Abstract.- A study was made
of age, growth, and reproduction of
the king mackerel *Scomberomorus
cavalla* in Trinidad waters captured
by hook-and-line and drift gillnets.
Ages, estimated from otolith rings,
ranged from 0 to VII in males and
from 0 to X in females. Mean back-
calculated lengths in 99 males ranged
from 43.7 cm FL at the end of year
I to 85.9 cm FL at the end of year
VI, and in 233 females from 41.8 cm
FL at the end of year I to 105.6 cm
FL at the end of year VIII. The von
Bertalanffy growth equations were
for males, $L_\infty = 112.3 [1 - \exp(-0.18
(t + 1.80))]$ and for females $L_\infty = 140.1
[1 - \exp(-0.15(t + 1.52))]$. Based on
gonad examination of 97 males and
224 females, spawning takes place
throughout the year around the island,
with peak spawning from October
through March, a period associated
with low salinity. First spawning takes
place at ages I–II for both sexes.
Females predominated in all size
groups, with the proportion of males
increasing during the peak spawning
season.

Age, Growth, and Reproduction of the King Mackerel *Scomberomorus cavalla* (Cuvier) in Trinidad waters

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The king mackerel *Scomberomorus
cavalla* (Cuvier) (Scombridae) occurs
in coastal waters of the western At-
lantic ranging from the Gulf of Maine
to Rio de Janiero (Briggs 1958). It
has also been reported throughout
most of the West Indies (Erdman
1949), and its distribution is said to
extend eastwards to Africa (Jordan
et al. 1930). However, more recent
reviews (Collette and Russo 1979)
make no mention of *S. cavalla* in the
Eastern Atlantic, although it has
been reported from St. Paul's Rocks,
a group of small islands in the mid-
Atlantic (Lubbock and Edwards 1981).

Scomberomorus cavalla has commer-
cial and recreational value through-
out its range. Griffiths (1971) consid-
ered *Scomberomorus* spp., especially
S. cavalla and *S. maculatus* (= *S.
brasiliensis* Collette et al. 1978) to
have greater commercial potential
than the tunas in Venezuela. The gen-
eral biology of *S. cavalla* has been in-
vestigated in North American waters
(Beaumariage 1973) and off the state
of Ceara, northeastern Brazil, includ-
ing age and growth studies (Nomura
and Rodrigues 1967, Ximenes et al.
1978). Manooch et al. (1978) provided
a useful annotated bibliography on
this species, and many aspects of its
biology and fishery have been sum-
marized by Collette and Russo (1984).
More recent work includes studies on
reproduction (Finucane et al. 1986)
and growth (Manooch et al. 1987) in
North American waters.

In Trinidad, Whiteleather and Brown
(1945) and more recently Sturm et al.
(1984) reported that *S. cavalla* ap-
proached *S. maculatus* (= *S. brasili-
ensis*) as the most abundant continen-
tal pelagic species in commercial land-
ings. The *Scomberomorus* fishery in
Trinidad is artisanal and seasonal
from March through October, and *S.
cavalla* is caught mainly by hook-and-
line (trolling and live-bait fishing) and
drift gillnets (Sturm et al. 1984). This
paper provides information on age,
growth, and reproduction of *S. caval-
la* (the kingfish or thazard) in Trini-
dad waters.

Materials and methods

The climate of Trinidad is tropical,
with a wet season from June to De-
cember. The surrounding waters are
mainly estuarine. Surface tempera-
tures vary little, ranging from 27 to
29°C (van Andel and Postma 1954,
Edwards 1983). Further details of the
study area may be found in Sturm
(1978).

Fish were bought from artisanal
fishermen in 1981–82 at six beaches:
Maracas and Las Cuevas in the north,
Mayaro and Guayaguayare in the
southeast, and Cedros and Icacos in
the southwest of the island. Artisan-
al catches consisted mainly of both
Scomberomorus species, which on be-
ing landed were separated into bask-
ets. There were usually not more than
about a dozen boats fishing on any

one day from a beach, and catch per boat of *S. cavalla* was usually small (<20 fish). Not more than three catches were sampled up to a maximum of about 25 fish per sampling day, to enable accuracy of sample treatment in the field. Entire catches were sampled, and when this was not possible, large fish (>90 cm FL) and/or small fish (<50 cm FL), when present, were selected to direct attention to the ends of the distribution, and the rest of the sample was taken at random. A total of 363 fish was obtained, 190 from hook-and-line, 165 from gillnets (average stretched mesh size 113 mm), and eight from beach seines. In addition, 264 fish were measured at the Port of Spain Fish Market. Fish were measured to the nearest 0.5 cm fork length (FL) and weighed to the nearest 20 g. Gonads were weighed to the nearest 10 g.

