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Age and Growth Rate of the Greenland halibut Reinhardtius hippoglossoides /Walbaum/ from the Northern Atlantic

by

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Introduction

Literature regarding the characteristics of age and growth of the Greenland halibut is considerably poor, although this species makes a significant position in the ICES and ICNAF areas. This situation is associated with methodical difficulties of age and growth rate determination. Even in the vast work of Smidt /1969/ of monographical character and presenting the investigations on biology of the Greenland halibut from the waters of Greenland this problem has not been solved to the end. The anterior investigators who tried to solve this problem, above all used otoliths /Smidt - 1969, Paschen - 1968/. The exception was Miliński /1944/ who used scales for this purpose. However, reading age from the otoliths is very difficult as they are of irregular shape, deeply notched edges and have a lot of secondary zones. The number of these zones increases with the growth in length of the fish. The percentage of readable otoliths of the Greenland halibut is not high and their readability worsens with the fish growth.

Thus, the purpose of these studies was to find a more useful method of age and growth rate determination. Moreover, length frequency distribution and age composition, rate of growth in length and weight, as well as length-weight relationship have also been examined.

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Materials and methods

The materials were collected in 1968 - 1972. They come from regions of the Northern Atlantic: the fishing grounds of the Barents Sea /IIb, IIa/, of Iceland /Va/ and New Foundland /3K, 3L/. Generally, 13 752 specimens of the Greenland halibut were measured, 1 364 of them were taken for a detailed biological analysis.

To find a proper method of age determination a comparative analysis of following five anatomic elements: fin radii, opercular bones, vertebrae, otoliths and scales were made. It has been stated, that because of their delicate structure and bad readability the fin radii as well as the opercular bones are not adequate for this purpose. The vertebrae after staining with alizerin may be used for age determination. However, on account of difficulties associated with preparation they are of no use in cases of a vast material. The calcinated otoliths are much clearer than uncalcinated but their readability is also unsatisfactory when the material is vast.

On purpose to find out the usefullness of scales in age and growth of rate determinations scales from 12 different spots of the Greenland halibut's body were taken from 173 fishes from the fishing grounds of the Barents Sea and from 180 fishes caught in the waters of New Foundland. The relationship between total length /l.t./ of the Greenland halibut and oral radius of scale from a certain spot has also been calculated. It was proved that the relationships of all 12 spots are associated with linear form relationship and that the highest values of correlation coefficient fall to the scales from the caudal part of the halibut's body. The equations of regression lines for the caudal scales which had

been calculated at the same time differ from the remaining in their higher slope. It happens so, because the scales of this part of body are of bigger size and the regression lines drawn for these scales, unlike majority of the remaining, cross the Y-axis near to the origin. As the caudal scales are the biggest, the clearness of annulii was the best. It has been stated that the scale size in the direction of the caudal fin increases and this regularity involves all fish caught in various regions.

So, the scales from the caudal part above the lateral line and from the eye side were taken as the basis for age and rate of growth determination in this spot. The smallest number of regenerated scales was found in this spot. The relationship between total length /l.t./ of the Greenland halibut and oral radius /r.or./ of its scale taken from this spot has been additionally calculated from the enlarged material /430 fishes/ caught in the fishing grounds of New Foundland. The fish length was of 13 to 81 cm. It is shown in Fig. 1, where the straight line, which is the result of this relationship, crosses the X-axis at 3,51 value. This value correspond to the length at which the scale of the caudal part developes. This relationship proves to be not permanent - it changes together with the fish length growth. But the relationship $\frac{l.t. - c}{r.or.}$ is almost always permanent and amounts to 178, where „c" is substituted by 3,51 value /Fig. 2/. On this basis to back calculation Rosy Lee's formula has been applied. Value „c" has been calculated in virtue of the fish caught in the fishing grounds of New Foundland. It has been also applied with the reference to the remaining regions, where the lack of young specimens of halibut made the determination of re-

liable relationship between scale radius and the fish length impossible.

