

International Council for the
Exploration of the Sea

C.M. 1963
Atlantic Committee
No. 85 \bar{E}

Biological Characteristics of Atlantic Sailfish
(Istiophorus Americanus Cuvier) off West Africa

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Sailfish (Istiophorus americanus Cuvier, Istiophoridae, Perciformes, Pisces) is a commercial fish of value now taken by Soviet fishing vessels in the tropical part of the Atlantic. Although large concentrations of sailfish are observed off West Africa the literature on their biology is extremely insufficient. However, the biology of this valuable commercial fish deserves a more thorough study. The present paper gives the biological characteristics of the commercial concentration of sailfish off West Africa.

Material and methods

The material was collected off West Africa in January-May 1962, mostly in the Conakry-Free Town area. The gear used was a long-line 15-20 km long with dense gangions (from 700 to 900 hooks). The captured fish was measured and weighed; their sex, maturity stage, stomach content (in points) and food composition were determined. Body length from the tip of pike to the end of the central rays of the caudal fin (AS) and the body length from the posterior edge of the eye to the end of the central rays of the caudal fin (OS) - both values were used for characterizing size composition of the concentration. Maturity stages were determined by a six-point scale and the rate of stomach content by a four-point scale. Qualitative composition of food was determined directly in field conditions. Part of the material (gonads, stomachs) was fixed with 4% solution of formalin and treated in captivity. Later treatment of the material was conducted in the East and Middle Atlantic laboratory of the Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO)

The causes of formation of sailfish concentrations in the area off West Africa

The hydrological regime of the waters adjacent to the West African coast was determined mainly by the presence of two water masses - the Canary Current and the Equatorial counter-current - in the area. A zone of the highest biological productivity was formed at the boundary of the colder and higher salinity of the Canary Current and the warmer but lower salinity of the Equatorial counter-current. The zone was characterized by a considerable development of feeding plankton (up to 1.4 mg/cm³) and aquatic invertebrates (squids, cuttlefish) and by dense concentrations of surface shoals of fish (Trachurus, Sardinella) on which sailfish fed.

The frontal zone of the above currents serves as a guide when oceanographical method of research for sailfish concentrations is employed. It must be borne in mind that the frontal zone shifts according to the movement of the currents, the nature of which sometimes changes from year to year. This shifting was, apparently, the cause of the migration of sailfish from the more southward Conakry-Free Town area northwards to the Saint Louis area in May-August 1961. In 1962 no considerable migration of sailfish concentrations was observed, and they stayed in the Conakry-Free Town area all year round.

It must be noted that favourable conditions for spawning of sailfish - high surface temperature of water (+ 28°) and high salinity (35.4-35.6‰) - exist in that area. Thus, the availability of rich food resources and favourable spawning conditions, determined by abiotic and biotic factors, created conditions for the formation of commercial concentrations of sailfish.

Size and weight composition

Sailfish caught in the Conakry-Free Town area in January/February 1962 was from 180 to 235 cm long (AS), the average length being 209.1 cm. Specimens 205-215 cm long prevailed in the catches (Table 1). The minimum weight of sailfish recorded in the period under review was 14.3 kg, the maximum about 38.0 kg. Sailfish weighing 20-26 kg were the most frequent in the catches (Table 2).

Table 1. Size composition of I. americanus in January/February 1962

Length	180-185	190-195	200-205	210-215	220-225	230-235						No. of specimens
Number of specimens	3	7	6	23	40	54	60	23	19	12	3	250
%	1.2	2.8	2.4	9.2	16.0	21.6	24.0	9.2	7.6	4.8	1.2	100.0

The length of the body from the posterior edge of the eye to the end of the central rays of the caudal fin (OS length) was used for the purpose of obtaining a comparative characteristic of the sailfish size composition in certain periods (January-May). This value is believed to be more reliable because it eliminates the changes in the total length, which may be caused by damage of pike.

