METAZOAN PARASITES OF THE JACK MACKEREL *TRACHURUS MURPHYI* (TELEOSTEI, CARANGIDAE) IN A LATITUDINAL GRADIENT FROM SOUTH AMERICA (CHILE AND PERU)

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Summary :

The metazoan parasite fauna of the jack mackerel *Trachurus murphyi* Nichols 1920, obtained from seven ports from a latitudinal gradient of more than 30° (From Paita Peru: 05° 10' S to Talcahuano, Chile 36° 40' S) was quantitatively described. 21 species of metazoan parasites were recorded (Monogenea 4, Digenea 3, Cestoda 5, Acanthocephala 2, Nematoda 4, Copepoda 2, Isopoda 1). Only four parasites (*Lernanthropus trachuri*, *Ceratomyxa gaudichaudii*, *Corynosoma australis*, *Anisakis simplex*) were common to the seven ports. Only twelve species reach prevalence over 5 % in at least one port. Main characteristic of the parasite fauna is the sparse of adult helminthes, specifically digenean and the dominance of larval forms, at both qualitative and quantitative levels. There are not evidence of changes in the parasite community along a latitudinal gradient, but at least *Anisakis simplex* (larvae) shows a trend in both, prevalence and mean intensity, increasing from north to south.

KEY WORDS : metazoan parasites, jack mackerel, *Trachurus murphyi*, latitudinal gradient, Chile, Peru.

Résumé : MÉTAZOAIRES PARASITES DU CHINCHARD *TRACHURUS MURPHYI* (TELEOSTEI, CARANGIDAE) SELON UN GRADIENT LATITUDINAL EN AMÉRIQUE DU SUD (CHILI ET PÉROU)

La faune des métazoaires parasites du chinchard *Trachurus murphyi*, Nichols 1920, étudiée dans sept ports le long d'un gradient latitudinal de plus de 30°, entre Paita (Pérou, 05° 10' S) et Talcahuano (Chili, 36° 40' S) est décrite de façon quantitative. 21 espèces de métazoaires parasites sont enregistrées : 4 Monogenea, 3 Digenea, 5 Cestoda, 2 Acanthocephala, 4 Nematoda, 2 Copepoda et 1 Isopoda. Quatre parasites seulement (*Lernanthropus trachuri*, *Ceratomyxa gaudichaudii*, *Corynosoma australis*, *Anisakis simplex*) sont observés dans les sept localités. A peine douze espèces atteignent une prévalence supérieure à 5 % au moins dans un port. La principale caractéristique de la faune parasitaire est la rareté des helminthes adultes, particulièrement des Digenea, et la prédominance des formes larvaires tant au plan qualitatif que quantitatif. Il n'y a pas de preuve de l'existence, le long du gradient latitudinal, de variations dans la communauté parasitaire bien que des larves de *Anisakis simplex* présentent du nord vers le sud une tendance à l'augmentation de la prévalence et de l'intensité moyenne.

MOTS CLÉS : métazoaires parasites, chinchards, *Trachurus murphyi*, gradient latitudinal, Chili, Pérou.

INTRODUCTION

The knowledge of the parasite fauna of marine fishes from Chile and Peru at community levels, has increased in the last years (see for instance Gonzalez & Acuña, 1998 for Chile and Oliva & Luque, 1998 for Peru). Studies have focused, primarily, on marine fishes of economic importance, such as hakes (*Merluccius* spp.) and jack mackerel (*Trachurus murphyi*). The jack mackerel *Trachurus murphyi* is the most important source for fish meal and the last available fishing statistics (SERNAPESCA, 1997) show that landing reached more than 2,900,000 metric tons for 1997, in Chile. In spite of the economic importance of this fish, only two papers (George-Nascimento & Arancibia, 1992; Oliva, 1994) dealing with quantitative studies about the metazoan parasitic com-

munities are known for the Chilean jack mackerel. There is no information on parasites of the Peruvian population of jack mackerel. The aim of this paper is to examine the parasite fauna of this important marine resource, along a latitudinal gradient of more than 30° in the Pacific coast of South America. Quantitative characteristics of the infectious processes are described and compared along a latitudinal gradient and with published information on parasites of *Trachurus*.