In age determinations based on scales the number of annulii in the form of closer circuli zones was of the first importance. The annules was localized in the exterior part of the zone. Apart from annulii there were also false annulii present on the Grennland halibut's scales. The most commonly found type was the juvenile ring. It was visible in the form of a boundary between closer circuli zone and near to the center and tetween rerefied circuli zone - further from the center. Rarely found was a double ring, which is next to some other ring and a partial ring which was visible only on the part of a scale.

The rate of growth of the Greenland halibut has been expressed by three mathematic methods: Ford-Walford, Gompertz and v. Bertalanffy's. The third one characterises best the growth of the discussed species and it has been also used to show the rate of growth in weight.

Results

The elaboration of lenght frequency distribution of the Greenland halibut caught in the fishing grounds of New Foundland subares were based on the measurements of 579 fishes. The age composition was based on the analysis of 524 fishes caught in 1968, 1871 and 1972. In this region /Fig. 3/ the length of the Fish was from 13 to 83 cm and in age groups from I to XII. The average length was 42,0 cm and age - 4,69. The specimens from III to VI age groups were prevailing and the fish from IV group was most aboundant.

The elaboration of length frequency distribution of the Greenland halibut caught in the fishing grounds of the Barents Sea in 1970, 1971 was based on the measurements of 8 364 fishes and 328 fishes were measured in order to determine age composition In this region the length of fish varied from 28 to 103 cm and V to XV age group. The average length was 52,5 cm and the average age - 7,95. The fish of VII age group was prevailing.

In the elaboretion of length frequency distribution of the same species but caught in the waters of Iceland in 1971, 4 809 fishes were measured and 381 fishes analysed for age composition. In this region /Fig. 5/ the length of fish was varied from 29 to 96 cm and the age group VII to XIII, the most prevailing was XI age group.

As the rate of growth in length of the Greenland halibut from the examined regions shows similarity in life course - the growth curves are also similar. The growth rate is rapidly growing in the first year of life, from the second to the fifth the growth rate is rather regular to become slower in further years. The most rapid growth rate is characteristic for the Greenland halibut from the fishing grounds of New Foundland, then from the Barents Sea and the slowest is noted for the fishing grounds of Iceland /Fig. 6/. The equations of the growth in length for these regions are as follow:

New Foundland $l_t = 126,5 \left[1 - e^{-0,08/t + 0,02/}\right]$

The Barents Sea $l_t = 116,5 \left[1 - e^{-0,08/t + 0,031/}\right]$

Iceland $l_t = 144,0 \left[1 - e^{-0,05/t + 0,93/}\right]$

The difference in the rate of growth of males and females have been observed. Thus, the females from the waters of New Foundland and the Barents Sea - from the eight year and from the fishing

grounds of Iceland from the ninth year grow faster than males. This restrain in the growth rate in length of males in these regions is the case with the fish of over 50 cm in length. Presumably, this phenomenon is associated with early maturity of males and their longer stay in the spawning grounds than that of females.

In Fig. 7 the relationship between length and weight of the Greenland halibut for the three compared regions is shown. It seems that of best condition was fish from the Barents Sea, of worse from the fishing grounds of New Foundland and the worst from Iceland. However, it must be noted that the material from this region has been collected in summer, whereas from New Foundland in spring and in autumn from the Barents Sea.

In Fig. 8 curves of weight for different fishing grounds have been drawn and calculated by Bertalanffy's equation. It is as follow:

New Foundland $W_t = 22990 \left[1 - e^{-0,08/t + 0,02/} \right]^{3,32}$

The Barents Sea $W_t = 18660 \left[1 - e^{-0,08/t + 0,031/} \right]^{3,35}$

Iceland $W_t = 25840 \left[1 - e^{-0,05/t + 0,93/} \right]^{2,98}$

The most rapid growth of weight is characteristic for the Greenland halibut from the fishing grounds of New Foundland, then from the Barents Sea fishing grounds and then from Iceland.