Table 2. Weight composition of I. americanus in January/February 1962

weight (kg)	14-16	16-18	20	22	24	26	28	30-32	34	36-38			No. of specimens
No. of specimens	1	13	11	45	34	41	16	8	4	4	1	1	179
%	0.6	7.3	6.2	28.5	19.0	23.0	8.9	4.5	2.2	2.2	0.6	0.6	100.0

During the period January-May the average length (OS) increased slightly from 150.95 cm at the beginning to 155.25 cm at the end of the fishing operations. At the same time the average weight of the sailfish increased from 23.4 to 25.9 kg. The above figures show that the size and weight compositions of sailfish remained rather stable during the whole fishing period. Individuals of larger weight and size appeared only in the catches at the final stage of the fishing operations (from 16-21 May, 1962).

Sex ratio

Sailfish reach maturity when they are 130-140 cm long. Sailfish spawning is partial and lasts throughout the year. Gonads are double. Testicles are solid long plaits of a grey (immature) and pinkish (mature) colour. They are composed of numerous large shapeless capsules connected with a longitudinal canal intended for releasing reproductive products. Ovaries represent two double sacs suspended in the dorsal cavity of the body. The internal cavity of the ovary is ribbed. Mature gonads are large and reach two kg in fish weighing 30 kg. The right ovary is usually larger than the left one. Eggs are small (from 0.1 to 0.9 mm in diam.) and pelagic. In maturing ova the yolk is placed in the centre and the mature ovum is completely filled up by the yolk. Ovocytes at various stages of ovaculation and yolk accumulation can be found in one ovary. The maturation stage of the ovary can be determined from the correlation of mature and immature ova.

The fecundity of the sailfish is very high. Apparently they lay about ten million eggs in a year. In the eastern part of the Atlantic sailfish spawn both in the high seas and in the shallow waters. Large spawning concentrations of sailfish were found in the Conakry-Free Town area in the period from February to May. Optimum temperatures for spawning were + 27-28°, the optimum depths 35-110 m. It is interesting to note that in January/February the males greatly prevailed over females (67.1% against 32.9%). The intensity of spawning was not high during that period. Mature running females (stage V) were caught only on the 25th of February. The majority of the fish had maturing gonads at stages II, II-III and III. In April/May the sex ratio changed. In a group of 613 specimens examined males comprised 58%. However, in the period from 16th/^{21st} May, 1962, the number of females increased sharply amounting to 59.1%. The intensity of the spawning increased correspondingly. So the group of intensively spawning sailfish which appeared in the second half of May, was characterized by large sizes and weight and predominance of males over females.

Feeding

The peculiar feature of the sailfish feeding in February-May 1962 was a wide variety of species in this food composition - Crustaceous (Crustacea), cephalopoda and fishes (Pisces) were found in their stomachs, fish - 27 species belonging to 22 families - prevailed. The most frequent species found were: squids (Loligo), cuttlefish (Sepia), shrimps (Penaeus), pilchard (Sardinella aurita), anchovy (Engraulus engrasicolus), Otoperca aurita and horse mackerel (Trachurus sp.). The length of fish on which sailfish fed varied from 3.0 to 28 cm. The longest of these being Thunnidae (25.0-28.0 cm), Decapterus sp. (up to 26 cm) and Sparidae (8.1-20.0 cm). The intensity of sailfish feeding varied somewhat in February-May (Table 3). A decrease in the intensity of feeding was observed in the third ten-day period of February (0 point - 38.5% (empty stomachs)) and in the second and third ten-day period of May (0-60.0-68.2%).

Table 3. Stomach content of sailfish in the Conakry-Free Town area in February-May 1963

No.	Stomach content (in points) month, ten-day period							No. of specimens
			0	1	2	3	4	
1.	February	I	6.6	14.1	40.6	3.0	5.7	106
2.	February	II	38.5	24.5	12.2	17.5	7.3	57
3.	April	II	22.8	25.7	16.5	21.7	13.3	272
4.	April	III	20.2	28.7	23.9	14.4	12.8	188
5.	May	I	20.0	33.3	21.7	20.0	5.0	60
6.	May	II	60.0	20.0	8.0	12.0	0.0	50
7.	May	III	68.2	24.3	0.0	4.8	2.7	40

The most intensive feeding was observed in the second and third ten-day periods of April (4 points 'overfilled stomachs' - 13.3% and 12.8%). Such irregular feeding of sailfish was caused by their physiological state. The periods of lower intensity of feeding more or less correspond to the time of intensive spawning.

