

1918. The intimate inverse relation shown to exist between surface water temperature and size of catch in September cannot be explained away on the basis of long period tendencies in temperature and catch. It is the short-period variations in temperature and catch which agree so nearly. Though the use of a varying "normal catch" changes the correlation coefficient from $-.85 \pm .07$ to $-.95 \pm .03$, yet the method seems entirely justifiable. The author is to be congratulated on producing results of real practical value to the fisheries, and of easy application.

H. J. B.-W.

A. W. H. Needler. The Migrations of Haddock and the Interrelationships of Haddock Populations in North American Waters. Contrib. to Canad. Biol. and Fish. N. S., Vol. VI, No. 10, Toronto, 1930.

To supply the increasing demand in North America for haddock, both fresh and fresh-frozen, a corresponding increasing toll is being taken of the available fish stocks in the waters to the east of the continent. The author of this paper shows that the haddock grounds are of large extent. Even so, we now know that the available supply (from within at least a reasonable range of the chief American fishing ports) is barely sufficient for current requirements, and that frozen cod filets will require to be produced to maintain fully or to increase a trade which has been fostered on haddock filets. Either or both of two possible explanations of the growing shortage may be correct. The latter may be coincident with a period when, owing to a succession of less than normally productive annual broods of haddock, the stock is, owing to natural causes, one which is attenuated in numbers. But we know that where a fishery is executed on a stock of older haddock, belonging to quite a series of broods, there is little likelihood of the comparative absence of any one or two broods having a particular effect on the fishing results. And NEEDLER now makes it quite clear that, in the waters whose haddock population he has studied, fish of less than 4 years of age are of no commercial importance, and that only mature haddock in their fifth year or in subsequent years of life are brought to market. Fish of less than 40 centimetres in length are not sought after, whereas in the North Sea, where the maximum possible harvesting of the haddock stock has been reduced to a fine art, the older fish are becoming less and less common, everything above 21 or 22 centimetres in length is brought to market, and the average catch in unit time varies from year to year chiefly in accordance with the degree of abundance of two or three broods of young fish. The incipient apparent shortage in west Atlantic waters must be explained on other grounds, which brings us to consider our second suggestion — that the degree of fishing effort has, owing to the increasing number of trawlers, for the first time passed the point where the stock can annually replace the weight of comparatively large fish which is annually removed.

Organised fishery research in Europe has in the past devoted a vastly greater effort to what may be called the biological or ecological study of the food fishes than to the study of the technical problems concerned in marketing these fishes in such a manner as will make a wider appeal to the potential consumer. As far as the study of haddock in North American waters is concerned the reverse has, until very recently, been the case. New

and improved methods of processing this fish have been developed and promise to be an enduring commercial success. In the form of fresh-frozen fillets haddock are now sold in the interior of the continent, whereas hitherto only a fresh-fish trade proper existed, and this was naturally restricted to the coastal zone near the fishing ports. At the moment the supply of haddock of a size suitable for the new trade is barely sufficient and the fear is gaining ground that the stock is being excessively exploited. An intensive biological inquiry is under foot in the United States with the object of studying the natural fluctuations of the haddock population and the changes which are being brought about in the latter's composition. The idea is that, if there can be produced evidence of progressive diminution of the relative numbers of older fish, the intensity of the fishing effort can be controlled on a rational basis.

NEEDLER, on the Canadian side, has in the above paper contributed many facts which will help to guide the new and more intensive investigations now to be made. For his task he has obtained little aid on the statistical side, for a really good system of collecting statistics, which yield information about sizes, weight and value of fish caught by a known expenditure of fishing effort, is lacking. But he has contrived to show pictorially how the yield of haddock varies on the different parts of the coast. Particularly interesting is his conclusion, confirmed and re-confirmed, that the Fundian and Laurentian gulfways subdivide the east North American haddock grounds into three portions containing virtually independent stocks, whose characteristics he describes. In the latter work he is assisted by having at his disposal the results of the first really extensive marking experiments made with haddock. No haddock marked in any one of the three natural areas was recaptured in another area. Seasonal migrations, however, were clearly demonstrated, especially in the Nova Scotian area, where there is a northerly trend each summer with the spread of warmer conditions. The northerly advance is continued — especially in the case of the largest (and, as he shows by scale examination, the oldest) fish — into the Gulf of St. Lawrence, and can be strictly correlated with the spread of suitable temperature conditions. These more venturesome fish are, however, beaten back by the sub-Arctic conditions supervening at the onset of winter — in fact haddock are during the winter season not found north of Halifax, and a large proportion of the shoals seek the still moderately warm layers on the edges of the banks, at below 70 metres' depth. He proves that with increasing age the broods take up a more and more northerly position.

