# GEOGRAPHICAL VARIATIONS IN THE JACK MACKEREL TRACHURUS SYMMETRICUS MURPHYI POPULATIONS IN THE SOUTHEASTERN PACIFIC OCEAN AS EVIDENCED FROM THE ASSOCIATED PARASITE COMMUNITIES

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ABSTRACT: The composition of the metazoan parasite communities within 2 fishing zones along the Chilean coast were compared to determine the population structure of the jack mackerel *Trachurus symmetricus murphyi* (Nichols) in these 2 geographical locations. More than 7,780 parasites belonging to 15 taxa were collected between 1990 and 1996 in 71 samples comprised of 3,946 hosts. The same taxa were found in both fishing zones. However, jack mackerel from northern Chile had a higher abundance of cymothoid isopods, *Ceratothoa* spp., whereas those from southern Chile had more *Rhadinorhynchus trachuri*, *Hysterothylacium* sp. larvae, and *Anisakis* type I larvae. Results were similar at all community levels because all parasites had low prevalence and infracommunities had low total abundance and richness. Analyses at the component community level may be more adequate for stock identification when infracommunities are simple. There were significant differences in composition of parasite communities between years in each fishing zone, presumably as a result of the increase in offshore catches since 1994. These results reinforce the hypothesis that more than 1 ecological stock of the jack mackerel exists in the southeastern Pacific and contradict the current assumption of a single stock in the management of this heavily exploited fish species.

The jack mackerel, *Trachurus symmetricus murphyi* (Nichols), is 1 of the major pelagic fish resources in the world, with a geographical distribution extending from the eastern Pacific coast of South America to the South Pacific off Australia and New Zealand (Elizarov et al., 1993). The fishery is centered in the southeastern Pacific Ocean, although catches have dropped dramatically since 1997.

The spatial and temporal dynamics of the jack mackerel populations) in the southern Pacific Ocean have been debated (Evseenko, 1987; Serra, 1991; Avdeyev, 1992; Storozhuk et al., 1994). Some authorities (e.g., Serra, 1991) believe there to be a single large population, whereas others (e.g., George-Nascimento and Arancibia, 1992), using patterns in the metazoan parasite fauna, have suggested that 2 ecological stocks exist along the Chilean coast, 1 off the south-central coast and another along the northern Chilean and Peruvian coasts. Further evidence supporting this second hypothesis is based on the differential reproductive pattern shown by 2 species of the parasitic isopod *Ceratothoa* found in jack mackerel from northern and southern Chile (Aldana et al., 1995).

The major goals of the present study are to reexamine the composition patterns of the metazoan parasite communities of *Trachurus murphyi* (Nichols) in the southeastern Pacific Ocean and to assess the stability of the previously identified patterns.

## MATERIALS AND METHODS

Parasitism by metazoan taxa was analyzed in samples of jack mackerel collected along the coast of Chile between 1990 and 1996 on a more or less regular basis (generally within the same week). Data from 1990 (localities at Talcahuano and Iquique) were available for analysis (George-Nascimento and Arancibia, 1992). In all, 71 samples from 33 to 183 hosts (usually 50) were taken from landings at 6 ports: Iquique, Caldera, Coquimbo, San Antonio, Talcahuano, and Valdivia (Fig. 1). Samples were not always available from all localities. Thirty-three samples originated from the northern fishing zone: 12 from Iquique in 1990, 4 from Caldera in 1990, 4 from Coquimbo in 1990, 8 from Iquique in 1994-1995, and 5 from Coquimbo in 1995-1996. An additional 38 samples were obtained from the southern fishing zone; 13 from Talcahuano in 1990, 1 from San Antonio in 1994, 12 from Talcahuano in 1994-1995, 4 from San Antonio in 1995-1996, 4 from Talcahuano in 1995-1996, and 4 from Valdivia in 1995-1996.

Methods used in host examination were previously described (George-Nascimento, 1996). The fork length (FL) of each host specimen was measured to the nearest mm. The broadest comparison of the composition of communities between fishing zones was made on the parasite faunas (sensu Poulin, 1998) by using a G-test on the total number of parasites collected per taxon. At the component and infracommunity levels, ordination of parasites and samples was examined using a detrended correspondence analysis (DCA) and univariate analyses of the sample scores along the first ordination axis (Jongman et al., 1995). Composition at the infracommunity level was assessed as the relative abundance of each taxon in an individual host. Ordination of infracommunities was performed for 791 parasitized jack mackerels with total body lengths ranging from 320 to 370 mm; ordination included only those taxa that occurred more than 20 times (11 taxa). Restriction in the range of host body sizes included in the analysis was undertaken to control for the likely effects of the host size on the composition of the parasite communities and to compare the modal FL class in each fishing zone.

