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THE GROWTH OF THE PLAICE IN THE
TRANSITION AREA

BY

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THE length of the different age-groups within the stock in the sea is determined partly by the growth and partly by the effect of the fishery on the stock.

The effect of the fishery is considerable throughout the area. In marking experiments carried out during recent years about 50 % of the fish marked at a length of 20—25 cm. were recaptured in the course of the first year after the marking (according to H. Blegvad, 1934, p. 291). It is therefore evident that a very considerable proportion of the plaice stock is removed by the fishery, but on account of the size limit none of the fish below about 26 cm. are taken.

When the plaice of a certain age-group reach the length at which the fastest growing individuals of the group begin to fall victim to the fishery — and the group thereby being perceptibly depleted — the average size of the remaining number will be correspondingly reduced. This reduction in the average size amounts in the Belt Sea to 2 cm. for the age-group which is just reaching the size limit (II-group). As regards the northern Kattegat where the fishery is equally intensive, but the growth slower, the reduction may be estimated to be about 1 cm.

¹⁾ H. Blegvad, Transplantations of Plaice from the North Sea to the Belt Sea 1928—1933. Rep. Dan. Biol. Stat., XXXIX, 1934.

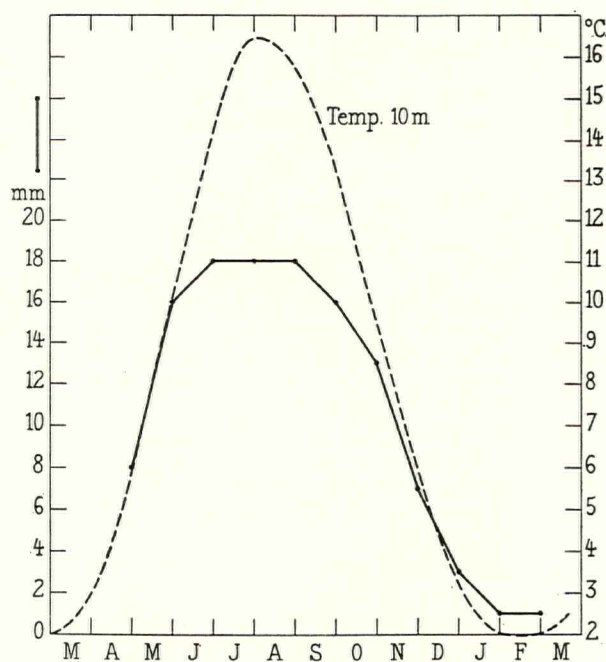


Fig. 1. Monthly growth of transplanted North Sea plaice in the Sejrø Bay compared with the mean temperature at "Schultz' Grund" L. V., 10 m. depth.

For the Bohuslän Fjords Dr. Molander⁹⁾ has shown that the increase in length with increasing depth is very great.

The length of the age-groups during September—March was:—

	Gullmar Fjord		Stig Fjord
	5—9 m.	30—35 m.	7—25 m.
I-group	—	—	16.6 cm.
II-group	—	—	23.4 cm.
III-group	27.6 cm.	34.0 cm.	25.1 cm.
IV-group	31.1 cm.	35.9 cm.	28.7 cm.

In the Aalbæk Bay—Herthas Flak area the difference in length of an age-group between the corresponding depths was a few cm. only.

Molander states that the differences are due, to some extent, to the varying density of the stock, but for the Stig Fjord, for instance, the small lengths persist in spite of a very rich bottom fauna. Molander ascribes it to the comparatively low salinity of about 21—24 ‰. Yet the transplantations of plaice from the North Sea to the Belt Sea have shown that the North Sea plaice may thrive well at salinities as low as about 15 ‰, and it must be assumed that other factors — perhaps the temperature — contribute to the slow growth-rate recorded.

⁹⁾ Arvid R. Molander: Investigations of Plaice off the West-Coast of Sweden. Rapp. et Proc.-Verb., Vol. LXXI, 1931, p. 77 et sequ.