From time to time certain changes in qualitative composition of sailfish food were also observed. As is seen from Table 4 during the first ten-day period of February the sailfish fed primarily on squid (65.9%), anchovy (50.5%), Otoperca aurita (37.5%) and cuttlefish (28.4%).

Table 4. Percentage of the most important fish and invertebrates in the food of I. americanus (in ten-day periods of February-May)

No.	Food components	February		April		May		
		I	III	II	III	I	II	III
1.	<u>Penaeus sp.</u>	-	-	2.9	-	-	5.2	-
2.	<u>Loligo sp.</u>	65.9	42.8	11.8	0.8	2.2	-	38.4
3.	<u>Sepia sp.</u>	28.4	50.0	24.1	10.3	6.8	26.3	7.6
4.	<u>Sardinella aurita</u>	-	-	24.1	57.1	18.1	26.3	7.6
5.	<u>Engraulus enkrasicolus</u>	50.0	17.8	18.8	1.6	2.2	-	7.6
6.	<u>Otoperca aurita</u>	37.5	3.5	1.1	0.8	-	-	-
7.	<u>Trachurus trachurus</u>	11.3	17.8	24.1	18.2	31.8	42.1	-

The percentage of components changed somewhat late in February (the third ten-day period). Cuttlefish and squids became the main food components (50.0 and 42.8% respectively). The percentage of anchovy eaten by sailfish decreased strongly from 50.0 to 17.8. In April the qualitative composition of sailfish food changed greatly again. In mid-April pilchard appeared in the stomachs of sailfish, constituting 24% of the content of all the stomachs examined. The percentage of pilchard and cuttlefish were equally high. Late in April sailfish fed mainly on pilchard (57.1%), the share of horse mackerel and cuttlefish was considerable smaller (18.2 and 10.3%, respectively) and the amount of squids was reduced to 0.8%. In May sailfish fed mainly on horse mackerel, squid and pilchard (Table 4.).

Thus the qualitative food composition of sailfish in February, April and May 1962 was not the same. In February sailfish fed mainly on squid, cuttlefish and anchovy, in April on pilchard and rarely on horse mackerel, in May primarily on horse mackerel and squid. The diurnal rhythm of sailfish feeding varied. A comparative analysis of 178 stomachs showed that the percentage of empty stomachs was greatest in the morning (45.6%) and smallest (12.1%) in the evening (Table 5). For overfilled stomachs this relation was inversed.

Table 5. Percentage of empty and overfilled stomachs in the morning, day-time and in the evening. The Conakry-Free Town area, February-May 1962.

Time stomach content	Morning	Day-time	Evening
0 point (empty stomachs)	45.6	25.0	12.1
4 points (overfilled stomachs)	2.0	7.6	12.2

Thus sailfish fed irregularly during the day.

Conclusion

1. The conditions in the West African area, determined by the interaction of two currents (the Canary Current and the Equatorial counter-current) are favourable to spawning and feeding of sailfish. This resulted in the formation of commercial sailfish concentrations representing a spawning feeding stock.
2. The length of sailfish range from 180 to 235 cm, the average being 209.1 cm. The weights vary from 14.3 to 38 kg. The usual weight of a sailfish is 20-26 kg.
3. The highest activity of spawning is observed on the shelf, the lowest in the high seas. The optimum temperatures for spawning are +27-28° at a depth of 35-110m. Sailfish are spawning all the year round, but the intensity of the spawning varies. An intensively spawning group of sailfish (May 1962) was characterized by large sizes, weight and with prevalence of females over males.
4. Qualitative composition of sailfish food is notable for a wide variety of species. The greatest share of their diet is composed by 27 species of fish. Squid, cuttlefish, pilchard, horse mackerel, Otoperca aurita and anchovy being the main food components.
5. The intensity of the feeding of sailfish decreases during the period of intensive spawning. The highest intensity of feeding is observed during evening hours.
6. Qualitative composition of sailfish food is not uniform. During February the main food components are squid, cuttlefish and anchovy, in April pilchard and horse mackerel (less frequent), in May horse mackerel and squid.