Composition at the component community level was assessed as the relative abundance of each taxon in a host sample. At this community level, the analysis included all 15 parasite taxa found in the 3,946 jack mackerels from the 71 samples. A nonparametric discriminant analysis using the raw vectors of parasite abundance per sample (component communities) was performed to determine whether the parasite composition could identify the geographical origin of fish. Group-specific probabilities considered the third nearest neighbor (Scher, 1984).

## RESULTS

The mean FL of jack mackerels during the entire study period ranged from 136 to 458 mm, representing fish ages of 17 yr. Significant variation in FL occurred among fish between fishing zones and within and among years for each zone. Figure 2 shows the significant positive correlation between the overall prevalence of each taxon and the respective proportion of the samples in which each occurred ($r$ – 0.79, $P$ G 0.01, $n$ = 15). This relationship, however, is curvilinear, with some taxa occurring in many samples albeit at a low prevalence, e.g., *Lernanthropus trachuri*, *Pseudoterranova*, and *Nybelinia*. The ectoparasites *Lernanthropus trachuri* and *Ceratothoa* spp. and the endoparasites *Rhadinorhynchus trachuri*, *Anisakis* type 1, and *Hysterothylacium* sp. occurred in more than 75% of the samples and accounted for approximately 80% of the 7,787 parasites collected.

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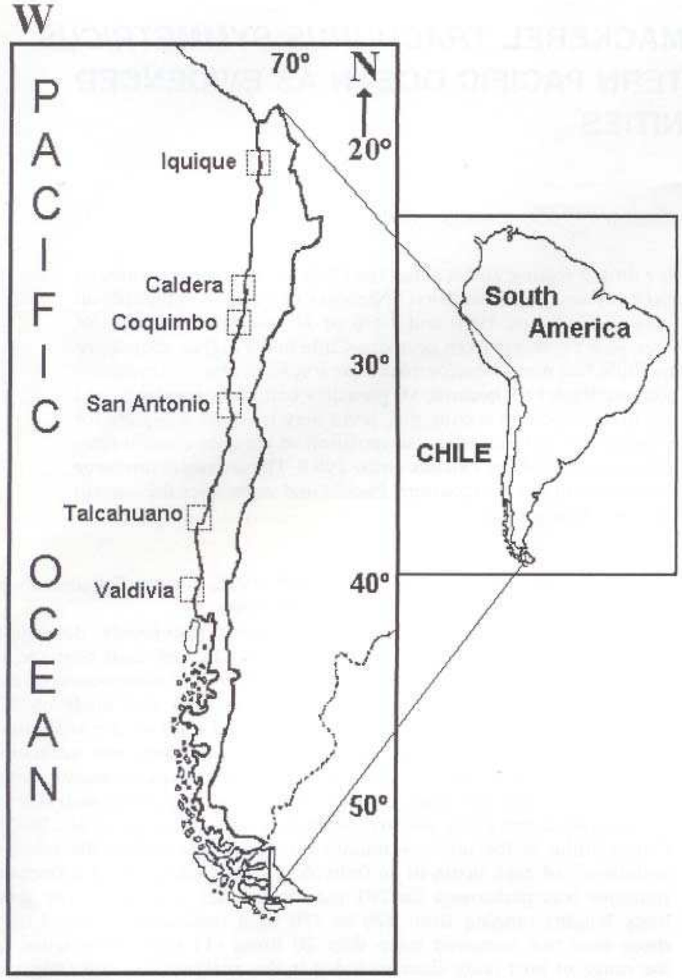


FIGURE 1. Map of Chile showing the 6 landing ports where samples of jack mackerels were taken between 1990 and 1996.

