The South Pacific Oceanic Horse Mackerel *(Trachurus picturatus murphyi)* Fishery

RICHARD H. PARRISH
Pacific Fisheries Environmental Group
National Marine Fisheries Service, NOAA
P.O. Box 831, Monterey
California, 93942, USA

PARRISH, R.H. 1989. The South Pacific oceanic horse mackerel *(Trachurus picturatus murphyi)* fishery, p. 321-331. *In* D. Pauly, P. Muck, J. Mendo and I. Tsukayama (eds.) The Peruvian upwelling ecosystem: dynamics and interactions. ICLARM Conference Proceedings 18, 438 p. Instituto del Mar del Perú (IMARPE), Callao, Perú; Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Federal Republic of Germany; and International Center for Living Aquatic Resources Management (ICLARM), Manila, Philippines.

Abstract

The horse mackerel fishery of the South Pacific currently dominates the world's catch of horse mackerels. The rapid increases in catches of horse mackerel by South American purse seine fleets and the distant water USSR trawl fleet are discussed and the geographical expansion of the trawl fishery is shown utilizing ship surface weather observations.

Due to disagreement on the taxonomic identity of the species which supports the fishery, a review of the world's *Trachurus* was made. The results of this review show that neither of the eastern Pacific forms of *Trachurus* merits full species rank. It is concluded that both are subspecies of the oceanic horse mackerel *(Trachurus picturatus); T.p. symmetricus* in the northeastern Pacific and *T.p. murphyi* in the southeastern Pacific. It is further suggested that it is likely that the range of *T.p. murphyi* extends clear across the southern hemisphere west wind drift region (i.e., from the South Atlantic to Chile).

Resumen

Las pesquerías de jurel en el Pacífico Sur dominan actualmente las capturas mundiales de jureles. Se discute el rápido incremento en las capturas de jurel por las flotas cerqueras sudamericanas y la flota arrastrera soviética que opera en aguas distantes y se muestra la expansión geográfica de las pesquerías de arrastre mediante el empleo de observaciones del clima efectuadas por los barcos.

Se hace una revisión de los *Trachurus* del mundo, en vista de los desacuerdos en la identidad taxonómica de las especies que soportan las pesquerías. Los resultados de esta revisión muestran que ninguna de las formas de *Trachurus* del Pacífico Oriental amerita plenamente la jerarquía de especie. Se concluye que ambas son subespecies del jurel oceánico *(Trachurus picturatus); T.p. symmetricus* en el Pacífico Nororiental y *T.p. murphyi* en el Pacífico Suroriental. Se sugiere además que es probable que el rango de *T.p. murphyi* se extienda a través de la región con vientos del oeste del hemisferio sur (desde el Atlantico Sur a Chile).

Introduction

Horse mackerels, of the genus *Trachurus*, are a widespread group occurring in nearly all of the temperate and subtropical, neritic regions of the oceans and they have extensive, but poorly understood, oceanic distributions in several regions. They also occur in a number of tropical neritic regions. The taxonomy of the group is in considerable flux and their extensive distribution is undoubtedly, at least partially, the cause of the present taxonomic confusion: forms which are very similar in morphology and meristics, but widely separated geographically, are assumed, a priori, to be separate species by many workers.

Over the last two decades the horse mackerels have had one of the largest increases in the world's fish catch. Landings rose from 1.2 x 10^6 tonnes (t) in 1965 to 3.9 x 10^6 t in 1984. In 1965 catches of horse mackerel were principally from the northern hemisphere (0.80 x 10^6 t); however, the increase in catches has been entirely the result of developing fisheries in the

southern hemisphere (Fig. 1A). Although horse mackerel occur in much of the world ocean, the bulk of its catches, and supposedly biomass, is concentrated in the eastern boundary currents (Fig. 1B).

Regionally the catches of horse mackerels have exhibited tremendous changes over the last two decades (Table 1). In 1965 half of the world catch of *Trachurus* came from the northwestern Pacific (0.55 x 10^6 t) and the rest was primarily taken in the northeastern Atlantic (0.22 x 10^6 t) and southeastern Atlantic (0.31 x 10^6 t). By the early 1970s catches from the northwestern Pacific had declined greatly, whereas catches from the other two regions had significant increases. Catches reached a maximum of 0.91 x 10^6 t in the northeastern Atlantic in 1973 and a maximum of 0.97 x 10^6 t in the southeastern Atlantic in 1978. Most of these increases in catches were due to the development of distant-water trawl fisheries off North and South Africa by European nations.

Development of the South Pacific Fishery

The most significant change in the world's horse mackerel catches occurred as the result of the development of the southeastern Pacific fishery which rose from 0.015 x 10^6 t in 1965 to a maximum of 2.32 x 10^6 t in 1984 (Fig. 1C). The South Pacific fishery was developed in the early 1970s by Chilean purse seiners forced to alter their fishing strategies due to the collapse of the

