

of the experiments make it possible for us, by a process of analogy, to "arrive at an approximate evaluation of the maintenance requirements of fully-feeding, freely-growing plaice, using methods which are more in keeping with growth experiments than others which might have been selected, e. g. determination of maintenance requirements by study of respiratory exchanges". A combination of the two methods is probably to be preferred.

The results of the experiments hold good for 2—3 year old plaice of that special area on the southern border of the whole area of distribution of the species and feeding on *Mytilus* flesh only; as soon, however, as we consider plaice of other races in other areas, e. g. Iceland and the Barents Sea and feeding on other material, it appears that similar experiments are necessary to get results of value for estimating the maintenance requirements of freely-growing plaice there. For instance, we have seen that growth ceases at Lymstone when the maximum temperature falls below 10° C; in some parts of the plaice area in the high North the water never or rarely reaches this temperature and yet the plaice grow fairly well. What are the maintenance requirements here and how many grams of *Mytilus* flesh and other food is necessary in this case to produce an increase of 1 gm. in weight? We have in the present experiments only faint hints as to the solution of this question, and we hope therefore that it will be possible in the future to perform investigations with other races of plaice also, giving information as to the importance of locality, food and temperature in the whole area of distribution.

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G. Lyman Duff. Factors Involved in the Production of Annual Zones in the Scales of the Cod. (*Gadus callarias*. Linn.). Contributions to Canadian Biology and Fisheries. N. S., Vol. IV., No. 21. Toronto, 1929.

The object of this work was to determine the relationship between the rate of growth of the cod in length, the rate of growth of the scale, and the production of the annual rings. Some 2,700 fish were examined and preliminary observations were carried out before the main work was begun. This consisted of determining the amount of dispersion of the measurements of several scales from a given area on a single fish, and, as the measurements seemed to group themselves fairly normally about a mode, it was decided that an average of ten scales taken at random would represent the length of the scale for any fish.

The growth of the cod was studied by measuring the individuals of the 1922 year-class, this being the youngest year-class in the material, and as such, made age estimation the more accurate. A curve showing the growth from August 1925 to September 1926 was produced.

By measuring the length of scale for certain increasing lengths of fish, it was found that there was a more rapid scale growth in early years than in the later years of the fish's life. The author also found that there was a variation in the rates of growth of the scale and the fish according to the time of year when the observations were made. To demonstrate this he selected fish of 50—55 cm. throughout the period of observation and measured the scales of the fish, the result being an undulating "scale-length"

curve with maxima approximately in early spring and minima in late summer. Now, there can be no doubt that this curve does not represent the true growth of the scale, and the author has fallen into the trap by using the same length-group of fish throughout a long period.

Space does not permit one to give a full graphical description of the fallacious use of the data, but the explanation lies in the drawing of a correlation surface representing the growth of the scale against the growth of the fish, and observing that as the ellipse moves along the axis of growth, the distribution of the fish in the 50—55 cm. group is constantly changing. If all the averages for each slight movement of the ellipse along the axis of growth are plotted, an increasing value will be obtained, the maximum being reached when the year-class has grown so much that most of the fish are larger than 50—55 cm. By continuing the observations, the series of averages will begin again at the minimum position as a new year-class makes its appearance, thus producing an undulating curve.

From the counting of the number of circuli on the scales throughout the year, it was found that the zone of broad circuli was produced between March and July, while the greater part of the narrow zone was formed between August and December, and during the winter the number of circuli was practically constant. These results agree fairly well with the observations on the time of growth of the herring scale.

In the section on the rates of growth of fish and scales, the author concludes that the cod grows quickest during May, June and July, and that in January and February there is practically no growth. His conclusions regarding the rate of growth of the scale cannot be altogether true since he has corrected the growth curve of the scale for the "seasonal variation" shown above to be fallacious.

The circuli in the scales are produced at the greatest rate during September, while in January and February there is practically no production.

W. C. H.

E. Ford. 1) Growth in Length during the Transition from Larva to Adolescent in the Pilchard and Sprat. 2) Changes in Length during the Larval Life and Metamorphosis of the Freshwater Eel (*Anguilla vulgaris* Turt). Journ. Mar. Biol. Assoc. N. S., Vol. XVII, No. 3. Plymouth, 1931.

1) In einer früheren Arbeit hat sich FORD mit der Frage nach den Veränderungen der Lage von After und Flossen zueinander und zu den Wirbeln beschäftigt. FORD hatte die Überzeugung ausgesprochen, dass gewisse Körperabschnitte, nämlich vom Hinterende des Kopfes bis zum Beginn der Rückenflosse und von der Ansatzstelle der Bauchflossen bis zum After, während der Metamorphose in ihrer Länge unverändert blieben, während andere Körperabschnitte an Länge zunehmen, dass also die Lageveränderungen durch ungleichmässiges Wachstum der verschiedenen Abschnitte hervorgerufen würden. Mit dem gleichen Problem beschäftigt sich FORD in der vorliegenden Arbeit bei der Sardine und beim Sprott. Die Methodik ist ebenso wie bei der ersten Arbeit.

FORD kommt nun auf Grund seiner Messungen und Vergleiche zu dem Ergebnis, dass im Gegensatz zum Hering, bei dem zwei Körperabschnitte