advantage of federation or of separation, the greatest peril to university education in South Africa lies in the excessive multiplication of institutions with poor endowment and small, underpaid and overworked staffs. The discussion was well sustained; and, in summing up, the chairman, Mr. S. J. Jennings, pointed out that in Germany and England a population of a million could support a university. Roughly speaking, a population of a million in South Africa would correspond in fee-paying capacity with a population of two millions in Germany or England. It therefore seemed within the range of possibility that South Africa could support two universities.

INTERNATIONAL MARINE INVESTIGATIONS.[1]

THIS summary of the results so far obtained by the international investigation of the North and adjacent seas is drawn up by the executive committee of the Swedish Hydrographic-biological Commission, and is the second of its kind. Being well written, illustrated by good charts and plates, and demanding no great previous knowledge from the reader, it is one of those accurate yet popular accounts which, by educating public opinion in the utility of research, possess a real public value. Its slight unevenness is probably inevitable in the rapid survey of so wide a field, and it is to be regretted that the language in which it appears will restrict so narrowly the number of its readers.

The introduction patriotically reminds us that Sweden took the initiative in cooperation in marine research when King Oscar issued invitations to the conferences of Stockholm (1899) and Christiania (1900), and states the aim of the work to be, in the terms of a resolution of the latter meeting, "to prepare for the rational exploitation of the sea on a scientific basis." The aim is thus practical; the writers proceed at once to discuss the urgent practical question which played a considerable part in securing British participation in the international scheme, namely, the over-fishing question.

The belief that the catch of fish (mainly trawl-caught fish) was greater than nature replaced had arisen, declined, and revived when the international work began. Remedies had been proposed, and, being based on insufficient knowledge of the sea, had failed. The authors unreservedly include among the failures the closure of areas to trawling and the replenishment of the sea by fish-hatcheries; they speak hopefully of the value of market statistics, recognise the recent improvements in English methods of collection, and pass to the biological attack on the problem. This section is a little disappointing. Much has been ascertained concerning intensity of fishing, migration, &c., the bearing of which on over-fishing is not clearly brought out in the text. Since, for instance, over-fishing is stated to affect plaice mainly by reducing the average size at which they are caught, any experimental evidence of a possibility of increasing the rate of growth deserves close consideration; yet the promising results of transplanting plaice from crowded "nurseries" to good feeding-grounds where growth is more rapid are very briefly dealt with.

To make any proposal for restrictive legislation before the International Council has fully sifted the evidence collected on over-fishing seems premature, and, from the representatives of a country not greatly interested in trawling, even a little out of place. The writers, however, advise that each country fix an inshore size limit independently, while no plaice should be landed from offshore grounds of less length than 28 cm., that limit to be gradually increased to 33 cm. As to the practicability of enforcing this rather complicated scheme they are silent; possibly wisely.

Numerous biological researches are described, but by far the greatest detail is accorded to hydrography. Even Prof. Petterssen's theory of the effect of ice melting is included, although, as Nansen's "Northern Waters" has shown, it is still controversial. The Baltic hydrography is perhaps the freshest section for English readers. Hydrography gained much from cooperation; the standardising of instruments and reagents removed one frequent source of wasted opportunity in earlier voyages, by making all observations more strictly comparable, while the periodic cruises of the numerous vessels employed ensured regular observations over the whole great area involved. The main result has been the discovery that European seas are flooded every autumn by Atlantic water (of 35 per mille salinity or more) which withdraws in spring, and that many fisheries depend on these movements. Such a fishery is that of the Swedish "winter herring"; the fish is abundant, and the fishery prosperous when southern bank-water, of characteristic salinity, temperature and plankton, forms a thick layer in the Baltic entrances, while in years of exceptional abundance of Atlantic water this displaces the overlying bank-water, and a "bad herring year" results. These years occasion considerable distress.

The summary closes with appendices, some of which, semi-diplomatic documents now apparently published for the first time, are worth careful perusal by all interested in fishery legislation and research. One, written by Prof. Petterssen in reply to a question from the English Board of Agriculture and Fisheries, as to the probability of practical results shortly appearing, is especially interesting. Prof. Petterssen mentions the confusion of ideas and opinions that, owing to lack of knowledge of the sea, prevailed before the international work began, describes the results attained and the value set on cooperation by the investigators, and, speaking of the protection of immature fish, he makes the noteworthy remark, "International measures of this kind must be founded on strong and indisputable evidence. . . . Such evidence can only be the outcome of a joint investigation of the total area in question, executed by the best specialists of every nation concerned." These words constitute now, as they did three years ago, a weighty defence of international cooperation in fishery research.