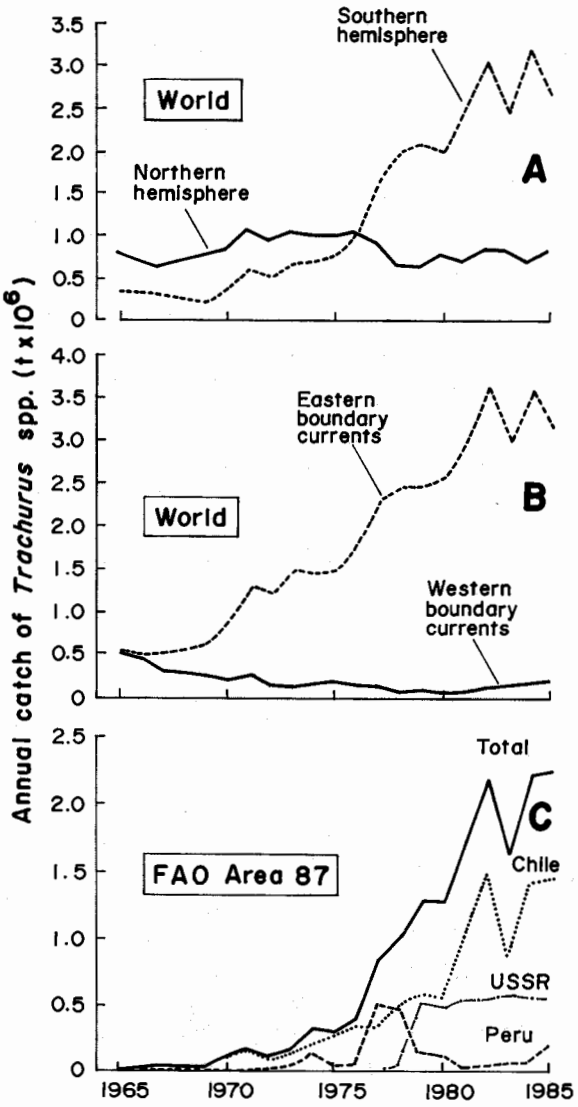

Fig. 1. Catches of *Trachurus* spp., 1965-1985. A. World catches, by hemisphere. B. Catches, by ecosystem type. C. Catches in FAO Area 87, by country.

Fig. 1. Capturas de Trachurus *spp., 1965-1985. A. Capturas mundiales, por hemisferios. B. Capturas, por tipos de ecosistemas. C. Capturas en el area 87 de FAO, por paises.*

Table 1. World catch of *Trachurus* by FAO statistical area (x 10^2 t).
Tabla 1. Captura mundial de Trachurus *por áreas estadísticas de FAO (x 10^2 t).*

OCEAN	Indian		N. Pacific		S. Pacific		N. Atlantic		S. Atlantic		Total
	E.	W.	E.	W.	E.	W.	E.	W.	E.	W.	
FAO AREA	51	57	61	67 + 77	81	87	31	27 + 37 + 34	41	47	
Year											
1965	0	0	5,534	303	0	153	0	2,175	2	3,121	11,288
1966	0	0	4,872	187	1	219	0	1,873	4	3,024	10,180
1967	0	0	3,342	174	5	295	0	2,779	37	2,492	9,124
1968	0	0	3,145	254	6	269	0	3,513	13	2,063	9,263
1969	0	0	2,858	236	3	227	0	4,25	3	1,838	9,688
1970	31	0	2,221	217	3	1,167	0	5,853	10	2,318	11,820
1971	4	0	2,834	272	138	1,676	0	7,626	4	3,992	16,546
1972	21	0	1,565	232	187	1,113	0	7,721	1	3,647	14,487
1973	16	0	1,308	94	157	1,644	0	9,067	2	4,818	17,106
1974	19	0	1,685	100	192	3,235	0	8,287	15	3,455	16,988
1975	45	0	1,932	204	138	2,991	0	7,855	5	4,534	17,704
1976	50	0	1,360	184	163	3,964	0	8,897	13	6,095	20,726
1977	349	0	948	501	175	8,480	0	7,792	17	7,511	25,773
1978	96	0	640	324	112	10,144	0	5,525	20	9,656	26,517
1979	79	0	932	166	75	12,873	0	5,112	6	7,672	26,915
1980	35	0	567	216	63	12,806	0	7,076	9	6,941	27,713
1981	24	0	716	159	116	17,403	0	6,054	14	7,725	32,211
1982	37	0	1,196	263	147	21,996	0	6,966	7	7,978	38,590
1983	64	0	1,461	187	207	16,682	0	6,739	4	7,464	32,808
1984	86	0	1,468	109	403	23,240	0	5,437	3	7,973	38,719
1985	83	0	1,738	97	413	21,488	0	6,487	4	4,472	34,782

anchoveta fishery in 1972-1973 (Table 2). Chilean landings of horse mackerel reached 0.5 x 10^6 t in 1978 and, except for the El Niño year of 1983, have exceeded 1.4 x 10^6 t since 1981. In the early 1970s Peru also began to develop a purse seine horse mackerel fishery; however, this fishery has not achieved the production of the Chilean fishery and with the exception of 1977-1978, when landings were near 0.5 x 10^6 t, landings have averaged less than 0.1 x 10^6 t.

Both the Chilean and Peruvian horse mackerel fisheries are neritic fisheries with catches almost exclusively coming from their respective 200 mile economic zones. The Chilean fishery started in northern Chile, in the Arica-Antofagasta region and expanded to central Chile in the late 1970s (Serra 1987). During the 1980s the Chilean landings have been about equally divided between the Arica-Antofagasta region (18-24°S) and the Talcahuano region (37°S); landings in the Coquimbo region of central Chile (30°S) have been an order of magnitude less than in the other two regions (Serra 1987). Fishing areas for the Peruvian catches are not well-documented in the available literature.

Table 2. Southeastern Pacific *Trachurus* catch by country (FAO Area 87; x 10^2 t).
Tabla 2. Captura de Trachurus *en el Pacífico Suroriental por países (Area 87 de FAO; x 10^2 t).*

	Chile	Peru	Ecuador	USSR	Other	Total
1965	127	26	0	0	0	153
1966	176	43	0	0	0	219
1967	264	31	0	0	0	295
1968	241	28	0	0	0	269
1969	185	42	0	0	0	227
1970	1,120	47	0	0	0	1,167
1971	1,584	92	0	0	0	1,676
1972	870	188	0	55	0	1,113
1973	1,216	428	0	0	0	1,644
1974	1,944	1,292	0	0	0	3,236
1975	2,612	379	0	0	0	2,991
1976	3,423	542	0	0	0	3,965
1977	3,408	5,049	0	0	22	8,479
1978	5,001	4,625	0	492	25	10,143
1979	5,975	1,516	0	5,322	60	12,873
1980	5,622	1,234	0	4,944	1,004	12,804
1981	10,609	379	0	5,546	868	17,402
1982	14,946	450	0	5,554	974	21,924
1983	8,652	679	249	5,910	792	16,282
1984	14,263	768	100	5,706	1,327	22,164
1985	14,569	1,843	6	5,639	398	22,455

In 1978, trawlers from the USSR began fishing for horse mackerel offshore of the 200 mile limits of Peru and Chile and during the period 1979-1985 they have annually taken between 0.49 and 0.59 x 10^6 t in the offshore area (Table 1). The development and distribution of this distant water trawl fishery is well documented in the positions of the trawlers as reported in international meteorological observations. At the beginning of the fishery (1979) the reported positions were spread out in a band along the coast, outside of the 200 mile zones (i.e., between 80°W and 90°W from 10°S to 45°S in Fig. 2A). By 1983 reports show the fishery was concentrated off southern Chile at about 80°W and 40°S (Fig. 2B); however, there were also a considerable number of reports along 85°W north of the area of concentration. There was an absence of reports within Chile's 200 mile zone; Chile also has 200 mile zones around San Felix Island and Juan Fernandez Archipelago. By 1985, in addition to a distribution of reports similar to 1983, the reports show that the fishery extended westward along the west wind drift between 39 and 45°S (Fig. 2C).

