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ON THE GROWTH OF THE BALTIC PLAICE.

BY

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IN the following, "Baltic plaice" is to be understood as plaice from the Baltic proper, i.e., the waters south of the Sound and east of the line Gedser—Darss.

The plaice of these waters belong to a separate race or group of races characterized by a lower number of anal fin rays and also by a lower number of vertebrae than plaice from other waters. It was formerly assumed that a low growth-rate of a certain value was a character of this race too. Recent investigations, however, have shown that under favourable conditions the Baltic plaice is able to grow as fast as the North Sea plaice.

The growth and growth-rate of the Baltic plaice have been dealt with in recent years in the following papers.

C. G. Joh. Petersen: The influence of fishing upon the stock of the plaice in the Baltic during recent years. Rep. Dan. Biol. Stat., 31, 1925.

S. Strodtmann und Langhammer: Untersuchungen über die Scholle in der westlichen Ostsee. Ber. deutsch. Wiss. Komm. f. Mf., N.F., Bd. I, 1925.

A. R. Molander: Undersökningar över Rödspotta etc. i södra Östersjön. Svensk. hydr.-biol. Komm. Skr., N.S., Biologi, I, 1925.

A. R. Molander: Recent researches into the fish population of the southern Baltic. Ibid., 1926.

R. Kändler: Erneuerung und Nutzung des Schollen- und Flunderbestandes im Gebiet der Oder Bank. Ber. deutsch. wiss. Komm. f. Mf., N.F., Bd. VI, 1, 1931.

S. Strodtmann: Das Wachstum der Schollen in der Ostsee. Ibid., Bd. VII, 1935.

For the waters east of Falster, Petersen (1925) compares his recent material with Reibisch's from 1908—09; the main results of this comparison are shown in the following table, the number of fish being shown in brackets:—

	Aug. 1908—Oct. 1909	Aug. 1921 and 1922	July—Aug. 1924
II-group	—	14·5 cm. (96)	—
III-group	15·2 cm. (31)	17·4 cm. (50)	26·7 cm. (22)
IV-group	18·4 cm. (32)	—	26·4 cm. (43)
V-group	19·3 cm. (51)	—	27·3 cm. (74)

As Petersen states, it is evident that in 1908—09 growth was exceedingly slow compared with the growth in 1924. Petersen further shows that the density of the plaice population has diminished greatly in the intervening years and he draws the obviously correct conclusion that the increased growth-rate is due to better feeding conditions caused by diminished density of the stock.

Strodtmann and Langhammer also published in 1925 some investigations regarding the growth of the Baltic plaice. Investigations in the area east of Falster were carried out in spring, 1922, and the following observations of age and length (cm.) were made:—

Age-group	III	IV	V	VI	VII
cm. ♂	22·6	22·9	23·0	23·0	22·9
cm. ♀	23·7	23·7	24·7	27·2	28·6

In this case no growth was observed at all for the males from the III- to the VII-group, whereas the length difference for the females was 5 cm. Comparing this growth-rate with the growth-rate found by A. C. Johansen in 1907—08 the authors arrive at the conclusion that a considerable rise in the growth-rate has taken place between 1908 and 1922, especially amongst the younger age-groups.

In May 1928 the Danish Biological Station examined 242 plaice from the area east of Falster. In the following table the results of this investigation are compared with the previous age analyses; the table also gives the lengths (cm.) of the 0-group as it appears from the Danish coastal fishing experiments with Johansen's young-plaice trawl in recent years:—

(see page 61, top)

Age-Group	0	I	II	III	IV	V	VI	VII
March 1907 (A. C. Johansen)	4·7	11·4	15·0	17·6	—	—	—	—
Aug. 1908 — Oct. 1909 (Reibisch)	—	—	—	15·2	18·4	19·3	—	—
Spring 1922 (Strodtmann u. Langhammer)	—	—	—	23·1	23·3	23·8	25·1	25·8
July—Aug. 1924 (Petersen)	—	—	—	25·8	28·5	29·2	32·6	36·3
May 1928 (Dan. Biol. Stat.)	5·5	—	—	—	—	—	—	—
Aug.—Sept. 1930—37 (Dan. Biol. Stat.)	—	—	—	—	—	—	—	—

On comparing these figures, it becomes clear that the increase in length of the various age-groups is very marked. From 1908 until 1928 the mean lengths of the III- IV- and V-groups have increased 10 cm. It is also obvious that the rapid growth of the younger age-groups had already begun in 1922 (in 1908 the III-group measured 15 cm., in 1922 23 cm.), whereas in that year there was no correspondingly rapid growth-rate among the older age-groups. In 1928, however, the older fish were also growing rapidly, the difference in length between the III- and the VII-groups being then 10·5 cm. against only 2·7 cm. in 1922.

The thinning out of the stock of plaice in the waters east of Falster has thus resulted in a marked increase in the growth-rate first of the younger age-groups and later of the older age-groups too. The growth-rate is accordingly not governed by internal factors only, but by feeding conditions as well. Here, then, the growth-rate is not a racial character but is the stamp of the external conditions upon the individuals of the stock; the growth-rate is a phaenotypic, not a genotypic character.