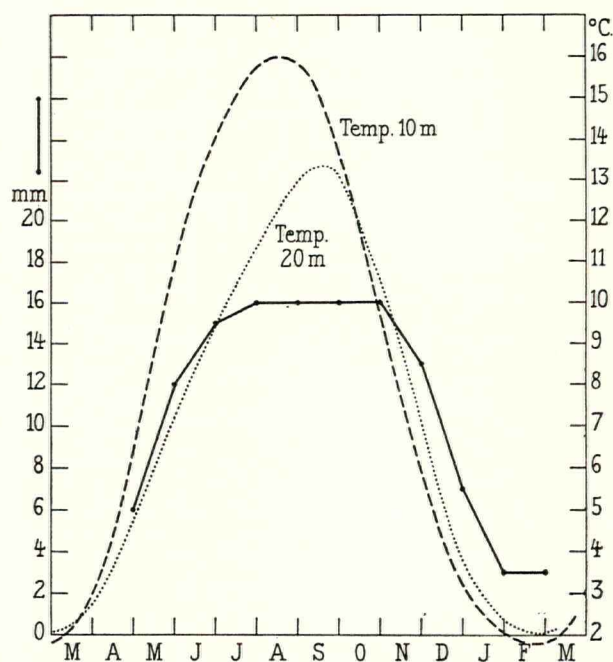


Fig. 2. Monthly growth of transplanted North Sea plaice in the southern Little Belt compared with the mean temperature at the station "South of Fyn", 10 and 20 m. depth.

The length of plaice of the youngest age-groups determined at fishing experiments carried out by the Danish Biological Station is — after correction for the plaice measured to the cm. below — at the end of the growth-year as follows²⁾ :—

	Aalbæk Bay Herthas Flak (northern Kattegat) Depth 5–35 m.	Southern Kattegat and the Belt Sea	Western part of the Baltic proper
0-gr.	8.5 cm.	10.5 cm.	9.5 cm.
I-gr.	15.0 cm.	18.5 cm.	16.0 cm.
II-gr.	22.5 cm.	ca. 26 cm.	23.5 cm.
III-gr.	ca. 26 cm.	ca. 30 cm.	

The growth of the local as well as of the transplanted plaice in the Belt Sea has in recent years been closely followed through marking experiments, and H. Blegvad has issued a very detailed report on the results of these experiments (*loc. cit.*). The length of the plaice marked during 1929–1933 varied between 20 and 25 cm.; average 22.4 cm. The growth of plaice, liberated in the different areas³⁾, was as follows:—

Growth in 1st year after marking.

		local	transplanted
Liberated	North of Fyn	7.8 cm.	11.9 cm.
"	Little Belt	8.3 "	12.3 "
"	South of Ærø	9.4 "	ca. 13.3 "
"	Great Belt	9.4 "	12.4 "
"	Sejrø Bay	9.4 "	12.5 "
"	Smaalands Sea	9.7 "	12.0 "

Causes of local Differences in Growth.

As we know the growth is dependent on the density of the stock; great density means less food per fish and therefore slower growth. In the Aalbæk Bay—Herthas Flak area the stock of plaice is ten times as dense, and the stock of dabs which are serious competitors with the plaice for food about twice as dense as in the Belt Sea. Further we find here a considerable number of competitors for food among the invertebrates (*Asterias rubens*, *Nassa reticulata*, and others). We therefore find a slow rate of growth here. The competing invertebrates which are fairly rare in the Belt Sea must be considered a factor of importance in the Kattegat.

Within the Belt Sea the differences in total yearly growth are fairly small. The growth seems to be slowest in the area north of Fyn both as regards the local and the transplanted plaice. A comparatively low summer temperature of the upper layer is a special feature of this area. This is caused by an especially strong admixture of

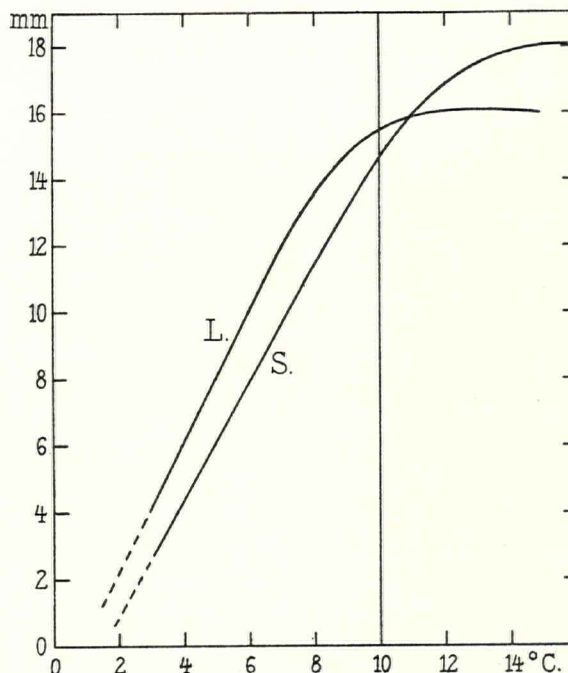


Fig. 3. Connexion between temperature and monthly growth of transplanted North Sea plaice in the Sejrø Bay, S.-curve (cf. Fig. 1), and the southern Little Belt, L.-curve (cf. Fig. 2), respectively.

water from the lower layers of the Kattegat (J. P. Jacobsen, p. 24)⁴⁾.