Literature

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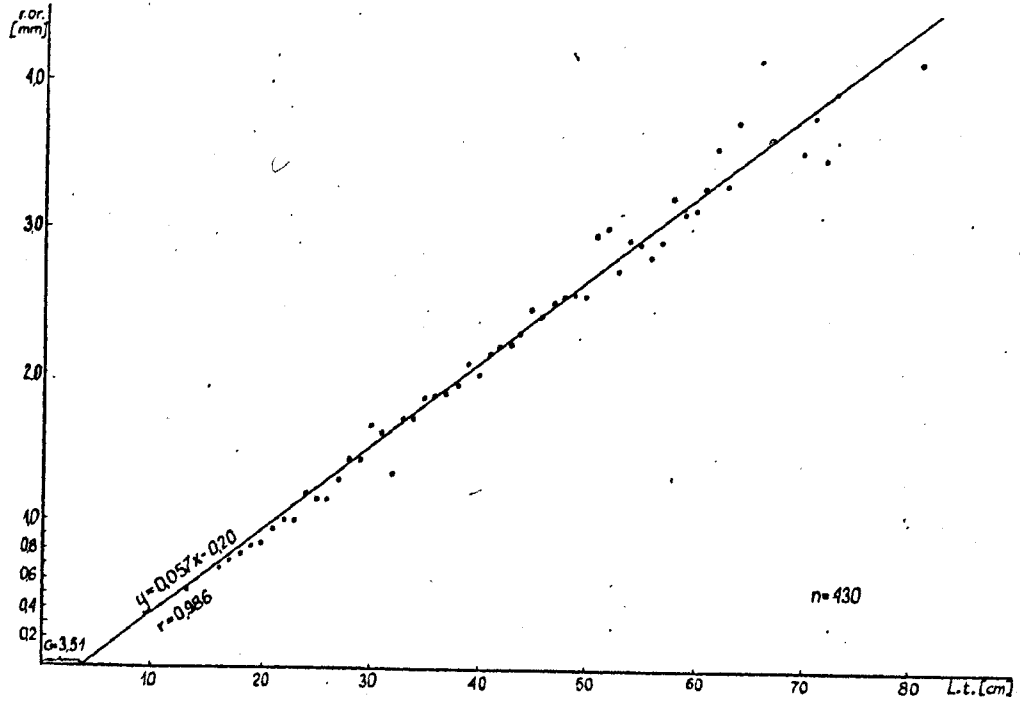


Fig. 1. Relation between total length /l.t./ Greenland halibut and oral radius /r.or./ of scale from caudal part

