Our Astronomical Column.

LIVERPOOL UNIVERSITY TIDAL INSTITUTE.—The first annual report of this institute, established in 1919 with funds provided by Sir Alfred and Mr. Charles Booth, gives a brief and interesting account of the work so far taken up under the auspices of Prof. J. Proudman, the honorary director, and Dr. A. T. Doodson, the secretary. Besides theoretical work on the seiches in Lake Geneva and on the dynamical equations of the tides, the study of tide-prediction has been vigorously prosecuted. The official British and American predictions of the tides in the Mersey, calculated by machines of Lord Kelvin's type on the basis of analyses made many years ago by a committee of the British Association, often differ by a foot in height between themselves, and from the actual observed heights by amounts up to 3 ft. Dr. Doodson finds that the predicting machines are susceptible to error, though further examination is necessary to determine whether to an extent which unfits them for use in research. Meanwhile, the institute has embarked on an intensive study of the tides at Newlyn, near Land's End, from the continuous record taken by the Ordnance Survey. This work has also been assisted financially and otherwise by a British Association committee. Analysis has been made by computations on a novel plan; the five most important constituents in the tides were first removed, using approximate values inferred from the results of analyses for neighbouring stations. This reduced the range from 18·5 ft. to 2·5 ft., and disclosed the presence of quarter-diurnal constituents, which also were removed by a method suggested by theoretical considerations. This revealed constituents of higher orders and the presence of some unremoved semi-diurnal constituents, as was to be anticipated. By this method the real constituents are discovered, and these alone removed.

LONGITUDE BY AEROPLANE.—The *Comptes rendus* of the Paris Academy of Sciences for August 2 contains a paper by M. Paul Ditisheim describing a new determination of the Paris-Greenwich longitude by the repeated transfer of a series of chronometer watches between the two observatories by an aeroplane. Twelve watches were used which had previously been tested at Teddington with most satisfactory results. They were packed in wooden cases surrounded by layers of wool, and remained in a horizontal position during transit. They were compared with the standard clocks at Greenwich and Paris by Mr. Bowyer and M. Lancelin respectively. The average time of transit was $2\frac{3}{4}$ hours; on one occasion the double journey was completed on the same day.

The resulting longitude difference is 9m. 20·947s., with a probable error of 0·027s. It is only 0·005s. less than the mean of the British and French results in the 1902 determination. It is needless to say that the new value does not claim anything like so much weight as that of 1902, in which the observers were exchanged and personal equation was eliminated. It is, however, an interesting confirmation of it, and it illustrates the fact, already known, that the use of the travelling wire in observing transits greatly diminishes personal differences. This fact gives ground for hope that the method of wireless signals, without interchange of observers, will give close approximations to the longitudes of all the participating observatories.

OBSERVATIONS WITH THE PHOTO-ELECTRIC CELL.—Prof. Joel Stebbins's valuable pioneer work with the selenium cell (with which he discovered the secondary minimum of Algol) is now being continued with still greater refinement with the photo-electric cell. The *Astrophysical Journal* for May contains two of his researches. The first is on the Algol-variable λ Tauri. The light-curve much resembles that of Algol, a secondary minimum being shown here also. Elements are deduced from Prof. Stebbins's results combined with the spectroscopic ones. The masses of the two stars are 2·5 and 1·0 times that of the sun; the radii are 4·8 and 3·6 times the sun's; and a third body is suspected with mass 0·4. The side of the secondary that is turned towards the primary is much brighter than the other, which is ascribed to the intense radiation of the primary.

The other star examined is π^5 Orionis. The variability was detected before Prof. Stebbins noted that it had already been classified by Lee as a spectroscopic binary (with only one visible spectrum). The total range of light is only 0·06 magnitude, yet the observations suffice to give a consistent curve. As this proves to be a sine-curve with two periods in the time of revolution, it is concluded that the light-variation does not arise from eclipse, but from the spheroidal figure of the bright component. The ratio of axes is 0·95, which is quite a reasonable figure.

Prof. Stebbins states that he has at last succeeded in obtaining a potassium cell, with walls of fused quartz, that gives complete satisfaction. It was only after ninety-eight trials that this result was reached.

The Scientific Investigation of the Ocean.

NEED FOR A NEW "CHALLENGER" EXPEDITION.

