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Fish Biology

CERTAIN BIOLOGICAL FEATURES OF SPRAT *SPRATTUS SPRATTUS BALTICUS*  
(G. SCHNEIDER) FROM BORNHOLM DEPTH

NIEKTÓRE CECHY BIOLOGICZNE SZPROTA *SPRATTUS SPRATTUS BALTICUS*  
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The investigations of Baltic sprat have been carried out for many years, while the sprat of Bornholm Depth had never been subjected to any definite biologic analysis. Subjected to these investigations was the sprat obtained from industrial catches during 1969 and 1970. The length of body, rate of growth, age, participation of sexes, maturity of gonads and the period of spawning were investigated and determined. The stomachs of sprats were analysed for composition during the whole year.

INTRODUCTION

First work on Baltic spratt from Swedish coast was given by Hessle (1927). Polish literature relating to spratt is substantially rich. The problems of spratt length, age, weight, sex and rate of growth in relation to changes appearing in stocks of spratt had been dealt with during the inter wars period. Dixon (1937) worked on changes of fat content in spratt in annual cycle, while Demel (1938a, 1939b) investigated the influence of hydrologic conditions on spratt distribution.

In years 1947-1948 some published works were based on the materials collected before the war: on food (Mańkowski, 1947b); on distribution of spratt egg and larvae in Gdańsk Bay (Mańkowski, 1947a, 1948); on spratt biology (Dixon, 1950, Mulicki, 1948a, 1948b). Elwertowski (1957a, b, and c, 1960a, b) very explicitly reported after the war on problems connected with spratt. Wrzesiński (1969) gives biological evaluations of spratt stocks in Gdańsk and Gotland Basins.

Polish catches of baltic spratt after the war exceeded 5% of totals. Quick rate of output was noted after 1950. During the last five years the catches of spratt increased from 13 579 tons to 31 855.1 tons, the quantity not noted

so far. (Data obtained from Central Board of Fishery). The output of spratt catches indicates annual differences and after period of high output, the catches are decreasing (L a b a t z k i, 1971).

Presented in this work are the results of biological investigations of spratt from Bornholm Basin.

### MATERIAL AND METHOD

The spratt from pelagic trawl fishing in eastern part of Bornholm Basin from February 1969-January 1970 served as material for this investigation (Fig.1).

