

SCOMBEROMORUS BRASILIENSIS, A NEW SPECIES OF SPANISH MACKEREL FROM THE WESTERN ATLANTIC

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ABSTRACT

Scomberomorus brasiliensis is most closely related to *S. sierra* of the eastern tropical Pacific and more distantly related to *S. maculatus* and *S. regalis* of the western Atlantic and to *S. tritor* of the eastern Atlantic. It differs from all four of these species in having a shorter pelvic fin (3.6-5.9% fork length, \bar{x} 4.53 compared with 4.4-7.1% in the other four species, means 5.07-5.71). *Scomberomorus brasiliensis* differs sharply from *S. maculatus* with which it has previously been confused in having fewer vertebrae (47-49 compared with 50-53). *Scomberomorus brasiliensis* is a more southern species than *S. maculatus*, occurring along the Atlantic coasts of Central and South America from Belize to Rio Grande do Sul, Brazil, while *S. maculatus* is confined to the Gulf of Mexico and the Atlantic coast of the United States.

RESUMO

Scomberomorus brasiliensis é uma espécie estreitamente relacionada com *S. sierra*, do Pacífico Oriental Tropical, tendo também relação com *S. maculatus* e *S. regalis*, do Atlântico Ocidental e *S. tritor*, do Atlântico Oriental. Diferencia-se dessas quatro espécies por ter a nadadeira ventral de menor tamanho (3,6-5,9% do comprimento zoológico, \bar{x} 4,53, comparado a 4,4-7,1% nas outras quatro espécies, que tem médias de 5,07 a 5,71). *Scomberomorus brasiliensis* difere claramente de *S. maculatus*, com a qual foi confundida anteriormente, por apresentar menor número de vértebras (47-49 comparado a 50-53). *Scomberomorus brasiliensis* ocorre na costa Atlântica da América Central e América do Sul, desde Belize (Honduras britânica) até o Rio Grande do Sul (Brasil), enquanto *S. maculatus* está confinada ao Golfo de México e à costa Atlântica dos Estados Unidos.

While revising the tribe Scomberomorini (Collette and Russo in prep.), two apparently undescribed species of *Scomberomorus* were discovered, one from Australia and New Guinea and the other from the Atlantic coasts of Central and South America. Because completion of the revision will be delayed and because Atlantic Spanish mackerels are of recreational and commercial fishing concern, we describe the Atlantic species herein. Naming of this species adds one to the currently recognized (Rivas 1951; Mago Leccia 1958) three species of western Atlantic *Scomberomorus*—the king mackerel, *S. cavalla* (Cuvier), Spanish mackerel, *S. maculatus* (Mitchill); and cero, *S. regalis* (Bloch).

METHODS AND MATERIALS

The methods of counting, measuring, and dissecting are those used by Gibbs and Collette (1967) in revising *Thunnus* and by Collette and Chao (1975) in revising the Sardini. Extensive anatomical data on the undescribed species will be presented in a future revision of the Scomberomorini by Collette and Russo. Only relevant diagnostic characters plus standard descriptive meristic and morphometric data are presented here. Statistical tests were performed on the IBM 370-148 computer⁴ at the George Washington University using computer programs written for the revision of the genus *Scomberomorus* following the statistical methods presented by Zar (1974).

Material examined is in the following collections: ANSP (Academy of Natural Sciences, Philadelphia); BMNH (British Museum, Natural History, London); CAS (California Academy of

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⁴Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Sciences, San Francisco); FMNH (Field Museum of Natural History, Chicago); LACM (Los Angeles County Museum of Natural History); MCZ (Museum of Comparative Zoology, Harvard University); MNHN (Museum National d'Histoire Naturelle, Paris); MPIP (Museu de Pesca do Instituto de Pesca, Santos); MZUSP (Museu de Zoologia da Universidade de São Paulo); NHMV (Naturhistorisches Museum, Vienna); NMC (National Museum of Canada, Ottawa); RMNH (Rijksmuseum van Natuurlijke Historie, Leiden); ROM (Royal Ontario Museum, Toronto); SIO (Scripps Institution of Oceanography, La Jolla); SU (Stanford University, specimens now at CAS); UDONECI (Universidad de Oriente, Nueva Esparta, Centro de Investigaciones, Venezuela); UF (Florida State Museum, University of Florida, Gainesville); UMML (Rosenstiel School of Atmospheric and Marine Science, University of Miami); USNM (National Museum of Natural History, Washington, D.C.); ZMA (Zoological Museum, Amsterdam); ZMH (Zoologisches Institut und Zoologisches Museum, Hamburg); ZMK (Zoological Museum, Copenhagen).