During the last 8 years we have had in the area east of Falster one especially rich year-class, viz., the 1934 year-class, whereas all the other year-classes have been more or less poor. Comparing the growth-rate (in the 0-group) of this rich year-class with that of the other year-classes, we get the following figures (the material was collected during the Danish coastal investigations): —

Year-classes 1930—33 and 35—37:
mean length of 0-group in Aug.. 5·7 cm. (45 fish)
Year-class 1934:
mean length of 0-group in Sept.. 5·3 cm. (40 fish).
Though the individuals of the rich 1934 year-class were fished about 3 weeks later than those of the other year-classes, they were half a centimetre smaller than these. This observation shows clearly that the rich year-classes grow slower than the poor ones and, therefore, that feeding conditions may influence growth-rate.

For the area Bornholm—Rügen (the Arcona Basin) the growth-rate can be seen from the following figures: —

Group	II	III	IV	V	VI	VII	VIII—X
$^{20}/_{11}$ 1921 (Strodtmann u. Langhammer)	—	—	—	22·9 (10)	25·8 (30)	24·9 (104)	25·2 (153)
March 1922 (A. R. Molander)	16·4 (22)	20·6 (23)	22·3 (12)	24·5 (36)	26·5 (31)	26·0 (29)	—
$^{12}/_{7}$ 1922 (Strodtmann u. Langhammer)	—	22·4 (13)	24·5 (19)	25·4 (25)	25·8 (73)	25·5 (102)	26·7 (209)
$^{17-21}/_{8}$ 1928 (Danish Biol. Stat.)	—	26·4 (44)	29·1 (31)	30·0 (67)	29·2 (10)	34·1 (6)	37·4 (17)

As appears from the figures, there is a considerable rise in the growth-rate from 1922 until 1928, the length of the age-groups being about 6 cm. longer in 1928 than in 1922. The increased growth-rate has resulted in the Danish size-limit of 26 cm. being reached in 1928 by the III-group, whereas it was first reached by the VI-group in 1922.

The following analyses may be tabulated for the Oder Bank area (a coastal area where the young plaice (0-III-group) grow up): —

Group	0	I	II	III
June 1930 (after Kändler, 1931)	—	7·0 (6)	13·6 (580)	21·1 (217)
Sept. 1930 (Mat. from the "Dana")	7·9 (118)	12·4 (93)	17·9 (300)	24·5 (44)
Oct. 1930 (after Kändler)	6·4 (346)	12·4 (96)	18·9 (720)	23·7 (30)
July 1937 (Dan. Biol. Stat.)	—	—	17·1 (60)	20·7 (197)

The figures from the various investigations agree rather well with one another. As regards the growth-rate of the various year-classes we may state as follows. The investigations show that in the Baltic the 1934 year-class was comparatively rich. It is apparent from the figures that the 1934

year-class (III-group in 1937) had a slower growth-rate than the poor 1927 year-class (III-group in 1930); at the end of July 1937 it had a mean length of only 20·7 cm., against 21·1 cm. at the beginning of June (1st to 6th) 1930.

The lengths of the various age-groups at the end of the growth season are approximately as follows: —

Group	0	I	II	III
Length about	8	13	19	25

As Kändler states, the growth of the young plaice is more rapid in the Oder Bank area than in the southern part of the North Sea off the German coast.

A comparison with the growth of the young plaice in the Horns Reef Area shows the same results: —

Group	0	I	II	III
Horns Reef Area (autumn 1935*))	7	13	16·8	19·6
Oder Bank	8	13	19	25

*) Aage J. C. Jensen: An Investigation of the Stock of Plaice in the Southern Horns Reef Area in the years 1925 and 1927. Medd. Komm. f. Havunders., Ser. Fiskeri, VIII, 6, 1928.

The growth-rate on the feeding grounds is thus somewhat higher for the Baltic plaice than for the North Sea plaice.

The following figures relate to the deeper area of the Baltic north and east of Bornholm where the older age-groups live:—

Years:	Age: 3	4	5	6	7	8
19th June 1919 (Molander, 1925) ...	—	19 (1)	23 (21)	25 (20)	27 (13)	27 (12)
20th March 1922 (Molander, 1925) ..	—	—	25 (3)	27 (8)	27 (11)	30 (11)
Sept.—Oct. 1925 (Molander, 1926) .	—	24 (155)	27 (211)	29 (151)	32 (96)	33 (35)
Aug. 1928 (Dan. Biol. Stat.)	25 (47)	27 (15)	28 (28)	29 (7)	—	—
Jan. 1931 (Dan. Biol. Stat.)	22 (54)	23 (127)	24 (14)	29 (2)	36 (2)	35 (1)

Though the figures are not quite in agreement with one another, there is on the whole an increase in the growth-rate from 1919 to 1931. This increase of the growth-rate has been dealt with in detail by A. R. Molander (1925 and 1926). He is no doubt right when he says: "If we look for an explanation of the greatly increased growth of the southern Baltic plaice, we shall no doubt find it in the thinning out of the stock caused by fishing, whereby a lessening of the struggle for food resulted".

By means of the observations of age and length of the Baltic plaice it has been shown (cf. the papers cited above) that the rate of growth is not a racial character and is thus not bound up with the internal condition of the individuals. The rate of growth is governed by external conditions, and as the investigations showed that the rise in the growth-rate occurred simultaneously with a thinning out of the stock, there is every reason to suppose that the growth-rate is governed in the main by feeding conditions. This supposition is further supported by the fact that in several cases it has been established that the growth-rate of the rich year-classes is slower than that of the poor ones.

Nevertheless, to a certain degree the growth-rate must be assumed to be determined by internal factors as far as each species or race has its own range of possibilities of growth-rate, but within this range the growth-rate is primarily governed by feeding conditions.