Otoliths (sagittae) were used to age *S. cavalla*. When viewed in a black dish containing water in reflected light under a binocular microscope (×10), the otoliths revealed opaque and translucent rings. The non-marginal opaque rings were counted as annuli following Beaumariage (1973), Ximenes et al. (1978), Johnson et al. (1983), and Manooch et al. (1987), and distances were measured along the longitudinal axis from the focus to the distal edge of each opaque ring and to the edge of the otolith. One person read the otoliths.

The relationship between fork length and otolith radius was determined by regression analysis using both linear and quadratic models. When the relationship was established, fork length at age was back-calculated using methods of Bagenal and Tesch (1978).

The von Bertalanffy growth equation (1938)—$L_t = L_\infty [1 - \exp(-K(t + t_0))]$ where L_t = fork length at age t, L_∞ = asymptotic fork length, K = growth coefficient, and t_0 = time when length is theoretically zero—was fitted to weighted mean back-calculated lengths using an MS-DOS/BASIC version of a computer program by Sparre (1987).

Macroscopic stages of gonad development for both sexes were identified as described for *S. maculatus* (= *S. brasiliensis*) by Sturm (1978). They were immature-inactive, immature-developing, ripe, and ripe-running. The gonadosomatic index (GSI) was computed by dividing gonad weight by total fish weight and multiplying by 100.

Results

Size composition of material examined

Length frequencies of *Scomberomorus cavalla* samples from gillnets and hook-and-line were approximately similar. Hook-and-line apparently selected slightly
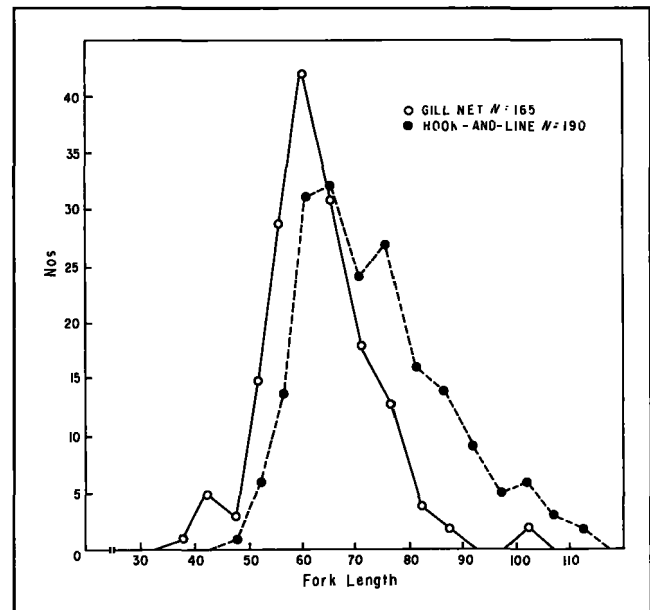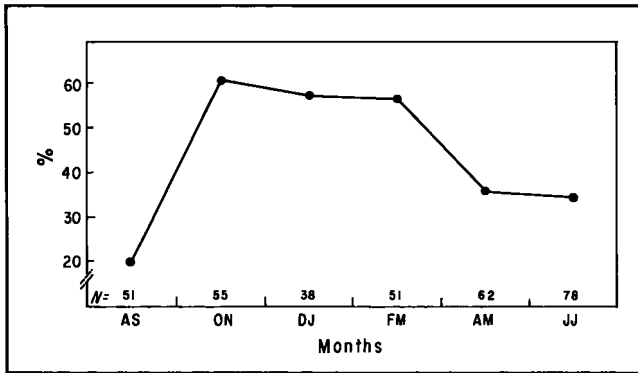

Figure 1
Length frequencies of gill net and hook-and-line samples of *Scomberomorus cavalla* from Trinidad waters. Lengths are grouped into 5-cm intervals. N = number of fish sampled.

larger fish—45–114.5 cm FL, with a modal length between 66 and 70 cm FL—than gillnets, which selected fish between 38.5 and 105 cm FL, with a modal length of between 61 and 65 cm FL (Fig. 1). The largest fish sampled was a 127-cm FL female caught in a beach seine. The size range of fish measured at the Port of Spain Fish Market was 37–135 cm FL with a modal length of 61–65 cm FL.