SERRA SPANISH MACKEREL

Scomberomorus brasiliensis n.sp.

Diagnosis.—A spotted species of Spanish mackerel without a dip in the lateral line, without scales covering the pectoral fins, with a moderate number of vertebrae (47-49, usually 48) and gill rakers (12-16, usually 13-15), and with a short pelvic fin (3.6-5.9% FL).

Scomberomorus brasiliensis is most closely related to *S. sierra* Jordan and Starks of the eastern tropical Pacific and more distantly to *S. maculatus* (Mitchill) of the western Atlantic and to *S. tritor* (Cuvier) of the eastern Atlantic. It differs from *S.*

maculatus in having fewer vertebrae (47-49 compared with 50-53, Table 1).

Morphometrically, *S. brasiliensis* differs from its four closest relatives in having a much shorter pelvic fin (Figure 1): 3.56-5.86, $\bar{x} = 4.53\%$ FL compared with *S. sierra* (4.71-6.37, $\bar{x} = 5.51$), *S. maculatus* (4.59-5.76, $\bar{x} = 5.71$), *S. tritor* (4.97-7.14, $\bar{x} = 5.07$), and *S. regalis* (4.41-6.33, $\bar{x} = 5.54$). The linear regression of pelvic fin length on fork length was tested by analysis of covariance. The slopes of the regression lines of all five species were not significantly different at the 0.01 level of significance (Table 2). The elevations of the five regression lines were significantly different at the 0.001 level ($P < 1.0 \times 10^{-7}$). The Student Newman-Keules multiple range test indicates that the elevations of the regression lines for *S. sierra*, *S. maculatus*, *S. tritor*, and *S. regalis* were not significantly different ($P > 0.2$); however, *S. brasiliensis* was found to be different from the other four species ($P < 0.001$). Data from *S. maculatus*, *S. sierra*, *S. tritor*, and *S. regalis* were resubmitted to analysis of covariance after removal of *S. brasiliensis*. This reduced the calculated *F* from 54.72 to 6.79 showing that most of the variance was caused by inclusion of *S. brasiliensis* with four other more or less homogeneous species.

TABLE 2.—Regression equations of pelvic fin length on fork length for five species of *Scomberomorus*.

Species	N	Y intercept	Slope	Coefficient of determination (r^2)
<i>S. tritor</i>	30	2.137	0.053	0.965
<i>S. brasiliensis</i>	49	-0.013	0.045	0.963
<i>S. sierra</i>	50	1.510	0.051	0.957
<i>S. maculatus</i>	32	1.029	0.054	0.960
<i>S. regalis</i>	37	1.179	0.051	0.933

Description.—Lateral line without a prominent dip in the region of the second dorsal fin (present only in *S. cavalla* among American and Atlantic

TABLE 1.—Numbers of precaudal, caudal, and total vertebrae in five species of *Scomberomorus*.

Species	Precaudal						Caudal						Total															
	18	19	20	21	22	N	\bar{x}	26	27	28	29	30	31	32	N	\bar{x}	45	46	47	48	49	50	51	52	53	N	\bar{x}	
<i>S. tritor</i> (E. Atlantic)	6	30				36	18.8	2	30	4					36	27.1	6	29	1							36	45.9	
<i>S. brasiliensis</i> (W. Atlantic):																												
Central and northern																												
South America			24	2		26	20.1			4	21				25	27.8			3	21	2					26	48.0	
Brazil		2	59	1		62	20.0			6	53	3			62	28.0			8	50	4					62	47.9	
<i>S. sierra</i> (E. Pacific):																												
Mexico		2	14	2		18	20.0			3	12	3			18	28.0			2	14	2					18	48.0	
Central and South America			16	1		17	20.1			3	13	1			17	27.9			2	14	1					17	47.9	
<i>S. maculatus</i> (W. Atlantic):																												
Eastern United States				23	4	27	21.1					9	18	1	28	30.7							5	20	3	28	51.9	
Gulf of Mexico				16	2	18	21.1					1	10	7	18	30.3						1	9	7	1	18	51.4	
<i>S. regalis</i> (Caribbean)		5	47	2		54	19.9			5	36	13			54	28.1			4	42	9					55	48.1	