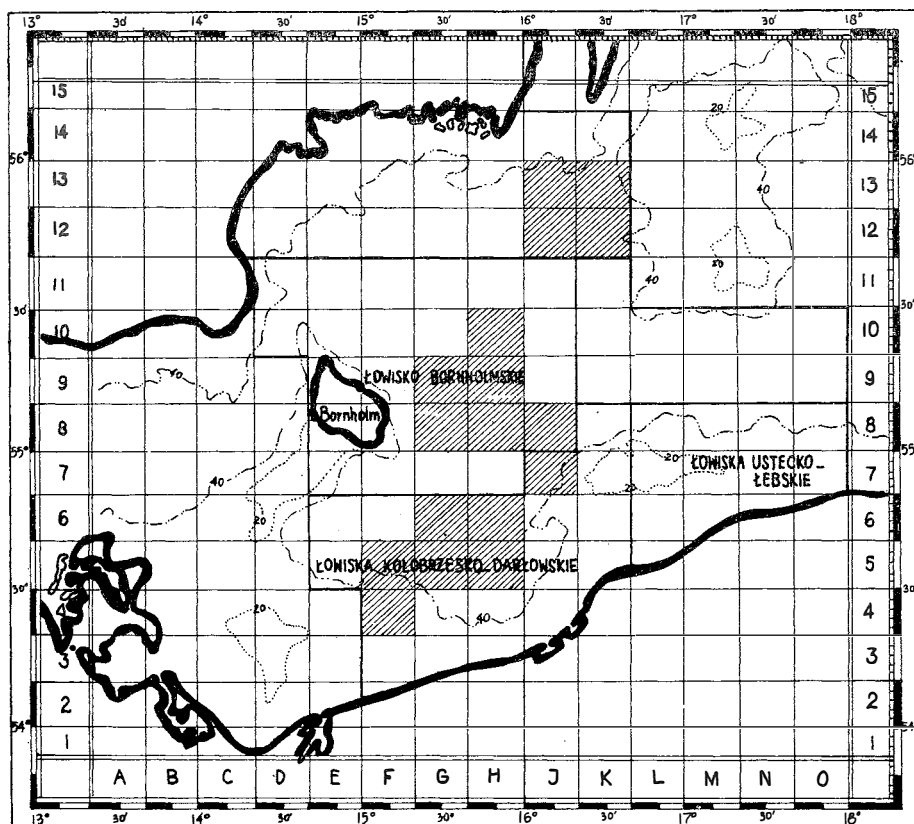


Fig.1. Spratt fishing grounds

The samples were generally collected once in a month, except in March 1969; in April and May of this year the samples were taken twice during each month and in August - four times. About 150 fishes were collected at random from net and immediately preserved in 4% formaline solution. Totally 1722 spe-

cimens of spratt were collected and subjected to investigations. The following measurements and determinations were made on material collected: length of body (Lc in cm), age according to readings from otoliths, sex, maturity of gonads in Mayer's scale, composition of species, quantity of organisms in stomach content, percentage of species in food and coefficient of gonads maturity.

## RESULTS

Length of body and rate of growth. The spratt of body length 8.5-15.5 cm (Lc) was used for investigations percentage of length class is changeable for particular months. Basic mass of catches in annual cycle (78-99%) is formed by the specimens of body length 12-14 cm. Smaller or larger fish appeared not numerously. From December, appeared sporadically (single specimen) the small spratt of body length 9-10 cm. Its percentage was increasing in subsequent months to reach maximum in April (about 15%), but was not present during the remaining months of spring, summer and autumn. Fish of length 15 and 15.5 cm was present in catches during summer months only and in autumn, as single specimens (Fig.2).

The average body length of spratt was calculated for each month of a year (Tab.1).

Table 1

Average body length of spratt in annual cycle (Lc in cm)

II	III	V	VI	VII	VIII	IX	X	XI	XII	I
11.7	11.9	12.7	13.6	12.8	13.4	13.4	12.5	12.8	12.9	12.8
1969										1970

The average body length of spratt from industrial fishing amounted to 12.7.

The collected material was composed by specimen of age up to 5 years (Fig.3).

From trawl-fishing, the spratt of first year of life was of length 8-11 cm. In second year of life the spratt attains 10-12 cm. For third, fourth and fifth year, the length of body amounts to 11-14.5 cm, 12-15 cm and 13-13.5 cm respectively. Calculated average length of spratt body in particular age-groups (Tab.2) indicated that, highest increase in length of body takes place at young spratt during first year of life (in average 9.5 cm). In third and second year of life, the increase of spratt growth is about 1.5 cm while in fifth - 0.5 cm only. Average length of body (Lc in cm) for particular age-groups was determined (Tab.2).

Table 2

Average length of spratt body in particular age-groups

Age	0+	1+	2+	3+	4+
Average length of body (Lc in cm)	9.5	11.0	12.7	13.6	14.1

In catches, the specimen of three and four years of life dominated (58.7% and 27% respectively).