Age and growth

Only 2 of 341 otoliths were considered illegible. However, not all of the remaining 339 otoliths had clear rings, though 85% were read with confidence. The main difficulty was determining the extent of the first opaque ring. The remaining 15% (52) were reread, with 79% (41) agreement between the two readings. The remaining 11 otoliths were then given new readings. For tracing the frequency of opaque-edged otoliths throughout the year, the data were grouped in bimonthly intervals due to the scarcity of data in non-seasonal months (Fig. 2). Otoliths with opaque edges were found throughout the year. The minimum percentage (20%) occurred in August–September after which there was a large increase to maximum percentages (60%, 58%, and 57%) from October through March, followed by 36% and 35% in April–May and June–July, respectively. These results suggest that opaque rings are formed

Figure 2

Bimonthly percentages of otoliths of *Scomberomorus cavalla* with opaque edges. N = number of fish sampled.

annually, mainly from October through March. Time of ring formation is similar to that recorded for Brazilian *S. cavalla* (Ximenes et al. 1978).

The relationship between fork length (FL) and otolith radius (OR) was represented by the following linear equations:

Males: FL = $-1.73 + 1.49$OR $(r = 0.86)$

Females: FL = $-11.64 + 1.76$OR $(r = 0.90)$

The intercepts were significantly different at the $P<0.001$ level ($F = 14.76$, df = 1, 336); therefore, the data were treated separately. Second-degree quadratic models were fitted to the separate data, but analysis of variance did not show significant curvature for males ($F = 3.03$, df = 1, 98, $P>0.05$) nor females ($F = 1.65$, df = 1, 235, $P>0.1$), therefore the linear equations were used to back-calculate length from age for males and females separately.

Observed and back-calculated lengths for 99 male and 233 female *S. cavalla* are shown in Table 1. Five age-0 fish (38.5–57.5 cm FL) were also recorded. The oldest male was age VII and the oldest female age X, but these were not included in the back-calculations. Length variation within age groups was large, as was the case for southeastern United States populations (Beaumariage 1973, Johnson et al. 1983). For example, age-II females ranged from 43.0 to 85.5 cm FL. From age II onwards, females grow faster than males. Figure 3 compares back-calculated growth of *S. cavalla* from Trinidad with that from southeastern United

Table 1

Mean observed and back-calculated lengths (cm) for *Scomberomorus cavalla* from Trinidad waters.