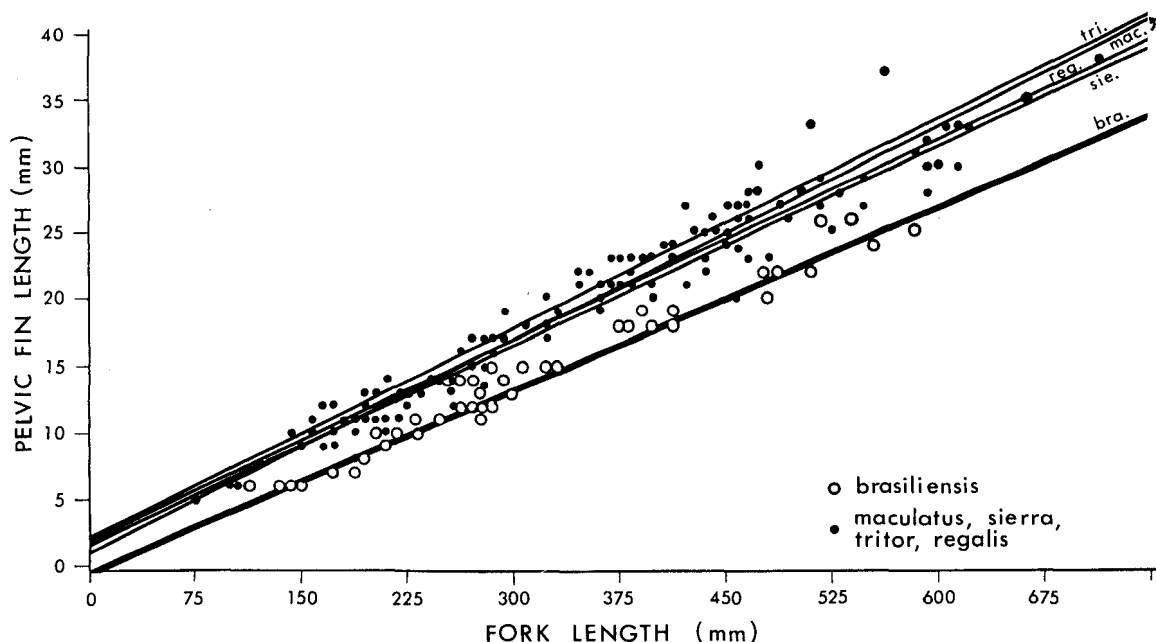


FIGURE 1.—Regression of pelvic fin length on fork length in five species of *Scomberomorus*. The regression line for *S. brasiliensis* is significantly different from those for *S. maculatus*, *S. sierra*, *S. tritor*, and *S. regalis*. The regression lines for these four species do not differ significantly from each other so the same symbol is used for plotting specimens of the four species.

species). Pectoral fin without scales (covered with scales in *S. regalis*). Vertebrae (19-21) + (27-29) = 47-49 usually 20 + 28 = 48. Gill rakers (1-3) + 1 + (9-12) = 11-16, usually 13-15 (Table 3) more than in *S. cavalla* (7-12) and many fewer than in *S. concolor* (21-27). Pectoral fin rays 21-24, usually 22 or 23, usually 21 in *S. tritor*, *S. sierra*, and *S. maculatus*, 21 or 22 in *S. regalis* (Table 4). Dorsal spines 17-19, usually 17 or 18; second dorsal fin rays 17-19; dorsal finlets 8-10; anal fin rays 18-20; anal finlets 8-10, usually 8 or 9. Morphometric data are summarized in Table 5. Intestine with three limbs and two folds (Figure 2).

Sides with several rows of round yellowish-bronze (in life) spots similar to *S. maculatus* and *S.*

TABLE 4.—Number of pectoral fin rays in five species of *Scomberomorus*.

Species	Pectoral fin rays					N	\bar{x}
	20	21	22	23	24		
<i>S. tritor</i> (E. Atlantic)	1	19	9			29	21.3
<i>S. brasiliensis</i> (W. Atlantic):							
Central and northern							
South America		6	13	11	1	31	22.2
Brazil		2	24	14		40	22.3
<i>S. sierra</i> (E. Pacific):							
Mexico	7	16	7			30	21.0
Central and South America	4	18	7	1	1	31	21.3
<i>S. maculatus</i> (W. Atlantic):							
Eastern United States	2	13	5			20	21.2
Gulf of Mexico		13	1			14	21.1
<i>S. regalis</i> (Caribbean)		15	17	4		36	21.7