THE outstanding feature of the proceedings of Section D (Zoology) at the meeting of the British Association at Cardiff was the discussion on August 26 on the need for the scientific investigation of the ocean.

In opening the discussion, Prof. W. A. Herdman, president of the Association, pointed out that this need may be considered under two heads—the scientific need and the industrial. Simply as a matter of advancing knowledge, the need for much further investigation of the ocean is very great indeed, and biologists realise that the industries connected with those marine animals—fishes and others—which are of economic importance are all of them badly in need of scientific investigation. There is not a single marine animal in regard to which it can be said that we know anything like all there is to be known and fully understand its mode of life. Even our commonest fishes, such as the herring and the cod, are in some respects unknown and mysterious to us. Prof. Herdman then proceeded to give a few examples of the need for further investigation.

The first report of the Tidal Institute of the University of Liverpool, issued a few weeks ago, shows that the two independent published predictions of the Liverpool tides—one issued by the Admiralty and the other by the United States Coast and Geodetic Survey—"seldom agree; they often differ by a foot in height; also, both of them sometimes differ from the actual tide by as much as 3 ft. in height." It is evident from this report that the present state of affairs urgently calls for more scientific research both in regard to the theory of the tides and to the accuracy of observations.

The work of the bio-chemist and of the physical chemist in connection with hydrography seems likely to be of fundamental importance, *e.g.* the possibility of determining the point of entrance to known currents of water by means of indicators showing the hydrogen-ion concentration may be of practical utility to navigators. Then again, Otto Pettersson's submarine waves in the Gullmar Fjord and elsewhere,

and their possible influence on the winter herring fisheries, is a subject worthy of further investigation. Enough is known as to the influence of variations in the great oceanic currents upon the movements and abundance of migratory fishes to indicate the need for further and more complete investigation of the subject.

Prof. Herdman pointed out that, though we may suspect that the periodic changes in the physico-chemical characters of the sea may be correlated with the distribution at different seasons of the microscopic organisms that are an important source of food to larger animals, the matter has still to be proved and worked out in detail. The plankton curve has to be traced and the succession of organisms explained in terms of environmental conditions, including the ion-concentrations in the water and the amount and quality of solar radiation, and that not only in temperate seas, but also in the tropics and in all the oceans, and at various depths. It is known that many marine animals are profoundly affected in their distribution by the hydrographic conditions. For example, it has been shown that the herring of our summer fisheries is influenced in its movements by the temperature of the water, the catches being heavier in seasons when the water is colder, so long as it is not below 54·5° F., when the shoals break up and disperse.

Bionomics is the basis from which all oceanographic work on the biological side started, and there is still much to be done in tracing and explaining the life-histories and distribution and relations of marine plants and animals. In this connection, Prof. Herdman referred to the recent investigations of Dr. Joh. Schmidt, who has devoted the present summer to an oceanographic expedition in the Atlantic, the work of which included a search for the spawning eel.

The whole of the large question of the evaluation of the sea—a natural extension of the old-fashioned faunistic work—is a great field for research lying before the oceanographer of the future. Dr. Petersen in Denmark has done notable work in the Kattegat and the Limfjord, but it is probable that the "animal communities" which he has defined differ in other seas, and will have to be worked out independently in each marine area. Prof. Herdman cited the excellent marine surveys made by Sumner at Wood's Hole and by the Royal Irish Academy at Clare Island as work on the right lines as a preparation for the evaluation of large areas.

Similarly, systematic plankton work, studied intensively and treated statistically, and correlated with the food of migratory fishes and of the post-larval and other young stages of all food fishes, is a promising subject requiring much further investigation. Dr. Hjort's suggestion that the future year-classes of commercial fishes may depend not only upon favourable spawning seasons, but also upon an exact coincidence between the appearance of the phyto-plankton in sufficient quantity in spring and the time of hatching of the larval fishes, provides a subject of careful and difficult investigation and of far-reaching practical importance. A cognate subject bearing upon the same practical results—viz. future commercial fisheries—is Dr. Johnstone's demonstration of a natural periodicity in the abundance of certain fish. The extent and causes of this periodicity clearly call for further investigation; and in any discussion of, say, pre-war and post-war fishery statistics, the possibility of this periodicity affecting the question must be kept in mind.