To evaluate the seasonality of the Soviet trawl fishery, the meterological reports were limited to Soviet vessels and to 1984-1987, the period when the fishery was operating in the offshore west wind drift region. During the austral spring (October-December) the meterological reports are furthest to the north with reports concentrated between 34-41°S and 78-92°W (Fig. 3A). Reports are noticeably absent in the 200 mile zones around San Felix Island (26°S, 80°W) and the Juan Fernandez Archipelago (33°S, 80°W) but there are reports in international waters between the two zones and between the San Felix Island 200 mile zone and the continental 200 mile zone. During the austral autumn (April-June) the reports are concentrated in two regions

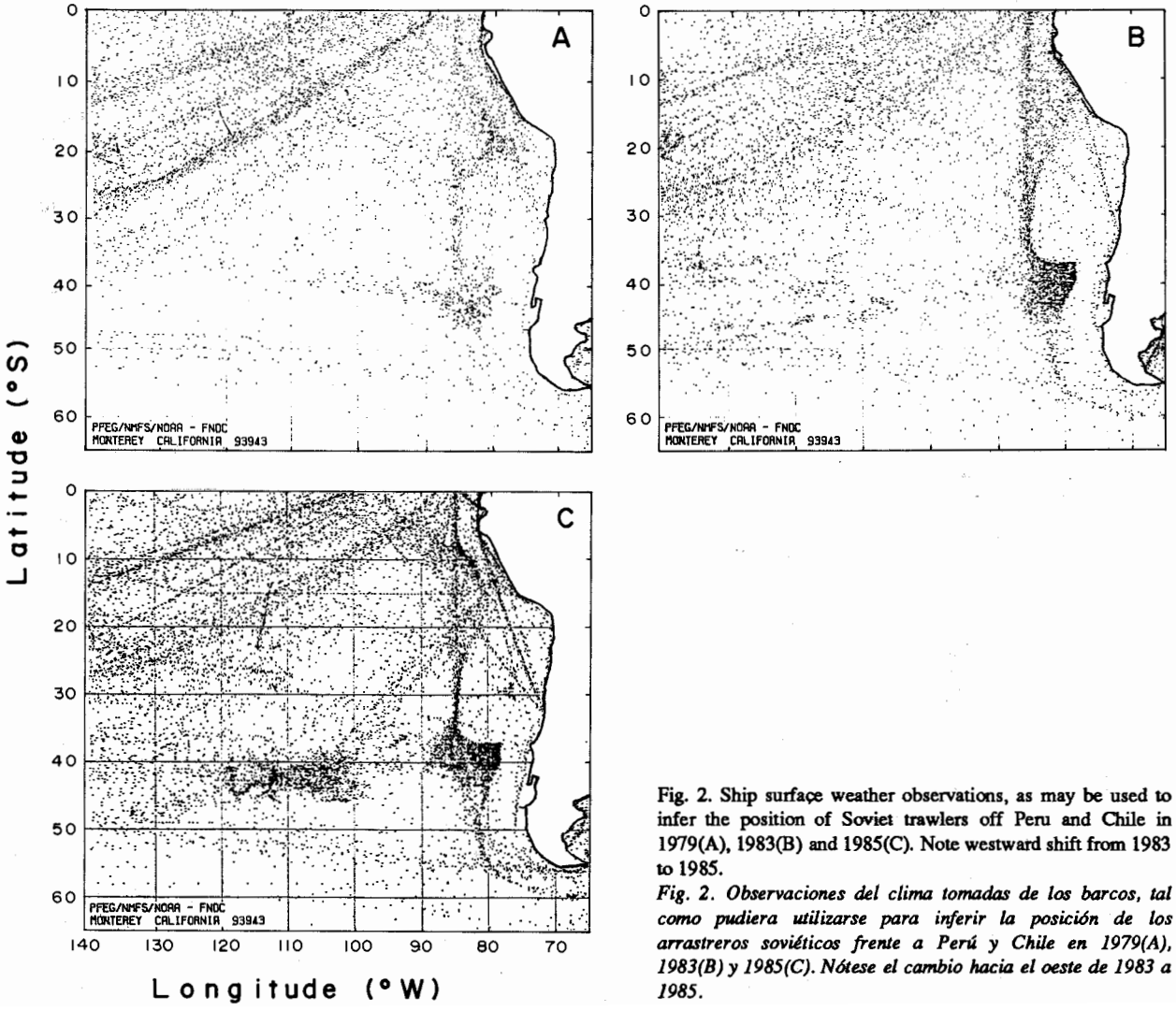

Fig. 2. Ship surface weather observations, as may be used to infer the position of Soviet trawlers off Peru and Chile in 1979(A), 1983(B) and 1985(C). Note westward shift from 1983 to 1985.

Fig. 2. Observaciones del clima tomadas de los barcos, tal como pudiera utilizarse para inferir la posición de los arrastreros soviéticos frente a Perú y Chile en 1979(A), 1983(B) y 1985(C). Nótese el cambio hacia el oeste de 1983 a 1985.

(Fig. 3B). The first is about five degrees south of the spring concentration (i.e., between 39-45°S and 79-90°W) and the second is much further offshore (39-45°S and 100-120°W). In both spring and autumn there are also considerable numbers of reports in the offshore region extending toward New Zealand.