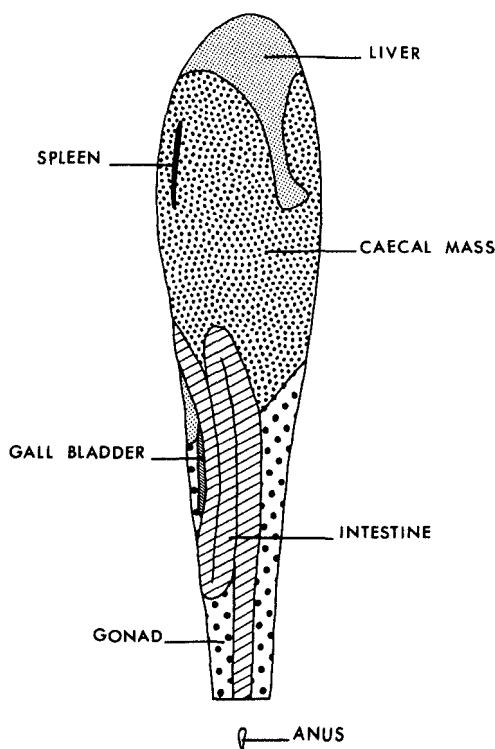
sierra but without any lines or streaks such as are present in *S. regalis*. The number of yellowish-

TABLE 3.—Numbers of upper, lower, and total gill rakers on the first gill arch in five species of *Scomberomorus*.

Species	Upper					Lower					Total					N	\bar{x}										
	1	2	3	4	\bar{x}	9	10	11	12	13	14	\bar{x}	11	12	13			14	15	16	17	18					
<i>S. tritor</i> (E. Atlantic)																											
<i>S. brasiliensis</i> (W. Atlantic):																											
Central and northern																											
South America		14	7		21	2.3	1	2	10	8		21	11.2	1	2	6	9	3						21	13.5		
Brazil	1	68	35		104	2.3						103	11.4												103	13.7	
<i>S. sierra</i> (E. Pacific):																											
Mexico		9	20	4	33	2.8					11	15	6	1	33	11.9									33	14.8	
Central and South America		2	31	1	34	3.0					1	5	13	13	2	34	12.7								34	15.3	
<i>S. maculatus</i> (W. Atlantic):																											
Eastern United States		13	6	1	20	2.4	2	8	7	2	1	20	10.6	2	5	7	4	1	1						20	13.0	
Gulf of Mexico	1	13			14	1.9						14	11.2													14	13.1
<i>S. regalis</i> (Caribbean)		8	26	4	38	2.9	1	4	12	17	4	38	12.5	1	2	2	16	11	5	1					38	15.4	

TABLE 5.—Summary of morphometric data of *Scomberomorus brasiliensis* expressed as percent fork length.

Character	N	\bar{x}	Min	Max	SD
Snout-anal distance	51	53.80	51.21	69.19	2.67
Snout-second dorsal distance	51	51.13	48.31	67.21	2.64
Snout-first dorsal distance	51	24.09	19.65	33.69	2.10
Snout-pelvic distance	51	25.15	21.75	35.86	2.21
Snout-pectoral distance	51	21.93	19.08	31.71	2.12
Pectoral-pelvic distance	50	10.83	8.75	15.95	1.12
Head length	51	21.20	12.12	30.90	2.34
Maximum depth	51	19.86	16.40	26.31	1.57
Maximum width	49	7.99	5.42	11.38	1.09
Pectoral length	51	12.29	9.66	14.32	1.00
Pelvic length	49	4.53	3.56	5.86	0.41
Pelvic insert-vent	49	27.51	23.87	34.86	1.65
Pelvic tip-vent	46	22.83	19.72	29.82	2.90
Base first dorsal	50	26.51	23.16	36.04	1.82
Height second dorsal	48	11.58	9.19	13.94	1.11
Base second dorsal	51	11.86	10.05	15.32	0.97
Height anal	48	11.30	8.27	14.86	1.18
Base anal	50	11.20	9.74	14.23	0.94
Snout (fleshy)	51	8.18	6.88	11.98	0.87
Snout (bony)	51	7.31	6.16	10.18	0.70
Maxillary length	50	12.23	8.16	18.83	1.50
Post orbital distance	51	9.48	8.43	12.70	0.69
Orbital (fleshy)	51	3.73	2.70	5.74	0.62
Orbital (bony)	51	5.27	4.15	7.66	0.71
Interorbital distance	51	5.66	4.78	10.65	0.83
Second dorsal-base caudal peduncle	50	49.34	42.75	59.37	3.29

FIGURE 2.—Ventral view of viscera in *Scomberomorus brasiliensis*, 556 mm FL, Belém, Brazil, dissected 17 June 1975.

bronze spots on the sides of the body increases with the size of the fish, young specimens (200 mm) have about 30 spots; adults more, 45 spots (422 mm), 47 (455), 46 (470), 45 (516), and 58 (530). The spots are arranged in 3 or 4 rows (sometimes in 2 rows). The rows are not very well defined but it is possible to recognize them. The spots in *S. maculatus* are not arranged in rows.