The course of the growth-curves must, however, necessarily depend to some extent on the nature of the fishery. In the growth-curves published by Dr. Blegvad for local and transplanted plaice it is shown that the maximum growth-rate is reached later in some places than in others. The growth-curves for the Great Belt and the Sound take a somewhat different course from those for other areas. The maximum growth is here reached late, but when it comes the rate of increase is, in return, faster than in any other area. As regards the Great Belt the explanation is this that during the first months after the marking especially large numbers of recaptures are made here in set nets close to the shore (See H. Blegvad, *loc. cit.*, p. 27). The smallest fish have a tendency to move coastwards. Their liability to recapture is therefore greatest and the average length of the recaptured fish in the early months has consequently been remarkably low. The remaining stock of marked fish, on the other hand, has contained the larger fish, a fact which explains the apparent great increase in the growth.

²⁾ Aage J. C. Jensen, Investigations on the Stock of Plaice in the Kattegat and the Belts in the Years 1927–1929. Rapp. et Proc.-Verb., Vol. LXXI, 1931.

³⁾ Partly recaptured in other areas (H. Blegvad, *loc. cit.*, p. 71 et seq.).

⁴⁾ J. P. Jacobsen, Mittelwerte von Temperatur und Salzgehalt. Medd. Komm. f. Havunders., Ser. Hydrografi, Bd. I, No. 10, 1908.

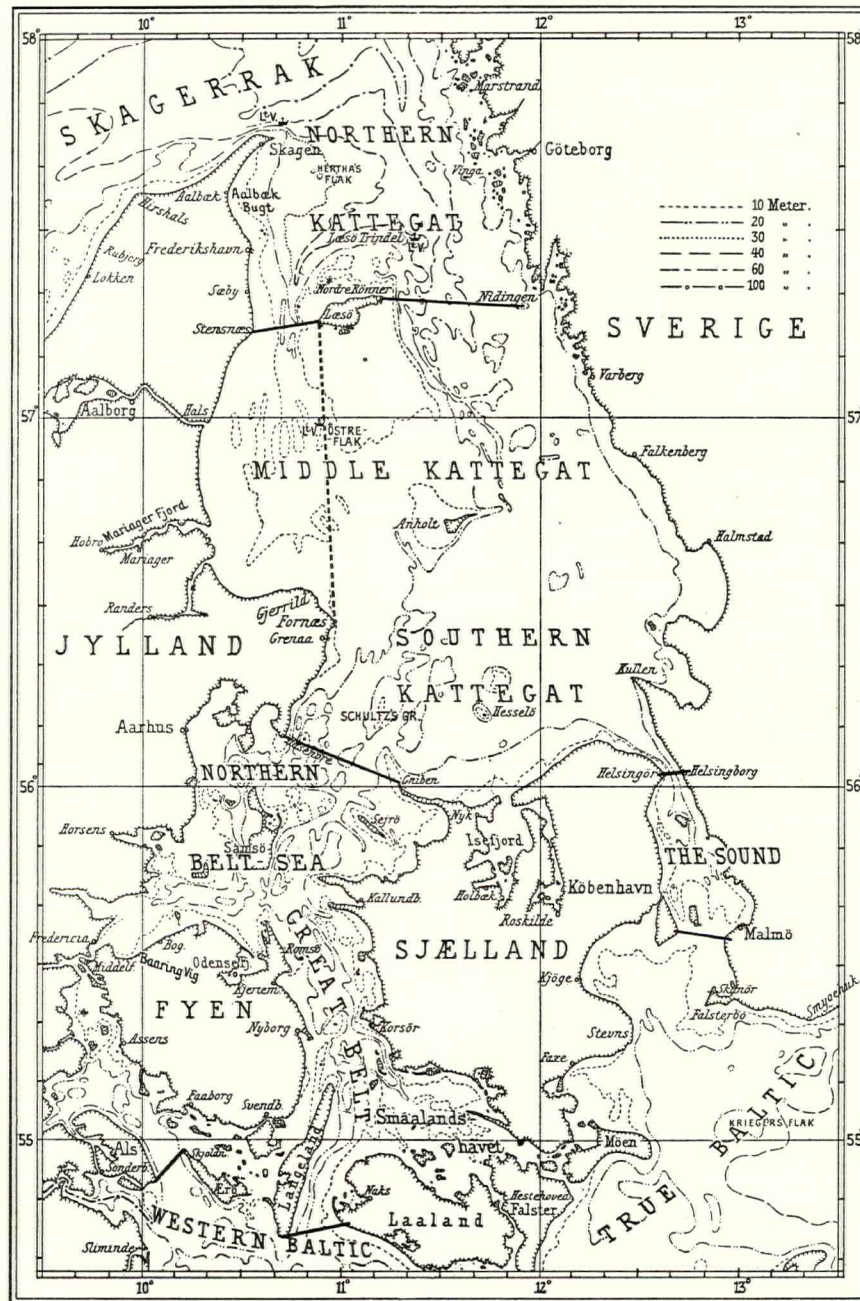


Fig. 4. Chart of the Kattegat and the Belt Sea.