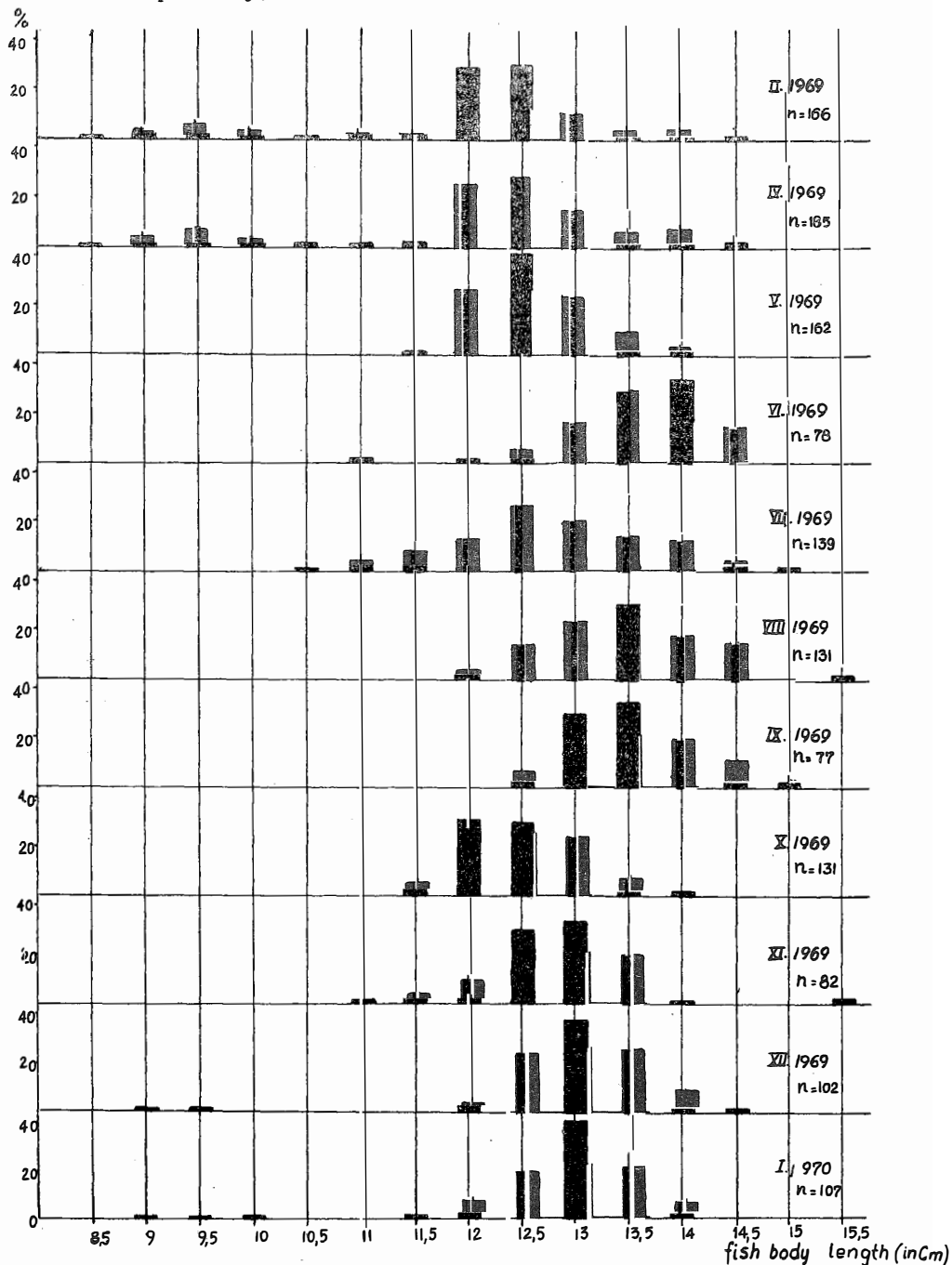


Fig.2. Length composition of spratt in annual cycle

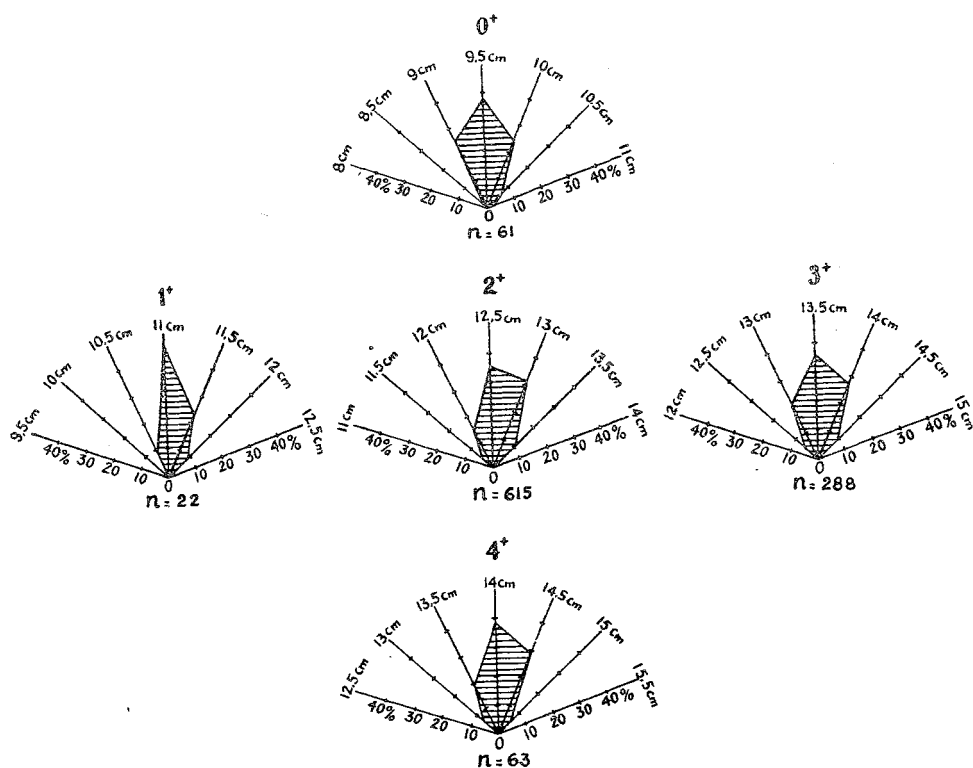


Fig.3. Length composition (Lc) of spratt in particular age-groups

#### Maturity of gonads and spawning period

The fish with gonads in VI maturity stage, according to Mayer's scale, were noted in investigated region from April to July 1969. Large quantities of spawning specimen were noted in May (33.7%) and maximum of spawning prevailed for July - 35% (Fig.4). The coefficient of gonads maturity calculated in annual cycle proved the increase beginning from October, to obtain maximum value during spawning period. After spawning, the coefficient decreases. Beginning of gonads maturity was ascertained already at fish of age 1+.

During first three years of life, the females dominate the males (Fig.5). The domination increases during fourth and fifth year of life and this proves that males live shorter than females.

