At stations not on the East coast the 1924 class was not predominant, and was weakly represented in 9 out of 11 stations. It appears therefore that there was, as the author writes:— 1) a good spawning year in 1924; and 2) a more or less complete concentration of the year-class in question in East-Icelandic waters. MICHAEL GRAHAM.

A. W. H. NEEDLER. Studies on the Life History of the Haddock (*Melanogrammus aeglifinus* Linnaeus). Contrib. Canad. Biol. and Fish., N. S., Vol. IV. No. 20. Toronto, 1929.

Since the summer of 1926 the author of the above paper has devoted particular attention to the study of the life history of the Haddock. The first fruits of this study were embodied in an important paper[1]) showing that, in the less saline portion of the waters of the Bay of Fundy, Haddock occur plentifully only in exceptional years, usually some three or four years after very successful spawning seasons in more seaward areas. Whether these areas lie northerly (off the Nova Scotian Coast) or southerly (in the Gulf of Maine) could not be determined from the data. In the present paper, however, much addition is made to the knowledge of biological features in the more northerly of these regions, although it is emphasised that only the more striking and incontestable results are given in this preliminary survey. The field of study has since been broadened to include the entire West Atlantic area in which Haddock occur, and the further results should prove most valuable.

The general distribution of West Atlantic Haddock is discussed, and that of the more northerly (Canadian) portion of this distribution is clearly depicted in two charts. The latter were constructed from the statistics supplied by some seventy District Fishery Officers. The offshore fishing has been developed since the adoption of otter trawling in 1920, and takes place on the Nova Scotian Banks and the southern portion of the Newfoundland banks. Hitherto the inshore fishing, conducted largely by lining operations, has provided the major portion of the catches, and it is from the recent statistics of this fishery that the charts referred to were constructed. Haddock are plentiful from the South side of the Bay of Fundy to Cabot Strait — that is right along the Acadian coast — but fail to penetrate in numbers into the fresher and colder water of the Gulf of St. Lawrence.

Hydrographic conditions are shown to have a very great bearing on this distribution, which is restricted to the same range of depth of water as is frequented by Haddock in European waters. Most of the details given refer to the warmer seasons of the year, the conditions on the spawning grounds, as indeed the exact positions of these grounds, remaining to be studied. The salinity of the water is several points lower than in the North Sea, ranging from about 30—34 $^0/_{00}$. The temperature is also relatively low, varying between zero and about 11° C. (The author points out that at Minas Basin, inner Bay of Fundy, the summer temperature

[1]) A. G. HUNTSMAN and A. W. H. NEEDLER. Fluctuations in the Haddock Fishery of the Bay of Fundy. (Contr. Canad. Biol., N. S., V. III, No. 18, 1927).

may reach 14° C., but that apparently this is too warm for Haddock life — at all events in water of very low salinity.) The main shoals live in water of temperature 0°—5° C. and salinity $31^1/_2$—33 $^0/_{00}$. This is probably colder and less saline than the optimum temperature and salinity for Haddock, for, as is stated by way of comparison, the shoals are relatively denser in the more southerly G. of Maine, where a summer temperature of over 4° C. and salinity of 32—$34^1/_2$ $^0/_{00}$ are attained. When neighbouring water-masses, as in the Laurentian district, show the one very low temperature and the other very low salinity, Haddock *faute de mieux* choose the former. As is the case in the western Baltic, entry to more or less landlocked areas, where the water is of low salinity, is effected from outside in the very young stages, and is inextensive save in exceptional years.

It will be particularly interesting when the effect of the low temperature — low salinity water of the West Atlantic area upon racial characters and growth rate is fully made known. With regard to the effect on growth rate NEEDLER presents the results obtained from scale-age analysis of Haddock from three parts of the northern region (Figs. 6, 8 and Table II). In the samples examined there were about 1000, 450 and 850 fish respectively. We may bring the approximate results together as below, those for *a* and *b* being read off the graphs on Figs. 6 and 8 respectively, and those for *c* obtained by combining the weighted means given in Table II:—

	Temperature	Salinity
a. Lockeport (inshore)	0°— 2° C.	$31^1/_2$—32 $^0/_{00}$
b. Sable I. banks (offshore)	0°— 5° C.	32 —33 -
c. St. Andrews (inshore)	0°—11° C.	31 —$31^1/_2$ -

Growth Rates in centimetres.