Age group	N	Mean observed length	Range	Mean back-calculated length at age							
				I	II	III	IV	V	VI	VII	VIII
Males											
I	23	57.3	44.0–72.5	44.9							
II	34	64.5	53.5–75.0	42.5	57.8						
III	25	71.4	62.5–78.0	44.6	58.4	66.9					
IV	9	72.2	65.5–81.0	41.5	54.5	61.8	68.3				
V	6	81.8	77.5–86.5	44.2	58.1	67.5	73.6	78.8			
VI	2	87.5	80.5–94.5	46.4	58.5	68.9	74.6	81.0	85.9		
Weighted mean				43.7	57.6	66.0	70.9	79.3	85.9		
N				99	76	42	17	8	2		
SD				5.0	5.3	5.2	5.5	4.3	9.8		
Annual increment					13.9	8.4	4.9	8.4	6.6		
Females											
I	46	58.2	42.0–70.5	43.7							
II	68	67.4	43.0–83.5	42.3	59.7						
III	48	71.8	62.0–93.5	39.8	57.1	66.7					
IV	33	80.2	65.0–101.0	41.1	57.6	67.4	75.1				
V	19	87.2	77.5–103.0	42.2	58.0	68.7	76.7	83.8			
VI	7	95.8	92.0–101.5	43.2	60.1	70.5	78.6	85.7	91.5		
VII	7	102.9	92.5–109.0	41.6	62.2	73.4	81.5	87.5	92.7	99.2	
VIII	5	109.7	101.0–127.0	39.9	59.8	70.0	79.6	88.4	95.8	101.2	105.6
Weighted mean				41.8	58.6	68.0	76.8	85.1	93.1	100.1	105.6
N				233	187	119	71	38	19	12	5
SD				5.7	6.2	7.0	6.8	6.2	5.4	1.9	9.9
Annual increment					16.8	9.4	8.8	8.3	8.7	7.0	5.5
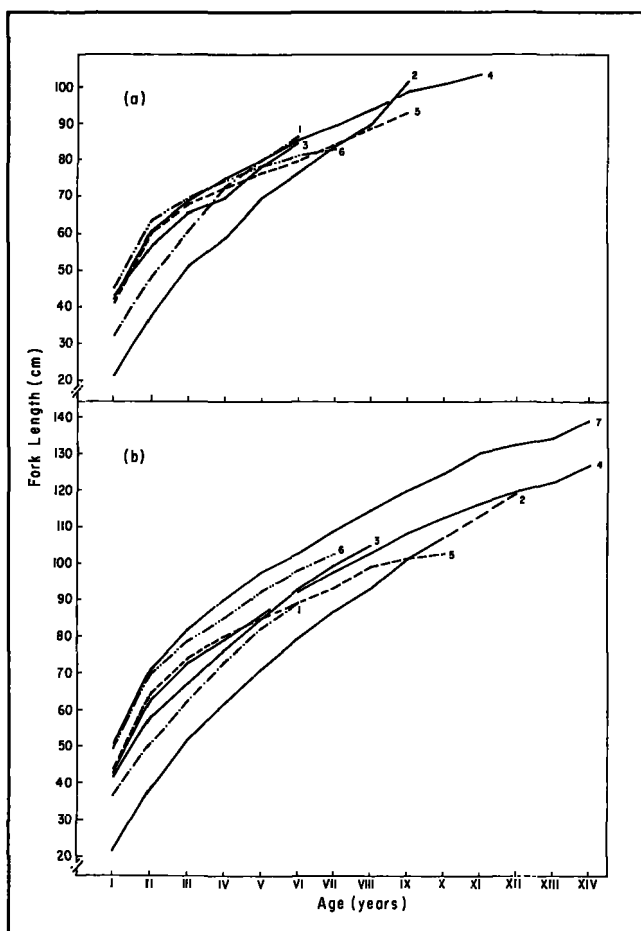
Figure 3

Growth (mean back-calculated fork lengths) of *Scomberomorus caval-la* (a) males and (b) females. 1 - Northeastern Brazil (Ximenes et al. 1978); 2 = Northeastern Brazil (Nomura and Rodrigues 1967), ages III and above observed lengths; 3 = Trinidad, this study; 4 = U.S. Gulf of Mexico (Manooch et al. 1987); 5 = Southeastern U.S., excl. La. (Johnson et al. 1983); 6 = Florida (Beaumariage 1973), fork length transformed from standard length by his formula FL = 1.096SL - 17.143; 7 = Southeastern U.S. incl. La. (Johnson et al. 1983).

States and northeastern Brazil. For both sexes, there is wide separation of lengths at age I, with those of Trinidad and North American fish being larger than those of Brazilian fish. The largest male lengths are from the Florida sample (Beaumariage 1973) up to age IV, and the smallest are for fish sampled in Brazil by Nomura and Rodrigues (1967) up to age VI. For females, the largest lengths are again for Beaumariage's sample except for an anomalous population of large females sampled in Louisiana (Johnson et al. 1983), and the smallest lengths are similarly for Nomura and Rodrigues' Brazilian sample. Back-calculated lengths at age of Trinidad fish lie between the larger lengths of North American fish and the smaller lengths of

Brazilian fish, up to age III for males (82.8% of the sample) and age V for females (91.9% of the sample). The growth curve of Trinidad males closely resembles those from the southeastern United States presented by Johnson et al. (1983) and Manooch et al. (1987) up to age V, whereas the growth of Trinidad females is more similar to that of Brazilian females sampled by Ximenes et al. (1978). Growth rates of males from the different areas are similar up to age II, with Brazilian males showing less incremental decrease in the later ages. The same trend is shown for females, with marked incremental decrease being shown by southeastern United States (excluding Louisiana) females sampled by Johnson et al. (1983).

The von Bertalanffy growth parameters of Trinidad *S. cavalla* are presented in Table 2 along with those from southeastern United States and Brazil. Asymptotic lengths are larger for females than males. The asymptotic lengths of Trinidad and Brazil males are close, and much larger than those from North America, except for the recent study from the Gulf of Mexico (Manooch et al. 1987). For females, the pattern is somewhat similar, with the Trinidad and Gulf of Mexico values being the largest, except for the additional sample of large females from Louisiana (Johnson et al. 1983). For both sexes the K values are fairly close, the lowest coming from Trinidad, Brazil, and the Gulf of Mexico, with again the exception of the Louisiana females.