The first dorsal fin is black in the anterior half (first 7 membranes) and the posterior half is white with the upper edge black. Pectoral fin dusky; pelvic and anal fins white. In young specimens (192-240 mm) (collected from estuarine waters) the caudal and pectoral fins are yellow (in the pectoral fin, yellow over the dusky color) and the whole body and the anal fin are slightly yellow.

Range.—Atlantic coasts of Central and South America from Belize at least as far south as Lagoa Tramandaí, Rio Grande do Sul, Brazil (Figure 3). Not known to overlap with *S. maculatus* which occurs in the Gulf of Mexico and along the Atlantic coast of the United States. Replaced in the West Indies by *S. regalis*.

Material examined.—Inasmuch as there is abundant material from Brazil, and because further study might show some differentiation within the range of *S. brasiliensis*, the type-material is restricted to the specimens examined from Brazil.

Holotype.—USNM 217550 (502 mm FL); Belém market; 22 May 1975; B. B. Collette 1642.

Paratypes.—103 specimens (110-630 mm FL) from 54 Brazilian collections. USNM 217551-57 (7, 509-588); Belém market; May 1975; B. B. Collette 1639, 1642, and 1645. MCZ 17131 (1, 220); Pará (= Belém). NHMV uncat. (2, 410-538); Pará; Brasil Exped.; Steindachner. NHMV uncat. (1, 325); Maranhão; Brasil Exped.; 1903. USNM 188424 (3, 153-281); *Oregon II* stn. 4250, 2°23'S, 40°31'W; 12 Mar. 1973. CAS-SU 52981 (1, 483); Ceará, Fortaleza, Mucuripe. CAS-SU 52989 (1, 359); Ceará, Fortaleza. CAS-SU 52988 (1, 300); Ceará, Fortaleza. CAS-SU 52987 (1, 220); Ceará, Fortaleza. MZUSP 13263-4 (2, 375-405); Ceará; May 1976. MPIP 0001-2 (2, 354-380); Ceará; May 1976. MZUSP 13262 (1, 385); axial skeleton; Rio Grande do Norte; Feb. 1976. CAS-SU 52971 (1, 340); Pernambuco, Recife. CAS-SU 52973 (1, 236); Pernambuco, Recife. MCZ 48894 (2, 392-412); Recife market; Equalant Exped.; *Chain*; R. H. Bakus;

