Work of the Rothamsted Experimental Station

THE work of the Rothamsted Experimental Station is mainly directed to obtaining exact information about soils and the growth of crops; information of a fundamental nature of this type is applicable wherever crops are grown and whatever the economic conditions prevailing at the time. Sir John Russell, in his report for 1932 (2*s.* 6*d.*), asks the question whether this type of experimental work is necessary in times of over-production. He replies to this by stating that it is in difficult times such as these that the need for exact information about crops and stocks is most urgent, as it enables farmers rapidly to alter their methods with the changing economic conditions. It might be added that the 'details' of crop husbandry, such as are accumulated at Rothamsted, help to provide a weapon for fighting the products of low cost mechanised farming abroad. The per acre costs on the small farms of Great Britain cannot be lowered much further, but, by attention to yield, the cost of the product can be kept down.

The results of the Station's work have gained wider interest amongst farmers since the acquisition of the Woburn Experimental Farm in 1926; experiments can thus be carried out on both the heavy soil at Rothamsted and on the light Woburn soil. This enables the relative suitability of the two soils to be assessed, not only for various crops under various meteorological conditions, but it also demonstrates the extent to which differences due to soil type can be smoothed out by manuring. Thus, in the six-course rotation experiments, while the yields of wheat and potatoes differ at the two farms, those of clover hay, barley, sugar beet and fodder crops do not differ so much.

Numerous trials with sugar beet, carried out between 1926 and 1932, are reported and commented upon; the responses to the various fertilisers are shown. The most interesting feature noted, however, is that factors not at present under control appear to play the chief part in determining the crop. Thus, at Rothamsted in 1932, this crop was grown in two fields not far apart and similarly manured. The yield of roots was very low in one and very high in the other. A similar occurrence was noted at Woburn. It is concluded that a new type of experiment is needed, different from the old fertiliser trial, and new methods are now under test at Rothamsted.

Other experiments with farm crops are discussed, and there is also an interesting summary of ten years' work on barley, carried out under the research scheme of the Institute of Brewing. Amongst the cereal trials, those on the growing of grain under mechanised conditions are likely to be of special interest. These are designed to show how to maintain fertility in a corn farm cultivated by machinery, and making little or no manure.

The range of problems dealt with is wide, and the laboratory section includes reports from the Soil Pathology and Entomology Departments. The Farm Director's report for the year is also included.

In the latter half of the report are given the yields from the plots in 1932, including those from centres outside Rothamsted. The latter form an interesting reflection of the work of the Statistical Department during the last few years. This work has resulted in a more critical outlook towards field experimental work throughout the country. Experiments designed on the Rothamsted lines are carried out by many institutions, and the results interpreted in the manner suggested by the designers of the trials. An additional indirect benefit results from this—greater co-ordination, not only in the method, but also in the selection of problems for field experimental work.

The report will prove valuable to farmers and to those engaged in research, and is indispensable to teachers of agricultural sciences.

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Biology of Brittle-Stars

IN papers recently published by Dr. T. Mortensen (*Vidensk. Medd. Dansk. naturh. Foren.*, vols. 93 and 96) are some remarkable additions to our knowledge of ophiurids. Perhaps the most interesting is the account of a new genus, apparently of Amphiuridæ, in which the female carries the male about with her in "a continuous erotic embrace". The male, the body of which has a diameter of about 1 mm. (one-fifth that of the female body) lives with his mouth turned towards the mouth of the female and his arms alternating with hers. This brittle-star, which Dr. Mortensen names *Amphilycus androphorus*, was found by him attached to the under side of the flat sea-urchin *Echinodiscus bisperforatus* on a sandy beach in Delagoa Bay.

This situation may explain how the animals get their food in spite of their mouths being turned to each other; Dr. Mortensen suggests that they feed on detritus whirled into their mouths by the ciliary currents of the sea-urchin's skin. It is possible that the male may be parasitic on the female, or on the way to becoming so, because its œsophagus is remarkably muscular and may act as a sort of sucking-pump. In any case one cannot help being reminded of the fishes with parasitic males described by Dr. Tate Regan.

This discovery led Dr. Mortensen to re-examine two ophiurids which were supposed to be viviparous: *Ophiodaphne materna* and *Ophiosphæra insignis*. These also make their home on sea-urchins, and the supposed young prove to be permanently attached males.

Although the three species just mentioned turn out not to be viviparous, a large number of viviparous ophiurids is known. Dr. Mortensen adds 4 to their number, thus bringing the total to 32, distributed among 12 genera. Of these no less than 25 are hermaphrodite, and in six of these the males mature before the females. Hermaphrodites are otherwise unknown among ophiurids. Here then is a problem of which the solution is still to seek.

Another ophiurid (also probably an amphiurid) attached to the under surface of a flat sea-urchin, apparently *Laganum depressum*, was found by Dr. Mortensen in the Sunda Strait, and is described as *Nannophiura lagani* n.g. et sp. It is the smallest brittle-star known, its body being only half a millimetre across, and it moves with great agility among the spines of the urchin "like a monkey in the trees of a tropical forest". The ends of its arms are exceedingly movable, "recalling a monkey's prehensile tail"; they are flattened and furnished with minute hooks. The radial nerves of the arms are strongly developed. The tube-feet, though quite short, are strongly adhesive.