MATERIALS AND METHODS

Three thousand and thirty four specimens of *Trachurus murphyi* were taken seasonally, between November 1993 to August 1994 from two fishing ports in Peru (Paita and Callao) and five fishing ports in Chile (Arica, Iquique, Antofagasta, Coquimbo and Talcahuano) (Table I). Fishes were frozen (-18°C) at the port within 12 hours after capture and transported to the Laboratory of Parasitology at the Universidad Ricardo Palma, Lima, Perú (fishes from Perú)

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	PAI		CAL		ARI		IQU		ANT		COQ		TAL	
	P	I	P	I	P	I	P	I	P	I	P	I	P	I
AXI*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.0	0.0	0.0	0.0	0.0
PSE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.5	0.0	0.0	0.0	0.0
CEM*	15.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KUH*	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0
CER*	27.1	1.2	19.5	1.4	18.3	1.3	39.0	1.5	37.3	1.5	18.3	1.3	6.4	1.4
CAL*	12.3	1.1	0.2	1.0	1.9	1.0	4.8	1.1	12.3	1.2	0.4	1.0	0.0	0.0
LER*	20.9	1.1	16.2	1.5	11.1	1.1	18.6	1.1	25.0	1.3	25.6	1.3	13.1	1.2
COR**	4.2	2.8	12.8	2.8	1.3	1.2	12.0	4.9	17.4	2.9	4.0	2.1	1.3	2.0
RAD*	0.0	0.0	0.0	0.0	5.0	1.1	4.3	1.1	6.7	1.1	14.8	1.5	12.6	1.7
ANS**	1.5	1.2	2.1	1.2	11.3	1.2	19.0	1.7	25.2	2.1	51.7	2.0	83.5	4.6
ANP**	0.0	0.0	0.0	0.0	4.4	1.3	17.0	1.7	4.9	1.4	5.5	1.2	2.3	1.2
HYS**	0.0	0.0	0.0	0.0	0.2	1.0	0.5	1.0	0.7	1.3	1.8	1.4	27.8	1.6
PTE**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0
SCO**	0.5	1.0	0.0	0.0	3.2	1.0	8.6	1.9	9.3	3.1	0.7	1.0	6.4	2.2
NYB**	2.2	1.0	0.0	0.0	0.0	0.0	3.9	1.1	7.6	1.7	15.2	1.2	12.3	1.6
TEN**	2.2	1.0	0.0	0.0	1.1	1.0	1.4	1.0	0.2	1.0	0.4	1.0	1.0	1.0
EUT**	8.6	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEP**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0	1.3	1.0
HEM*	0.0	0.0	0.0	0.0	0.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POP*	0.0	0.0	0.0	0.0	0.2	1.0	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0
SYN*	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0

Parasites: AXI: Axinidae gen sp., PSE: *Pseudoanthocotylodes* sp., CEM: *Cemocotyle aff. trachuri*, KUH: *Kubnia scombri*, CER: *Ceratomyxus gaudichaudii*, CAL: *Caligus bonito*, LER: *Lernanthropus trachuri*, COR: *Corynosoma australis*, RAD: *Rhadinorhynchus trachuri*, ANS: *Anisakis simplex*, ANP: *Anisakis physeteris*, HYS: *Hysterothylacium* sp., PTE: *Pseudoterranova decipiens*, SCO: *Scolex pleuronectis*, NYB: *Nybelinia surmenicola*, TEN: *Tentacularea coryphaenae*, EUT: *Eutetrarhynchus* sp. HEM: Hemiuridae gen. Sp., POP: *Pseudopecoelus* sp. SYN: *Syncoelium filiferum*. *: adult stage, **: larval stage.

Table I. – Prevalence (P) and mean intensity (I) for each metazoan parasite of *Trachurus murphyi*, from seven ports along the coast of Perú and Chile. Code for ports: PAI = Paita (Perú), CAL = Callao (Perú), ARI = Arica (Chile), IQU = Iquique (Chile), ANT = Antofagasta (Chile), COQ = Coquimbo (Chile), TAL = Talcahuano (Chile).

or Laboratory of Marine Parasitology, at Universidad de Antofagasta (fishes from Chile). Fork length (nearest millimeter) and sex was determined after defrosting.