Size and age at first maturity

There were 14 ripe males (11 ripe + three ripe-running) and three ripe females in the age-I group, indicating first spawning for both sexes to take place in this age group. The shortest ripe male was 54.5 cm, and the largest immature developing male was 80 cm. The shortest ripe female was 58.5 cm, and the largest immature developing female was 114.5 cm. These sizes at maturity indicate that first spawning for both sexes may also take place at age II (Table 1).

Gonad analysis and GSI

Gonad stages and corresponding GSI values are shown in Table 3. No ripe-running females nor spent fish were observed in this study. Figures 4 and 5 show gonad analysis of the 97 males and 224 females that were capable of spawning as indicated by size at first maturity. Of these, 70 males and 164 females were analyzed for GSI, and the results are also shown in Figures 4 and 5. Male gonad analysis was more difficult because milt was present in the early stages of gonad development; this explained the trend to higher percentages of ripe males. Ripe fish were present during all months

Table 2
von Bertalanffy growth parameters for *Scomberomorus cavalla* from Trinidad, southeastern United States, and Brazil.

Area and source	L_∞ (FL cm)	K	t_0 (yr)
Males			
Trinidad (this study)	112.3	0.180	-1.79
Northeastern Brazil (Nomura and Rodrigues 1967)	116.0	0.180	-0.22
Northeastern Brazil (Ximenes et al. 1978)	113.3	0.229	-1.50*
Florida (Beaumariage 1973)	90.3**	0.350	-2.50
Southeastern U.S. (Johnson et al. 1983)	96.5	0.280	-1.17
U.S. Gulf of Mexico (Manooch et al. 1987)	111.3	0.208	-1.48
Females			
Trinidad (this study)	140.1	0.150	-1.52
Northeastern Brazil (Nomura and Rodrigues 1967)	137.0	0.150	-0.13
Northeastern Brazil (Ximenes et al. 1978)	131.7	0.164	-2.00*
Florida (Beaumariage 1973)	124.3**	0.210	-2.40
Southestern U.S., excl. La. (Johnson et al. 1983)	106.7	0.290	-0.97
Southeastern U.S., La. (Johnson et al. 1983)	152.9	0.140	-2.08
U.S. Gulf of Mexico (Manooch et al. 1987)	141.7	0.136	-1.98

*Assumed negative.
**Calculated from Beaumariage's formula FL = 1.096SL - 17.143.

Table 3
Gonad stages and gonadosomatic indices of *Scomberomorus cavalla* from Trinidad waters.

Gonad stage	Males			Females		
	N	Mean GSI	Range GSI	N	Mean GSI	Range GSI
Immature inactive	2	0.77	0.32-1.37	10	0.58	0.41-1.16
Immature developing	21	0.38	0.14-0.78	113	0.63	0.16-1.37
Ripe	18	0.92	0.30-1.92	41	1.75	0.41-5.68
Ripe running	29	1.11	0.33-3.73	—	—	—

except December (when only nine fish were sampled), and ripe females were absent in April. Maximum percentages of females occurred from September to October and January to March. GSIs for females peaked in September, November, January, and February. Males showed similar patterns, though data were more limited. The above observations indicated that *S. cavalla* spawns throughout the year with more intense spawning from September through March.

Sex ratio

Females were dominant in all size groups, both in gillnet and hook-and-line samples, and in the peak spawning and non-peak spawning seasons (Table 4). The degree of dominance varied with size class, type of gear, and season. Dominance increased with size class,

