DESCRIPTION AND SURFACE DISTRIBUTION OF JUVENILE PERUVIAN JACK MACKEREL, *TRACHURUS MURPHYI*, NICHOLS FROM THE SUBTROPICAL CONVERGENCE ZONE OF THE CENTRAL SOUTH PACIFIC

KEVIN BAILEY[1]

ABSTRACT

Juvenile Peruvian jack mackerel, *Trachurus murphyi*, were collected with a dip net and from albacore stomachs during research cruises to the Subtropical Convergence Zone of the central South Pacific between January and March of 1986 and 1987. The morphometrics and meristics of 40 specimens measuring 46 to 83 mm SL are presented. The predominance of *T. murphyi* in the diet of albacore suggests that the jack mackerel are abundant between latitudes 34°S and 41°S, longitudes 127°W and 165°W during the austral summer. Evidence of the transpacific distribution of *T. murphyi* along the Subtropical Convergence Zone is presented.

Between January and March of 1986 and 1987, research vessels of the New Zealand, United States, and French Governments surveyed the Subtropical Convergence Zone east of New Zealand to determine the extent of the albacore, *Thunnus alalunga*, resource and its potential for exploitation by surface trolling. Stomachs of troll caught albacore were collected to investigate their feeding habits.

A preliminary analysis of stomachs collected during 1986 showed that albacore from the central South Pacific fed almost exclusively on juvenile jack mackerel of the genus *Trachurus*. Although partially digested, the jack mackerel were identifiable as *T. murphyi* Nichols from the descriptions of Berry and Cohen (1974), Kotlyar (1976), and Shaboneyev (1980). This identification was supported by Smith-Vaniz[2] and confirmed with live specimens caught in 1987.

This paper summarizes the morphometrics and meristics of juvenile jack mackerel from the Subtropical Convergence Zone of the central South Pacific, and describes their surface distribution with respect to predation by albacore.

MATERIAL AND METHODS

Jack mackerel were collected from the stomachs and regurgitum of albacore caught during daytime surface trolling by RV *Townsend Cromwell*[3] (cruises TC-86-01 and TC-87-01) and RV *Coriolis*[4] (cruise Prosgermon87), and by dipnetting from schools of jack mackerel attracted to the *Townsend Cromwell*'s lights during the night. Stomach contents were preserved in buffered 10% formalin on *Townsend Cromwell* and frozen on *Coriolis*. In the laboratory the contents were sorted and counted, and their displacement volumes measured. The least digested mackerel were measured to the nearest lower mm of fork length. Where possible the number of scales and scutes along the lateral line and the end point of the accessory lateral line were determined to verify that only one species of *Trachurus* was present (Berry and Cohen 1974).

Live *Trachurus murphyi* were caught with a dip net on two occasions during cruise TC-87-01. These specimens were photographed and preserved in 70% ethanol. On three other occasions, dipnetting was unsuccessful.

Forty jack mackerel (46–83 mm SL) were examined in detail, 1 collected in 1986 and 39 in 1987 (Table 1). Five specimens are catalogued in the National Museum of New Zealand, Wellington (NMNZ 21410) and four in the Academy of Natural Sciences, Philadelphia (ANSP 158517).

[1]Ministry of Agriculture and Fisheries, Fisheries Research Centre, P.O. Box 297, Wellington, New Zealand; present address: South Pacific Commission, Tuna and Billfish Assessment Programme, B.P. D5, Noumea Cedex, New Caledonia.

[2]W. Smith-Vaniz, Academy of Natural Sciences, Philadelphia, PA 19103, pers. commun. August 1986.

[3]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Pacific Marine Center, 1801 Fairview Avenue East, Seattle, WA 98102-3767, U.S.A.

[4]Groupement pour La Gestion de Navires Oceanologiques, B.P. 310, 29273 Brest, CEDEX, France.

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TABLE 1.—Collection data of juvenile *Trachurus murphyi* from the Subtropical Convergence Zone of the central South Pacific by RV *Townsend Cromwell*.