Parasitological analysis included total necropsy of each fish host. Only metazoan parasites were considered. Each fish was systematically analyzed, first for ectoparasites, including skin, gills and mouth and then for endoparasites. All the viscera, including heart and blood vessels (arterial cone and branchial artery), were analyzed. In order to count parasites, each viscera was separately dissected and washed in running water, all the material retained in a mesh (0.5 mm) was examined under stereoscope (20×). Parasites were fixed, preserved and stained according to traditional techniques (Pritchard & Kruse, 1982). Ecological descriptors (prevalence, intensity and mean intensity) were calculated according to Bush *et al.* (1997). Only parasites with prevalence higher than 5 % in at least one locality, were considered in the analysis. Significance of the differences in mean intensity and prevalence along the gradient, were tested with an ANOVA, previous log (n + 1) transformation of intensity data and the log-likelihood "G" test, respectively. Association between mean length and mean intensity was explored with the

Pearson product-moment correlation coefficient r_p previous log (n + 1) transformation of intensity data. Mean species richness, total richness and number of species in the richest component community (see Guegán & Kennedy, 1993) for each port, were correlated with mean sea surface temperature, to detect changes in diversity along the latitudinal gradient. SYSTAT (Willkinson, 1990) was used as statistical tool.

RESULTS

Twenty one species of metazoan parasites were obtained. Prevalence, mean intensity, and developmental stage for each parasitic species are given in Table I. Mean size (fork length) of the host differs significantly among localities, as indicated by an ANOVA ($F_{6,3027} = 459.46$, $P < 0.001$), an "a posteriori Tukey test" shows that size differences are not associated with a latitudinal gradient, so, smaller fishes were those from Arica, and the larger those from Paita and Talcahuano, the most northern and southern ports, respectively (Table II). As a rule, the main characteristic of the parasite fauna of jack mackerel for the seven localities is the strong dominance of larval forms.

Port	Latitude	T	n	Mean size	MSR	TR	RCC
PAI	05° 10'	18.9 (1)	406	34.0	0.95	11	5
CAL	12° 00'	18.0 (1)	437	26.5	0.51	5	3
ARI	18° 30'	17.7 (2)	476	21.2	0.56	12	5
IQU	21° 20'	17.0 (3)	441	26.6	1.18	14	6
ANT	23° 40'	17.5 (4)	432	27.2	1.46	14	6
COQ	29° 55'	15.9 (5)	453	29.6	1.32	11	5
TAL	36° 40'	12.9 (6)	389	35.0	1.61	12	4

(1) Mean of 1939-1969, (2) mean of 1951-1995, (3) mean of 1983-1997, (4) mean of 1946-1995, (5) mean of 1979-1997, (6) mean of 1949-1995.

Table II. – Ports, latitude, mean sea surface temperature(T), sample size (n), mean size (fork length in cm) of fishes, Mean Species richness (MSR), Total Richness (TR) and number of species in the richest component community (RCC). Temperature from Peruvian ports according to Zuta and Urquiza (1972). Temperature from Chilean Ports provided by CENDOC-SHOA (Centro Nacional de Datos Oceanográficos-Servicio Hidrográfico y Oceanográfico de la Armada). Code for ports as in Table I.

Ectoparasites (Monogenea, Copepoda and Isopoda) account for 33.3 % of the metazoan parasitic species, and endoparasites reaches 69.5 % of the total number of individuals (total number of parasitic individuals was 6,426). Larval helminthes were 94 % of the endoparasites and adult endohelminth account just 0.41 % of the parasites. This pattern occurs in all localities, except Callao, where ectoparasites are dominant. Richest parasite fauna (Table II) was found in Antofagasta and Iquique (14 species), the lower in Callao (five species). Mean number of parasitic species and mean number of individuals differ significantly along the gradient (ANOVA $F_{6,3027} = 124.85$, $p < 0.0001$ for species, $F_{6,3027} = 186.1$, $p < 0.001$ for individuals), the “*a posteriori* Tukey test” shows that differences are not related to the north-south gradient. In a similar way, no correlation was detected between mean size of fishes (for each port) and mean number of parasitic species and mean number of individuals ($r = 0.59$, $P = 0.19$, $df = 5$; $r = 0.61$, $P = 0.14$, $df = 5$; respectively).

Only four species are common to the seven localities: the copepod *Lernanthropus trachuri* a species proper of fishes of the genus *Trachurus*, the isopod *Ceratomyxa gaudichaudii* found in pelagic fishes from this zone and larval stages of *Corynosoma australis* (Acanthocephala) and *A. simplex* (Nematoda) that are common parasites of marine fishes.