The South Pacific distribution of the meterological reports from the Soviet trawl fleet suggests that, in the offshore region, horse mackerel are concentrated along the South Pacific subtropical convergence and that they seasonally move north and south with the convergence. It appears that the horse mackerel are able to complete their entire life cycle in the South Pacific subtropical convergence; independent of the neritic zone. Evseenko (1987) reported several larvae and a juvenile in the South Pacific convergence and Bailey (1989) shows that the horse mackerel spawns across the South Pacific from New Zealand to Chile. Bailey found juvenile horse mackerel along the subtropical convergence from 128°W to 166°W.

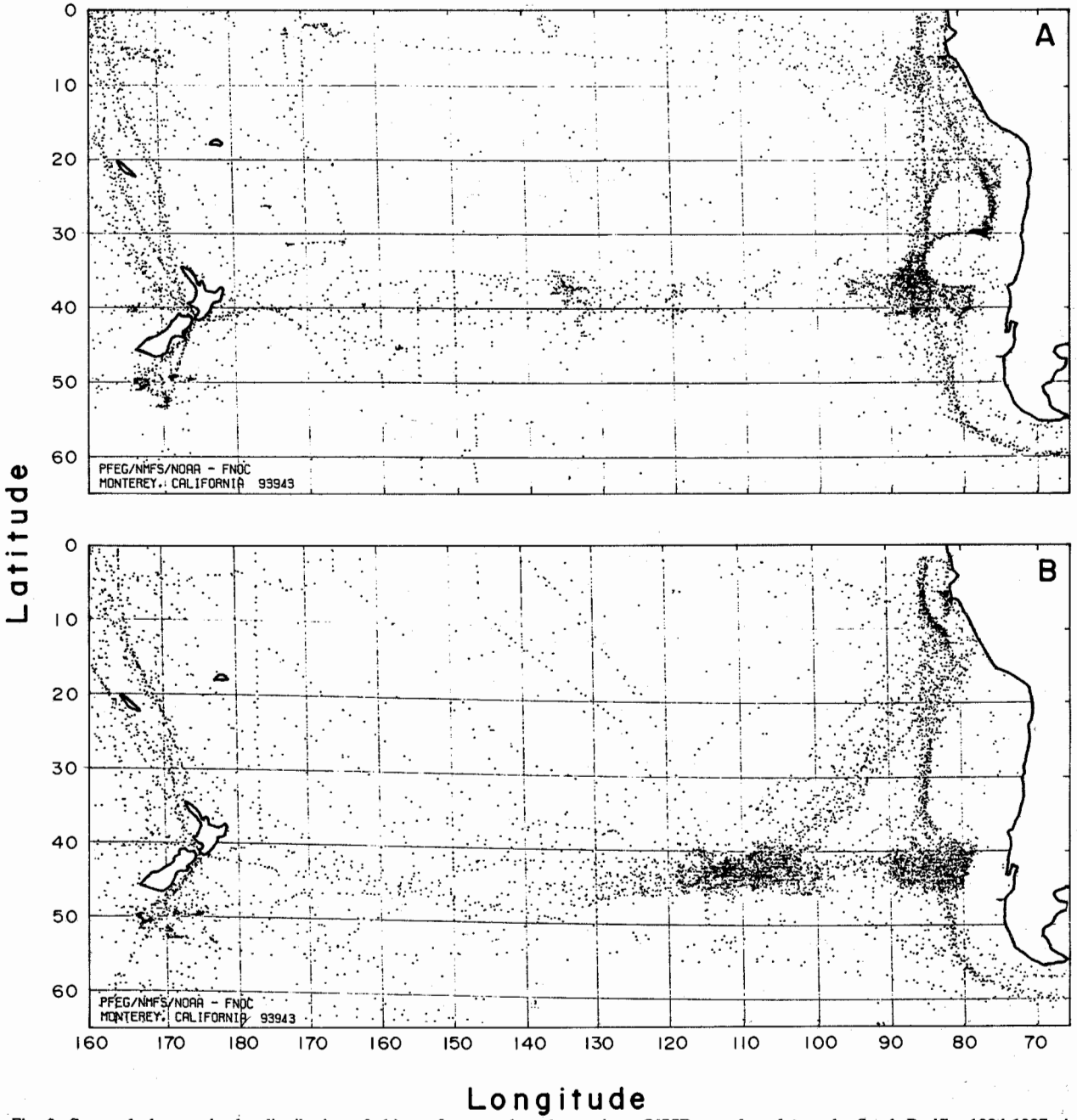

Fig. 3. Seasonal changes in the distribution of ship surface weather observations (USSR vessels only) in the South Pacific, 1984-1987. A. October-December. B. April-June.

Fig. 3. Cambios estacionales en la distribución de las observaciones del clima de los barcos (sólo embarcaciones soviéticas) en el Pacífico Sur, 1984-1987. A. Octubre-Diciembre. B. Abril-Junio.

Review of the Taxonomy of *Trachurus*

As shown above, the recent increase in the world's catch of *Trachurus* is primarily due to increases in the catch off Pacific South America. The FAO catch statistics consider the horse mackerel in this region to be *Trachurus murphyi,* but there is little agreement in the literature as to the correct species name. For example, in Peru the commonly used name is *T. symmetricus murphyi,* whereas in Chile the name *T. murphyi* is used (Santander and Flores 1983; Serra 1983). Therefore a review of the literature on the taxonomy of the horse mackerels was carried out to ascertain the status of the Pacific South American form.

The world's trachurids have been reviewed by Nichols (1920, 1940), Berry and Cohen (1974) and Shaboneyev (1980). Since Nichols (1920) the literature has contained 17 species and 2 subspecies (Table 3). The number and relative size of the scutes along the lateral line and the relative length of the dorsal accessory lateral line has been of primary importance in separating the various forms of *Trachurus* and all three reviews are heavily based on these characteristics. The taxonomy of the group is still in flux and it is not known if the forms in many regions are separate at the species, subspecies or even lower levels. The problem was perhaps best stated by Nichols (1940):

> "The systematic treatment of the forms of *Trachurus* is puzzling. They are sometimes so nearly identical from different oceans that authors synonymize them, but in no case where I have had material for comparison do they seem to me to be quite identical. They might all be races of a single widely distributed species except that two quite unlike forms are often recognized in the same waters."