Cruises and date	Time	Position	Sea surface temp (°C)	No.	Size range (SL mm)	Collection method
TC-86-01						
19 Feb.	0700	39°10'S, 146°53'W	17.2	1	56	albacore regurgitum
TC-87-01						
22 Jan.	0500–0545	35°34'–38'S, 149°00'W	19.6	1	46	albacore regurgitum
25 Jan.	0830–1050	37°26'–38'S, 151°27'–37'W	18.8–18.9	4	57–70	albacore regurgitum
27 Jan.	1450	38°37'S, 152°00'W	17.6	2	62	albacore stomach
30 Jan.	1153	37°34'S, 153°11'W	18.8	2	60,66	albacore regurgitum
31 Jan.	0745	37°54'S, 154°48'W	18.7	2	66,72	albacore stomach
	1053	37°48'S, 155°06'W	18.7	1	53	albacore regurgitum
01 Feb.	0500–0535	37°44'S, 156°14'W	19.0	12	59–67	dip net and vessel lights
02 Feb.	0310–0450	39°59'S, 158°00'W	19.2	15	65–83	dip net and submersible light

Morphometric and meristic characters were determined using the procedures described by Hubbs and Lagler (1957), and Berry (1968) with respect to the lateral line. Measurements were made of fork length (FL), standard length (SL), body depth (BD), head length (HL), snout length (SnL), eye diameter (ED) (= orbit length), and pectoral fin length (PL). Additional measurements included the lengths of the curved and straight sections of the lateral line (LL Curv, LL Str), and the height of the largest scale in the curved section (Ht Curv) and the largest scute in the straight section (Ht Str). Measurements were made to the nearest 0.1 mm using vernier calipers and fine-point dividers where practical and a dissecting microscope fitted with an eye piece graticule for SnL, ED, Ht Curv, and Ht Str. Counts were made of dorsal and anal fin softrays, gill rakers on the first gill arch, and scales and scutes along the lateral line. The end points of the dorsal accessory lateral line (LL Acc) and the curved section of the lateral line were measured with reference to the nearest dorsal softray.

DESCRIPTION

The morphometrics and meristics of *Trachurus murphyi* from the central South Pacific are shown in Table 2. The color of live specimens is dark blue dorsally to a line slightly above the lateral midline, and silver-gray immediately below. The fins are clear, with numerous black speckles on the dorsal and caudal fins. In most specimens the operculum has a black spot on the upper posterior margin.

A total of 566 jack mackerel from the two *Townsend Cromwell* cruises, including the 40 specimens described here, was measured. Fork length ranged from 17 to 96 mm (mean FL = 60.7 mm, SD = 12.9 mm). Jack mackerel measured from the 1987 sample (n = 335) differed from the 1986 sample in the occurrence of 31 specimens between 17 and 40 mm length. Although fins appeared completely formed in this size range, specimens below about 35 mm could not be identified beyond genus because scales and scutes did not cover the entire length of the

TABLE 2.—Morphometric and meristic characters of juvenile *Trachurus murphyi* from the Subtropical Convergence Zone of the central South Pacific.

Character[1]	Range	No.	Mean	SD
Measurements (mm)				
FL	52.4–90.3	40	73.4	7.2
SL	46.6–83.1	40	66.4	6.9
	as percent of SL			
BD	19.6–22.5	40	20.6	0.7
HL	26.8–31.9	40	28.6	0.9
SnL	7.6– 9.8	40	8.6	0.4
ED	6.9– 9.4	40	8.0	0.5
PL	18.1–21.8	39	20.3	0.8
LL Curv	31.6–38.6	40	35.3	1.7
LL Str	35.1–41.2	40	37.8	1.2
Ht Curv	3.2– 4.7	40	4.1	0.4
Ht Str	3.9– 5.4	40	4.8	0.4
	as percent of HL			
SnL	28.3–33.8	40	30.2	1.1
ED	25.0–32.1	40	28.0	1.4
Ht Curv	10.0–17.4	40	14.3	1.7
Ht Str	12.2–19.6	40	16.8	1.7
Ht Str/Ht Curv	1.05–1.30	40	1.18	0.07
LL Str/LL Curv	0.95–1.27	40	1.07	0.07
Counts				
Dorsal softrays	30–35	37	33.2	1.4
Anal softrays	26–31	37	28.5	1.2
Scales Curv	48–58	40	52.8	2.5
Scales and scutes Str	43–53	40	48.4	2.8
Scales and scutes total	96–111	40	101.2	3.2
End point LL Acc	1– 5	40	1.9	1.0
End point LL Curv	8–11	40	9.5	0.7
Gill rakers - upper limb	14–18	38	15.5	0.8
- lower limb	40–45	38	41.9	1.5
- total	54–61	38	57.4	1.8

