Two Oceanographical Expeditions.

I.—The German South Atlantic Expedition of the *Meteor*.

IN 1919 plans were formulated by the late Dr. Alfred Mertz for a national expedition to study the physical and chemical conditions of the South Atlantic. In conjunction with the Deutsche Seewarte at Hamburg and the Institut für Meereskunde at the University of Berlin, a very thorough programme was drawn up, a scientific staff gathered together, and the use of the gunboat 'C,' renamed *Meteor*, obtained. The vessel is of 1300 tons displacement, having a ship's company numbering 133, which includes the scientific staff of nine, exclusive of assistants, and nine ship's officers, exclusive of engineers and under-officers.

Whereas former oceanographical expeditions have been concerned very largely with the life in the oceans, the programme of this expedition is almost entirely limited to hydrographical and meteorological observations, to be made at numerous positions while crossing the South Atlantic fourteen times between the South American continent and Africa, the various positions being chosen so as to allow of the best use being made of Bjerknes' theory in calculating the currents at various levels and the consequent circulation of the water masses. Particulars of the objects, equipment and first fruits of the cruise, which commenced in January 1924, have been published by Dr. Mertz,[1] and in two later reports by Captain F. Speiss,[2] who succeeded to the leadership of the expedition after the unfortunate death of Dr. Mertz, which occurred shortly after the programme of work was commenced in the South Atlantic.

Fig. 1, taken from Captain Speiss's report, shows the tracks which have been followed and the 139 positions or stations where observations have been made at depths between surface and bottom. Besides these, numerous observations have been made at a number of other positions on the voyage out from Germany. The section from Cape Town to Buenos Aires shown in Fig. 2 indicates the nature and depths of the observations; considered in conjunction with Fig. 1 the intensity of this hydrographic survey is apparent.

With regard to the scope of observations, besides the distribution of temperature and of density, from which the probable circulation of the water in the ocean will be calculated, observations of hydrogen ion concentration, of the oxygen, carbon dioxide, gold, silver, phosphate and nitrate content of the water are provided for, and a method has been devised and used for measuring the rate of evaporation from the surface of the sea. Measurements are made of the waves encountered by a stereophotographic method, and echo-soundings are carried out by three different systems, from the results of which the production of a very complete bathymetric chart will doubtless be possible. Microplankton organisms collected at the various stations are being examined and their quantity measured on board. Regular meteorological observations are made on board and to a height of above 15 kilometres by means of pilot balloons and kites, while at the various ports visited the local geological formation has been investigated.

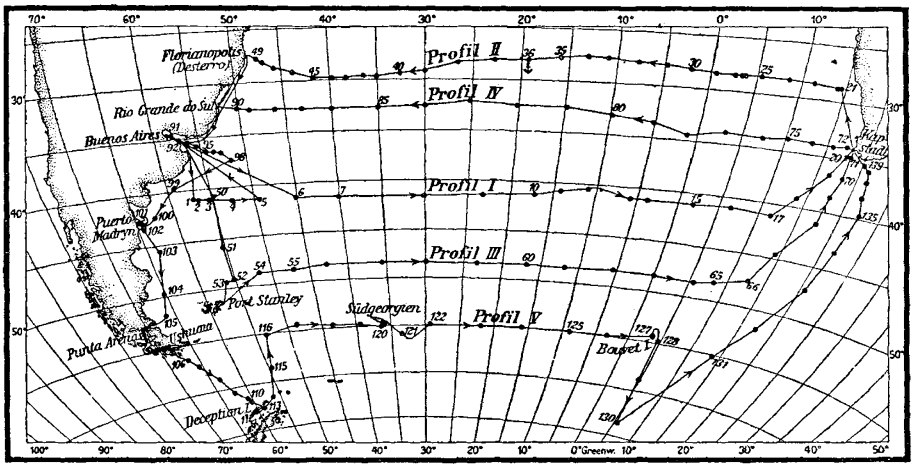

FIG. 1.—Course of the *Meteor*, with the 139 stations where observations between surface and bottom were made.

The reports give particulars of how the work is being carried out and of how it progresses according to the original plan, which the *Meteor* has been able to follow very closely in spite of bad weather experienced in the more southerly latitudes. When the observations are published and the data worked up and charted, they should present a more perfect picture of the observed conditions in this area than we have for any other ocean, and from such a survey there can be little doubt that several general principles will emerge of fundamental importance to the rapidly growing science of physical oceanography.

II.—The Cruises of the *Armauer Hansen* in the Eastern North Atlantic.

For a very considerable time it has been known that the British islands owe their warm climate, in comparison with that of Newfoundland in the same latitude

[1] "Die Deutsche Atlantische Expedition auf dem Vermessungs- und Forschungsschiff *Meteor*," by Prof. Dr. A. Mertz, *Sitzungberichte der Preuss. Akad. der Wissenschaften*, **31**, 1925.

