

establishments, in each case written by the superintendent—the Royal Laboratory, Woolwich, by Colonel Sir Hilario Barlow; the Royal Gunpowder Factory, Waltham Abbey, by Colonel Sir Frederic Nathan; and the recently re-constituted Research Department at Woolwich, by Major H. Mansell. The history and development of these important Government establishments will prove of general interest. The Royal Laboratory alone must be prepared to manufacture at short notice some 3000 articles of approved design for war purposes. An interesting comparison of the cost of shells may be quoted. In 1849 the finished shell for 8-inch smooth-bore guns alarmed the authorities. It was 11s. 3½d. The modern 12-inch shell costs about 29l. when completed!

One extract may be permitted from Colonel Jocelyn's article on military fireworks. "In the Mathematical Society of London a rule existed which imposed a fine of sixpence on any member who should let off fireworks in the place of meeting." This but reflects the playfulness of the times when Pepys and his friends enjoyed pelting each other and "the people over the way" with fireworks.

The book is illustrated with some fine portraits of those who have been prominently associated with the industry, and a number of old illustrations of powder-making processes, which greatly add to the value of the work. Those selected for reproduction are of more general interest than others relating to powder manufacture itself. The recovery of by-products from the carbonisation of wood, as shown in the first illustration (Fig. 1), cannot fail to be of interest to chemists, as will also the sulphur-refining plant (Fig. 2) with its retort, fume-hood, and condensing chamber.

J. S. S. B.

#### DANISH RESEARCHES ON THE EEL AND THE PLAICE.<sup>1</sup>

THE "Kommission for Havundersøgelse," the official body entrusted with the execution of Denmark's share in the international exploration of the sea, devotes a considerable portion of its resources in endeavouring to solve certain important problems connected with the natural history of the eel and the plaice. These investigations are producing very definite results.

Two papers recently contributed by Dr. Johs. Schmidt to the "Meddelelser" of this commission considerably advance our knowledge of the metamorphosis and distribution of the larvæ of the eel and other murænoids. Since the publication of Dr. Schmidt's notable treatise of 1906, in which the distribution of the larvæ of the eel in the Atlantic, west of Europe, was described in detail for the first time, a large quantity of new material has been collected by means of the Danish research steamer *Thor*.

The new captures included more than 500 larvæ of the common eel, 300 of which were in different stages of metamorphosis. The material previously dealt with (in the treatise of 1906) consisted of 265 specimens, only eight of which showed an advance on the leptocephalus stage. Taking the captures of 1905 and

<sup>1</sup> Meddelelser fra Kommissionen for Havundersøgelse. Serie Fiskeri. Bind iii., Nos. 1, 3, 5, and 6.

No. 1. C. G. Joh. Petersen: On the Larval and Post-larval Stages of some Pleuronectidæ (Zeugopterus, Arnoglossus, Solea). With two plates.

No. 2. Johs. Schmidt: Remarks on the Metamorphosis and Distribution of the Larvæ of the Eel (*Anguilla vulgaris*, Turt.). With one plate and one chart.

No. 5. A. C. Johansen: Contributions to the Biology of the Plaice, with special regard to the Danish Plaice Fishery. iv. Is the Plaice Indigenous to the True Baltic? With two text-figures.

No. 6. Johs. Schmidt: On the Occurrence of Leptocephali (Larval Murænoids) in the Atlantic W. of Europe. With two plates and one chart.

1906 together, the following is a list of the leptocephali of murænoids so far taken by the *Thor*:—Leptocephalus of eel, 790; of *Synaphobranchus* (deep-sea eel), 126; of the conger, 32; other leptocephali belonging to four unknown species, 12.

Confining our attention to the common eel, it may be said that these new researches throw light on obscure points, amend former statements, and fill up several gaps. The more important new facts may be briefly summarised as follows:—

(1) In May all the leptocephali were in stage 1; in September they were mostly in various stages of metamorphosis. This implies that the propagation of the eel is limited in the main to a certain portion of the year, as is the case with most other fishes.