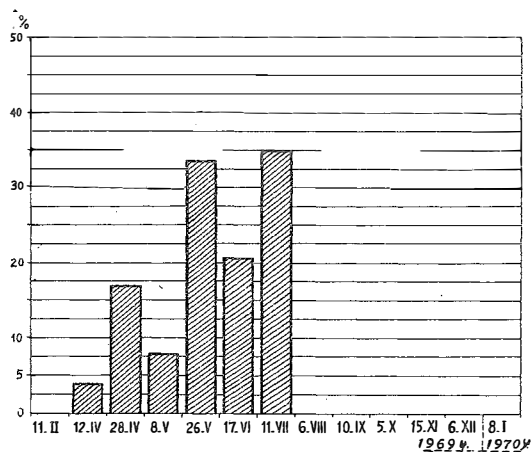


Fig. 4. Changes in percentage of spratt in VI maturity stage in annual cycle

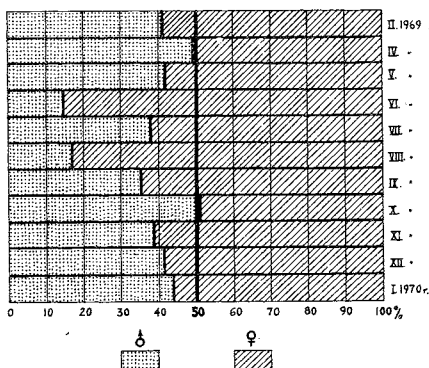


Fig. 5. Male-female quantitative relationship of spratt in annual cycle

#### Spratt food

Food of spratt was separated into two groups: constant components appearing during whole or nearly whole annual cycle demonstrating some quantitative fluctuations; seasonal components which most frequently demonstrate only one quantitative peak in food after which they disappear. To such constant compounds belong: Temora longicornis, Centropages hematus, Podon sp., and young forms of Copepoda (Fig. 6). Most dominating in seasonal compounds are: Pseudocalanus elongatus (May) and Bosmina coregoni maritima P.E.Müll. Besides these two animal groups present also in food were: Evadne nordmani, Acartia longiremis, Evadne spinifera, Eurytemora hirundoides, Limnocalanus grimaldi and naupliar forms of Copepoda.