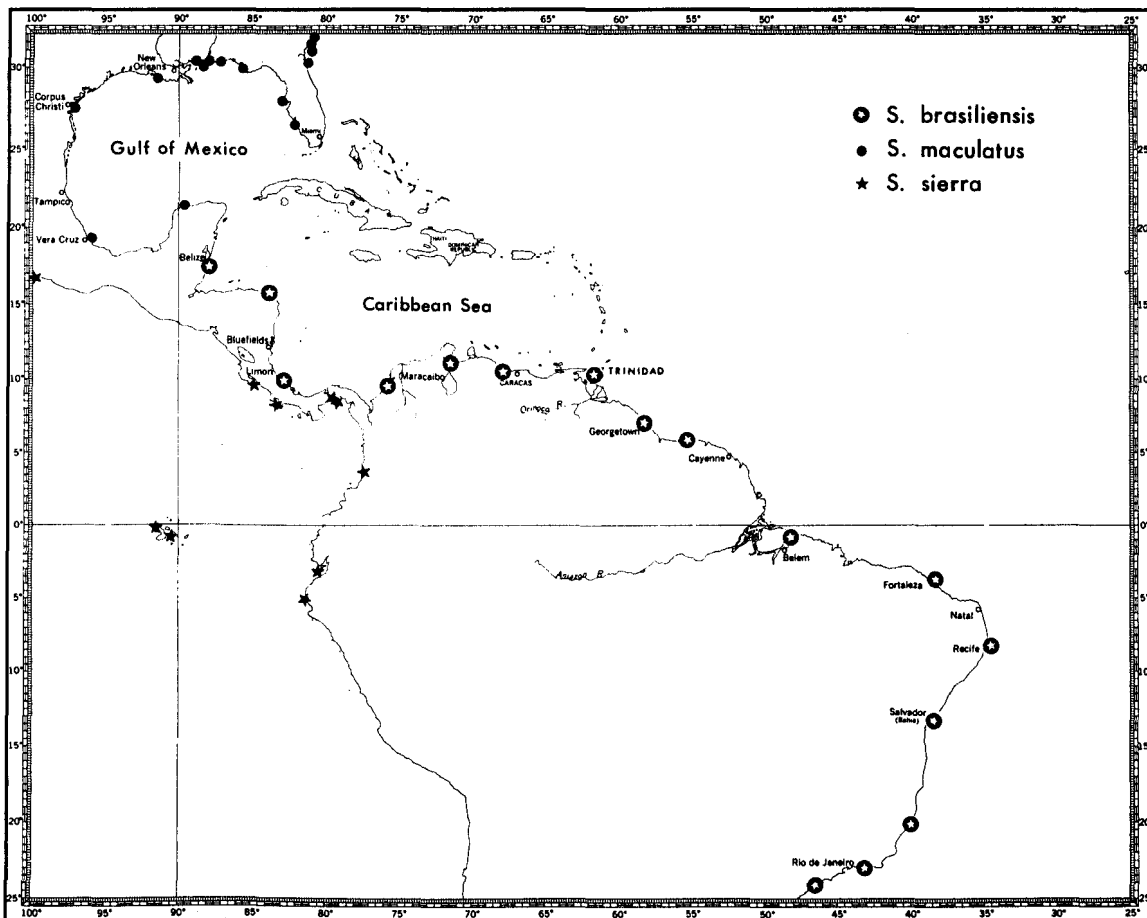


FIGURE 3.—Distribution of *Scomberomorus brasiliensis* (stars in circles) and adjacent populations of *S. maculatus* (dots) and *S. sierra* (stars). The ranges of *S. maculatus* and *S. sierra* extend farther north and that of *S. brasiliensis* farther south.

3 Mar. 1963. NHMV uncat. (1, 378); Pernambuco; Brasil Exped.; Steindachner; 1904. CAS-SU 52983 (1, 403); Bahia, Salvador, Soburá. MZUSP 13265-7 (3, 278-319); Bahia; Dec. 1976. MPIP 0003 (1, 292); Bahia; Dec. 1976. MPIP 0004 (1, 407); axial skeleton; Bahia; Jan. 1977. MZUSP 13628-9 (2, 283-354); axial skeleton; Jan. 1977. CAS-SU 52972 (1, 196); Espírito Santo, Vitória. MZUSP 13270 (1, 483); Espírito Santo; Dec. 1976. MZUSP 13271-2 (2, 424-462); axial skeleton; Espírito Santo; Dec. 1976. MPIP 0005 (1, 477); axial skeleton; Espírito Santo; Jan. 1977. MCZ 877 (3, 270-300); Rio de Janeiro. MCZ 17261 (1, 252); Rio de Janeiro. MCZ 17236 (8, 234-307); Rio de Janeiro. MCZ 23802 (1, 630); Rio de Janeiro. BMNH 1896.6.29.9 (1, 480); Rio de Janeiro; Capt. Milner. BMNH 1923.7.30.305 (1, 395); Rio de Janeiro; Ternetz. ZMH 4029 (1, 282); Rio de Janeiro; 1885.

NHMV 1874.I.532a (2, 253-284); Rio de Janeiro; Steindachner. NHMV 76740 (3, 255-286); Rio de Janeiro; 1857-59. MZUSP 13273-6 (4, 251-420); axial skeleton; Rio de Janeiro; Jan. 1976. MPIP 0006 (1, 435); Rio de Janeiro; May 1976. MPIP 0007-8 (2, 372-374); Rio de Janeiro; June 1976. MZUSP 13277 (1, 394); Rio de Janeiro; June 1976. CAS-SU 52985 (1, 490); São Paulo, Santos. CAS-SU 52984 (1, 383); São Paulo, Santos. MZUSP 878 (1, 110); São Paulo; Miranda Ribeiro; 1913. MZUSP 13279-80 (2, 304-365); axial skeletons; São Paulo; Dec. 1976. MZUSP 13281-8 (8, 187-203) axial skeletons; São Paulo, Cananéia; Feb. 1977. MZUSP 13289 (1, 240); São Paulo, Cananéia; Feb. 1977. MPIP 0009-12 (4, 196-201); axial skeletons; São Paulo, Cananéia; Feb. 1977. MZUSP 13278 (1, 353); São Paulo; July 1977. MZUSP 13290-1 (2, 340-450); axial skeletons;

Santa Catarina; Aug. 1976. MPIP 0013 (1, 425); Santa Catarina; Aug. 1976. MZUSP 1329-30 (2, 405-600); Santa Catarina; Dec. 1976. MPIP 0014 (1, 405); Santa Catarina; Dec. 1976. MZUSP 13294 (1, 372); axial skelton; Santa Catarina; Jan. 1977. CAS-SU 52986 (1, 416); Rio Grande do Sul. MZUSP 13295-6 (2, 240-245); Rio Grande do Sul. Lagõa Tramandai; May 1977; MCZ 17158 (4, 136-216); Brazil.

