Forecasting the Annual Yield in Sea Fisheries

It is well known that the annual yield of the sea fisheries varies very much from year to year. An example of such variation is shown in Fig. 1 in which the broken curve shows the number (in millions) of skrei—spawning cod (*Gadus callarias*)—caught in the Lofoten fishing area of northern Norway in the years 1885–1958. It is obvious that such fluctuations make the planning of the fishing industry very difficult and that reliable forecasts would be helpful, even if they are only rough approximations.

In an earlier paper[1] I made the suggestion that it might be possible to compute yield forecasts by means of an aggregate of sine functions, using the periodic or period-like components found in series of measurements of the width of the annual growth zones in forest trees. The underlying idea was that the width of the growth zones and the size (in number) of the year-classes of fish populations might be determined by common factors. A rough outline of a theory was given.

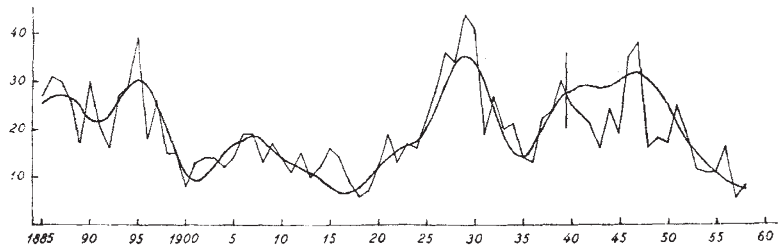

Fig. 1

Hjort[2] succeeded in showing that there are great fluctuations in the size of the year-classes in fish populations and concluded that these fluctuations were the main cause of the fluctuations in the yield. But fluctuations in the yield are also caused by other factors, such as weather conditions and altered fishing technique. Therefore, a successful forecast of the relative size of the stock of fish may not be a successful forecast of the yield; but it might show an approximately correct trend.

In 1939 I became acquainted with the results of the analyses of some series of measurements of the width of the growth zones of the Scots pine (*Pinus silvestris* L.) found by Ording[3]. His samples were taken in a forest in the neighbourhood of the Lofoten fishing area. Then, in order to verify my idea I fitted the series of annual yields of the skrei fisheries in the years 1885–1939 by a function constructed by means of four components (substituted by sine functions) found by Ording. The lengths of these components were 11, 17·5, 23 and 57 years. Also the phases of the components were taken from the results obtained by Ording. The actual yields were used merely for the computations by the least-square method of the weights of the components. The result, as well as the method of computation, is described in ref. 1. Later on I also included the 8·5 years component. The result so obtained is given by the smooth curve for the years 1885–1939 in Fig. 1.

Since this curve is constructed by means of an aggregate of sine functions, it can be extended to future years and might be used as a forecast of the annual yields. Actually, it is intended to be a forecast of the relative size of the stock of skrei.

The thin curve 1940–58 shows the actual yields and the thick curve the 1939 forecasts for the same years.

It is evident that differences of the same magnitude as those observed in the years 1885–1939 should be expected. The largest differences between actual yield and forecast are found for the war years 1941–45 and in the years 1948–49. In the fishery reports from the Lofoten area I have found nothing which shows conclusively that the fishing was hampered by the war. But, bearing in mind the changes in the general conditions brought about by the war, I think we can assume that this was in fact the case. In 1948 and 1949 the weather conditions were uncommonly unfavourable. Bearing this in mind, the following conclusions seem to be justified: (1) That the width of the growth-zones of the pine and the size of the year-classes of the skrei are determined by the same main factors. (2) That it is possible to compute reliable forecasts of the yield of fisheries by means of the components found in series of measurements of the width of the growth-zones of the pine.

There is no doubt that the technique of forecasting can be improved. But in order to make improvements possible, it is necessary to sample new series of measurements of the width of growth-zones in forest trees and try to get better estimates of the lengths and the phases of the more important components.

The same method might prove to give satisfactory forecasts in other fisheries, too. However, the fishing technique used in the Lofoten area is very conservative, so that it can be assumed that the yield is a fairly constant percentage of the stock of fish. In other fisheries this may not be so. It is obvious that, for example, the introduction of a new technique may cause disturbances which are difficult to overcome.

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[1] Ottestad, Per, Rep. Norw. Fish. and Marine Invest., 7, No. 5 (1942).
[2] Hjort, Johan, *Conc. Perm. Internat. l'Explor. Mer, Rapp. et Proc.-Verb.*, 20 (1914).
[3] Ording, Asbjørn, *Medd. norske skogforsøksvesen*, B, 7, H.2 (1941).

ANATOMY

Fine Innervation of the Carotid Body of the Rhesus Monkey

Although first mentioned in 1744[1], the first clear and accurate description of the carotid body was not published until 1862[2]. However, modern knowledge of the structure of this organ dates from 1926[3]. Since that time detailed macroscopic and microscopic studies of the structures found in the carotid bifurcation have been made on many different animal species. But in the Anthropoidea, except for the work of Sato[4], only macroscopic studies of this region have so far been undertaken (1852[5], 1899[6], 1928[7], 1932[8], 1935[9,10]). Sato's work is concerned only