and all but a single specimen over 90 cm FL was female. Females predominated to a greater extent in the hook-and-line samples compared with gillnet samples. In gillnet samples, the proportion of females decreased from 74% during the non-peak spawning season to 62% during the peak spawning season, which corresponded with an overall decrease in females from 77% to 63% in the respective seasons. In the southeastern United States, the sex ratio was also found to favor females (Fischer 1980, Trent et al. 1983).
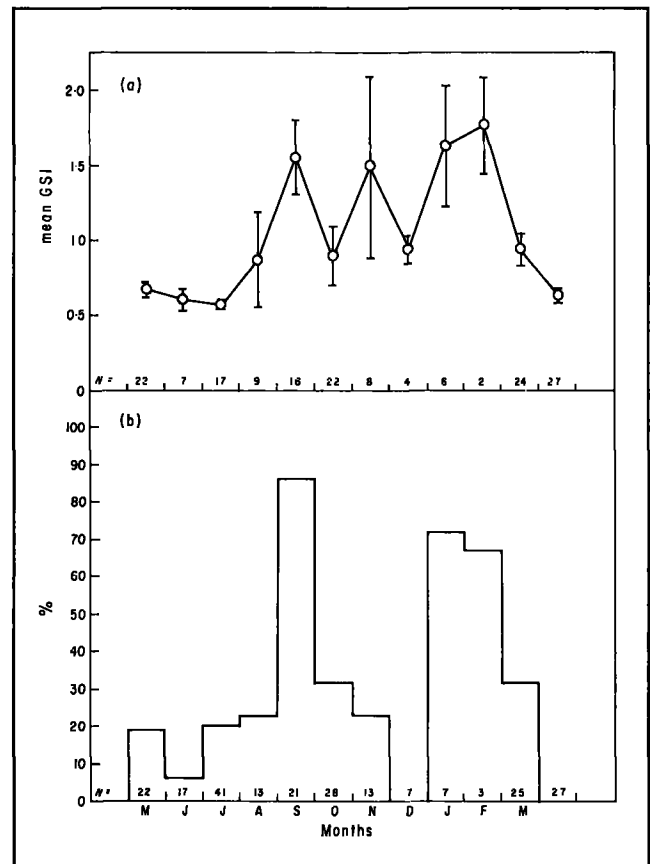
Discussion

Evidence for time of annulus formation in Trinidad *Scomberomorus cavalla* is weak. Tracing of otolith edges throughout the year suffered from a paucity of
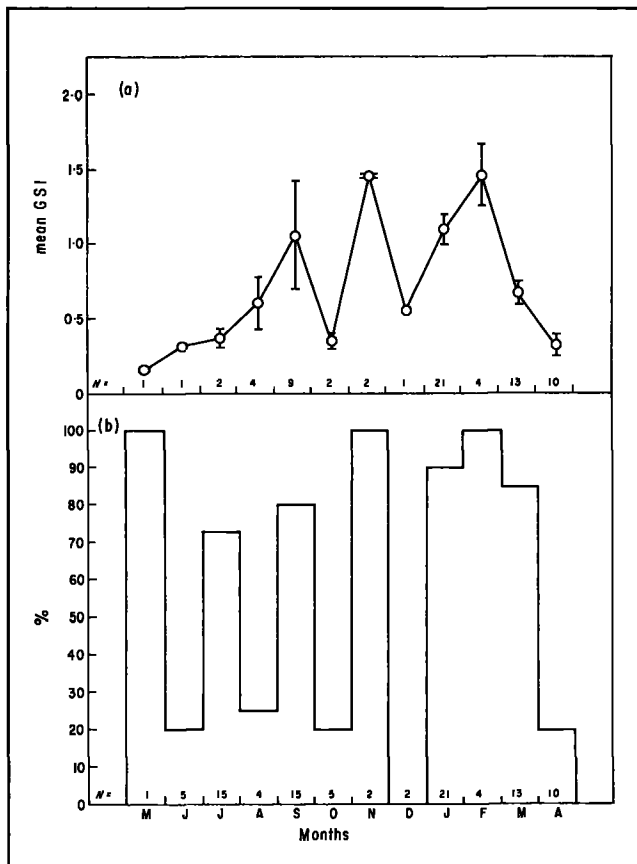
Figure 4

Seasonal maturation cycle of male *Scomberomorus cavalla* (>54.5 cm) by (a) mean monthly GSI and (b) monthly percentages of ripe (ripe and ripe-running) gonads. *N* = number of fish sampled.