Prof Herdman emphasised the point that it is impossible to keep purely scientific research and investigations with a practical end in view completely separate. They are inter-related, and the one may become the other at any point. It was in the purely scientific investigation of the bionomics of the "warm" and "cold" areas of the Faroe Channel, in the *Triton* in 1882, that Tizard and Murray incidentally discovered the famous Dubh-Artach fishing-grounds which have been so extensively exploited since by British trawlers. It was a French man of science, Prof. Coste, who made the investigations and recommendations that started the flourishing oyster industries at Arcachon and in Brittany. It was his purely scientific studies of the deep-sea deposits that enabled Sir John Murray to discover the valuable phosphatic deposits of Christmas Island.

Metabolism, the cycle of changes taking place in the sea, the income and expenditure and the resulting balance available, is perhaps the department of oceanography which deals with the most fundamental problems and is most in need of immediate investigation.

The question of the abundance of tropical plankton as compared with that of temperate and polar seas, the distribution and action of denitrifying bacteria, the variations of the plankton in relation to environmental conditions, the determination of what constitutes uniformity of conditions over a large sea-area from the point of view of plankton distribution, the questions of the ultimate food of the ocean, the supply of the necessary minimal substances such as nitrogen, silica, and phosphorus to the living organisms, and the determination of the rate of production and rate of destruction of all organic substances in the sea—these are some of the fundamental problems of the metabolism of the ocean, and all of them require investigation. Most of these, moreover, are cases where the biologist or the oceanographer requires to appeal for assistance to the bio-chemist. In fact, in many oceanographic investigations team-work, in which the specialists of two or more sciences unite in tackling the problem, leads to the best results.

To the question, then: Is there need for further investigation of the ocean? Prof. Herdman answered emphatically in the affirmative, and referred, in conclusion, to the two suggestions made in his presidential address: (1) that there should be established at Cardiff a department of oceanographic and fisheries research, and (2) that there should be a great national oceanographical expedition—that is, another *Challenger* expedition, fitted out by the British Admiralty, and embracing all departments of the science of the sea investigated by modern methods under the best expert advice and control. Such an expedition would require long and careful preparation, so even though the present time may seem to some inopportune to press such an undertaking, if this suggestion is received with favour by oceanographers, it might be wise to form a preliminary committee to collect information and prepare a scheme.

Prof. J. Stanley Gardiner urged that to obtain results in economic work on fisheries there must be advance in wider scientific research. He endorsed the suggestion of the president for the establishment of oceanographical investigation in Cardiff, and said that, in his opinion, if this country is to keep in the fore-front of oceanographical research, a new *Challenger* expedition has become necessary.

Dr. E. J. Allen supported the proposals for a new deep-sea expedition, and illustrated the need for further researches on marine organisms by reference to his recent experiments at Plymouth on the culture of plankton diatoms in artificial sea-water. He found that in solutions of pure chemicals, having as nearly as possible the composition of sea-water, to which nutrient salts such as nitrates and phosphates were

added, diatom cultures did not develop, but when to such artificial sea-waters traces (say 1 per cent.) of natural sea-water were added, very good growth occurred. Experiments indicated that probably an organic substance in the natural sea-water stimulated growth, but its composition was still quite unknown. The culture method had also been used to obtain a minimum figure for the number of organisms living in a given volume of natural sea-water, and had shown that, whereas the number obtained in the usual way with the centrifuge was 14,000 per litre for a particular sample, there must actually have been at least 460,000 per litre.

Dr. E. C. Jee directed attention to the necessity for elucidating the movements of the current of dense water which pours out of the Mediterranean and forms an intermediate layer in the deeper waters of the near Atlantic Ocean. It seemed to him likely that the current moves northward, and in certain circumstances comes to the surface within the region of the pelagic fisheries of the British south-western area. It is important to ascertain the influence of this current on the northward migration of planktonic organisms and on the migrations of plankton-feeding fishes, and the investigation of its boundaries would throw light on the salinity variations observed in the surface waters of the English Channel, which are known to exhibit varying degrees of periodicity.