[2] "Die Deutsche Atlantische Expedition auf dem *Meteor*," *Zeit. der Gesellschaft für Erdkunde zu Berlin*, No. 1 and No. 5/6, Berlin, 1926.

to the Atlantic or European current which bathes our coast, and passes northward, and to the south-westerly winds which produce it. Towards the end of the last century the Scandinavian hydrographers found that the surface temperature of the Norwegian sea varied from year to year largely in relation to the amount of warm Atlantic water which passed into it over the submarine ridge which extends from the Shetlands to Iceland. This variation in temperature in turn affected the climate and several seasonal occurrences along the Norwegian seaboard, such as the annual growth of pine trees, the time of flowering of various plants and probably the seasonal fisheries.

As a natural result, more information was desired concerning the circulation of water in the eastern North Atlantic, and particularly of the fluctuations in the Atlantic current. Owing to the costly nature of investigations over such a wide area, the observations which it has been possible to make have been severely limited; nevertheless, considerable knowledge has been accumulated, notably through the active interest taken by Dr. Nansen. He found water of Mediterranean origin mixed with Atlantic water so far north as Ireland during an expedition made by him in 1910 in the *Frithjof*—a vessel lent for the purpose by the Norwegian Navy. In consequence of this and similar Norwegian and Danish investigations, a new set of questions were raised which made it especially desirable to carry on more extensive studies of the great Atlantic current off Europe.

In a recent publication [3] the scientific results are presented which were made during cruises of the *Armauer Hansen* in 1913, 1914, 1922, 1923 and 1924, extending so far south as Madeira and to Lat. 30° W. some 700 miles to the westward of Ireland. The ship was a small yawl of 56 tons burden, with auxiliary motor only used occasionally; that is to say, she is a vessel smaller than the trading ketches and Thames barges which ply around the British coast. The oceanographical observations were mainly made by Helland-Hansen at numerous stations to depths exceeding 2000 metres. This necessitated manœuvering the ship so that the line along which the instruments are suspended remained in a vertical position throughout the time of observations, even if there is a strong drift caused by wind or current. In this connexion they write: "Care has always been taken to make sure of the vertical position of the sounding line, and the determination of the depths may therefore be considered very trustworthy." No mention is made of the difficulties encountered in carrying out the work from the small vessel during these extensive ocean cruises, but the amount and nature of the scientific data obtained are in themselves a record of the skill, endurance and careful preparation involved. Certainly the cruises were made in summer, but nevertheless this record shows how much can be done with a small sailing vessel suitably equipped.

From the density of the water, the currents were calculated for different water layers by means of Bjerknes' theory and are shown on a number of charts. These show a strong current passing eastward over the submarine bank which extends roughly north and south down the centre of the North Atlantic. This current is in about Lat. 47° N., and on arriving at Long. 25° W., a position roughly five hundred miles north

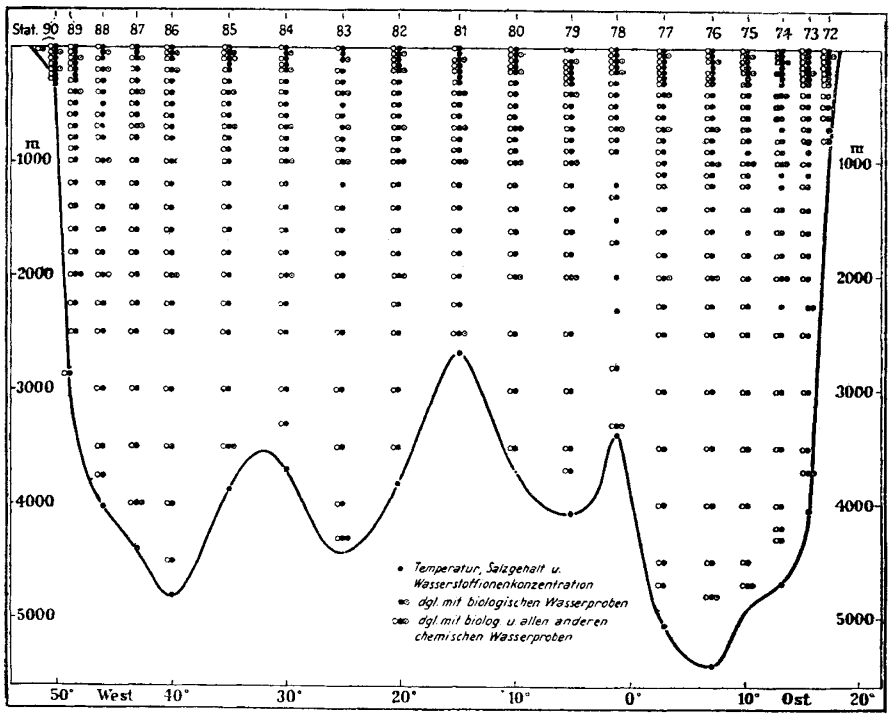

FIG. 2.—Section of the South Atlantic from Cape Town to Buenos Aires obtained from soundings by German South Atlantic Expedition in the *Meteor*.