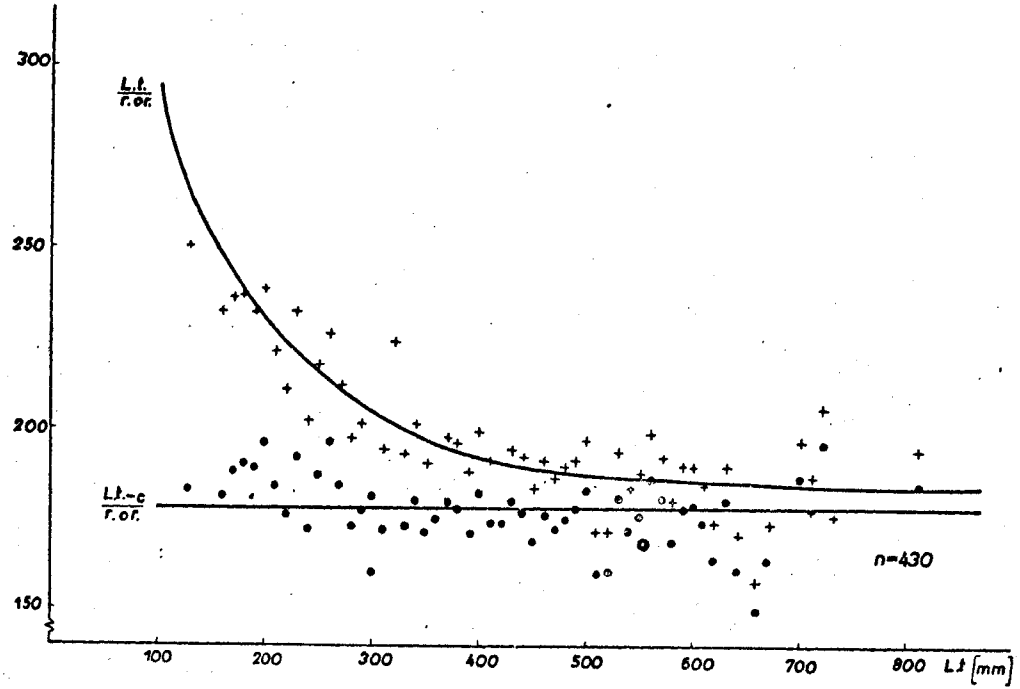


Fig. 2. Relation between ratio $\frac{L_t t_{r.or.}}{}$ and $\frac{L_t t_{r.or.} - c}{}$ from total length of Greenland halibut

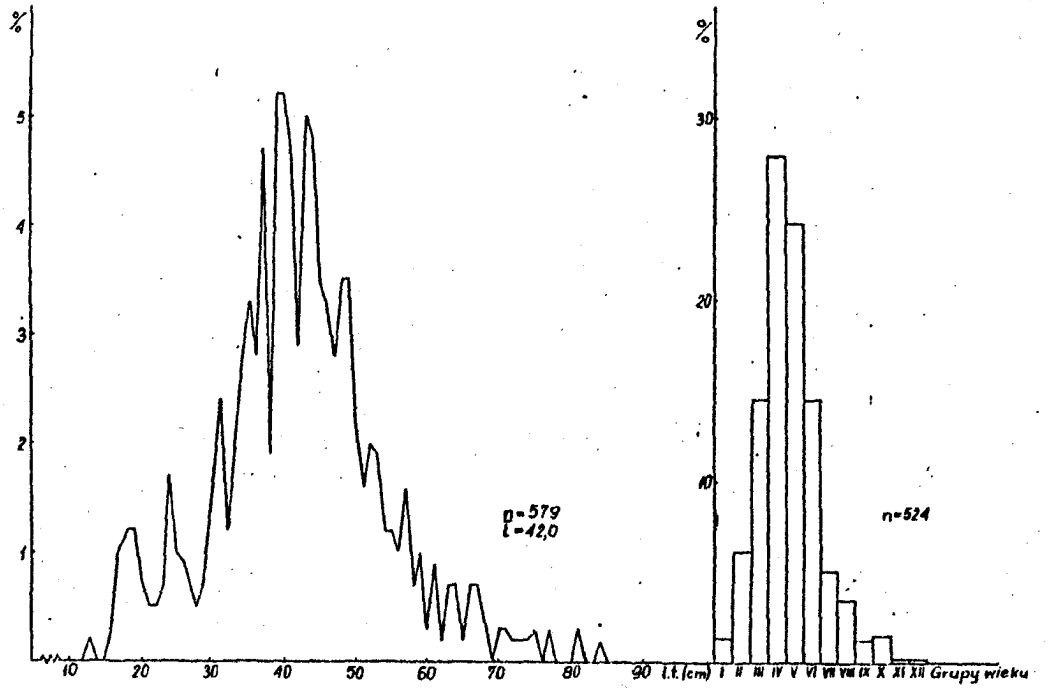


Fig. 3. Length and age composition of Greenland halibut from New Foundland fishing grounds

