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On the Fecundity of Polar Cod
(*Boreogadus saida*) in the Barents Sea

by

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Introduction

In recent years, the Polar cod which is one of the numerous fish in the Arctic sea, has become of great importance to the fisheries. Almost all studies on the ecology of this species have been made by Klumov, (1935, 1949), Manteufel (1943), Ponomarenko (1965) and Rass (1941). However, the papers of these above authors are devoted to problems such as migrations to the coast, fishery management off the coast, areas and times of spawning, distribution of the concentrations in the autumn-winter period, etc. Problems like the distribution of commercial concentrations throughout the year, dynamics of the size-age composition of the stock, feeding and many others need further investigation.

An important element in the study of the dynamics of fish populations is the determination of the reproductive capability, the natural rate of reproduction and, consequently, the fecundity of the species (Anokhina, 1969).

The fecundity of Polar cod has been poorly investigated. Only few data are published which indicate a comparatively low fecundity for this fish. However, these data are rather contradictory. Many of the authors point out that the fecundity of Polar cod fluctuates from 9 000 to 21 000 eggs with an average of 12 000 (Andriyashev, 1954; Klumov, 1949; Manteufel, 1943; Tambovtsev, 1952). Rass, (1941) mentions a fecundity of 30 000 to 67 000 eggs. In one ovary of one adult female (length 172 mm) from the Northern Bering Sea, only 580 eggs were found (Andriyashev, 1937). Jensen, (1948) mentions 12 700 eggs from the area off Greenland. More detailed information on the fecundity of Polar cod cannot be found in papers on ichthyology.

Material and Methods

The material for studying the fecundity of Polar cod was collected aboard the research vessels of FINRO "Nikolai Maslov" and "Akademik Knipovich" in November/December 1969 and 1970. Polar cod was caught by bottom trawl on the Kanin-Kolguev Shelf and in the area off the Central Deep. During this period, 152 ovaries of Polar cod in maturity

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stages III-IV and IV (coefficient of maturity 5.6-13.8) were analysed. Each individual was weighed and measured for length and otoliths were taken for age determination. Gonads were weighed and then fixed in a 4% formalin solution.

One gramme was taken for counting the eggs and the total amount of eggs in the whole ovary was determined (absolute fecundity).

Results

The changes in fecundity of Polar cod are subject to the same regularity as for other fish. The absolute fecundity increases with fish size and with the increase in weight and age. The minimum absolute fecundity of 5 500 fish eggs was found in a Polar cod, four years old with a length of 15.5 cm; the maximum fecundity of 69 700 eggs was observed in an eight year old Polar cod with a length of 28 cm.

The indices of fecundity of Polar cod from the Barents Sea by size groups are given in Table 1. The fecundity of fish with the same size and weight can be different. Larger fish spawn more eggs, as compared to smaller ones; the correlation of fecundity with length, as compared to weight, is better for most of the specimens, and the correlation of fecundity with weight, as compared to age, is also better. A statistical analysis of the data corroborated these observations. The best correlation was observed between fecundity and length ($r = 0.97$) and between fecundity and weight ($r = 0.96$).

The criterion of reliability of the correlation coefficient (i.e. $t_r = \frac{r}{m_r} \geq t_{st}$) is, in the first case, 13.7 and in the second case 11.5, while the standard values of Student's criterion $t_{st} = (2.2 - 3.1 - 4.3)$. The correlation between fecundity and age is somewhat lower; the coefficient is 0.78. The reliability criterion is 7.8, when the standard values of Student's criterion $t_{st} = (2.8 - 4.6 - 8.6)$.

The linear relationships between fecundity and length, weight and age of the fish (Figure 1) were found by the method of least squares. The equations of regression are as follows :

$$\begin{aligned} \text{fecundity} &= \text{length} \\ y &= 2.475 x - 33.290 \\ \text{fecundity} &= \text{weight} \\ y &= 0.273 x - 0.479 \\ \text{fecundity} &= \text{age} \\ y &= 4.409 x - 2.931 \end{aligned}$$

where y - fecundity; x - length (cm) respectively, weight (g) or age.

It is seen from the equations that with an increase of one centimetre in the body length of the Polar cod, the absolute fecundity increases by 2 470 eggs; but with an increase in total weight by one gramme, it increases by 270 eggs and with an increase in age by one year, the fecundity becomes 4 400 eggs greater.

According to Tanbovtsev's data (1952) "four year old Polar cod have the greatest fecundity, then with age it considerably increases". However, our data do not confirm this (Table 2). The fecundity of four year old Polar cod does not reach the maximum value; the greatest amount of eggs is registered in Polar cod at an age of seven plus years, namely 69 700 eggs (length 28 cm) with a further increase in length and age, the frequency of fish loosing their capability of reproduction increases (Table 3). This phenomenon is due to the last stage in the Polar cod's life, i. e. the stage of old age. Nikolsky, 1965, showed that this is well pronounced for many fish species with repeated spawning (salmon, carp, bream, pike, cod, flounder, etc.).