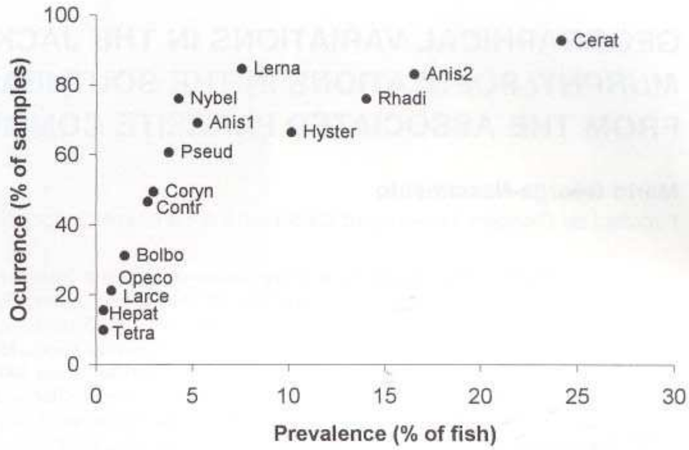


FIGURE 2. Relationship between the overall prevalence (percentage of fish parasitized) and the occurrence (percentage of samples in which the parasite is present) of each parasite taxon in jack mackerels sampled between 1990 and 1996 along the coast off Chile. Name of taxa are abbreviated to the first 5 letters of the name: Cerat = *Ceratothoa* spp.; Lerna = *Lernanthropus trachuri*; Pseudo = *Pseudoterranova*; Nybel = *Nybelinia*; Rhadi = *Rhadinorhynchus trachuri*; Hyste = *Hysterothylacium* sp.; Coryn = *Corynosoma* sp.; Bolbo = *Bolbosoma* sp.; Anis1 = *Anisakis* type I; Anis2 = *Anisakis* type II; Contr = *Contracaecum* sp.; Tetra = Tetrarhynchida; Opeco = Opecoelidae; Hepat = *Hepatoxylon*; Larce = Pseudophyllidea.

Although the same taxa were recorded in both fishing zones, their relative abundance differed significantly (G-test = 3,066.2, df = 14, $P < 0.001$; Table 1). Two of the most persistent and prevalent taxa (Ceratothoa and Rhadinorhynchus) showed strong variations in abundance among years. After 1994, the prevalence of Ceratothoa decreased, whereas that of Rhadinorhynchus increased. Ordination of the infracommunities (11 taxa and 791 fish) from fishing zones and sampling years yielded eigenvalues of 0.89 and 0.69 in the first 2 DCA axes (Fig. 3a). Approximately half of the variance in composition of the infracommunities along the first DCA axis was explained by fishing zone ($F_{13,787}$) = 253.8, $P < 0.001$). The mean composition of the infracommunities also differed between zones in each sampling year (Fig. 3a). Ordination of component communities (15 taxa and 71 samples) produced eigenvalues of 0.57 and 0.26 in the first 2 DCA axes (Fig. 3b). Fishing zone accounted for 54.8% of the variance in composition along the first DCA axis after adjusting for FL ($F_{(,s9)}$) = 51.5, $P < 0.0001$). The slopes of the regressions between the first compositional gradient and FL were similar between fishing zones ($F_{,1,67}$) = 0.03, $P = 0.86$). However, the elevation of the regression between the first compositional gradient and FL was higher in the southern zone ($F_{,,68}$) = 54.5, $P < 0.0001$).

Figure 4 displays the first DCA compositional gradient of the component communities according to FL, revealing a high concentration of samples from the northern fishing zone around the coordinates corresponding to the isopods Ceratothoa spp. Samples from the southern fishing zone clustered around the corresponding coordinates of Anisakis type 1, Rhadinorhynchus trachuri and Hysterothylacium. Discriminant analysis of the

TABLE I. Total number of individuals (n) and prevalence (Prev) of 15 parasite taxa collected between 1990 and 1996 in jack mackerel in 2 fishing zones off the coast of Chile.

| | | Fishing zone | | | |
|---|---|---|---|---|---|
| | | North | | South | |
| Parasite taxon | Type | n | Prev | n | Prev |
| *Lernanthropus* | Co | 140 | 7.2 | 198 | 7.9 |
| *Ceratothoa* | I | 1,630 | 36.6 | 469 | 12.9 |
| Opecoelidae | D | 21 | 1.6 | 5 | 0.1 |
| *Rhadinorhynchus* | A | 187 | 4.7 | 948 | 22.7 |
| *Contracaecum* | N | 25 | 3.3 | 67 | 2.1 |
| *Anisakis* I | N | 276 | 7.7 | 1,725 | 24.3 |
| *Anisakis* II | N | 85 | 3.9 | 316 | 6.6 |
| *Bolbosoma* | A | 51 | 2.7 | 8 | 0.3 |
| Tetrarhynchida | C | 10 | 0.9 | 4 | 0.1 |
| *Pseudoterranova* | N | 37 | 3.2 | 196 | 4.4 |
| *Hysterothylacium* | N | 27 | 2.5 | 692 | 17.4 |
| *Corynosoma* | A | 220 | 5.0 | 71 | 1.8 |
| *Nybelinia* | C | 116 | 4.0 | 158 | 4.5 |
| Pseudophyllidea | C | 9 | 0.7 | 41 | 0.9 |
| *Hepatoxylon* | C | 2 | 0.1 | 13 | 0.7 |
| Number of fish | | 1,831 | | 2,115 | |

* I = Isopoda; Co = Copepoda; A = Acanthocephala; D = Digenea; N = Nematoda; C = Cestoda.