Figure 5

Seasonal maturation cycle of female *Scomberomorus cavalla* (>58.5 cm) by (a) mean monthly GSI and (b) monthly percentages of ripe gonads. *N* = number of fish sampled.

data when the annulus is apparently formed as fish were scarce from November to February. Maximum (bimonthly) percentages of opaque otolith margins compare well with those (monthly) of North American studies (Beaumariage 1973, Johnson et al. 1983, Manooch et al. 1987). However, in the present study the minimum (bimonthly) percentage (20%) was much higher than in North America where in all the studies there were one or more months with no edged otoliths. In Trinidad the period September to March, when maximum percentages of opaque otolith margins are found, corresponds with the period of greatest spawning intensity. In Brazil, the opaque ring is laid down from November to March corresponding to a period of intense spawning (Ximenes et al. 1978). Otoliths of North American fish generally had the largest percentages of opaque margins from April through June (Beaumariage 1973, Johnson et al. 1983, Manooch et al. 1987) at the start of a well-defined spawning season (Beaumariage 1973, Finucane et al. 1986). The process of spawning may therefore be related to annulus forma-

tion in *S. cavalla*. If first spawning takes place at age II, as might occur on occasion for Trinidad *S. cavalla*, an annulus in immature (age-I) fish may be explained by some internal physiological rhythm, together with the environmental changes that trigger spawning, causing annulus formation. This explanation was put forward for annulus formation in immature fish for hake *Merluccius merluccius* (Hickling 1935) and red snapper *Lutjanus campechanus* (Nelson and Manooch 1982). As spawning is year-round in the tropical waters around Trinidad, the finding of relatively large numbers of opaque margined otoliths in the months outside the period of their maximum occurrence during peak spawning can be expected. These, however, obscure the results of tracing the frequency of otolith edges throughout the year compared with the more clear-cut results from the more temperate North American waters.

The differences in length at age and theoretical growth parameters between Trinidad, Brazilian, and North American fish may result from different environ-

Table 4

Sex ratio of *Scomberomorus cavalla* from Trinidad waters.

Length range (cm)	Gillnets Male (N)	Gillnets Female (N)	Gillnets Female (%)	Hook-and-line Male (N)	Hook-and-line Female (N)	Hook-and-line Female (%)	Totals Male (N)	Totals Female (N)	Totals Female (%)
Peak spawning (September–March)									
30.0–49.5	1	0	0	0	1	100			
50.0–69.5	24	36	60	10	24	71			
70.0–89.5	18	12	40	9	29	76			
90.0–109.5	0	1	—	1	11	92			
110.0–130.5	0	0	—	0	0	—			
Total	43	49	53	20	65	76	63	114	60
Non-peak spawning (April–August)									
30.0–49.5	1	6	86	0	0	—			
50.0–69.5	14	39	74	14	26	65			
70.0–89.5	4	7	64	8	42	84			
90.0–109.5	0	2	100	0	13	100			
110.0–130.5	0	0	—	0	2	100			
Total	19	54	74	22	83	79	41	137	77
Totals	62	103	62	42	148	78			

ments, feeding habits, exploitation rates, methods of capture, sample sizes, etc. The fishery in North America is better developed than in Brazil (Collette and Russo 1984) and Trinidad, which enabled larger samples for age and growth studies to be collected from the former region. There were considerable differences between sample sizes of older fish in the various studies, which could introduce bias in the comparison of von Bertalanffy parameters. Best representation of growth of older fish came from Manooch et al. (1987) and the anomalous group of Louisiana females (Johnson et al. 1983). Changes in populations between studies brought about by exploitation and other factors could also influence the results.

Different methodologies could also contribute to these differences. Nomura and Rodrigues (1967) counted translucent rings to age Brazilian fish, thus omitting part of a year. This probably resulted in their obtaining the slowest growth of all the studies. Back-calculated lengths were fitted to the von Bertalanffy equation by Ximenes et al. (1978), Johnson et al. (1983), and in this report. Beaumariage (1973) fitted observed standard lengths and advised caution in extrapolation of the theoretical growth curve for size at older ages, because it was derived from Walford plots that excluded older fish; this resulted in conservative estimates. Nomura and Rodrigues (1967) used both back-calculated and observed lengths, which probably resulted in large values of L_∞. Other differences in

methodology, e.g., the weighting of mean back-calculated and observed lengths and more exact fitting of the von Bertalanffy curve using computer programs in the later studies, and the non-use of an intercept value for back-calculation in some of the studies, could lead to minor differences in the results. Comparisons of results between the three areas evidently cannot be properly done due to differing sample sizes and methodologies.