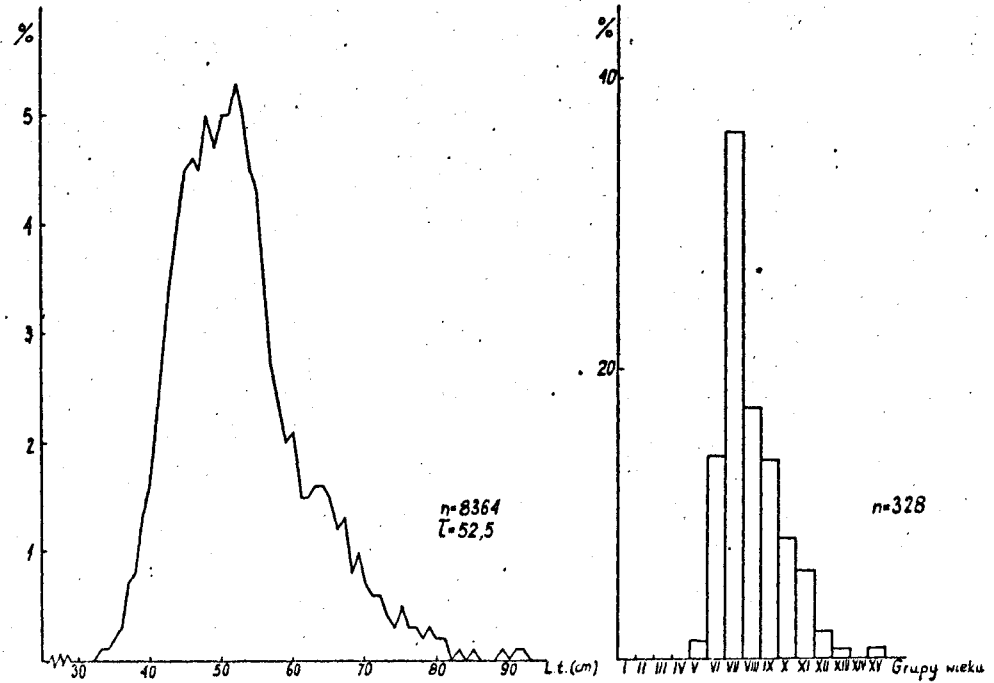


Fig. 4. length and age composition of Greenland halibut from Barents Sea fishing grounds

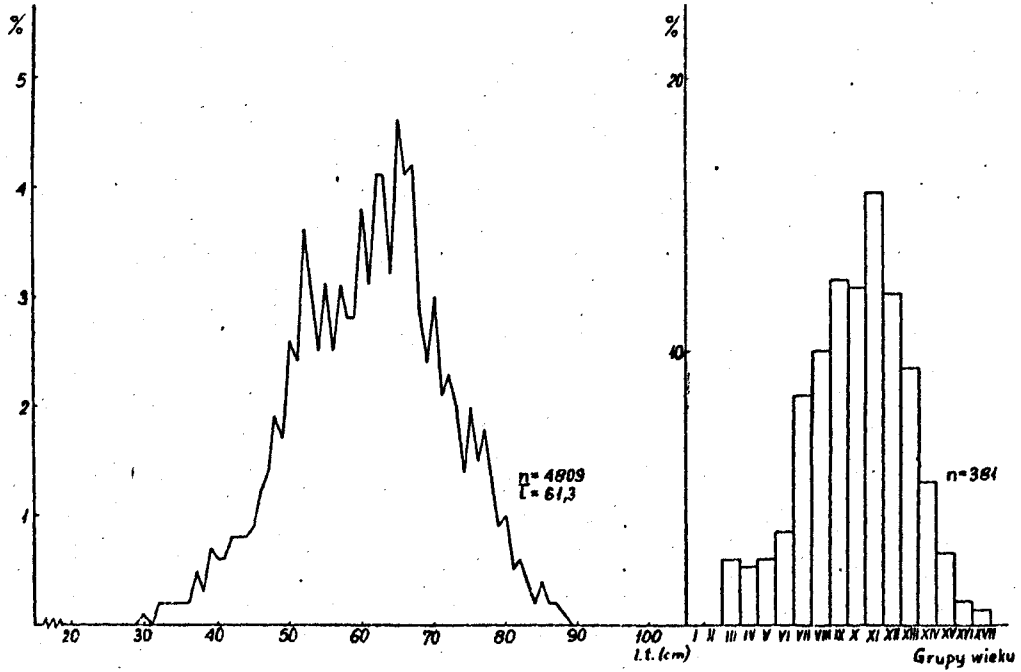


Fig. 5. Length and age composition of Greenland halibut from Iceland fishing grounds