[1] "Resultaten af den Internationella Hafsforkningens arbete under åren 1902–1906, och Sveriges andel däruti. By G. Ekman, O. Petter-sen, F. Trybom. Pp. 164. (Stockholm: Isaac Marcus, 1907.)

THE TRANSVAAL DEPARTMENT OF AGRICULTURE.

WE have received from the director a copy of the annual report of the Transvaal Department of Agriculture for the year 1905–6. The department was formed soon after the close of the war, and was placed under the charge of Mr. F. B. Smith, who had been trained at Cambridge and had gained experience as an agriculturist at Wye College, of which he was for some years the vice-principal. On his arrival in the Transvaal Mr. Smith gathered round him a band of zealous and competent workers, and organised the new department on American lines, assigning the work to a number of "divisions." Each of these, while independent and under the charge of separate heads, was kept in close touch with the work of the other divisions through the director of the department and his office staff.

The report for the past year gives a *résumé* of the work on which the new department is now engaged, which should prove of interest not only to those directly concerned, but to many in our own country who may wish to know what the trained agriculturist can do to assist the development of the colonies. The most obviously beneficial work of the department is that of the veterinary division, which was formed partly to investigate the numerous diseases which threatened the live stock of the colony at the close of the war, but chiefly to check the spread of disease by treating diseased animals and by administering acts regulating their movements. The need for this type of work may be inferred from the fact that during the year 726 outbreaks of contagious disease were dealt with, 140,000 animals inspected, and 660,000 examined for soundness at the ports or on the borders of the Transvaal before being admitted into the country.

The acts regulating the movement of diseased animals have caused stock-owners some inconvenience and have been the subject of occasional complaints, but they have succeeded in a remarkable way in improving the health of the live-stock. For example, the disease known as East Coast fever, which at the close of the war was a serious menace to the cattle of the colony, has been overcome, and large areas have been altogether freed from it. In 1904–5 about 8000 cattle died of this disease; in 1905–6 the number was

reduced to 800. As an instance of the protective measures adopted by the department, we may cite the case of rabies. The Transvaal is free from this disease, but it is found in Rhodesia, and in the hope of preventing its introduction a strip of country fifty miles wide, along the northern border of the Transvaal, has been entirely cleared of dogs.

A large part of the time of the chief of the division of botany is taken up by consultative work. Information upon new crops, weeds, poisonous plants, forest trees, &c., is in constant demand, and, apart from interviews and attendances at shows, this work alone involves the writing of some 3000 letters per annum. A herbarium is being formed. Some progress has been made in crossing and selecting maize, but it is remarked that, owing to the pressure of other work, plant-breeding has not hitherto received the attention it deserves. An important section of the work of the division is that which deals with plant pathology. A pathologist was recently appointed by the department, and the number of diseases which he has already observed is referred to in the director's report as "amazing." Special attention has been directed to the rusts, and five have been so far identified, viz. *Puccinia graminis* on wheat and barley, a second form of *P. graminis* on oats, *P. triticini* on wheat, *P. coronifera* on oats, and *P. maydis* on maize. Some attention has been directed to disease-resistant varieties, and stress is laid on the fact that a cereal which may be immune to the attacks of one rust may be very susceptible to infection by another; the practical conclusion is drawn that every effort should be made to obtain disease-resisting varieties, and that the continued growing year after year of the same variety of any cereal should be avoided as much as possible.

The chemical division has been engaged in an examination of soils, and attention is directed to the fact that the soils of the Transvaal are generally well supplied with potash, but are deficient in phosphoric acid, lime, and organic nitrogen. In conjunction with the veterinary division, the chemist has carried out an investigation into the composition of the bone of animals suffering from osteo-porosis, and he finds that affected bones are deficient in total ash, lime, and phosphoric acid. The normal proportion of nitrogen to total ash is about 1 : 14; in diseased animals the proportion is approximately 1 : 11.

The "division of publications" issues a quarterly journal, each number of which extends to some 300 pages; there are two editions, an English of some 8000 copies, and a Dutch of about 2000 copies. The journal contains original articles, notes from the various divisions, extracts from foreign journals and Government circulars, market prices, customs returns and other figures of interest to farmers. In addition to the journal, this division publishes leaflets and bulletins; among the latter, those written by members of the veterinary division upon the common diseases of the live stock of the colony have been of most importance.