Mr. C. Tate Regan remarked that the study of the ocean was important in many other ways than in relation to fisheries, *e.g.* it was found, during the war, that a knowledge of salinity and currents was of great value in regard to submarine operations and the course of drifting mines. He suggested that work oversea should include the investigation of the seas on the coasts of our colonies; the fauna of the great area within the 100-fathom line that surrounds the Falkland Islands and extends northward to Montevideo is known only from two hauls made by the *Challenger* and five or six by the *Albatross*. In view of the pre-eminence of our Navy, mercantile marine, and fisheries, this country should lead the world in oceanographical research.

Prof. C. A. Kofoid pointed out that the magnitude of oceanographical problems and their diversity necessitate a definite but flexible programme and the co-operation of many investigators, for without such co-operation results must be fragmentary. Standardisation of methods, elimination of unnecessary duplication, and international co-operation are indispensable. He remarked upon the need for a monthly bulletin which should contain a bibliography of the subjects in this field of work together with synopses of the contents of these papers—a work which might well be undertaken by the International Commission for the Investigation of the Sea. He referred briefly to the project for the renewed exploration of the Pacific which is under consideration by a committee of the National Research Council of the United States.

Prof. J. E. Duerden urged that in the organisation of any extensive scheme of research in oceanography, or of a new *Challenger* expedition, the possibility of assistance from, and co-operation with, the various Dominions should be kept in mind. He had no doubt that, upon proper representation being made, the Union of South Africa would take its part, both financially and in *personnel*.

Mr. F. E. Smith, director of scientific research at the Admiralty, stated that his department had considered the question of a new *Challenger* expedition, and was of opinion that such an expedition was required, and he felt sure that the Admiralty would take its share in the organisation thereof.

At the close of the discussion a resolution was unanimously agreed to pointing out the importance of urging the initiation of a national expedition for the exploration of the ocean, and requesting that the council of the British Association should take the necessary steps to impress this need upon his Majesty's Government and the nation. On the following day, at the Committee of Recommendations, this resolution also received vigorous support from other sections, *e.g.* those dealing with chemistry, physics, geology, and geography, in all of which, as well as in zoology, investigations are required which could be undertaken by such an expedition. The General Committee of the Association recommended the Council to appoint an expert committee to prepare a programme of work and to consider the *personnel* and apparatus required. It is the hope of all those who have heard the cogent reasons for the expedition that it may be possible for the Government, in the not distant future, to undertake this great enterprise.

The New Star in Cygnus.

FROM the occasional observations which I have been able to make of the nova in Cygnus, I have formed the impression that the star has followed the normal course for such objects, except that the rise to maximum may have been more prolonged, and the subsequent decline in brightness more rapid, than usual. On August 22, two days after discovery, bright lines were not discernible with a small spectroscope attached to a 3-in. refractor, thus suggesting that the maximum had not then been reached. The star was seen for a short time on August 23, when it had risen to nearly second magnitude, but there was no opportunity of making spectroscopic observations. On August 26 observations were made by Sir Frank Dyson and myself with the 12-in. reflector of the Penylan Observatory, Cardiff, from 10h. to 11h. G.M.T. The star was then very slightly brighter than δ Cygni, but not so bright as γ Cygni, so that its magnitude would be about 2·8. Bright lines were then well developed, Hα being conspicuous, and also the group of four lines in the green assumed to be Hβ, 4924, 5018, and 5169. On August 28, so far as could be observed with a 3-in. telescope (in London), the spectrum showed no marked change, though the star had then fallen to nearly fourth magnitude.

A. FOWLER.

The announcement of the discovery of the new star in Cygnus was received at the Hill Observatory, Sidmouth, on the afternoon of August 21, but the cloudy state of the sky prevented any observation being made on that night. The sky was, however, clear on the night of August 22, and several photographs of its spectrum were secured. The following table sums up the observations taken since that date, and shows the fluctuations in magnitude recorded and the number of photographs of the spectra taken :—

Day.	State of Sky.	Estimated Magnitude.	No. of Spectra obtained.
21	Cloudy	—	—
22	Clear	2·8	4
23	Cloudy	—	—
24	Clear	2·2	3
25	Clear	2·2	5
26	Clear	2·8	4
27	Cloudy	—	—
28	Clear	3·6	3
29	Clear	3·8	4

On the night of August 22 the spectra were all very closely similar to that of α Cygni, the type of star