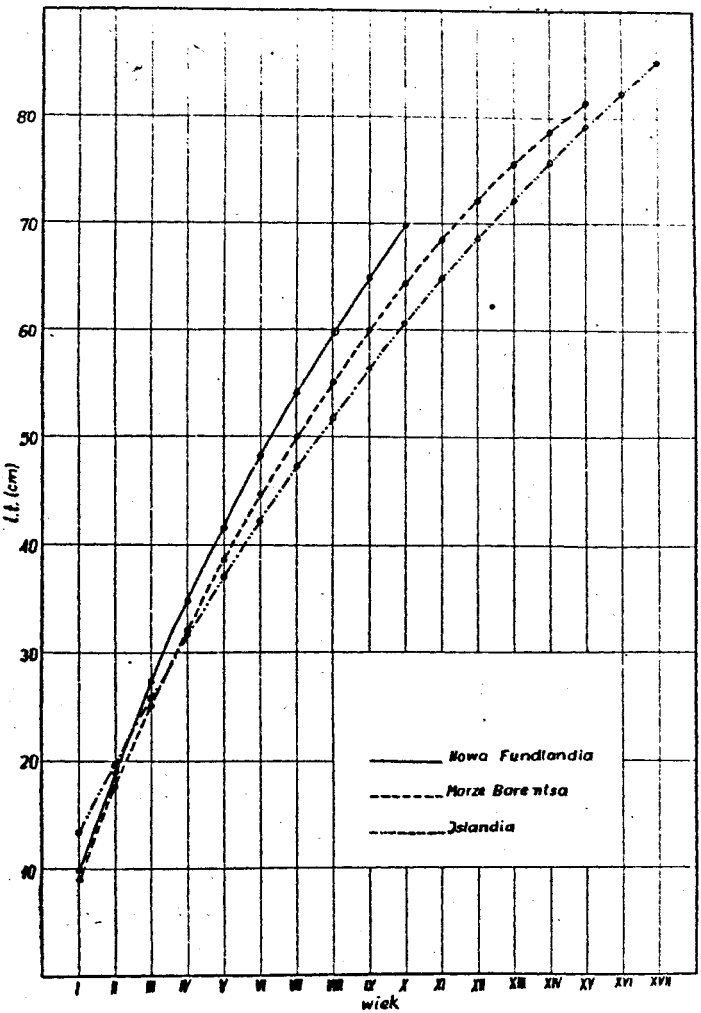


Fig. 6. The rate of length growth of Greenland halibut

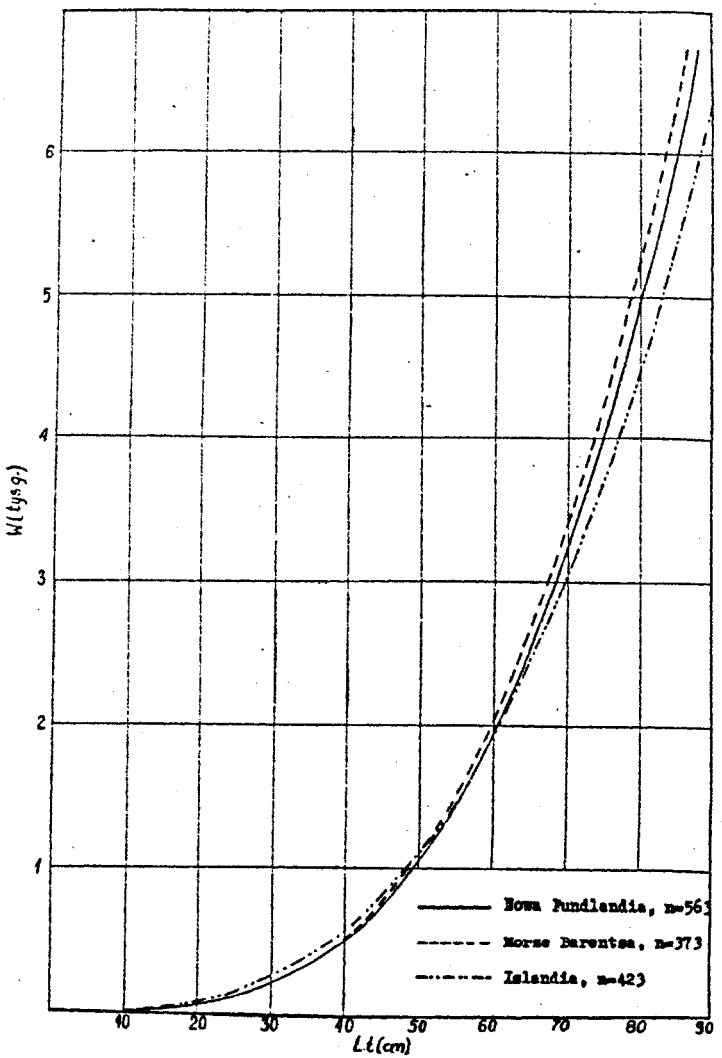