It is satisfactory to learn that the work of the department commended itself to the Public Service Commission which inquired into the working of all branches of the Civil Service. The commission report emphasises the importance to the Transvaal of agricultural research, and goes on to state that it "has been impressed by the zeal, devotion, and business-like methods which characterise the Department at present, and that it finds itself unable to suggest any improvements in the organisation, or in the distribution of the business."

THE ARC AND THE SPARK IN RADIO-TELEGRAPHY.[1]

THE discovery by Heinrich Hertz between 1887 and 1889 of experimental means for the production of electric waves, and Branley's discovery that the conductivity of metallic particles is affected by electric waves, form the foundation on which, in 1896, Signor Marconi built up his system of wireless telegraphy.

Many of the early investigators certainly had glimpses of a future system of being able to transmit messages without connecting wires, for as early as 1892 Sir William Crookes predicted in the *Fortnightly Review* the possibility of telegraphy without wires, posts, cables, or any of our costly appliances, and said, granting a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment.

Two years later Sir Oliver Lodge gave his memorable lecture on the work of Hertz, and carried the matter a step nearer the practical stage.

There will not be time to dwell to-night on the early history of the art and its development. It will be necessary, however, to explain some of the fundamental properties of signalling by means of Hertzian waves in order to be able to bring out clearly the relative advantages and disadvantages of the two rival methods now in practical use for producing Hertzian waves for wireless telegraphy.

The fundamental part of the transmitting apparatus may be said to consist of a long conductor generally placed vertically, in which an alternating or oscillating current is set up by some suitable means. Such a conductor radiates energy in the form of Hertzian waves at right angles to itself into space, in very much the same way that an ordinary candle sends out light in all directions. This radiation, though it is strictly in the nature of light, is invisible to our eyes, as the frequency is too low.

If we set up any other conductor approximately parallel to the first, there will be produced in this second conductor alternating or oscillating currents having the same frequency as those in the first conductor, and which can be detected by suitable instruments.

The simplest and one of the earliest methods for producing Hertzian waves for use in wireless telegraphy consisted in charging up, by means of an induction coil, a vertical insulated conductor, which was allowed to discharge itself to earth by means of a spark taking place between its lower end and another conductor which was connected to earth. To detect the Hertzian waves Marconi employed an improved form of the Branley filings tube, which is known as the coherer.

In order to transmit messages the radiation is started and stopped so as to form short and long signals, or dots and dashes of the Morse code, out of which the whole alphabet is built up in the well-known way.

As I have already stated, the radiation takes place round the vertical conductor approximately equally in all directions. Suppose that I set up my transmitting apparatus here in Leicester, a receiving station set up either in Nottingham, Derby, Rugby, or Peterborough would be able to receive the message equally well. Should I wish to send a message from here to Nottingham at the same time that Derby wishes to speak to Rugby, then the receiving station at Nottingham would receive both the message from Leicester which it should receive, and the message from Derby which it was not required to receive.

To get over this difficulty, known as "interference," a large number of devices have been patented. The most successful in practice is syntony, or tuning; in this method each station has allotted to it one definite frequency or tune, and the apparatus is so arranged at each station that it will only be affected by messages which are radiated by other stations on its own frequency or tune, and not by any other radiations. To take a musical analogy, supposing I had somebody who was either deaf to all notes of the piano except, say, the middle "C," or had such a musical ability that he could tell at once when I struck the middle "C," then I could transmit to that person a message in the ordinary Morse code by playing on the middle "C," and that person, whom I shall call Mr. C., would not take any notice of the fact that I might also be playing on the notes D, E, F, G, &c., but Mr. C. would confine his attention entirely to what is being done with the middle "C." It is conceivable that I might find a series of persons or train them so that they could each pick out and hear one note only of the piano, irrespective of what was being played on the other notes or of any other noises that were taking place. Taking an ordinary seven-octave piano, and neglecting for a moment the black notes, this would give me fifty-six distinct notes on which I could transmit messages; so that, transmitting from Leicester, I might send messages simultaneously to fifty-six different towns.

[1] Discourse delivered at the Leicester meeting of the British Association on Friday evening, August 2, by Mr. W. Duddell, F.R.S.