There is another ophiurid with a very small body, but in it the smallness is relative as well as absolute; indeed it "can hardly be said to have a disk" at all. This is *Ophiocanops fugiens*, first made known by Koehler and now re-described from better specimens by Dr. Mortensen. The chief features, unique among ophiuroids, are connected with the minute size of the body. The first is the position of the genital glands as a series of small isolated organs along each side of the arm, each opening separately on the side of the arm. The second is the continuation of the stomach as a sort of radiating intestine out in the arms, in the dorsal space, above the genital organs, for about two-thirds the length of the arm; its walls are much folded and it is supported by a horizontal mesentery. *Ophiocanops* may be related to the Ophiomyxidæ but it is here separated as a new family.

It is, of course, well known that in some of the ophiuroids with branching arms—the Euryalæ—the genital glands pass into the arms, but the arrangement is quite different from that in *Ophiocanops*. In a paper describing several specimens from the Indo-Pacific, Dr. Mortensen shows that "all the Trichasterids have the gonads extending into the arms to a various degree". They do not branch, however, but lie side by side like a bundle of telegraph cables.

An ophiurid that has given rise to a good deal of discussion is *Ophiopteron*, which Ludwig described in 1888 as "eine neue wahrscheinlich schwimmende Ophiuridenform". The reason for the supposition was that the arm-spines were united by a fine membrane, so that each group looked like the foot of a duck. Ludwig's suggestion was therefore generally accepted, but Dr. Mortensen, who has repeatedly observed living specimens, has never seen *Ophiopteron* swimming. Actually it lives concealed in crevices. The arm muscles are not exceptionally developed, and swimming by an up and down motion of the arms seems out of the question. There remains, none-the-less, the possibility that swimming is effected by a waving movement of the spine-groups, and this is indicated by strong muscles and a definite articulation at the base of the spines. Further observations are required.

This, however, is not the whole story. Dr. Mortensen's re-examination of many specimens referred to *Ophiopteron* shows that they are the young stage of one or other species of *Ophiothrix*. All species of *Ophiothrix* do not pass through an *Ophiopteron* stage, but why any should do so, and what may be the use of the "fins", are questions still to be solved.

Manufacture of Phosphoric Acid

IN the *Chemiker-Zeitung* of September 6, Dr. Carl Heinrich discusses at length the merits of the two main processes which are used for the manufacture of phosphoric acid from calcium phosphate. The essential features of these two processes, which may be conveniently termed the wet and dry processes, are set forth in textbooks of inorganic chemistry. In the wet process, the phosphate is decomposed by sulphuric acid, whereas in the dry process, silica replaces sulphuric acid and the furnace may be heated either externally or by means of an electric resistance. In view of the increasing importance of the product as a fertiliser, it is desirable that a more complete comparison of these two processes should be carried out.

One of the chief drawbacks to the wet process is the solubility of calcium sulphate in the liquor. Nevertheless, it is possible to extract 95–98 per cent of the phosphoric acid by modern decantation methods. This acid may still contain calcium sulphate, sulphuric acid and other impurities, but these are without much significance if the acid is to be used for the manufacture of fertilisers. But for many other purposes a much higher degree of purity is necessary, and the dry process must then be adopted. Thus iron and aluminium are difficult to eliminate from the acid solutions, whereas unless they are present in excessive amount they cause no trouble in the dry process.

In the United States, the dry process is generally carried out in one operation and the electric furnace is used. In Germany, on the other hand, there are usually two stages and external heat is applied. In the former method, the vapours of phosphorus and carbon monoxide are burned in the upper part of the furnace, the phosphorus pentoxide being afterwards condensed in a separate chamber. In the two-stage process, the phosphorus is not burned until its vapour has been completely separated by condensation from other vapours, and the carbon monoxide is then available as fuel. In both methods, considerable difficulty is caused by the highly corrosive nature of the hot phosphorus pentoxide vapour. The electric furnace gives a much higher concentration of phosphorus and its oxide than the other furnace, but it must be pointed out that a one-stage process is not thermally economical as much heat is necessarily wasted. On the other hand, the electric furnace is not so well adapted to a two-stage process since the yield of carbon monoxide is usually small, so that its heat of combustion cannot be utilised.

Several advantages are claimed for the externally heated furnace and the two-stage process. Thus by eliminating air from the first chamber, a high temperature can be employed without any danger of forming the obnoxious colloidal mist of phosphorus pentoxide vapour, which will neither dissolve readily nor condense completely without the application of the costly Cottrell high-tension discharge. Moreover, any loss which might arise from the adoption of an additional operation is much more than compensated by the elimination of the loss caused through corrosion of the silicate lining of the furnace by the hot phosphoric oxide. The vapours of phosphorus and carbon monoxide are then completely separated and the former is burned in air while the carbon monoxide is used as fuel.

Whilst a direct comparison of the two methods under comparable conditions is not available at present, the author inclines to the view that the wet process is the more economical, whenever it can be usefully applied, although the product is apt to be less pure. On the other hand, since no steam is involved in the dry process, the latter can be adapted to the production of phosphoric acid of any desired concentration without the use of evaporation plant.