrachiella* sp. 1 were more abundant than in S.R.C. samples.

In the S. R. C. sample site found *H. manteri* and *Ligophorus* sp. were more abundant than observed in A.R. samples, perhaps as result of fresh water or physical-chemical environmental conditions.

The six individuals of S3 size class from A.R. in our sample were in poorly preserved condition. More fishes







Figs 1-3. The Berger Parker dominance index: 1, in size 1; 2, in size 2; 3, in size 3 [A. (P.) l., *Ascocotyle* (*Phagicola*) *longa*; D. f., *Dicrogaster fastigata*; E. a., *Ergasilus atafonensis*; E.v., *Ergasilus versicolor*; F. m., *Floridosentis mugilis*; H. m., *Hymenocotta manteri*; L. sp, *Ligophorus* sp.; M. m., *Macrocotyle macracantha*; H. gen. sp., Metacercariae Hemiuridae gen. sp.; M. p., *Microcotyle pseudomugilis*; M. u., *Myzobdella uruguayensis*; P. sp. 1, *Parabrachiella* sp. 1; P. sp. 2, *Parabrachiella* sp. 2; P. m., *Phyllodistomum mugilis*].

of this size must be examined to be positive of observed patterns being valid, but even with these preservation problems was observed a pattern of an increase of *F. mugilis* present as mullets parasitized got to be older/bigger. That pattern was also observed across the two sizes of mullets in S.R.C. samples.

The A.R. samples evidenced differences between juvenile fish size classes in the prevalence and abundances of some parasites (*D. fastigata*, *Ligophorus* sp. and *Parabrachiella* sp.) perhaps reflecting different use of the habitat, different habitats, or different susceptibility to the parasites. In the S.R.C. study area the habitat frequented by the young mullets appeared to be more homogenous, because there was not a great difference in the parasite species present across mullet age classes, and, only a moderate increase in the presence of *H. manteri* and *F. mugilis* observed in the S2 age class mullets.

A special analysis must be done to identify parasites of *Ligophorus* species. They are very small monogenans and determine them is complex because species only differ in characteristics of the vagina or penis. Thus, differences of *Ligophorus* species found within and between both sample sites (and fish sizes in each) may obscure different species identification, including some which could be new to science.

The increase in the prevalence and mean abundance of monogenean in the higher sizes could be explain by a grown of the fish or a bigger encounter of mullets facilitating the transmission of this parasites.

In Argentina the metacercariae of *A. (P.) longa* was not reported in adult mullets, but have been mentioned parasitizing juvenile mullets by CARNEVIA & SPERANZA (2003) and LADO *et al*. (2013) from Uruguayan coast of La Plata River and MARCOTEGUI *et al*. (2009), MARTORELLI *et al*. (2012) and MONTES *et al.* (2013), in Argentinean waters. In this work we increased the distribution between different sizes of mullets analyzed by MARTORELLI *et al*. (2012). In both sites studied, the prevalence of *A (P) longa* increased as the mullets parasitized got bigger, and the mean abundance and mean intensity remained similar within each size for the same site. The mullets from A.R. and the S2 from the S.R.C. had a greater prevalence of parasitism by *A. (P.) longa* because they seem to live in waters with a higher salt concentration (or marine influence). That environment is suitable for the development of *A. (P.) longa* or the intermediate host (*Helobia australis* d'Orbigny, 1835). The absence of this parasite in the mullets analyzed by ALARCOS & ETCHEGOIN (2010) could be explained by the type of life cycle of the parasite, more vulnerability of the juveniles, sampling errors or environmental condition in Mar Chiquita lagoon.

The great numerical dominance played by *D. fastigata* reduced values of community indexes at the S. R. C. study site and more in A.R. sample even when species richness was greater than in S.R.C. samples. The digenean may be filling the habitat for other intestinal parasites being a strong competitor and perhaps displacing other species. *Dicrogaster fastigata* may be used as sentinel for controlling ambient changes. The high presence in A.R of this parasite agrees with LADO *et al*. (2013) who found a high prevalence of this parasite in mullets from saline waters of Uruguay. In neither site of this study did we find the snail species that serves as host of the immature stages of this parasite.

New works about juvenile (and mainly adults) of *M. liza* in the Samborombón bay as in other localities of Argentina, help provide elucidation of how the different life histories of the various parasites are be important in understanding the risk of finding zoonotic metacercariae of *A. (P.) longa* in local mullet populations. They also may help find ways of using mullet parasites in other promising fields, such as functioning as indicators of biodiversity, environmental contamination, and expanded use of this fish as food and as an economic resource for local export.

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