Age..	3	4	5	6	7	8	9	10	11	12	13
a....	41	47.5	54	58	64	66	68	69	70.5	72	73
b.....	41	49	55	60	64	67	69.5	71.5	..	..	..
c.....	38.2	47.5	52.6	58	..	..	..	..	..	..	..

a and *b* refer to completed growth for the year, *c* to sizes attained about the middle of the annual period of growth. In the case of *c* therefore a few centimetres require to be added to make the figures strictly comparable. It will be seen that the growth rate for the three areas is very similar, although some justification may be said to be apparent for the author's conclusion that the growth rate tends to increase — in the direction *a* to *c* — with increase in the temperature of the water. There seems to be no obvious correlation between growth rate and salinity. In a graph (Fig. 9) these three growth rates are plotted out and compared with those for Faroe and for North Sea Haddock. Unfortunately the explanatory lettering has escaped reproduction in the diagram, which demonstrates that West Atlantic Haddock grow, for the first few years of life, more

quickly than even the fast-growing Faroe Haddock, but that this advantage is more than lost by the earlier and more pronounced slowing down of rate of growth from about the seventh year. NEEDLER makes a point of the fact that growth in Canadian waters far exceeds that in the deeper portions of the North Sea, although the mean annual temperature of the latter exceeds that of the former. It follows that temperature *per se* is not an absolute factor controlling growth rate. The thesis is still tenable, however, that within areas supporting independent Haddock stock there is for Haddock growth probably an optimum temperature, lying well on the high side of the mean annual temperature. Conversely there is probably a temperature not far above zero where growth effectually ceases. (NEEDLER finds that more than 80 % of the year's growth is put on between Aug. 1st and Nov. 1st, the temperature for the remaining portion of the year being very low.) That the optimum temperature in the North Sea may be higher than in Canadian waters is conceivable if we consider the effect of temperature as two-fold — first, as a physical factor affecting the metabolic processes of the fish, secondly, as a physical factor setting in motion the complex chain of elaboration of fish food from lower organisms, the particular species of which are not the same in the two localities, whose sources of organic and inorganic raw material are different. In short, a slightly lower temperature in one region as compared with another where the raw material for organic growth is scantier or different in type, may engender a more copious or more nutritious food supply and more than counterbalance a possible restraining effect on the sheer metabolic processes of the fish. H. T.

MICHAEL GRAHAM. Studies of Age-Determination in Fish. Part I: A Study of the Growth-Rate of Codling (*Gadus callarias* L.) on the Inner Herring Trawling Ground. Min. of Agric. and Fisheries, Fishery Invest., Ser. II, Vol. XI, No. 2, 1928. London, 1929.

This paper will rank among the most important of those dealing with methods of age-determination of Cod. GRAHAM has examined his subject with meticulous care, envisaging and evaluating (or discounting) all the possible obstacles to the practice of his technique. It is probable that the work of age-determination of any fish (in at least some parts of the habitat of the latter) will ultimately come to have some such mechanical basis as he sets forth. The author's thesis was to attempt, by a rigid method independent of personal judgment, to determine the age of Codling within a circumscribed area of the North Sea. It is a desideratum that, in a study involving the comparison of scales, the average scale used should be from approximately the same part of the body of the fish. The author admits, however, that both by selection at sea and again in the laboratory this ideal was somewhat departed from. In a repetition of such work this fault would be remediable with, most probably, the removal of some of the difficulties GRAHAM encountered in making his deductions. To take an example, by no means isolated, we find that the scale from a 30 cm. fish (No. 124, Fig. 51) has been so selected that it is larger than one from a 56 cm. fish (No. 87). In an allied fish (Haddock) this contingency is well