The Conditions for Calcareous Metabolism in Oysters and other Marine Animals.

THE summer of 1924 was remarkable for an unusually large and heavy growth of the shell of native oysters on most beds in England. In a recent survey of the Fal Estuary oyster beds, full details of which it is hoped will be published later, it was found that a total shoot (*i.e.* maximum increase in height or depth of a shell in a ventral direction) of 30 or more millimetres was quite common. Similar large shoots have been observed in shells from East Coast and other beds in 1924. The fact that the summer of 1924 was not a warm one is a matter of common knowledge and of great interest in connexion with the unusual shell-growth. In warm summers, such as we had in 1921, a big growth of shell is usual, but is then attributed to the generally increased metabolism following upon a high temperature, when biological conditions are otherwise satisfactory; but the rate of shell-growth of the oyster (*i.e.* increase in shell-area, and total increase in shell-weight) under any continuously known conditions is still undetermined. It is, therefore, not possible to state what are the precise conditions which are essential for normal or abnormal shell-growth. These conditions, like those in many other problems relating to the oyster, may not be determined until greater concerted attention can be given to what is admittedly a valuable mollusc. In the meantime it may be worth while to summarise a few observations on the subject.

Most lamellibranchs increase the area of the shell by the repeated addition of small concentric deposits at the edge. The oyster, however, makes a relatively large more or less concentric deposit of thin shell at one operation; this thin deposit, called a shoot, quickly hardens by being thickened.

Good practical oyster-producers say that two of such shoots are frequent in a fair year of growth, and the radius of each such shoot in a 2- to 3-inch oyster may be about 10 mm. This year on the Fal 3 and 4 such shoots, all with practical but not absolute certainty this year's growth, may be found. The variability in the number of shoots laid down from year to year is the main cause of the difficulty or impossibility of estimating the age of young oysters, without very intimate local knowledge of the growth-features. In an average year of growth it would appear that the two usual shoots are laid down in the spring and autumn, that is, on either side of the warm —and also spawning—period. But growth ceases in winter for an undefined period, even on beds such as those off Whitstable (in 1920–21 for example) where abundant food is available. Moreover the present writer has shown that oysters taken from the beds *in winter* and kept under warm conditions, even in practically sterile (Berkefeldt-filtered) water, will grow shell. (See Fish. Invest. 2, VI, 3, pp. 43-44—owing to the demands of economy it was only possible to give the bare observations in that paper.) Further, oysters kept in the laboratory in summer will lay down shell automatically in the practical absence of food (see NATURE, vol. 111, p. 14). These facts point to a controlling factor represented by a minimum temperature, below which shell is not or cannot be laid down, and above which shell-material may be produced automatically.

There is no doubt that lamellibranchs in general at our latitudes resemble the oyster in their physiological reactions with regard to shell-growth, one example of which is shown by the writer for the cockle, in NATURE, vol. 111, p. 147, Fig. 2. If, therefore, calcareous material be only laid down with difficulty at low temperatures, it would be highly instructive to have chemical analyses of those thin-shelled forms which are found in polar and deep-sea waters. Indeed a deposition of calcareous material by living marine organisms, although made so easily in the tropics, appears to be found increasingly difficult as the habitat becomes colder. One is tempted, therefore, to inquire what may be the chemical composition of the vertebræ or any bony parts of polar and deep-sea fishes. There is a fundamental similarity in living animals which warrants such an inquiry.

It may be noted in passing that the secretion of siliceous matter can be effected at very low temperatures by polar and deep-sea organisms, in some of which it is possible that deposition of silica may replace that of calcareous material.

In the good shell-growth of warm and relatively cold wet seasons, in Great Britain the corresponding hydrographical conditions are respectively high estuarine salinities, alkalinities, and temperatures, and low fluctuating salinities with medium temperatures and (probably) alkalinities; in the wetter seasons one would also expect a smaller amount of available food-material. An explanation of growth which meets the facts partially may be given as follows: shell-deposition in a warm summer is rapid, and any arrest of growth which may be due to breeding is masked, while in the wet summer, growth occurs continuously in the medium temperature and low salinity and is only slightly arrested by the generally—but not totally—repressed reproductive phases. Shell-growth may occur in the pre-spawning period of females, *i.e.* in the spring, but requires to be observed more fully in marked individuals in the post-spawning period, in which there is a suspicion of a slowing down of the operation.

The good shell-growth in the summer of 1924 may, therefore, be understood if we assume that repression of the reproductive capacities in the relatively cold summer permitted continuous growth, which was apparently accelerated by the low salinity. The arrest of growth when reproduction is possible in invertebrates is indicated in the diminutive size of the breeding individuals in the summer crops of the sponges, Grantia and Sycon, and the very large size possible in the non-breeding wintering forms of the same genera. There is therefore nothing unreasonable in the explanation of growth so far offered. There is, however, another important type of growth which seems to require a different explanation, namely, that which appears to follow removal of oysters to a fresh habitat. For this type of growth a supposition of a general increase in the well-being of the animal does not seem to be sufficient, nor for the fact that an unusual amount of growth occurred in many stunted forms in the Fal Estuary last summer, except that the low salinities, which can be predicted as a result of the heavy rainfall, would be equivalent to a change of habitat. In this respect it is important to note that in the oyster, and doubtless also in related forms, growth does not necessarily follow a mere accumulation of reserve products, as is shown by the fact that "dumpy" (stunted) oysters, which may constitute 40 or more per cent. of a population, were this year on the Fal mostly very well fished (full of reserve products), while the fast-grown oysters were mostly thin and emaciated as though expended in their efforts in growing. Some biological factor appears to shut down the shell-producing mechanism in certain individuals, while in others automatic response to the environment is clearly very prompt. The problem here denoted once more presents the dual interests of science and economics, the boundaries of which cannot be universally defined.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, June 5.