[1]See text page 274 regarding abbreviations.

lateral line and the accessory lateral line was not visible. In fish smaller than 25 mm FL the lateral line was not fully developed, but the specimens had the typical shape, pigmentation pattern, and procumbent dorsal spine of *Trachurus* juveniles (Haigh 1972). Jack mackerel collected on *Coriolis* were too digested to measure accurately, but from general body size they were similar to the *Townsend Cromwell* samples.

SURFACE DISTRIBUTION

Trachurus murphyi is a schooling, pelagic species found along the west coast of South America from northern Peru and the Galapagos Islands to southern Chile (Gutierrez 1986). Eggs and larvae have been found over 1,000 km from this coastline (Santander and de Castillo 1971; Gutierrez 1986), and recently two larvae and a juvenile were caught in the Subtropical Convergence Zone at lat. 39°42′S, long. 125°46′W and 40°46′S, long. 139°28′W respectively (Evseenko 1987). In addition, adults have recently been discovered off the east coast of New Zealand, particularly over the Chatham Rise (Kawahara et al. 1988). The surface distribution of juvenile *Trachurus murphyi* shown in Figure 1 was drawn from the positions where they were netted or found in albacore stomachs. The limits of the distribution are from lat. 34°35′S to 42°02′S and long. 127°00′ W to 165°00′W. These limits reflect the cruise tracks and fishing effort of *Townsend Cromwell* and *Coriolis*.

Albacore from the *Townsend Cromwell* and *Coriolis* survey areas had similar diets. *Trachurus murphyi* occurred in 93% of the 174 stomachs examined that contained food (66 stomachs from TC-86-01, 72 from TC-87-01, and 36 from Prosgermon87) and comprised 90% of the diet by volume. That albacore fed so heavily on a single prey species in the two areas suggests that *T. murphyi* are relatively abundant and probably present in the unsurveyed area between 140°W and 147°W. Albacore caught to the west of 165°W during the same periods (9 fish from TC-86-01 and 126 from RV *Kaharoa*[5] cruises K03/86 and K04/87) had not fed on *T. murphyi* or other jack mackerel. Unfortunately the number of albacore caught between the easternmost edge of the Chatham Rise (about 175°W) and 165°W was very low and the presence or absence of jack mackerel can not be inferred.

The present study indicates that jack mackerel occur in the area of the Subtropical Convergence Zone encountered by *Townsend Cromwell* (Laurs et al.[6,7]) and in Subtropical Surface Waters to the north. The Subtropical Convergence Zone is characterized by summer surface temperatures of 15° to 18°C (Roberts 1980; Heath 1985); during this study jack mackerel occurred in temperatures of 16.4° to 21.3°C. During cruise TC-87-01 jack mackerel were found in water 0.5° to 3.0°C warmer than in 1986. This may be due to the greater amount of fishing effort in more northern waters in 1987.

DISCUSSION

Body features most often used to separate and identify *Trachurus* species include the number of scales and scutes along the lateral line, the height (or depth) of the largest of these scales and scutes, the endpoint of the accessory lateral line, and the number of gill rakers and dorsal and anal softrays (Berry and Cohen 1974; Shaboneyev and Kotlyar 1979; Stephenson and Robertson 1977). Three species of *Trachurus* are recognized from the South Pacific: *T. declivis* and *T. novaezelandiae* from temperate waters of New Zealand and Australia (Stephenson and Robertson 1977), and *T. murphyi*. The latter can be separated from the former two species by having on average 18 more scales and scutes along the lateral line.

The juvenile *Trachurus murphyi* examined here are identical in most respects with published descriptions of the species (Table 3) and closely resemble the large jack mackerel from New Zealand waters identified as *T. murphyi* by Kawahara et al. (1988). Unfortunately, Evseenko (1987) did not provide a description of his juvenile *T. murphyi* from the central South Pacific.