As seen from Table 3, specimens 29 cm long constituted 3.8% of 1 150 Polar cod, 57% of them are fish which have lost their reproductive capability.

Conclusions

1. The Polar cod from the Barents Sea produce an average of 20 600 eggs with fluctuations from 5 500 to 69 700 eggs.

2. The highest coefficient of correlation is observed between fecundity and length ($r = 0.97$), the lowest between fecundity and age ($r = 0.78$). The correlation coefficient between fecundity and body weight is 0.96.

3. The species lose their reproductive capability at a length of more than 29 cm and at an age of 6+ to 8+ years. In catches taken by bottom trawl in 1970, such fish constituted 2.2% of the Polar cod specimens analysed.

References

- ANDRIYASHEV, A.P., 1954. Fish of the northern seas of the USSR. Keys to the fauna of the USSR. No. 53. Acad. USSR, Moscow-Leningrad (Israel Programme for Scientific Translations, No. 836, Jerusalem, 1964).
- ANOKHINA, L.E., 1969. Regularities in the changes of fish fecundity. Izd. "Nauka", Moscow.
- KLUMOV, S.K., 1949. Commercial fishes of the USSR. VNIRO, Moscow.
- KLUMOV, S.K., 1935. The Polar Cod - Arctic Fish. Ryb. Khoz., 5.
- MANTEUFEL, B.P., 1943. The Polar Cod and its Fishery. Arkhangelsk.
- NIKOLSKY, G.V., 1965. Theory of fish population dynamics as the biological background for rational exploitation and management for fishery resources. Izd. Akad. Nauk SSSR, Moscow.
- PONOMARENKO, V.P., 1965. Gonad development and spawning periods of the Polar cod (*Boreogadus saida* Lepechin) in the Barents Sea. Dok. Akad. Nauk. SSSR, 161:697-700.
- RASS, T.S., 1941. Analogous or parallel variations in structure and development of fishes in northern and Arctic seas. Moskovskoe Obshchestvo - Ispytatelei Prirody, Moscow, 60 pp.
- PLOKHINSKY, N.A., 1961. Biometria. Novosibirsk.
- POSTOLOAKY, A.I., 1967. On fecundity of cod of the Labrador stock. Trudy PINRO, XX, Moscow.
- SVETOVIDOV, A.N., 1948. The fauna of the USSR. Gadiformes. Izd. Akad. Nauk SSSR, 2:(4).
- TAMBOVTSEV, B.M., 1952. Polar cod. Commercial fishes in the Barents and White Seas. 161-2 pp. Leningrad.
- JENSEN, S., 1948. Contributions to the ichthyofauna of Greenland, 8-24. Skr. Univ. Zool. Mus., 2, Copenhagen.

TABLE 1. Fecundity of the Polar Cod from the Barents Sea

Length Classes (cm)	Number	Average Weight (g)	Coefficient of Maturity(%)	Fecundity thousand eggs		
				Average	Minimum	Maximum
14.6-15.5	1	27.0	5.6	5.5	-	-
15.6-16.5	6	34.4	8.2	8.7	8.0	10.0
16.6-17.5	10	39.2	8.0	10.0	7.7	12.0
17.6-18.5	11	45.1	8.3	11.6	9.0	17.0
18.6-19.5	9	50.8	9.8	13.4	9.9	19.4
19.6-20.5	24	59.5	9.2	14.6	9.9	20.8
20.6-21.5	17	63.5	8.9	16.5	10.4	24.2
21.6-22.5	19	73.4	9.2	18.9	11.6	30.5
22.6-23.5	19	86.1	10.1	24.3	13.3	35.1
23.6-24.4	13	95.8	10.0	24.2	10.1	34.1
24.6-25.5	11	105.3	10.0	27.6	21.6	36.1
25.6-26.5	5	111.5	10.4	31.2	23.2	38.1
26.6-27.5	3	121.7	10.1	27.9	23.8	34.1
27.6-28.5	4	132.5	10.4	44.6	29.0	69.7
For all Length Classes	152	61.4	9.1	20.6	7.7	69.7

TABLE 2. Relationship between fecundity and age of fish with equal length

Length Classes (cm)	Age of fish					
	3+	4+	5+	6+	7+	8+
14.6-15.5	5.5(1)	-	-	-	-	-
15.6-16.5	8.8(5)	8.0(1)	-	-	-	-
16.6-17.5	10.1(8)	9.2(2)	-	-	-	-
17.6-18.5	11.8(2)	11.2(7)	13.0(2)	-	-	-
18.6-19.5	11.5(1)	13.4(6)	14.0(2)	-	-	-
19.6-20.5	-	14.0(14)	14.7(9)	20.8(1)	-	-
20.6-21.5	-	15.0(7)	15.5(5)	19.5(5)	-	-
21.6-22.5	-	16.5(5)	18.3(8)	21.7(6)	-	-
22.6-23.5	-	-	21.2(9)	24.1(10)	-	-
23.6-24.5	-	-	23.3(6)	24.8(7)	-	-
24.6-25.5	-	-	25.0(1)	27.2(8)	29.7(2)	-
25.6-26.5	-	-	-	29.5(4)	38.1(1)	-
26.6-27.5	-	-	-	30.0(2)	-	23.8(1)
27.6-28.5	-	-	-	36.9(1)	47.3(3)	-
Average by age	9.7(17)	13.5(42)	18.2(42)	22.8(54)	39.9(6)	23.8(1)

Note: Figures in brackets are number of fish analysed.