Somewhat analogous movements are shown to exist in the New England region, from which the north side of the Bay of Fundy receives its summer immigrants. The shallow water of this bay — a bay rich in biological interest — provides a narrow passway between the New England and Nova Scotian regions, and a limited amount of interchange of haddock seems to result. Of the stock of the third — the Newfoundland — region, little or nothing is known except that haddock are probably relatively scarce there (except, the reviewer might add, in abnormal years, when they have been known to outnumber cod in certain coastal cod-traps). The author thinks that each of the three regions will yet come to be subdivided into sub-areas each with a more or less distinctive haddock stock, each "community" sorting itself out as a relatively intact entity after such a spell of commingling

as is inevitably caused by seasonal migrations, which are shown to have a scope of anything from 100 to 500 miles.

The conditions of temperature under which west Atlantic haddock live are, season for season, several degrees lower than those found in the North Sea. The range between 2° and 8° is that most favoured. It is unfortunate that the haddock of the Norwegian coast and the White Sea have received so little study, for one would expect to find many parallels between them and those living off the North American coast. The reviewer has seen many scales from haddock of both areas, and has found them to be rather difficult to interpret. Whereas the scale-age of haddock from most other regions can usually be easily determined by examination under water, the distinct impression was formed that those of the two colder regions mentioned should be as carefully mounted as possible. NEEDLER examined his material by placing the dry scales between two slides — a rapid, but not the best method, and one which was largely forced upon him by lack of time. It is to be hoped that part of the material originating from marked and recaptured fish — and therefore especially valuable as a source of facts — will receive a second and an intensive study. On the whole, however, his conclusion that west Atlantic haddock excel in growth rate those of any other region may be accepted as substantially correct. But it must be remembered that only a portion of the material was obtained by the otter trawl, and one would expect, from a wider study of trawled haddock, a general lowering of the figures shown to be attained at each year of age. It must also be borne in mind that most European waters are very intensively fished over and that, at least in the early years of life, the trawl removes more of the better-grown than of the more poorly-grown fish, so that it is the growth rate of the survivors, which had on the whole a slower start, which has been determined. Even allowing for these considerations, however, we must probably agree that European haddock are outgrown by west Atlantic haddock, and therefore that higher temperature in itself is not inducive of faster growth. NEEDLER shows that within the area he has studied the haddock feeding in the St. Andrews region of the Bay of Fundy exhibit the greatest rate of growth. This, he points out, is not because the water temperature there is higher than elsewhere — it is, in fact, exceeded in the Nantucket region — but probably because nutrient salts, the first link in the food chain, are continually renewed in the waters by the mixing caused by the great tides which course over the uneven sea-floor in these parts. It becomes more and more obvious that the biological study of the fish is inseparable from the biological study of the fish's prey, and it is to be hoped that the latter study will bulk largely in the impending haddock investigations in west Atlantic waters.

H. T.

R. E. Savage. The Influence of Phaeocystis on the Migrations of the Herring. Ministry of Agriculture and Fisheries. Fishery Investigations. Ser. II. Vol. XII. No. 2. 1930. London, 1930.

This paper gives an account of the distribution of Phaeocystis in the Southern North Sea during three cruises made in April 1924, April 1926 and November 1927, with speculations as to the possible effect that such distribution may have had on the herring fishery in those years. The spring fishery of 1924 was a good one and on this occasion the main efflorescence