A noticeable difference with the present specimens is the significantly fewer gill rakers as compared with the descriptions of Shaboneyev and Kotlyar (1979) (Z test, $P < 0.05$) and Berry and Cohen (1974) (Student's t test, $P < 0.05$, df = 48). This difference is probably related to the size of fish examined as Ahlstrom and Ball (1954) found a similar difference in gill raker number between juveniles and adults of the closely related *T. symmetricus*. Other diagnostic features appear com-

[5]Ministry of Agriculture and Fisheries, Fisheries Research Centre, P.O. Box 297, Wellington, New Zealand.

[6]Laurs, R. M., K. A. Bliss, and J. A. Wetherall. 1986. Preliminary results from R/V *Townsend Cromwell* South Pacific albacore research survey. Southwest Fish. Cent. La Jolla Lab., Natl. Mar. Fish. Serv., NOAA, Admin. Rep LJ-86-13, 80 p.

[7]Laurs, R. M., K. Bliss, J. Wetherall, and B. Nishimoto. 1987. South Pacific albacore fishery exploration conducted by U.S. jig boats during early 1987. Southwest Fish. Cent. La Jolla Lab., Natl. Mar. Fish. Serv., NOAA, Admin. Rep LJ-87-22, 31 p.

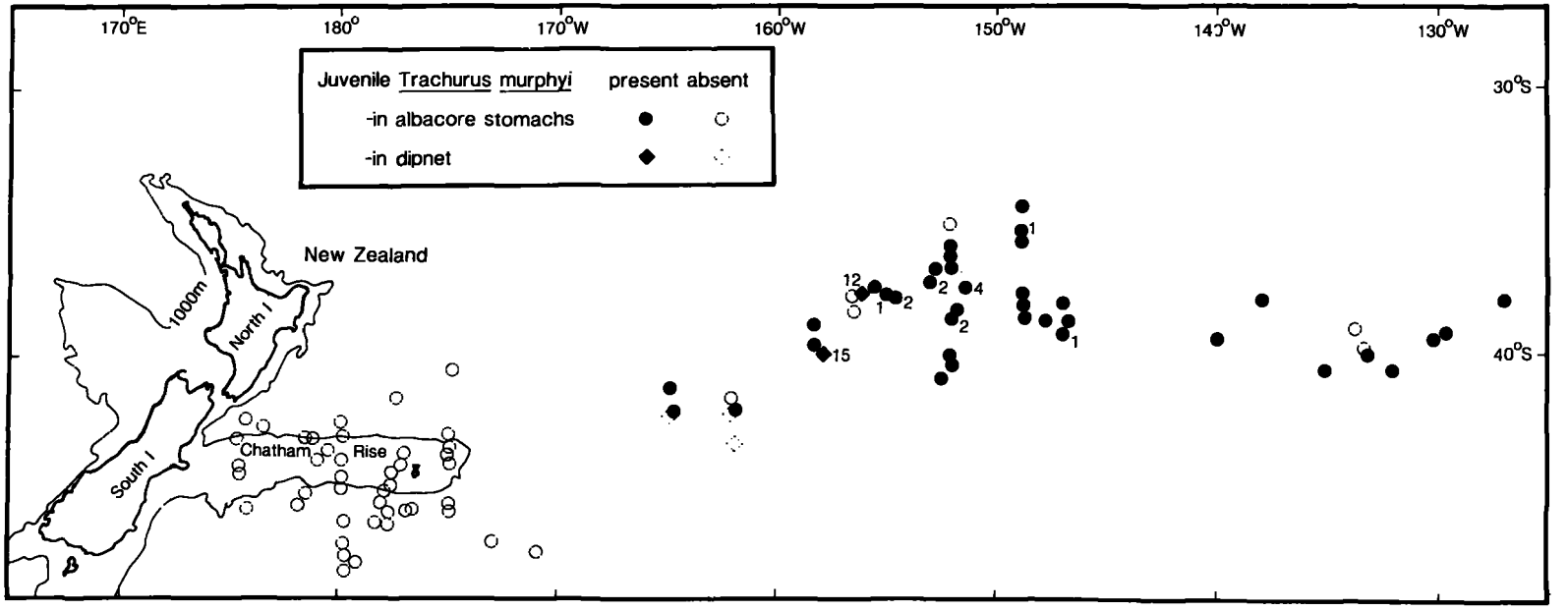

FIGURE 1.—The surface distribution of juvenile *Trachurus murphyi* from the Subtropical Convergence Zone of the central South Pacific, January-March 1986 and 1987. (numbers refer to the 40 specimens examined here)

TABLE 3.—Comparison of meristic and morphometric characters of *Trachurus murphyi* (numbers shown are range and mean).