[3] "The Eastern North Atlantic." By B. Helland-Hansen and F. Nansen, *Geofysiske Publikasjoner*, vol. 4, No. 2 (Oslo, 1926).

of the Azores, it divides, part turning northward and north-eastward and part turning south to the Azores and Canaries, where it divides again, part turning south and part turning northeastward towards Spain. The currents immediately westward of the continental slope between Ireland and Portugal indicate a number of eddies and a more involved system than that previously supposed; however, the northerly drift of highly saline water welling out of the Mediterranean as a warm undercurrent is shown extending certainly so far as the north of Spain. The existence of these calculated currents at the various depths is based upon the assumption that the movement of water at 2000 metres depth is negligible, for which evidence is presented.

There has been evidence for some time pointing to vertical oscillations of the water layers at a depth of fifty metres or more below the surface in various regions of the Atlantic. This expedition has provided further evidence which indicates that the oscillations may be considerable, particularly in the deeper layers. The oscillations show a more or less regular diurnal or semidiurnal period, which suggests that they are subsurface waves or undulations having some connexion with tidal phenomena; but how the tidal wave, producing in the open ocean oscillations of less than three feet at the surface, can produce vertical oscillations of the dimensions observed in the lower strata remains inexplicable. The desirability of further knowledge is manifest since a vertical series of observations cannot be expected always to represent the *average* conditions at any particular station; it is therefore of great importance for the discussion of the general conditions of a sea area to study how far the actual observations at the different stations and different depths may be regarded as representative.

During the course of the 1913 cruise some interesting current measurements at various depths were made from a boat moored on the bank around Rockall, an isolated rock some 200 miles north-west of Ireland. At a depth of two metres a rotary tidal stream was found, continuously varying and completely reversing in direction every six hours, a type of tidal streaming which is characteristic of the sea over isolated banks. A limited number of observations at greater depths suggest a similar variation in direction. During the fifth and sixth hours of observation a breeze sprang up and the observations indicated a wind drift of the uppermost water strata superimposed upon the tidal streaming.

Archæology of the Channel Islands.[1]

By Dr. R. R. MARETT.

THOUGH there is nothing very new to be said about the archæology of the Channel Islands, some brief notes are here brought together because well-attested facts relating to such an *angulus terrarum* are apt to escape attention. For example, in recent discussions concerning Depéret's proposed method of classifying the subdivisions of the Quaternary, namely, by giving weight primarily and chiefly to the indications afforded by ancient marine shorelines, I have come across no references to the rather striking data of this type provided by the islands (see, for example, my summary account of them in *Archæologia*, 62, 469-80). Thus, one Jersey cave, La Cotte de St. Ouen, exhibits a Mousterian industry with cordiform 'points,' *i.e.* belonging to a phase that is not the latest, as resting more or less directly on a marine deposit of sand and rolled pebbles forming the floor-bed of a cave at about 20 metres above present mean tide-level. On the other hand, another cave in Jersey, La Cotte de St. Brelade, contained the remains of a copious fauna, mammoth, woolly rhinoceros, reindeer, etc., conjoined with the later of two well-represented phases of the Mousterian industry; from which fact it is fairly safe to argue that Jersey was then freely accessible from more spacious lands.

Here, then, is almost crucial evidence that the later Mousterian culture coincided with a period of land elevation preceded by one of subsidence (to use such terms without prejudice to the question whether sea or land was the active factor responsible for the change of level). This would accord well enough with Depéret's Monastirian stage with its 20-metre shoreline marking the downward movement (from the point of view of a man as contrasted with that of a fish) and a later oscillation of at least a like extent in the opposite or upward direction; exactly 20-metres in the way of land elevation being at present necessary to render Jersey accessible from the Continent at low tide. Of previous changes of sea-level it must suffice here to say that at Le Cané de la Rivière, on the north coast of Jersey, there is clear evidence that the sea had time to hollow out a cave at the 10-metre level before it rose to 20 metres and plastered the sides and top of the cave in question with beach-pebbles. Still earlier, one may presume, is a solitary deposit of such pebbles at South Hill at a height of about 45 metres. Unfortunately, these various raised beaches contain no shell whereby to correlate them with Depéret's palæontological series.

When, on the other hand, we turn to post-Mousterian evidence of change of level, a section taken almost anywhere in the valley-bottom on which the town of St. Helier's stands (the level being about 10 metres above O.D.), reveals with remarkable uniformity beneath a few feet of modern alluvium, two peat-beds alternating with two underlying marine layers of sand and shells. In the upper peat-bed a mould for a spear-head has been found, giving it a Bronze Age horizon. From the lower peat have come several rough sherds, one characteristically decorated with punctured dots in rows, that proclaim the horizon Neolithic. Moreover, there can be little doubt that this lower peat-bed is to be correlated with the submerged forest so well in evidence round the islands down to low-tide level and beyond it, as notably at Vazon Bay in Guernsey, whence proof of Neolithic age is also forthcoming. Considerable land-elevation in this region in Neolithic times is thus indicated.

How far these facts have a bearing on the general history of the Channel is hard to say. As for Jersey in particular, its position at the end of a narrow spit of

[1] Substance of three lectures delivered at the Royal Institution on Nov. 18, 25, and Dec. 2.