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Biology, distribution, and abundance of the spiny dogfish in the Northwest Atlantic

by

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Abstract

Some problems of the biology and distribution of the spiny dogfish in the Northwest Atlantic are considered. The minimum estimated biomass is 500 thous. tons. The total biomass is likely to be 1 mill. tons. The annual catch does not exceed 25 thous. tons and constitutes less than 1% of the total catch of the fish.

The feeding is based on the commercial fish species and invertebrates. 500 thous. tons of the spiny dogfish consume over 900 thous. tons of food organisms.

A direct fishing for the spiny dogfish of 50 thous. tons a year is recommended to meet the requirements of the rational fishery.

Introduction

The Northwest Atlantic is the traditional fishing area. Despite intensive fishing , however, certain fish species which are rather numerous there are not actually utilized. This results in both the loss of important resources and disturbance of ecological balance, which may consequently tell upon the major commercial fish stock sizes (Daan N., 1975).

Among these underutilized and numerous species in the Northwest Atlantic is the spiny dogfish. The role of this predator in the ecosystem of the area is very important. In the present paper the biology, distribution and abundance of the spiny dogfish are

considered. A draft calculation of the food amount in the feeding of the spiny dogfish and recommendations concerning the possible commercial utilization of the species are given.

Biology

The spiny dogfish inhabiting the Northwest Atlantic belongs to the family Squalidae, genus Squalus, group Acanthias and subspecies of shortfinned sharks, Squalus acanthias acanthias.

Like all Squalidae, the spiny dogfish is an ovoviviparous shark (Nikolsky, 1971). The egg and embryo development cycle is a rather prolonged process lasting about 4 years. The period from the moment of the egg fertilisation to the birth of the young dogfish lasts about 2 years, that is the spiny dogfish female bears once within two years (Kondjurin V., 1973; Von Bonde, 1945; Ford, 1921; Hisaw and Albert, 1947; Holden and Meadows, 1964; Templeman, 1944). The females attain sexual maturity at the length of 74 to 90 cm. The spiny dogfish females over 95 cm in length are practically all mature. The fecundity of the females increases with the increase of the fish length and amounts to 6.8 on the average in the females exceeding 90 cm in length (table 1). The minimum number of the embryos is 2, the maximum recorded number is 13. The males attain sexual maturity at the length of about 60 cm (Templeman,1944). The lengths of the embryos before birth are 27-33 cm, the weight ranges between 60 and 110 g. The young spiny dogfish at liberty usually are of 27 cm in length. Occasionally, however, there occur the specimens of 24 cm. The maximum sizes of the females and males do not exceed 110 and 85 cm respectively. The weight of the largest females is about 6 kg.

In the Northwest Atlantic, like in other areas (Bennet B., 1967; Holden M., 1966), the spiny dogfish feeds mainly on the fish, showing preference to pelagic species (Bigelow H.B. and Schroeder W.C., 1953, Jensen A.C., 1966). Squids are of great importance in its diet. The crustaceans are common in the stomachs, the worms, molluscs and Ascidiidae (table 3) are less frequent. The bulk of the examined stomachs (about 90%) appears to

be empty, which is, evidently, due to periodical feeding pattern and high digestion rate.

Distribution

In the Northwest Atlantic the spiny dogfish inhabits the area from Newfoundland in the north to the Northern Carolina in the south (Bigelow H.B., 1953). It is common in the shelf waters down to 200 m, rarely to 300 m.

As is evident from the results of the tagging experiment (Templeman, 1954), the spiny dogfish performs seasonal migrations from the Norfolk area to Newfoundland. A part of the stock stays in the Gulf of St. Lawrence in winter (Jensen, 1968). The nature of seasonal migrations has yet received little consideration, however, the available data indicate that the variation of the water temperature is one of the major factors causing this migration. The intrapopulation interrelations between the sharks may be another cause for the females to leave the nursing area (Springer, 1967).