The same phenomenon probably occurs in the Sound, but the low salinity of the upper layer there is without doubt another factor of importance. This causes especially the transplanted fish to keep to the lower layer where the temperature rises more slowly in the spring.

It may be noticed from the above growth-table that in the Smaalands Sea, the shallowest area (where the depth only in a small channel in the western part exceeds 15 m.) and where the salinity is always comparatively low, the greatest growth for local plaice, but the smallest growth for transplanted plaice is recorded.

Up to about 10° C. the growth is in linear proportion to the temperature, above this degree it increases but little.

In Figs. 1 and 2 the average monthly growth of transplanted plaice in Sejro Bay and Little Belt is compared to the temperature of the water. The monthly growth-curves are based on the growth-curves given by Dr. Blegvad (*loc. cit.*, Fig. 33). In the shallow Sejro Bay area the growth follows the temperature of the water at a depth of about 10 m. (the temperature curve is taken from "Schultz' Grund" L. V., 10 m.). In the Little Belt area where the depth is largely above 15 m., and even in a considerable section above 20 m., the growth follows the temperature of the water at a depth of 20 m. (The temperature curves are taken from a station south of Fyn at 10 and 20 m. The course of the temperature curve at a depth of 10 m. varies but little from the course of the corresponding curve from "Schultz' Grund" L. V. as shown on Fig. 1.)

It should be kept in mind that the growth does not follow the change in temperature with complete accuracy as the depth at which the plaice are to be found varies with seasons, even in the two just mentioned areas which show great similarity as regards depth (See H. Blegvad, *loc. cit.*, p. 61). Especially in the early months the plaice have been found at depths considerably less than 20 m.

It is most remarkable that the ratio growth/temperature is about the same in spring and autumn. This fact shows that about the same amount of plaice-food is available at both these seasons. This is not the case at overpopulated areas such as, e.g., Horns Reef Area where the growth in the autumn is perceptibly less than in the spring.

The figures show that the monthly growth rate is not greatly increased when the temperature rises above 10° C. It is most probable that the monthly growth reaches its optimum at about 13°—15°. The material at present discussed is not extensive enough to form a basis for any accurate judgment on this point.

In Fig. 3 is shown, on the basis of Figs. 1 and 2, the connexion between temperature and growth. It appears to be different for the two areas, and this very important question should be the subject of further investigations.

Causes of Changes in Growth.

Within the Transition Area a section exists in the northern and western Kattegat where the lengths of the different age-groups have remained practically unchanged since the beginning of this century⁵). The explanation is this that already before the year 1900 the fishery was carried out with such intensity that the total yield of the fishery culminated, i.e., A. C. Johansen's "third stage" was reached. This means that the stock has been thinned to such an extent that the accumulated stock has practically disappeared and the density has been reduced to the point below which the growth-rate does not perceptibly increase⁶) by thinning. The comparatively low growth-rate at the young-fish grounds in the Aalbæk Bay—Herthas Flak area remains low for the very reason that the Danish "saving"-fishery does not reduce the stock of young fish.

In the southern Kattegat and the Belt Sea the average length of the age-group has, however, become substantially greater. In the northern Belt Sea and the Great Belt the average length of the II-group in September—March increased in the years from 1907—11 till 1927—29 from about 20.5 cm. to about 26 cm.; the average length of the III-group increased from about 26 cm. to about 30 cm., and in the southern Kattegat the increase was so great that the average length of the II-group in 1930 was greater than the average length of the IV-group in 1905—07⁷).

The change in the southern Kattegat I have explained, on a previous occasion, partly as a direct consequence of the thinning of the stock caused by the fishery, and partly as caused by a change in the numerical ratio between the North Sea plaice and the Baltic plaice to the effect that the North Sea plaice has now become numerically the stronger⁸).

As regards the Belt Sea we find a corresponding thinning of the stock, caused by the intensive fishery, and a change in the racial character of the plaice.

⁵) Aage J. C. Jensen, *loc. cit.*, p. 35.

⁶) *loc. cit.*, p. 39.

⁷) *loc. cit.*, p. 38.

⁸) *loc. cit.*, p. 39.