Trends of mean intensity and prevalence of infection, for those parasites with prevalence higher than 5 % in at least one locality along the latitudinal gradient, are shown in Figure 1 and Figure 2. Graphically appears that just the Nematoda *Anisakis simplex* and *Hysterothylacium* sp. and the adult Acanthocephala *Rhadinorhynchus trachuri* show trends in a latitudinal gradient, increasing both prevalence and mean intensity from north to south, but statistical analysis shows that differences are significant only for *Anisakis simplex*, in both prevalence and mean intensity. Diversity, expressed as mean species richness, total richness and

richest component community are not associated ($r = 0.67$, $P = 0.09$; $r = 0.234$, $P = 0.24$; $r = 0.21$, $P = 0.65$, respectively. $df = 5$) with mean sea surface temperature for each port.

DISCUSSION

Of the listed species in Table I, the Monogeneans, the larval Eucestode *Eutetrarhynchus* sp. and the Digenea *Syncoelium filiferum* are registered for the first time in this fish host, also they represent new geographical records. The Monogeneans *Pseudanthocotyloides* sp. and *Kubnia scombri* are considered as accidental parasites. *Pseudanthocotyloides* is a genus proper of Engraulids and Clupeids and *Kubnia scombri* is a well known parasite of horse mackerel of the genus *Scomber* (Mamaev, 1982). *K. scombri* and *K. sprostonae* are parasites of the horse mackerel *Scomber japonicus peruanus* in peruvian waters (Luque *et al.*, 1991). Also they have been found in mackerel from Antofagasta, Chile (unpublished information). At least six species of monogeneans are known as parasites of fishes of the genus *Trachurus* (Llewellyn 1962, Gaevskaya & Kovaleva, 1980), but only one of them (*Cemocotyle aff. trachuri*) has been found in the northeast locality of Peru (Paita). Absence of *C. aff. trachuri* in Chile (in all localities) and in Callao (central Peru) suggests the presence of two independent stocks of jack mackerel. Furthermore, absence of monogenean proper of jack mackerel of the genus *Trachurus* in the Pacific coast of South America has been considered as a consequence of a long isolation period from its congeners (Oliva, 1994).

Published information about metazoan parasites of the Chilean jack mackerel are consistent in detecting a poor parasite fauna. George-Nascimento & Arancibia (1992) found 14 species of metazoan parasites in a sample of 1,383 specimens of jack mackerel from

Fig. 1. – Trends in mean intensity, for species with prevalence higher than 5 % in at least one port, along the latitudinal gradient. Species and port code as in Table I.

Fig. 2. – Trends in prevalence of infection, for species with prevalence higher than 5 % in at least one port, along the latitudinal gradient. Species and port code as in Table I.

Iquique, Talcahuano and the oceanic fisheries. Oliva (1994) was able to detect nine species of metazoan parasites in a sample of 78 jack mackerel from Antofagasta. The mean number of parasite individuals per host found by George-Nascimento & Arancibia (1992) and Oliva (1994) (1.73 and 1.65, respectively) is less than the now reported (2.11).

A characteristic of marine fishes from Chile and Perú is the sparse of their parasite fauna (metazoa), when compared with related fishes from different geographical areas; this phenomena has been documented for the flatfish *Paralichthys adpersus* by Oliva *et al.* (1996), the rock fish *Sebastes capensis* by Gonzalez & Acuña (1998) and the sciaenids *Menticirrhus ophicephalus*, *Stellifer minor*, *Paralonchurus peruanus*, *Sciaena deliciosa* and *Sciaena fasciata* by Oliva & Luque (1998). In the main, differences are related to trophically transmitted parasites, specifically digeneans. This picture applies also to the jack mackerel. Both, George-Nascimento & Arancibia (1992) and Oliva (1994) were able to found just one species of Digenea, an unidentified opoecelid (*Pseudopocoelus* sp.) in jack mackerel from Chile. In this study I found three digenean species: *Pseudopocoelus* sp., an unidentified juvenile Hemiurid and *Syncoelium filiferum*. *Pseudopocoelus* sp. is a rare species, present only in two ports, with low values of prevalence that agree with those reported by George-Nascimento & Arancibia (1992), but are significantly lower than those indicated by Oliva (1994). The Hemiurid and *S. filiferum* must be considered as accidental parasites: both species were obtained just once: the hemiurid from Arica (Chile) and *S. filiferum* also from a Chilean port, Iquique. In a similar way, Piasecki (1982) was unable to found digeneans in a sample of 87 cape mackerel *Trachurus t. capensis*. But in contrast, jack mackerel from the Atlantic coast of Africa and Europe are parasitized by numerous species of Digenea, as showed by extensive surveys done by Gaevskaya & Kovaleva (1980, 1982) who were able to find 17 and 21 species of digenean in the Atlantic mackerel *Trachurus trachurus*. Other endohelminth parasites show a similar pattern, for instance, adult Acanthocephala are poorly represented in jack mackerel from Chile and Peru, *Rhadinorhynchus trachuri* was found by George-Nascimento & Arancibia (1992) with low prevalence (2.0 %), in this research this worm was found only in the Chilean port, with prevalence ranging from 4.3 % to 14.8 %, suggesting a latitudinal gradient with higher prevalence in the south, also main values of intensity are associated to the south. Cystacanth of *Corynosoma australis* were found along the seven ports, but *Bolbosoma turbitella*, a larval acanthocephala recorded by George-Nascimento & Arancibia (1992) was not found. Observed Eucestoda were all larval forms of Tetrphyllidea and Try-