Nichols (1940) recognized 12 species but he concluded by suggesting that the genus might be divided into 3 species, each having a number of geographically isolated races. Under this arrangement all of the species described to that time would have been races of *T. trachurus, T. picturatus* and *T. mediterraneus* (Table 4).

Table 3. Original descriptions of *Trachurus* used in recent literature.
Tabla 3. Descripciones originales de Trachurus *empleadas en la literatura reciente.*

Species	Author(s)	Synonyms
trachurus	Linnaeus 1758	
picturatus	Bowdich 1825	
semispinosus	Nillson 1832	= *trachurus*
declivis	Jenyns 1841	
novaezelandia	Richardson 1843	
japonicus	Temminck and Schlegel 1844	
symmetricus	Ayres 1855	
capensis	Castelnau 1861	
mediterraneus	Steindachner 1868	
murphyi	Nichols 1920	
muccullochi	Nichols 1920	= *novaezelandia*
lathami	Nichols 1920	
binghami	Nichols 1940	= *lathami*
trecae	Cadenat 1949	
indicus	Nekrasov 1966	
delagoa	Nekrasov 1970	
margaretae	Berry and Cohen 1974	= *delagoa*
Subspecies		
T. mediterraneus ponticus	Aleev 1956	
T. picturatus aleevi	Rytov and Razumovskaya 1984	

Berry and Cohen (1974) synonymized two of the species recognized by Nichols (1940), accepted two new species described by other authors and described a new species; thus recognizing 13 species. They did not group the species as did Nichols but described the relationships between similar forms in different regions. These descriptions result in groups of similar species which are very much like those of Nichols (Table 4). They also showed that there is only one species in the entire western Atlantic *(T. lathami)* and this has recently been verified by Saccardo (1987).

Table 4. Groupings of similar species by various authors.
Tabla 4. Agrupamiento de especies similares según diversos autores.

Nichols (1940)	Berry and Cohen (1974)	Shaboneyev (1980)	No. of [a] scutes	No. of [b] scutes	Scutes[c] depth
Trachurus Races	Similar Forms	*Trachurus* Group			
trachurus	*trachurus*	*t. trachurus*	74.3	72.9	26.4
capensis	*capensis*	*t. capensis*		73.8	
semispinosus		*japonicus*	71.5	71.5	25.6
muccullochi =		= *novaezelandia*	72.4	72.3	22.5
	margaretae[d] (= *delagoa*)	*delagoa*			
Mediterraneus Races	Similar Forms	*Mediterraneus* Group			
		m. ponticus			
mediterraneus	*mediterraneus*	*m. mediterraneus*	83.2	83.3	16.6
lathami	*lathami*	*lathami*	72.5	72.5	12.2
japonicus	*japonicus muccullochi*		71.5	71.5	
	indicus	*indicus*	72.8	74.6	15.5
	trecae[d]	*trecae*	74.3	74.2	13.2
Picturatus Races	Similar Forms	*Picturatus* Group			
picturatus	*picturatus*	*picturatus*	98.3	99.4	13.5
symmetricus	*symmetricus*	*s. symmetricus*	99.0	100.1	17.3
murphyi	*murphyi*	*s. murphyi*	100.3	97.8	17.8
		Aberrant Form			
	declivis[d]	*declivis*	81.6	81.8	23.1

[a]Number of scutes as given in Shaboneyev (1980).
[b]Number of scutes as given by other authors.
[c] Depth of the largest scute in the posterior part of the lateral line as a percentage of head length as given in Shaboneyev (1980).
[d]Berry and Cohen (1974) made no comment on the relationships of these forms.

Shaboneyev (1980) accepted 11 species of *Trachurus*. He followed Nekrasov (1978) and Kompowski (1975) treating *capensis* as a subspecies of *T. trachurus* and he also followed Kotlyar (1976) and Shaboneyev and Kotlyar (1979) in considering *murphyi* to be a subspecies of *T. symmetricus*. Shaboneyev placed the 11 species into three groups of similar species and one aberrant form (Table 4).

The grouping of similar forms by Nichols (1940), Berry and Cohen (1974) and Shaboneyev (1980) are nearly identical and result in a separation of *Trachurus* into a temperate form (the *trachurus* type), a tropical form (the *mediterraneus* type) and an oceanic form (the *picturatus* type). The geographical distributions of Shaboneyev's *trachurus* group (Fig. 4A) and *mediterraneus* group (Fig. 4B) demonstrate the separation into a more temperate group *(trachurus)* and a more tropical group *(mediterraneus)*.

The number of scutes is considerably greater in the oceanic form than the other forms (Table 4) and all three reviews are in agreement in the species included in this group; however, there are minor differences in the inclusion of *japonicus* and *novaezelandia* within the other two groups. These are the two forms which Nichols (1940) was unsure of, stating that *muccullochi* (now *novaezelandia*) should perhaps be included in the *trachurus* group and that *japonicus* should perhaps be included in the *mediterraneus* group. Berry and Cohen (1974) stated that *muccullochi* may be a southern hemisphere cognate of *japonicus* and that *japonicus* was the most morphologically similar to *lathami* and they placed both *muccullochi* and *japonicus* in the *mediterraneus* group. Shaboneyev (1980) separates the various forms in his *trachurus* and *mediterraneus* groups primarily on the relative size of their scutes. In his *trachurus* group the depth of the largest scute in the posterior part of the lateral line averages from 12.2 to 16.6% of the head length; whereas in his *mediterraneus* group it averages from 22.5 to 26.4% (Table 4). He therefore placed both *novaezelandia* (= *muccullochi*) and *japonicus* in his *trachurus* group.