Estimates of maturity of 58.5 cm FL or age I–II for Trinidad female *S. cavalla* generally agree well with those of other studies. In Brazil, first maturity was found to take place at 58.6 cm FL (Alves and Tome 1967) and 63.5 cm FL or age III (Gesteria and Mesquita 1976). Another study showed that females first matured between 43.5 and 56.5 cm FL or age III, with 50% maturity at 77 cm FL or age V–VI (Ivo 1972). Size of maturity of Trinidad females compares well with that in Brazil. However, greater age at maturity of Brazilian fish could be due to overestimated age at length based on the use of translucent rings for ageing by Nomura and Rodrigues (1967). Finucane et al. (1986) reported size at maturity at 44.9 cm FL in the southeastern United States. In Florida waters, Beaumariage (1973) round ripe eggs in age-I females (61.4 cm SL = 65.6 cm FL) similar to Trinidad results. However, he concluded that these eggs were aborted or reabsorbed, and spawning did not really take place until age IV (88.0 cm FL). As with females, ripe males

first appeared at age I (63.4 cm FL) as they did in Trinidad, but Beaumariage believed that males spawned initially at age III (77.0 cm FL) due to the greater development of spermatogenesis in the testes of older fish. However, in Trinidad initial spawning takes place at age I, as shown by the presence of ripe-running males in this age group.

The spawning pattern of *S. cavalla* in Trinidad is apparently similar to that off the coast of Ceara, in northeastern Brazil. Gesteria and Mesquita (1976) observed year-round spawning with maximum intensity from October through March, as in Trinidad. Spawning throughout the year was also recorded by Ivo (1972), but his period of maximum activity was from January through June. Another study (Menezes 1969) indicated that they spawn during the period October through March. Further north, the spawning season is reversed, where in the northeastern Caribbean it lasts from April through November (Erdman 1976) and in the southeastern United States, from April through October (Beaumariage 1973, Finucane et al. 1986). Spawning migrations in North America are determined by temperature (Moe 1972, Beaumariage 1973). In Trinidad, however, spawning and migration may be influenced by salinity changes because there is little variation in the water temperature. Peak spawning starts after the rains have set in, and may be triggered by a drop in salinity; minimum salinities have been recorded in August and September (van Andel and Postma 1954, Edwards 1983). The presence of ripe-running males in the samples indicates spawning in local waters, but the spawning grounds remain to be discovered. The scarcity of the fish during November through February remains unexplained. Spawning on the outer Continental Shelf, 50–60 km offshore, as occurs in the northwestern Gulf of Mexico (McEachran et al. 1980) would place part of the population beyond the reach of the artisanal fishing fleet which is limited to some 40 km offshore. Another possible factor could be migration along the Venezuelan coast to the northwest and/or the southeast, although part of the population may be resident throughout the year. Decreased vulnerability to hook-and-line due to decreased feeding activity during spawning, and/or gillnets due to spawning in waters deeper than that in which the gillnet is effective, are other possible reasons to be considered.

Beach landing data indicate that a southerly migration takes place in Trinidad during the months when the fish is seasonally abundant (Sturm et al. 1984). In the present study, gonad analysis did not suggest any migratory trends since ripe fish were taken around the coast throughout the year. Moreover, observations on stomach contents showed no clear feeding patterns as evidence of migration (unpubl. data). The spawning and abundance patterns of *S. cavalla* approximately cor-

respond to those of *S. maculatus* (= *S. brasiliensis*), which spawns throughout the year with more intense spawning from October through April and is seasonally abundant from May through September (Sturm 1978). *S. brasiliensis* also moves in a southerly direction during peak abundance, part of likely clockwise movements around the island (Sturm 1978, Sturm et al. 1984). In Florida, Williams and Sutherland (1979) and Sutherland and Fable (1980) have shown that *S. cavalla* undertakes long-range migrations compared with the shorter range migrations of *S. maculatus*, which is closely related to *S. brasiliensis* (Collette et al. 1978). In Trinidad, a similar situation would explain the difficulty in recognizing migratory trends of *S. cavalla*, compared with the more local movements described for *S. brasiliensis* (Sturm 1978).

Female dominance in samples may be the result of more females than males being hatched or mortality being higher in males than females. Higher mortality probably is associated with slower growth in males. Alternatively, female dominance may be a function of gear selection in gillnets or of behavioral differences between the sexes. Increased voracity in females was recorded in Brazil (Menezes 1969) and may explain why the sex ratio favored females in hook-and-line samples. Also, males may inhabit greater depths than females and are less vulnerable to gillnets. If this was the case, a meeting of the sexes for spawning by an upward migration of males and/or a downward migration of females could explain the increase in the male:female ratio observed for gillnets during peak spawning.

Acknowledgments

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