The analysis of the spiny dogfish distribution in the USA shelf and Georges Bank areas showed that most dense aggregations are formed in the winter period off Norfolk, Nantucket and southern slopes of Georges Bank at the depth of 200-300 m. Similarly dense aggregations can be often observed at the depth of 40-80 m as well. In summer good aggregations of the spiny dogfish can be found at the depth of 60-150 m on Georges Bank and in the area of Nantucket, and in warm years on Browns Bank (figs. 1, 2).

The spiny dogfish occurs at the temperatures ranging between 4°C and 17°C. Dense dogfish aggregations were recorded at the temperatures of 6 to 14°C. Major winter aggregations were formed at the water temperature of 7-10°C, and summer aggregations at the temperature of 8-12°C. Only a sudden sharp fall of temperature may ruin the spiny dogfish (Templeman, 1965).

Like the majority of the fish, the spiny dogfish performs diurnal vertical migrations (Jensen, 1966). The analysis of the bottom trawl catches showed that the dogfish catches taken in

the day-time are considerably larger than those taken at night. The increase of the vertical trawl opening at night resulted in significantly increased catches, which indicates that the fish in large do not migrate to the upper water layers but keep close to the bottom (table 4).

Abundance

The spiny dogfish is one of the most numerous fish species in the Northwest Atlantic (Jensen A.C., 1966; Bigelow H.B. and Schroeder W.C., 1953). It is next to impossible to precisely assess the total abundance of its stocks in the Northwest Atlantic due to small-scale fishery, difficulties in determination of the age composition of the catches and lack of interest in complete utilization of this species by the fishery. Certain data on the stock size and abundance of the dogfish in the fall are obtained from the trawl surveys which are carried out consistently on the USA shelf and on Georges Bank in September-October. However, the trawl surveys in the fall do not allow for reliable information to be obtained, since they do not cover the entire distribution area of the spiny dogfish, and consequently the results are extremely underestimated. This can be vividly seen from the comparison of the estimates with the data of the winter trawl surveys (table 5) which cover almost the entire wintering ground of the spiny dogfish.

As is evident from table 5, the minimum dogfish biomass amounted to 475 thous. tons in 1974 and 427 thous. tons in 1978. The total biomass is apparently considerably higher and is likely to be 1 mill. tons.

Tables 6 and 7 show that despite very high biomass of the spiny dogfish in the catches of the winter trawl survey (45.1% of the total biomass), the catch of the species in the Northwest Atlantic is below 1% of the total yield of the fish.

Based on the calculations made by Holden (1966) for the North Sea spiny dogfish stock we estimated the amount of food consumed by the Northwest Atlantic dogfish population. The calculations were made for the stocks of 500 thous. tons and

1 mill. tons.

According to Holden the spiny dogfish stock of 125 thous. tons consumes 227.5 thous. tons of food organisms. Consequently, the stock of 500 thous. tons will consume 910 thous. tons, and the stock of 1 mill. tons about 1 820 thous. tons of food organisms. Like in the North Sea, the feeding of the spiny dogfish in the Northwest Atlantic is based on the commercial fish species and squids.

Conclusions and Recommendations

1. The Northwest Atlantic spiny dogfish is an extremely numerous species playing a very important role in the ecology of the area. Being a predator, the spiny dogfish consumes a great amount of the commercial fish and invertebrates.

2. In spite of intensive fishing in the Northwest Atlantic the spiny dogfish stocks are not actually utilized, since the catch of this species is below 1% of the total catch of the fish.

3. The spiny dogfish form dense aggregations well accessible to modern pelagic and bottom trawls.

A direct fishing for the spiny dogfish in the Northwest Atlantic will meet the requirements of the rational fishery.

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TABLE 1. Maturation rate and fecundity of the spiny dogfish females.