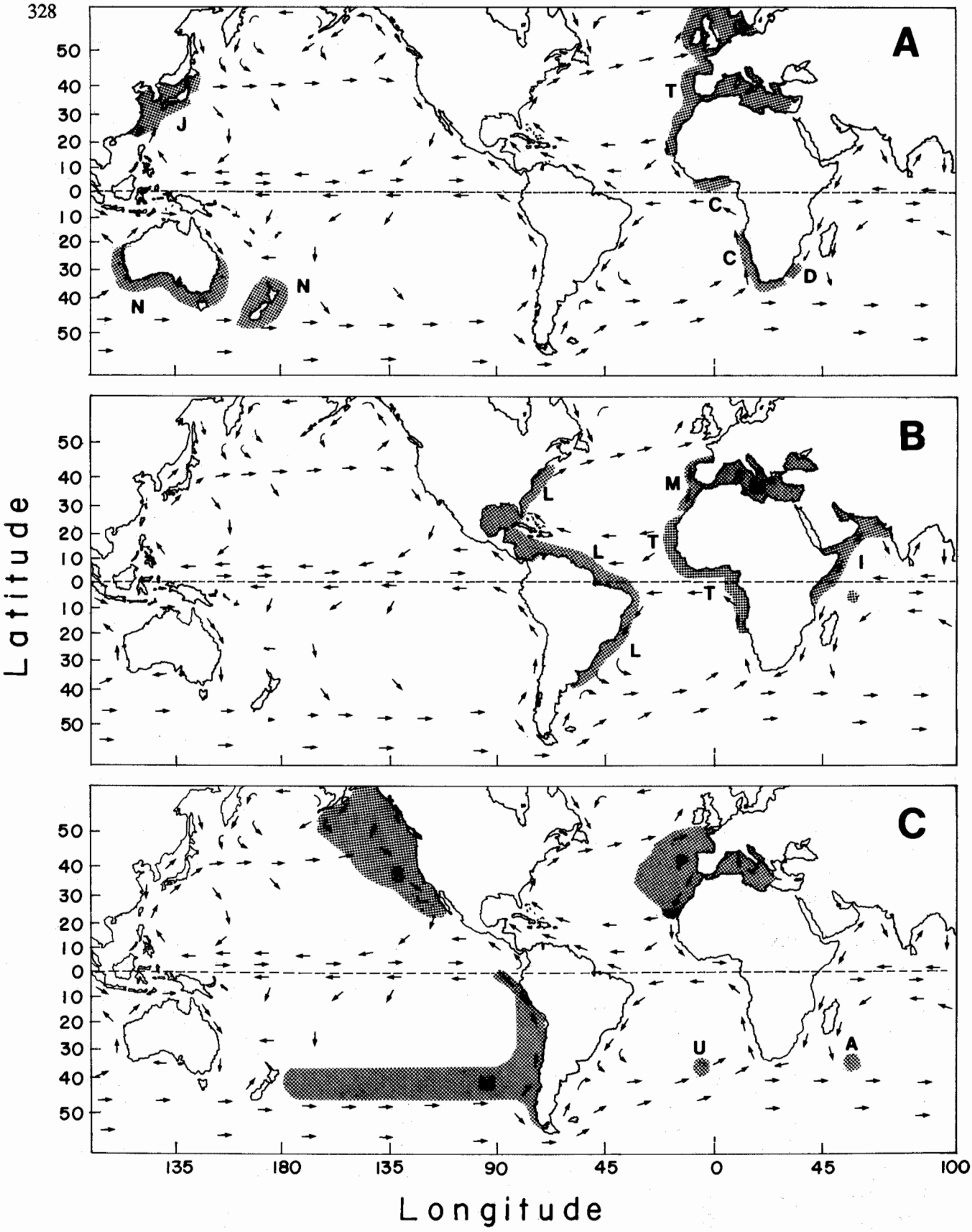

Fig. 4. Geographical distribution of trachurids: A. Shaboneyev's (1980) *"trachurus"* group: *trachurus* (T), *capensis* (C). *novaezelandia* (N), *japonicus* (J) and *delagoa* (D). B. Shaboneyev's (1980) "mediterranean" group: *mediterraneus* (M), *lathami* (L), *trecae* (T), and *indicus* (I). C. Oceanic horse mackerel: *picturatus* (P), *symmetricus* (S), *murphyi* (M), *aleevi* (A) and unnamed (U).

Fig. 4. Distribución mundial de trachuridos: A. Grupo "trachurus" *de Shaboneyev (1980):* trachurus *(T),* capensis *(C),* novaezelandia *(N),* japonicus *(J) y* delagoa *(D). B. Grupo "mediterraneo" de Shaboneyev (1980):* mediterraneus *(M),* lathami *(L),* trecae *(T), y indicus (I). C. Jureles oceánicos:* picturatus *(P),* symmetricus *(S),* murphyi *(M),* aleevi *(A) y sin nombre (U).*

Stephenson and Robertson (1977) showed that *T. muccullochi* was a junior synonym of *T. novaezelandia* and they found no grounds for distinction between *T. novaezelandia* and *T. japonicus*. They did not formally synonymize these forms apparently due to the fact that there is no gene flow across the present day Indo-Pacific gap in their distributions and they felt this necessitated retaining both species. Stephenson and Robertson (1977) also point out the close similarities between *japonicus, novaezelandia* and *lathami*.

There is a general consensus that the members of the *picturatus* or oceanic group are very closely related. Shaboneyev (1980) even states that the members of this group are morphologically so similar that it is difficult to identify them. This consensus rapidly disappears when it comes to deciding whether each is a distinct species or whether they differ at some lower level. Early workers (Jordan and Everman 1896; Meek and Hildebrand 1925) considered them a single species *(T. picturatus)*. Nichols (1940) tried to have it both ways by listing them as separate species but concluded by suggesting that *symmetricus, murphyi* and perhaps *declivis* might stand as races of *T. picturatus*.

Roedel and Fitch (1952) found minor differences between the relative size of scutes in *symmetricus* and *murphyi* but were unable to distinguish *symmetricus* from *picturatus*. Berry and Cohen (1974) gave all three the status of species but considered *murphyi* to be an ecotype of *picturatus* and considered *murphyi* and *symmetricus* to be an antitropical species pair. In contrast, Kotlyar's (1976) extensive morphological analysis of the Peruvian horse mackerel concluded that *murphyi* was not sufficiently different from *symmetricus* to merit species rank and he considered it to be a subspecies *(T.s. murphyi)*.