TABLE 3. Number of specimens of Polar cod which lost their reproductive capability among fish with a length of more than 29 cm in catches taken by bottom trawl in 1969/1970.

Age	Length (cm)							
	29	30	31	32	33	34	35	36
6+	1(4)	1(1)	2(5)	1(1)	2(2)	-	-	-
7+	2(3)	2(6)	-	2(3)	-	-	3(3)	-
8+	-	-	2(2)	2(4)	1(3)	1(3)	2(3)	1(1)
Total	3(7)	2(7)	4(7)	5(8)	3(5)	1(3)	5(6)	1(1)

Note: Figures in brackets denote total number of fish of a length of more than 29 cm.

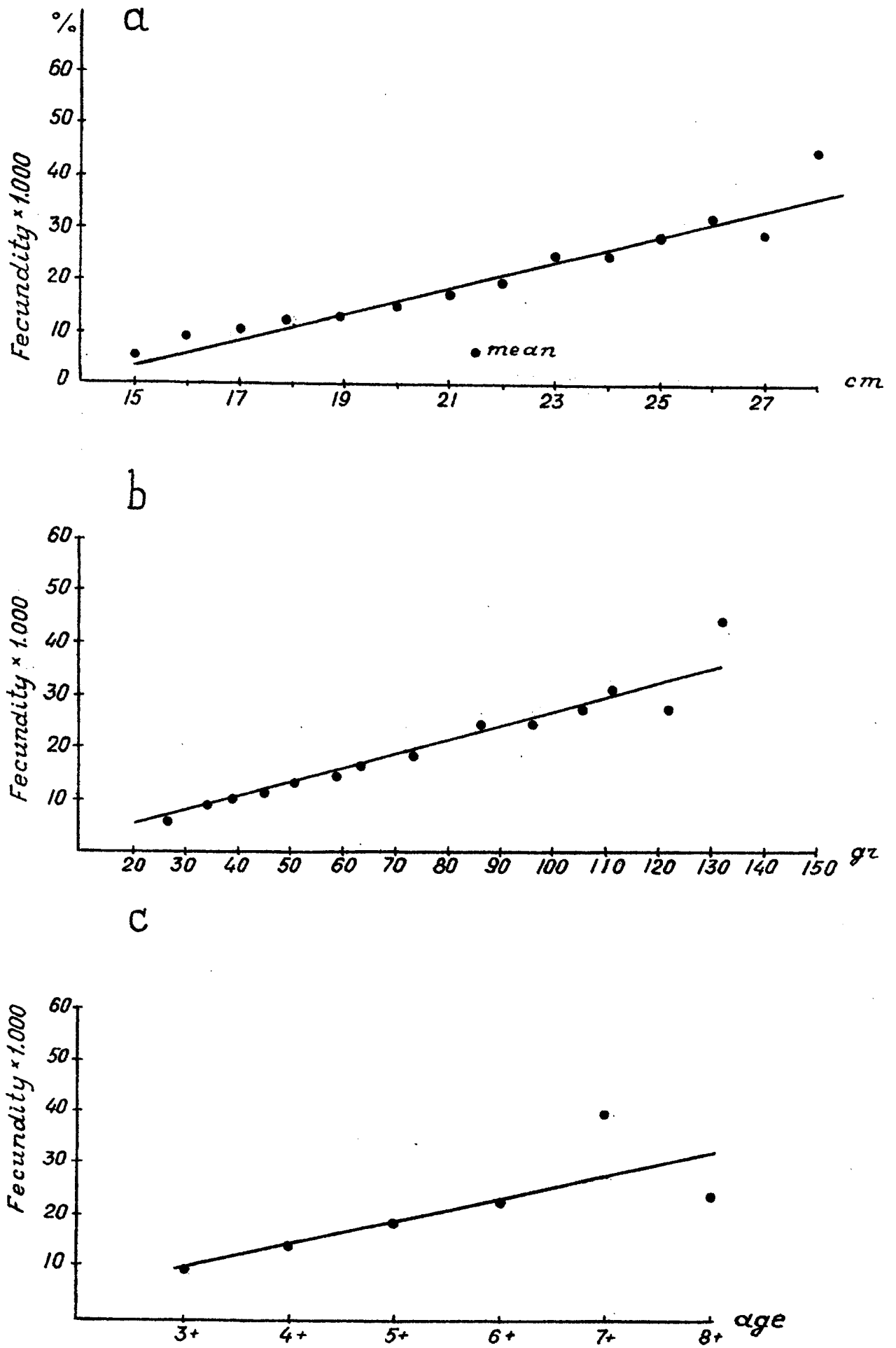


Figure 1. The relationship between fecundity of the Polar cod from the Barents Sea:

- a - length
- b - weight
- c - age.