Size groups	No. of specimens examined	No. of mature females	% of mature females	No. of specimens examined for fecundity	Mean fecundity of females
61-65	12	-	0	-	-
66-70	10	-	0	-	-
71-75	8	1	12	-	-
76-80	20	9	45	4	6.2
81-85	37	30	81	22	4.7
86-90	65	61	94	53	5.4
91-95	48	45	98	35	6.8
96-100	12	12	100	8	6.8

Table 2. Age and growth of spiny dogfish (asterisks denote the age groups represented by less than 5 specimens)

Mean length	AGE																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Males	32.0	35.6	48.2	47.1	56.8	58.9	64.7	69.5*	69.2	71.6	72.9	73.7	75.6	75.7	79.2	80.9*	81.3*	-	88.0	-	-	-	-	-	-	-
Females	29.9	37.7	46.1	50.4*	52.4	58.2	64.4	67.8	69.8*	69.5*	73.7	75.0*	78.0*	79.0*	83.3*	83.7*	85.8	87.3	88.4	91.8	91.1	93.2	95.0	95.4	99.0*	101.0

TABLE 3. Occurrence of food organisms in the spiny dogfish stomachs (from the material of the Laboratory of the Northwest Atlantic, AtlantNIRO).

Food organisms							
Fish				Invertebrates			
Herring	Silver, red hake	Mackerel	Not identified	Squid	Crustaceans	Molluscs	Worms
5.5%	3.3%	8.9%	45.6%	16.7%	17.8%	1.1%	1.1%
		63.3%			36.7%		

TABLE 4. Spiny dogfish catches in the day-time and at night.

Time of the day:	Catch per haul (sp.)			
	36 Yankee Trawl	41 Yankee Trawl	27.1 m Trawl	23.5 m trawl
Vertical opening	2.4	4.6	4.5	4.5
Day-time (06.00-18.00)	91.6	42.7	70.5	53.1
Night (18.00-06.00)	19.8	28.8	35.6	34.5

TABLE 5. Minimum spiny dogfish biomass in the Georges Bank and USA shelf areas (Statistical Areas 5 and 6), thous. tons.

Fall surveys			"Albatross-IV"		USA	Winter-spring surveys	
1970	1971	1972	1973	1974	1975	1974 "Albatross-IV"	1978 "Argus"
106.7	13.5	61.2	121.3	31.5	132.6	475.0	427.2

TABLE 6. Spiny dogfish catches in the Northwest Atlantic (% of the total catch of the fish).

1970	1971	1972	1973	1974	1975	1976
0.18%	0.27%	0.59%	0.42%	0.62%	0.60%	0.49%

TABLE 7. Proportion of spiny dogfish in the catches, % (the material of the winter trawl survey by R/V ARGUS in 1978).

Strata Nos	1	2	3	4	5	6	7	9	10	11	13	14	15	61	62
% of spiny dogfish in catch	61.5	62.5	1.2	0.0	0.3	40.4	17.2	0.0	7.3	18.3	22.1	35.8	11.1	70.2	57.8
Strata Nos	63	64	65	66	67	68	69	70	71	72	73	74	75	76	76
% of spiny dogfish in catch	10.6	38.0	55.8	52.0	0.8	11.5	70.0	55.0	58.6	48.3	42.0	73.7	41.8	70.0	45.1