Other material.—28 specimens (111-520 mm FL) from 15 collections arranged here by country from north to south. BELIZE: BMNH 1864.1.26.304-5 (2, 217-230); Salvin. HONDURAS: UF-TABL 67-106 (1, 243); 15°21'N, 83°34'W; 10 Apr. 1967. COSTA RICA: 3(172-194) from 2 collections. LACM 30727-13 (2, 191-194); Canuita Bay; W. Bussing and party. LACM 30726-3 (1, 172); Canuita Bay; W. Bussing and party. PANAMA: 4(114-225) from 2 collections. ANSP 86721 (1, 225); Balboa; 5th G. Vanderbilt Exped.; 11-14 Apr. 1941. ANSP 45270 (3, 114-182); Colon market; D. E. Hanover; June 1945. COLOMBIA: USNM 217433 (1, 326); *Choco* cruise 6908, stn. 127, 9°22.1'N, 75°36.4'W; 6 Sept. 1969. VENEZUELA: 9(89-520) from 3 collections. ZMA 114.581 (1, 520); Puerto Cabello; 10 Aug. 1905. USNM 121802 (2, 296-330); Maracaibo market; L. P. Schultz; 15 May 1942. UDONECI 1071 (6, 89-198); Peder-nales; 3 July 1974. TRINIDAD: 8(260-311) from 5 collections. BMNH 1931.12.5.173 (1, 260); Gulf of Paria; Totten, *Rodney*. ANSP 94311 (2, 278-311); Brighton Pier; L. Wehekind; 10 May 1930. ANSP 94325 (2, 280-287); Brighton Pier No. 2; L. Wehekind; 7 May 1930. ANSP 94329 (2, 268-289); Brighton Pier No. 2; L. Wehekind; 17 May 1930. UF-TABL uncat. (1, 233); M/V *Calamar* cruise 67-B, stn. 260; 13 Nov. 1967. SURINAM: RMNH 24764 (1, 111).

DISCUSSION

Although it is a common fish, *Scomberomorus brasiliensis* has not been formally described because adults closely resemble *S. maculatus* in their spotted pattern. The juveniles are similar to *S. regalis* in having low vertebral counts (47-49) and have probably been confounded with that species (which is actually uncommon in the range of *S. brasiliensis* off the coasts of Central and South America).

A fairly extensive literature pertains to *S. brasiliensis* (as *S. maculatus*) dating back to

Ribeiro (1915). Particularly important are a series of 30 papers on various biological and fisheries aspects of *S. brasiliensis* from Laboratório de Ciências do Mar da Universidade Federal do Ceará at Fortaleza, Brazil. Bastos (1966) summarized morphometric and meristic data for 90 specimens (163-553 mm FL). His gill raker counts (usually $2 + 1 + 11 = 14$ or $3 + 1 + 11 = 15$) agree closely with ours (Table 3). His vertebral counts (26 specimens with 46 and 55 specimens with 47) are 1 less than ours (Table 1) because he presumably did not include the hypural plate in his counts as we did. Menezes (1972) also counted gill rakers and found no differences between counts for 225 males and 275 females; the most typical count was $3 + 1 + 11 = 15$.

The digestive tract was studied both grossly and histologically by Mota Alves (1969). The histology of the pyloric caeca of *S. brasiliensis* was found similar to that found in *S. cavalla* by Mota Alves and Tomé (1970). The pyloric caeca were found to contain the same enzymes as the intestine in both species—lipase, maltase, and trypsin but the pyloric caeca in *S. brasiliensis* also contained pepsin which was restricted to the stomach in *S. cavalla*.

The food of *S. brasiliensis* in the State of Ceará was studied around the year by Menezes (1970). Fish composed the major part of the diet; penaeid shrimps and loliginid cephalopods also were important. The most important fishes were, in order: *Opisthonema oglinum*, Engraulidae, *Chloroscombrus chrysurus*, *Hemiramphus* sp., and *Haemulon* spp. The diet of *S. maculatus* in southeastern Florida is similar to this according to Klima (1959), consisting mostly of clupeids (especially *Harengula pensacolae*) plus *Penaeus*, engraulids, and other fishes.

Mota Alves and Tomé (1968a) reported on the sexual development of *S. brasiliensis* and recognized five developmental stages in the ovary. They also (1968b) described the sperm. Gesteira (1972) found that females first become sexually mature at about 460 mm FL at an age of III or IV. She presented equations for calculating fecundity based on length, age, and weight. Klima (1959) found that the smallest mature female *S. maculatus* from southeastern Florida was 250 mm FL and that both sexes matured at age I or II.