panorhyncha, suggesting that jack mackerel is a frequent item of sharks' diet. Presence of *Eutetrarhynchus* sp. in Paita may provide more parasitological evidence for existence of two independent stocks.

Scott (1982) claims that lower helminth richness can be explained as a function of the sampled geographical area, because of the relationship between species richness and latitudinal range of the host. This must be true for those studies that imply samples for only one geographical locality independent of the host latitudinal range (i.e. Oliva, 1994; Gonzalez & Acuña, 1998; Oliva & Luque, 1998). In this paper, is demonstrated that the poor fauna of adult intestinal endohelminth parasites of the jack mackerel remains along more than 30° of latitudinal gradient. Moreover, diversity, expressed as mean species richness, total richness and richest component community does not follow a latitudinal gradient, when those community descriptors are associated to temperature. Latitudinal effect on diversity is related with changes in available energy, that can be measured as temperature (Rohde, 1992).

The data set of the parasite fauna of marine fishes from this geographical area, the Peruvian Faunistic Province (PFP), is yet scarce. PFP includes the central and southern Peruvian coast and the northern and central Chilean coast, with a southern boundary ca. 30° S (Brattström & Johanssen, 1983; Mac Lean, 1984) and is characterized by oceanographic processes such as upwelling and the El Niño Southern Oscillation (see Oliva & Luque, 1998).

As pointed above, parasite community, specifically digeneans, of the jack mackerel follows a similar pattern with other coastal marine fishes from the PFP. Oliva *et al.* (1996) gave a list of 13 host species and the number of digeneans harbored, the recent finding of Gonzalez & Acuña (1998) reinforced this picture. Sample size has been considered as a factor that can affect community descriptors, such as prevalence, intensity and diversity (Gregory & Blackburn, 1991). The sample size, along the seven ports was high and similar, so the well known effect of sample size and sample effort (Guegán & Kennedy, 1996) is excluded. The importance of benthic and planktonic organisms on the transmission of parasites has been discussed by Marcogliesse (1995) and Jackson *et al.* (1997). A low diversity of the pelagic and benthic systems has been proposed as an explanation for the poor parasite fauna of fishes from this area (Oliva & Luque, 1998). Unpublished data of Kong *et al.* demonstrated that the diet of the jack mackerel, from Chile, includes at least 20 items, but the anchovy *Engraulis ringens* explains more than 80 % of the index of relative importance, the second most import food item are Euphausiids. Parasites of *E. ringens* have been studied by Rizzo (1990) nearby Talcahuano, but the author was unable

to detect either larval, or adult digeneans. Also, features of *E. ringens* parasites match with those of the parasite fauna (metazoa) from the FPP.

Diversity of trophically transmitted parasites, such as digeneans, might reflect the diversity of the diet (Cribb *et al.*, 1994). Thus a combination of two factors: a highly specialized diet and a low diversity in the pelagic and benthic community, can explain the scarce fauna of trophically transmitted parasites. More studies on diet and structure of benthic and pelagic communities can reinforce or reject this hypothesis. Additionally, the extenuation of the continental shelf must be considered as a potential factor that can explain the sparse fauna of digenean. Digenea use molluscs as first intermediate host, and the presence of a narrow continental shelf implies a "relative limited habitat" available for benthic molluscs. This hypothesis can be tested by association between richness of digenean parasites in marine fishes and width of the continental shelf. In Chile such shelf is rather narrow, whose slope (200 m isobath) can be found within 20 nm from the shoreline (at least between Talcahuano and Arica). Although the continental shelf is wider in Perú (ca. 40 nm off Callao and 25 nm off Paita), digenean parasites of *Trachurus murphyi* do not increase northward. Certainly, to test this hypothesis a more robust data set would be needed.

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