According to Shaboneyev and Kotlyar (1979), Aleyev (1957) considered the eastern Pacific forms to be a subspecies of *picturatus* and he also considered the northern and southern Atlantic forms of *picturatus* to be separate subspecies. In their morphological analysis of the eastern Pacific forms of *Trachurus* (i.e., *symmetricus* and *murphyi*) and the oceanic horse mackerel *(picturatus)*, Shaboneyev and Kotlyar (1979) state: "our data, based on a considerably greater amount of material, show overlap in all the characters investigated between the oceanic horse mackerel and the eastern Pacific forms of the genus *Trachurus*". However, they found differences in the number of gill rakers which they felt almost reached the subspecies level and differences in the length of the dorsal branch of the lateral line which reached the subspecies level. Although they admitted that they did not find sufficient morphological reasons for considering the eastern Pacific forms and *picturatus* as distinct species, they concluded by suggesting that the ecological differences between them was great enough to merit species rank for the Atlantic and Pacific forms. Their reasons for this conclusion were as follows:

- They considered that *picturatus* differed from the eastern Pacific forms in that it is a neritic-oceanic form widely distributed not only on the continental shelf but also far beyond its boundaries.
- This distribution demonstrated that *picturatus* may live in different water masses, for example, in the cold Canary Current, and in the subtropical waters south of the North Atlantic Current.
- "The most striking contrast with the eastern Pacific forms is provided by the possibility of the existence of the oceanic horse mackerel in the epicontinental Mediterranean, in water masses characterized by heightened salinity."

Recent work has added further complications to the *picturatus* group. Rytov and Razumovskaya (1984) have described a new subspecies of *picturatus (T.p. aleevi)* from the southern Indian Ocean and Evseenko (1987) and Bailey (1989) have shown that *murphyi* occurs in the west wind drift region (along about 40°S) from Chile to New Zealand. According to Rytov and Razumovskaya (1984), "the present grouping of the ocean scads into separate species on the basis of geographic isolation is artificial". They agreed with early authors who recognized only one species of oceanic horse mackerel *(T. picturatus)* which occurs in the eastern North and South Atlantic, the eastern North Pacific, the South Pacific and the southern Indian Ocean.

The distribution of three of the *picturatus* group are presently described; *picturatus* (Shaboneyev and Kotlyar 1979), *symmetricus* (Blunt 1969) and *murphyi* (Serra 1983; and Bailey, in press). Unfortunately the southern Indian Ocean distribution of *aleevi* is not given by Rytov and Razumovskaya (1984), who give only the location of the holotype. The distribution of

picturatus in the South Atlantic is also poorly documented in the literature and it is further confounded by the fact that *T. picturatus bingami* has been synonymized with *T. lathami* (Berry and Cohen 1974; Saccardo 1987). The only verified record found for *picturatus* from the South Atlantic was the holotype of *Decapterus longimanus,* from Tristan de Cunha examined by Berry and Cohen (1974). The distribution of the *T. picturatus* group as described in the above works is obviously underrepresented in the South Atlantic and Southern Indian Ocean (Fig. 4C). Its occurrence along the warm side of the west wind drift regions of the South Atlantic, South Indian and South Pacific suggests that *picturatus* may occur in a continuous band along the west wind drift region from the South Atlantic to Chile.

As shown above, Shaboneyev and Kotylar's (1979) ecological distinction between the Atlantic and Pacific forms of the *picturatus* group is unwarranted as the eastern Pacific forms should also be considered neritic-oceanic fishes in that they have even more extensive offshore distributions than *picturatus*. They occur from the cold waters of the Gulf of Alaska and Southern Chile to the subtropical waters of Southern Baja California and the Galapagos Islands. They also extend offshore from Chile to New Zealand. It is true that they are not known to occur in waters as saline as the Mediterranean. However, since such waters do not occur in the Pacific Ocean, this does not prove that the eastern Pacific forms are not capable of existing in such water. Therefore, Shaboneyev and Kotylar's (1979) arguments appear to be reduced to the fact that *picturatus* and *symmetricus* differ because they are isolated.

In summary, the differences between the various geographical forms of the oceanic horse mackerel are insufficent to warrant breaking the group into more than one species. The species *Trachurus picturatus* would appear to have at least three subspecies or races: *T.p. picturatus* in the northeastern Atlantic, *T.p. symmetricus* in the northeastern Pacific and *T.p. murphyi* in the southern ocean. The southern ocean form may be subdivided into three subspecies or races: *murphyi* in the Pacific, *aleevi* in the Indian and an unnamed form in the Atlantic. The recent large increase in the world's catches of horse mackerels therefore comes almost exclusively from exploitation of *Trachurus picturatus murphyi*.

Table. 5. Splitter and lumper classification of the genus *Trachurus*.
Tabla 5. Clasificación desdobladora y englobadora del género Trachurus.

Splitter species (13) and subspecies	Lumper species (7) and subspecies
trachurus	*trachurus*
capensis	*t. trachurus*
novaezelandia	*t. capensis*
japonicus	*novaezelandia*
delagoa	*n. novaezelandia*
mediterraneus	*n. japonicus*
m. mediterraneus	*n. delagoa*
m. ponticus	*mediterraneus*
lathami	*m. mediterraneus*
trecae	*m. ponticus*
indicus	*lathami*
picturatus	*trecae*
p. picturatus	*indicus*
p. aleevi	*picturatus*
symmetricus	*p. picturatus*
murphyi	*p. symmetricus*
declivis	*p. murphyi*
	p. aleevi
	p. unnamed
	declivis

After reviewing the available literature, in my opinion, a definitive analysis of the relationships between the *Trachurus* occurring in different geographical regions cannot be made without a properly designed biochemical genetics analysis. In the absence of such an analysis, the division of the genus into species is probably more a function of the philosophy of individual authors rather than the genetic relationships among the various populations. Therefore, I have included two classification schemes: one for splitters and one for lumpers (Table 5). I also note that considerable further lumping within the *trachurus* and the *mediterraneus* groups may be in order, perhaps even to the three species suggested by Nichols (1940).

References

Aleyev, Yu. G. 1957. *Trachurus* of the seas of the USSR. Tr. Sevastopol' skoy Biol. St. 9: 1-137.

Bailey, K. 1989. Description and surface distribution of juvenile Peruvian horse mackerel *Trachurus murphyi* Nichols from the Subtropical Convergence Zone of the Central South Pacific. U.S. Fish. Bull. 87(2): 273-278.