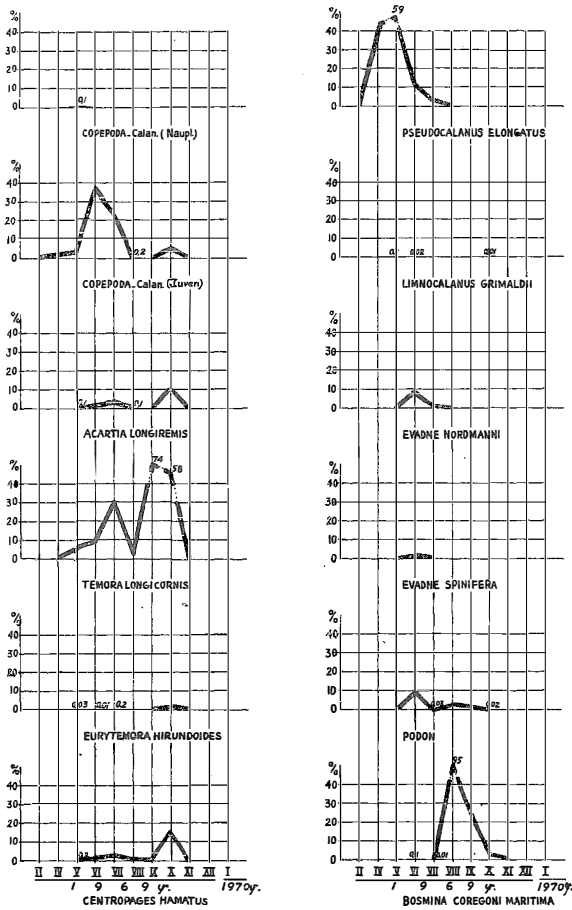


Fig.6. Food composition of spratt in particular months (in %)

Some interrelations between spratt length and food composition (also with age) were determined. In food of specimen of body length 10.6-11.5 cm, *Limnocalanus grimaldii* and *Evadne spinifera* were noted. Remaining species were present in food of all size-classes. In relation to some species, large quantitative differences were appearing in particular classes (Fig.7). With growth of body length the increase of percentage of such species as: *Bosmina coregoni maritima*, *Podon* sp., *Evadne spinifera*, *Evadne nordmanni* was observed. Contrary, i.e. decrease of species participation in food with fish growth was noted for: *Acartia longiremis*, *Eurytemora hirundoides* and partly *Centropages hamatus*. No deciding pattern in this respect was noted in relation to *Temora longicornis* and *Pseudocalanus elongatus*.

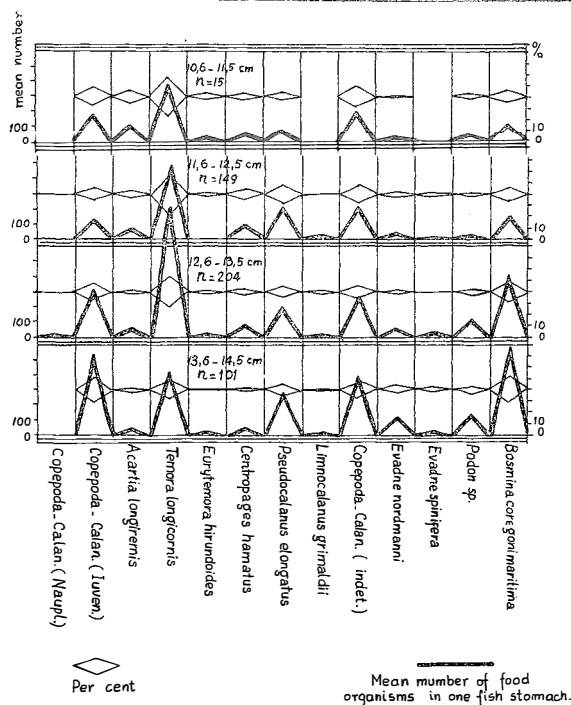


Fig. 7. Food composition of spratt in relation to length-class

## DISCUSSION

From industrial point of view an attainment of length of spratt body is of importance. Distribution of specimen in length classes originating from Bornholm catches indicated that for a period of year, basic groups are formed by the specimens of 12 and 14 cm in length, i.e., the fish relatively large. For particular months, clear pattern in increase and decrease of average body length appears during the year, viz: the length of body increases between February and June and decreases between July and January. This is due to fact that the specimen in first year of life are accounted to industrial group of fish. This proves to a very high rate of spratt growth during first year of life. After 8-9 months some specimen attain the size of 9-10 cm. This was reported already by Schneider (1918) that, up to about 3 cm of length, the spratt grows at rate of 4.7 mm weekly.