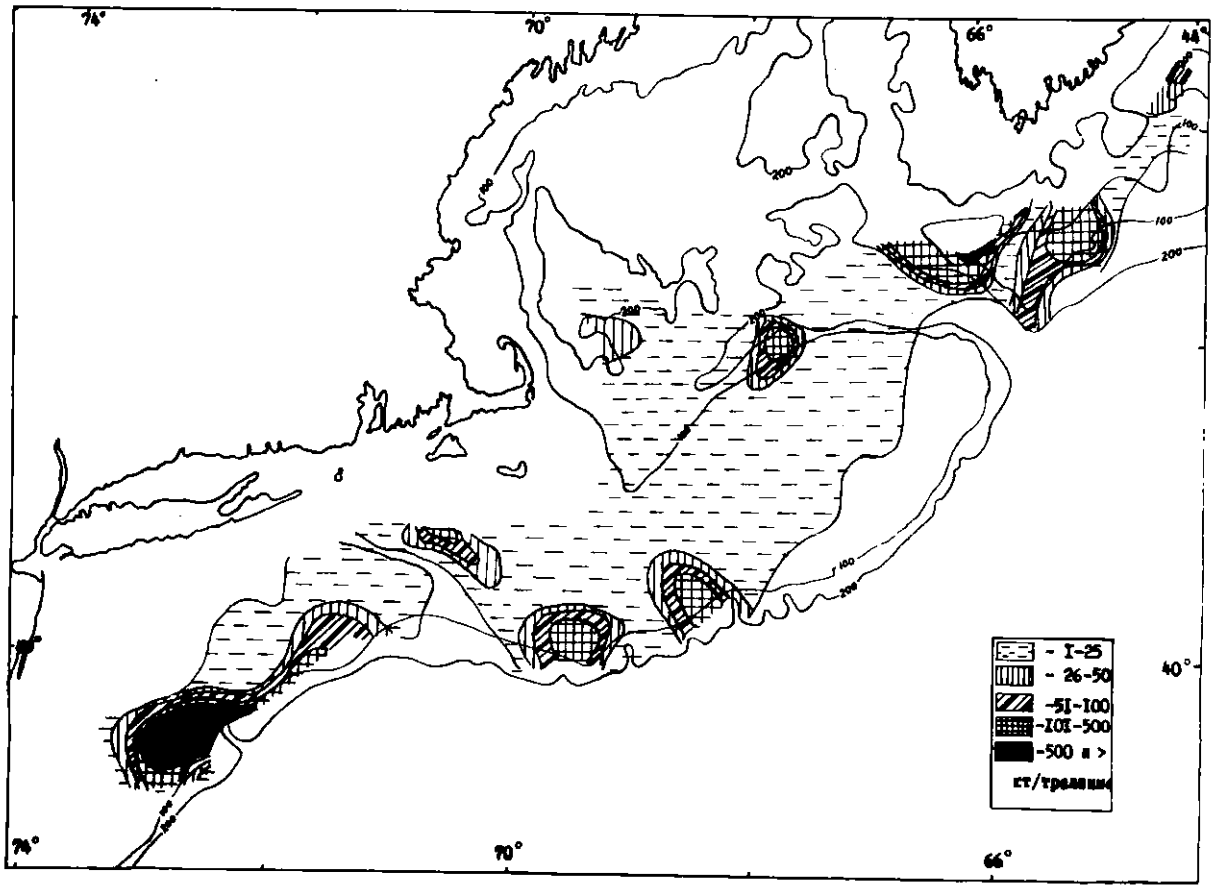

Fig. 1. Distribution of the spiny dogfish in summer (June 1971).

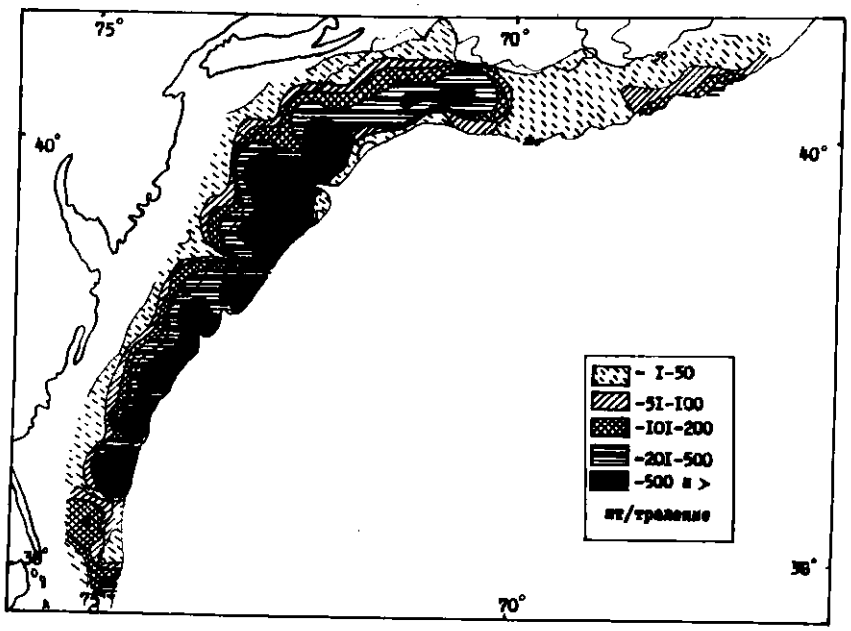

Fig. 2. Distribution of the spiny dogfish in winter (February-March 1978).