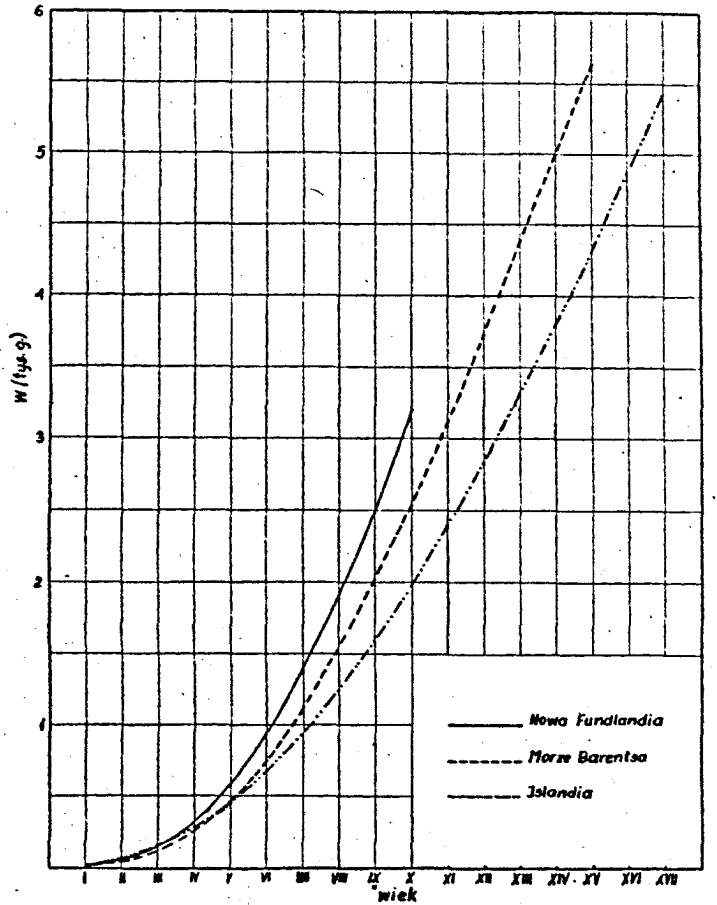


Fig. 7. Length-weight relationship for Greenland halibut



Rys. 8. The rate of weight growth of Greenland halibut