Length-frequency data for *S. brasiliensis* (and *S. cavalla*) were collected and published annually, starting with the data for 1962 and continuing through 1969 by Costa and Paiva and then for

1971-73 by Costa and Almeida (1974). For 32,514 specimens of *S. brasiliensis* measured from 1962 through 1973, the size range was 267-1,250 mm FL. Of 16,170 specimens measured between 1962 and 1968, 9 were longer than 950 mm FL: 6 (951-1,000); 1 (1,001-1,050); 1 (1,051-1,100); and 1 (1,201-1,250). More than 60% each year from 1962 to 1968 were in the size range 401-650 mm FL. *Scomberomorus maculatus* is a much smaller species; the largest of 1,279 specimens examined by Klima (1959) from southeastern Florida was 700 mm FL and most were between 300 and 500 mm. The length-weight relationship was determined by Nomura and Costa (1968) for Brazilian *S. brasiliensis*: for males $\log W = -2.2051 + 2.973 \log L$, and for females $\log W = -2.154 + 3.035 \log L$. For 1971-73, the age composition of the catch was II to X, concentrated at III to VI, and mostly III or IV (Costa and Almeida 1974).

Color pattern, possession of nasal denticles, lateral line curvature, and other characters suggest that *S. brasiliensis*, *S. sierra*, *S. maculatus*, and *S. tritor* are closely related. *Scomberomorus regalis* may also belong to this group of species and *S. concolor* Lockington of the eastern tropical Pacific is even more distantly related. *Scomberomorus cavalla* belongs to another species group, containing *S. commerson* (Lacepède). The center of origin of *Scomberomorus* appears to be in the Indo-West Pacific as is the case with many other groups of fishes. It appears likely that an ancestor of *S. tritor* crossed the Atlantic and populated the tropical western Atlantic and eastern Pacific. When the Panamanian isthmus emerged, this population was divided into two, which subsequently differentiated into *S. sierra* (eastern Pacific) and *S. brasiliensis*. *Scomberomorus maculatus* is presumably derived from the *S. sierra-brasiliensis* stock and developed a higher number of vertebrae along with its movements into more temperate waters along the U.S. east coast.

COMPARATIVE MATERIAL EXAMINED

Scomberomorus maculatus. East coast of United States: 24 specimens (163-712 mm FL) from 13 collections from Cape Cod, Mass.; New York; Cape Hatteras, N.C.; Charleston, S.C.; and Brunswick, Ga., at MCZ, NHMV, USNM, ZMH, and ZMK. Gulf of Mexico: 29 specimens (176-439 mm FL) from 16 collections from Captiva Key and St. Andrew Bay, Fla; Mobile, Ala.; Biloxi, Miss.; Atchafalaya Bay, La.; Aransas Bay, Tex.; Vera

Cruz, Mexico; and Progreso, Yucatan, Mexico at BMNH, MCZ, NHMV, USNM, and ZMK.

Scomberomorus sierra. SIO 62-338 (1,594), La Jolla, Calif. Mexico: 42 specimens (183-685 mm FL) from 22 collections from Baja California, Guaymas, Mazatlan, and Sonora at BMNH, CAS, LACM, MCZ, NHMV, SIO, and USNM including the lectotype SU 1720 (332 mm) from Mazatlan. Costa Rica: 6 specimens (237-515 mm FL) from 4 collections from Golfo Dulce and Golfo Nicoya at LACM. Panama: 15 specimens (226-605 mm FL) from 8 collections at FMNH, MCZ, NHMV, SU, USNM, and ZMH. Colombia: 8 specimens (202-260 mm FL) from Buenaventura at USNM. Peru: 4 specimens (135-460 mm FL) from 3 collections at LACM and NHMV. Galapagos: 4 specimens (422-621 mm FL) from 3 collections at ANSP, CAS, and NMC.

Scomberomorus tritor. Mediterranean: 2 specimens (365-475 mm FL) from Nice at NHMV and Florence. Gulf of Guinea: 36 specimens (69-600 mm FL) from 25 collections from the Canary Islands, Senegal, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Nigeria, and Angola at BMNH, CAS, MCZ, MNHN, NHMV, USNM, and ZMA including the holotype MNHN A.6871 from Gorée, Dakar.

Scomberomorus regalis. Caribbean: 40 specimens (77-525 mm FL) from 27 collections from Florida, Bahamas, Cuba, Haiti, Jamaica, Puerto Rico, Virgin Islands, Lesser Antilles, and Barbados at BMNH, MCZ, NHMV, ROM, USNM, ZMA, ZMH, and ZMK.

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