Distinguishing character[1]	Present study juveniles	Hildebrand (1946) juveniles	Hildebrand (1946) adults	Berry and Cohen (1974) juveniles & adults	Shaboneyev and Kotlyar (1979) adults
Size range (SL mm)	46–83	60–117	485–497	94–552	233–475 (FL)
Number examined	40	—	7	17	250
Scales and scutes					
number Curv	48–58 (52.8)	—	—	51–56 (53.0)	46–55 (50.9)
number Str	43–53 (48.4)	—	—	41–50 (44.8)	44–56 (49.4)
number total	96–111 (101.2)	—	93–104	94–106 (97.8)	92–107 (100.3)
Ht Curv (%SL)	3.2– 4.7 (4.1)	—	—	4.6–5.6	3.1– 5.1 (4.1)
Ht Str (%SL)	3.9– 5.4 (4.8)	—	—	4.8–5.7	4.1– 5.9 (5.3)
Ht Curv (%HL)	10.0–17.4 (14.3)	15.9–17.5	17.0–20.0	—	11.0–18.6 (14.4)
Ht Str (%HL)	12.2–19.6 (16.8)	15.9–21.3	16.1–18.9	—	13.8–21.7 (17.3)
Endpoint LL Acc	1–5 (1.9)	—	—	1–5	[2]2–7 (4.2)
Gill rakers					
upper limb	14–18 (15.5)	—	15–17	15–18 (16.5)	14–23 (17.2)
lower limb	40–45 (41.9)	—	45–48	42–45 (43.9)	39–49 (44.7)
total	54–61 (57.4)	—	—	58–63 (60.4)	57–68 (61.9)
Softrays					
dorsal	30–35 (33.2)	—	30–33	30–36 (33.6)	[2]32–38 (34.0)
anal	26–31 (28.5)	—	25–27	27–31 (28.9)	[2]26–33 (29.5)

[1]See text page 274 regarding abbreviations.
[2]Included in these counts is the first spine of the second dorsal fin and anal fin.

pletely formed in the juveniles, for example, Santander and de Castillo (1971) noted that fin formation was complete in *T. murphyi* of 13 mm SL. In other *Trachurus* species lateral line scales and scutes are well developed by 35 mm (Ahlstrom and Ball 1954; Haigh 1972; Stephenson and Robertson 1977).

There are significant differences in the numbers of scales and scutes along the curved and straight sections of the lateral line between the present specimens and those described by Berry and Cohen (1974) (Student's t test, $P < 0.05$, df = 51), Shaboneyev and Kotlyar (1979) (Z test, $P < 0.05$), and Kotlyar (1976) (Z test, $P < 0.05$). These differences may be due to how the dividing line between the two sections is defined. When the curved and straight sections are combined into single counts along the entire lateral line, the present specimens only differ significantly from those of Berry and Cohen (1974).

Evseenko (1987) suggested that *Trachurus murphyi* has a spawning area centered on the Subtropical Convergence Zone extending from Chile to between 150°W and 160°W. He based his suggestion on an average transport figure for the area, growth data of *T. symmetricus* and the occurrence of one juvenile and two larvae in the central South Pacific. Results from the present study verifies his suggestion in the central South Pacific and, by using a similar approach, extends the probable spawning area westward to include the Chatham Rise.

It is apparent that *Trachurus murphyi* is found and likely to spawn across the South Pacific from New Zealand to Chile. The abundance of juveniles in the Subtropical Convergence Zone between 127°W and 165°W further suggests that a large commercial resource may exist in the central and western parts of the South Pacific.

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