Average length of specimen in first year of life in material obtained from industrial catches, is however exceeded. Therefore the averages for this age groups given in Table 2 and the distribution of specimens in length classes of Figure 3, relate only to that part of first year fish which was present in catches due to determined mesh size of net.

The basic group of fish in catches is formed by the specimen in third year of life - average 58.74%. Older fish presents lower participation due to its actual minority, while younger fish due to smaller sizes of body. Hypothetic natural



age distribution of population, with consideration to large mortality rate of spratt (E l w e r t o w s k i (1960a) is correct, i.e. the quantity of specimen decreases with growth of age group. Considering, however, the assumptions of L a b a t z k i (1971), such distribution may be derranged during some years.

Of basic importance for growth of spratt population as species of short life cycle, is the age at which it starts to reproduce. As may be assumed on bases of L a b a t z k i's (1971) hypothesis, the fact that fish starts spawning in first year of life is of deciding importance for output of catches. The investigations of various authors (E h r e n b a u m, 1902, 1906; H e s s l e, 1927; M i e l c k, 1935; M a n k o w s k i, 1958) proved that spawning of spratt is considerably prolonged in time and its beginning depends mainly on temperature of water. Deciding majority of Kiel spratt attains sexual maturity and spawns in first year of life (M o r a w a, 1954). It was noted that Bornholm spratt possessed the gonads in VI stage of maturity between first and second year of life in very small quantity only (0.92%). According to E l w e r t o w s k i (1957b), the spratt of Southern Baltic may start spawning at size 8-10 cm and therefore actual percentage of spawning young specimen is higher.

In 1969, the spawning was noted on 12 April (it is possible that it started already in March but no materials from that period are available) and lasted till July. On 6. August no specimens with matured roe were noted. The intensity of spawning was different during this period (Fig.4). As the spawning is spread so much in time, only negligent part of fish originating from that roe is capable for spawning during the next year. Thus, in 1969 the fish will originate from April spawning and probably from spawning at beginning of May. The remaining ones shall not attain suitable size of body and maturity of gonads before November when they cease to feed. In Baltic, the spawning grounds of spratt extend between Kiel Bay, Alands Islands and entrance to Finnish Bay. Larger concentrations of roe are observed in Gotland Basin, Gdańsk Bay, Slupsk Depth, Bornholm Basin and Kiel Bay (E l w e r t o w s k i, 1957 a, c). As it was proved by M a n k o w s k i (1955), under one square meter of Bornholm Depth during 1951 present were 1.7 roe granules against 50 in Gdańsk Depth and 70 in Slupsk Depth. The same author (M a n k o w s k i, 1948) for year 1938 noted considerably larger quantity of roe in Bornholm Depth amounting to 300 eggs under one square meter of sea surface. These quantities are however lower than those ascertained during the same period in Gotland Depth and in Latvia coast. According to investigations from 1949 (M a n k o w s k i, 1951), the roe was appearing in largest quantities in Bornholm Basin. Quantity of roe in Suthern and Middle Baltic demonstrated considerable changes for each year.

According to investigations of S v e t o v i d o v (1952), W r z e s i n s k i (1969), and to our investigations, the quantity of females always exceeds the quantity of males. According to S v e t o v i d o v (1952) the females present 55.5-73.5%. In Gdańsk and Gotland Basin the percent of females amounts to 55, and for open sea-65% (W r z e s i n s k i 1969). The present investigations proved considerable differences in quantity of females and males in respect to year and age. During all months of 1969, except October, the quantity of females exceeded the quantity of males; in October, the males presented 51.06%. It is apparent however that females dominated as a rule and the exception noted in October results from casual structure of material

collected. Average annual participation of females in catches amounts to 62.09% and of males 37.91%. In age distribution, evident decrease of males quantity appears for fourth (3+) and fifth (4+) year of life.