(2) In September the later stages were found further towards the shore than the earlier stages. This indicates shoreward migration during metamorphosis.

(3) It was found that both leptocephali and glass eels were larger in the southern than in the northern part of the area of distribution.

(4) Whereas in the treatise of 1906 calculations of the shrinkage of the larvæ during metamorphosis were based on fragmentary material, belonging to different regions and different years' groups, it is now possible to say definitely that the diminution in length involved in the retrogressive metamorphosis amounts to 1 cm. This average is based on a large number of measurements of leptocephali and glass eels from the same region, and belonging to the same year's group. Further, weighings of leptocephali and glass eels prove for the first time that the metamorphosis involves an actual loss of substance, the dry-weight of glass eels being only one-third of that of leptocephali.

(5) There is good evidence that the larvæ execute diurnal vertical movements in the sea, coming nearer the surface at night than during the day.

(6) There are places where the larvæ of the eel are the commonest fish, just as we find in the case of the different species of gadoids, each of which (as we know from Dr. Schmidt's own investigations) chooses its own conditions of depth, salinity, and temperature for spawning purposes. Thus the specific trait shows itself in the selection of spawning habitat, as well as in anatomical and physiological peculiarities.

The first and final chapters of this weird and fascinating history have yet to be written. Neither the eggs nor the spawning adults have been found, though there is good reason to believe that the former are bathypelagic, *i.e.* floating at considerable depths, as is the case with other murænoids, Argentines, and other deep-sea fishes. The discovery of these things can only be a matter of time and resources. Ships and men are not lacking, apparently.

In regard to other murænoids, the recent investigations show that the conger is a more southern form than the eel. Its larvæ do not range further north than Rockall, whereas the leptocephali of the eel extend to the latitude of the Færøes. The larvæ of the conger do not occur over such great depths as those of the eel. They show the same inshore movement during metamorphosis, there being a close connection between depth and pre-anal length.

The larvæ of the deep-sea eel (*Synaphobranchus pinnatus*) were never taken so near the surface as the leptocephali of the common eel, never higher in the water than 100 metres. In the case of this species there is nothing to suggest shorewards migration. During metamorphosis the larvæ sink to the bottom in deep water, where fully-developed eels of this species were caught in large numbers over a wide area of the north-east Atlantic.

Of the other leptocephali (four kinds) it is impossible to say at present to what species they belong,

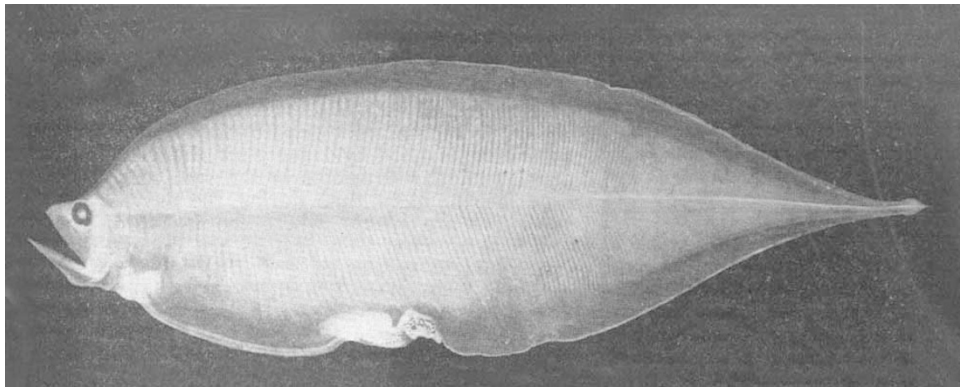
and it may be some time before this can be stated, owing to the difficulty of capturing the slippery and swift-moving adults. It will be necessary to have these for comparison with the leptocephali (e.g. to count the vertebræ). From the small numbers of these leptocephali captured, it is practically certain that their breeding-places or "nurseries" are considerably to the south of the Bay of Biscay.