Berry, F.H. and A. Cohen. 1974. Synopsis of the species of *Trachurus* (Pisces, Carangidae). Q. J. Fla. Acad. Sci. 35(4): 177-211.

Blunt, J.E., Jr. 1969. The horse mackerel *(Trachurus symmetricus)* resource of the eastern North Pacific. Calif. Mar. Res. Comm., CalCOFI Rep. 13: 45-52.

Evseenko, S.A. 1987. Reproduction of Peruvian horse mackerel, *Trachurus symmetricus murphyi*, in the southern Pacific. J. Ichth. 27(3): 151-160.

Jordan, D.S. and B.W. Evermann. 1896. The fishes of North and Middle America. Bull. U.S. Nat. Mus., No. 47, pt. 1. p. 1240.

Kompowski, A. 1975. The intraspecific geographical variability of horse mackerel, *Trachurus trachurus* (L) in West African shelf waters. Acta Ichthyol. Piscat. 5(1): 13-29.

Kotlyar, A.N. 1976. A morphological description of the Peruvian horse mackerel. *Trachurus symmetricus murphyi*. J. Ichthyol. 16(1): 45-55.

Meek, S.F. and S.F. Hildebrand. 1925. The marine fishes of Panama. Chicago. 500 p.

Nekrasov, V.V. 1978. Systematic position of the horse mackerel of the genus *Trachurus* from the Western part of the Indian Ocean. J. Ichthyol. 18(1): 15-19.

Nichols, J.T. 1920. A key to the species of *Trachurus*. Amer. Mus. Nat. Hist. Bull. 42(13): 477-88.

Nichols, J.T. 1940. Notes on carangid fishes. V. Young *Trachurus* in the Gulf of Mexico. Amer. Mus. Nat. Hist., Amer. Mus. Novit. No. 1067. 4 p.

Roedel, P.M. and J.E. Fitch. 1952. The status of the carangid fishes *Trachurus* and *Decapterus* on the Pacific coast of Canada and the United States. Copeia 1: 4-6.

Rytov, A.N. and T.M. Razumovskaya. 1984. A new subspecies of ocean scad, *Trachurus picturatus aleevi*, from the southwestern Indian Ocean. J. Ichthyol. 24(2): 1-6.

Saccardo, S.A. 1987. Morfologia, distribuicao, e abundancia de *Trachurus lathami* Nichols, 1920 (Teleostei: Carangidae) na regiao sudeste-sul do Brazil. Bolm. Inst. Oceanogr. S. Paulo 35(1): 65-95.

Santander, H. and R. Flores. 1983. Los desoves y distribución larval de cuatro especies pelágicas y sus relaciones con las variaciones del ambiente marino frente al Perú. *In* Proceedings of the expert consultation to examine changes in abundance and species composition of neritic fish resources. San José, Costa Rica. FAO Fisheries Rep. 293(2): 835-867.4.

Serra, J.R. 1983. Changes in the abundance of pelagic resources along the Chilean coast. *In* Proceedings of the expert consultation to examine changes in abundance and species composition of neritic fish resources. San José, Costa Rica. FAO Fisheries Rep. No. 291(2): 255-284.

Serra, J.R. 1987. Impact of the 1982-83 ENSO on southeastern Pacific fisheries, with an emphasis on Chilean fisheries, p. 24-29. *In* M. Glantz, R. Katz and M. Krenz (eds.) Climate crisis: the societal impacts associated with the 1982-83 worldwide climate anomalies. Pub. NCAR, Boulder, Colorado.

Shaboneyev, I.Y. 1980. Systematics, morpho-ecological characteristics and origin of carangids of the genus *Trachurus*. J. Ichthyol. 20(6): 15-24.

Shaboneyev, I.Y. and A.N. Kotlyar. 1979. A comparative morphoecological analysis of the Eastern Pacific forms of *Trachurus symmetricus* and the Atlantic oceanic horse mackerel, *Trachurus picturatus picturatus*. J. Ichthyol. 19(2): 24-29.

Stephenson, A.B. and D.A. Robertson. 1977. The New Zealand species of *Trachurus* (Pisces: Carangidae). J. R. Soc. N. Z. 7(2): 243-53.

The Peruvian Upwelling Ecosystem: Dynamics and Interactions

Edited by

D. Pauly
P. Muck
J. Mendo
I. Tsukayama

1989

INSTITUTO DEL MAR DEL PERÚ (IMARPE)
CALLAO, PERÚ

DEUTSCHE GESELLSCHAFT FÜR TECHNISCHE ZUSAMMENARBEIT (GTZ), GmbH
ESCHBORN, FEDERAL REPUBLIC OF GERMANY

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
MANILA, PHILIPPINES

The Peruvian Upwelling Ecosystem: Dynamics and Interactions

Proceedings of the Workshop on Models for Yield Prediction in the Peruvian Ecosystem, 24-28 August 1987, Callao, Perú

EDITED BY

D. PAULY
P. MUCK
J. MENDO
I. TSUKAYAMA

1989

Published by Instituto del Mar del Perú (IMARPE), P.O. Box 22, Callao, Perú; Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH, Postfach 5180, D-6236 Eschborn 1 bei Frankfurt/Main, Federal Republic of Germany; and International Center for Living Aquatic Resources Management (ICLARM), MC P.O. Box 1501, Makati, Metro Manila, Philippines

Printed in Manila, Philippines

Pauly, D., P. Muck, J. Mendo and I. Tsukayama, Editors. 1989. The Peruvian upwelling ecosystem: dynamics and interactions. ICLARM Conference Proceedings 18, 438 p. Instituto del Mar del Perú (IMARPE), Callao, Perú; Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH, Eschborn, Federal Republic of Germany; and International Center for Living Aquatic Resources Management (ICLARM), Manila, Philippines.

ISSN 0115-4435
ISBN 971-1022-47-8

Cover: False color satellite images of the Peruvian upwelling system taken during a 4-day period (5-8 May 1985) with a well developed area of cold waters along the Peruvian coast (front cover) and during a 3-day period (2-4 March 1986) when warm oceanic waters invaded the nearshore habitat of anchoveta (back cover). (Images: courtesy of the US National Oceanic and Atmospheric Administration).

PROCOPA Contribution No. 92
ICLARM Contribution No. 409