Majority of authors discerned in food of spratt the constant and seasonal compounds. According to Mańkowski's (1947b) investigations on spratt of Gdańsk Bay and Gotland Depth, the composition of food by species proved to be poor. The samples for investigations were collected from coastal regions and contained such compounds which were not appearing in food of Bornholm spratt, viz. Chydoridae, naupli form of Cirripedia, Mysidacea and larvae of molluscs. The examined spratt proved absolute lack of food in alimentary ducts and this means "no feeding" between November and February. Also Elwertowski (1957b) and Wrzesiński (1969) pointed to "no feeding" of spratt during winter. Mańkowski (1947b) located the food in spratt's stomach during winter. These were small specimen (up to 8 cm in length) which were not present in samples for the present investigations. It is worth noting that cessation of feeding of Bornholm spratt in 1970 was noted very early i.e. 15 November at water temperature about 8°C.

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# NIKTÓRE CECHY BIOLOGICZNE SZPROTA SPRATTUS SPRATTUS BALTICUS (G.SCHNEIDER) REJONU GŁĘBI BORNHOLMSKIEJ

## S t r e s z c z e n i e

Badania szprota *Sprattus sprattus balticus* (G.Schneider) z rejonu Głębi Bornholmskiej prowadzono w latach 1969 i 1970. Przyrosty długości ciała szprota, zwłaszcza w pierwszych latach jego życia są dobre, w trzecim i czwartym wynoszą już ok. 1,5 cm na rok, a w piątym roku życia tylko 0,5 cm. W połowach dominowały szprotki trzyletnie oraz czteroletnie (odpowiednio 90 i 27%). W stadzie przemysłowym dominują samice, a w przekroju wiekowym obserwuje się wyraźny spadek liczby samców zwłaszcza w czwartym i piątym roku życia. Tarło szprota bornholmskiego trwa od kwietnia do lipca z maksymalnym nasileniem w lipcu; początek dojrzewania gonad stwierdzono już u ryb w wieku 1+.

Różnorodność gatunkowa pokarmu badanego szprota jest mniejsza niż u szprota Bałtyku Środkowego, a w okresie żerowania od kwietnia do października ustalono stałe składniki pokarmu, do których należą: Temora longicornis, Centropages hamatus i Podon sp. Okresowo podstawowym pokarmem szprota są: Bosmina coregoni maritima, Temora longicornis i Pseudocalanus elongatus. Stwierdzono pewną wybiórczość pokarmową ryb dużych, które wydają głównie wioślarki i Temora longicornis.

## НЕКОТОРЫЕ БИОЛОГИЧЕСКИЕ ПРИЗНАКИ ШПРОТА SPRATTUS SPRATTUS BALTICUS (G.SCHNEIDER) ИЗ РАЙОНА БОРНХОЛЬМСКОЙ ВПАДИНЫ

## Р е з ю м е

Исследования шпрота *Sprattus sprattus balticus* (G.Schneider) из района Борнхольмской впадины проводились в 1969 и 1970 г.г. Увеличение длины тела шпрота, особенно в первые годы, наступает хорошо, в третьем и четвертом году жизни составляет около 1,5 см в год, а в пятом году жизни только 0,5 см. В уловах преобладали трёх- и четырёхлетние шпроты (соответственно 90 и 27%). В промысловом стаде преобладают самки, а в возрастном аспекте наблюдается заметное уменьшение числа самцов, особенно в четвертом и пятом году жизни. Нерест борнхольмского шпрота продолжается с апреля до июля с максимальным увеличением в июле; начало созревания gonad установлено уже у рыб в возрасте 1+.

Видовое разнообразие исследуемого шпрота является меньшим, чем у шпрота из средней Балтики, а в период нагула с апреля до октября установлены постоянные компоненты корма, к которым относятся; *Temora longicornis*, *Centropages hamatus* и *Podon* sp. В отдельные периоды основным кормом шпрота являются; *Bosmina coregoni maritima*, *Temora longicornis* и *Pseudocalanus elongatus*. Установлена определённая кормовая прихотливость крупной рыбы, которая поедает в основном веслоногих рачков и *Temora longicornis*.

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