*Leptocephalus hyoproroides* is particularly interesting, because it is the only species which it has been possible to trace back to the not fully-grown pre-leptocephalus stage, which, it is significant to observe, is also pelagic, like the later stages.

Much praise is due to those concerned in the production of the three beautiful plates of photographs which illustrate these two papers. One plate (in No. 3) shows seven stages (typical size) in the metamorphosis of the common eel. These figures are a great improvement on the photographs of the same series of stages published in Dr. Schmidt's original treatise; they are larger, and were taken from specimens in a much better state of preservation, so that they display the characters of the larvæ, especially the glassy transparency, more faithfully. The same remark applies to the plates illustrating No. 6. One of these shows seven stages in the growth of the

had been the subject of continual investigation and discussion by German and Danish investigators under the international scheme, with, so far, inconclusive results. It seemed even probable that a third alternative might be the right explanation, viz. that the fry had not been looked for in the right places with the proper appliances. This seems to have been the case. Dr. Johansen, in the present paper, records the capture in the true Baltic of large quantities of yearling plaice "for the first time in such numbers as to compete with each of the older annual series." He also found that pelagic fry of this species were plentiful everywhere in the water between Falster and Bornholm. Other convincing evidence of the plaice being indigenous to the true Baltic is also brought forward, it being shown that the average size of plaice of a given age and the average size at first maturity are much smaller in the Baltic than in the Belts and southern Kattegat. This could hardly be the case if any considerable immigration from the latter regions took place. More light on this question may reasonably be expected from marking experiments in the future. The few experiments of this kind which have so far been made in this region have not yielded conclusive results.

In No. 1, Dr. C. G. Joh. Petersen gives the results of an exhaustive study of the diagnostic characters of *Arnoglossus*, *Zeugopterus*, and *Solea* in the larval and post-larval stages. These results (which need not be detailed here) are quite new. The author also discusses in a critical manner all previous observations in regard to these species and stages. Dr. Petersen is the greatest living authority



*Leptocephalus latus*. Slightly less than three times natural size.

pre-leptocephalus into the leptocephalus of "hyoproroides."

Dr. A. C. Johansen, in No. 5, makes a very important original contribution to the much vexed question, "Is the plaice indigenous to the true Baltic?" For a long time, neither eggs, pelagic larvæ, nor early bottom stages of the plaice could be found in the true Baltic, and Dr. Petersen, the chief Danish scientific expert on sea fisheries, considered that the large stock of this fish in these waters must be entirely derived by immigration from the Belts and southern Kattegat. He thought that they must begin to immigrate when about one year old. As time went on, however, the capture of large numbers of eggs in the cold saline bottom water of the Baltic, and of occasional pelagic larvæ and bottom fry, seemed to indicate that this extreme view might require modification. It seemed unlikely, however, that the eggs could develop in the cold water at that depth, and the fact that the number of pelagic fry obtained were extremely few in comparison with the numbers of eggs and adults lent support to this view. But it was not impossible that the stock of plaice was partly, if not mainly, indigenous, being an "accumulated stock" grown up slowly by means of small additions from year to year. This problem

on the later development of the Pleuronectidæ, and this paper and his other papers dealing with the subject are of standard importance, and indispensable to the investigator.

#### THE POSITION OF SCIENCE TEACHING IN PUBLIC SCHOOLS.

THE Board of Education has issued as an "Educational Pamphlet" a report on science teaching in public schools. The material for this report, made at the instance of the Association of Public School Science Masters, has been collected and edited by Mr. O. H. Latter, of Charterhouse, and the pamphlet is both instructive and amusing. The ground covered by the report is to some extent the same as in another report recently made by a committee of the British Association on the sequence of science studies in secondary schools; but a comparison of the two lists of questions sent out will show that Mr. Latter's investigation deals more particularly with equipment and finance. On the other hand, the field of inquiry was restricted to the class of school represented on the Association.

Of the seventy-one schools to which the circular was