Systematic Investigation of the Oceans.

AN international oceanographic conference was held in May 1928 in Berlin to commemorate the centenary of the Gesellschaft für Erdkunde, which has published a series of papers dealing with recent and imminent expeditions.[1] Most of these naturally deal with the results obtained by the *Meteor*, but articles also describe the work of the *Carnegie*, of the little Norwegian auxiliary ketch *Armauer Hansen* in the north-east Atlantic, and the aims of the new Dutch Expedition to the East Indies in the *Willebrord Snellius*.

As these articles are for the most part summaries of methods used and results achieved, they cannot be condensed into a short review, but the following notes on various points in this symposium may be of general interest.

Numerous samples of sea-water collected by the *Meteor* in the Atlantic were analysed for gold by the method due to Haber, whereby the gold in the water is adsorbed on a precipitate of lead sulphide which on heating with lead formate and boric acid leaves a minute bead of gold. This is picked out from the crucible and measured under the microscope.

An ingenious method was used to collect the small amount of lead sulphide, about 40 milligrams in each litre of sea-water. The full flask was inverted over a crucible also containing water and the whole spun in a centrifuge, when the lead sulphide collected at the bottom of the crucible. To prevent loss of water in handling, the top of the crucible was covered with a rubber cap.

The plankton rich upper layers were found to be richer in gold than the water below, much of this being adsorbed on, or contained in, the organisms. The quantity varied from about $\frac{1}{100}$th milligram of gold per cubic metre to a third of this amount, or less in the deep water.

The greater part of the scientific work of the *Meteor* centred around depth and physical measurements, from which to deduce the oceanic circulation from the internal field of force produced by differences in density, from the general distribution of salinity, and from direct-current measurements. For the first time these were successfully made from a ship at anchor in mid-Atlantic where the depth was over 4 kilometres. For this purpose stocked anchors weighing a quarter of a ton and a tapered wire cable $7\frac{1}{2}$ kilometres long were carried. The circumference of the wire cable at the anchor end was 3·6 cm. and at the end made fast to the winch 5 cm.

The temperature measurements at various depths were made with reversing thermometers, every precaution being taken to attain the greatest possible accuracy. In order to avoid error in reading due to parallax—a matter of very real difficulty on board a small ship in rough weather—the thermometer tubes were ground semicircular in section, with the bores close to the flat face upon which the graduations were marked. The readings were carried to the third place of decimals, the graduation being in 0·05°.

Only general conclusions regarding circulation in the Atlantic have yet been published; the mass of data and calculation for the application of Bjerknes' theory is in process of being worked up.

An account of the biological survey by E. Hentschel includes a chart showing the number of plankton organisms present per litre of surface water (Fig. 1).

The effect of water rising from below and bringing nutrient salts to the upper layers, where there is sufficient light for plant growth, is clearly shown along the west coast of Africa. The same effect is also shown in lower latitudes due to convection currents and unrestrained turbulent motion unchecked by a discontinuity layer.

The chemical observations by H. Wattenberg are of particular interest. The distribution of phosphates and nitrates and the relation of these nutrient salts to the density of plankton in the south Atlantic confirm and extend previous investigations in more limited areas. The distribution of dissolved oxygen was found to be regular and to reflect the circulation in the deep water, saturated cold water falling in high altitudes and filling the depths of the oceans, overlaid by water layers of less oxygen content in lower latitudes. The minimum occurs at about 200 metres in the tropics, where a relatively thin warm and light layer lies like oil on the heavier water below; mixing by convection is hindered, and the supply of oxygen is cut off from above. This minimum layer appears to be the graveyard of plankton organisms where oxygen is used up during their decay. The presence of 5 to 6 c.c. of oxygen per litre in the deep water of the oceans indicates its origin in those latitudes where the surface water is at a temperature where more oxygen is needed for saturation, and where in winter convection currents can extend deep into the sea.

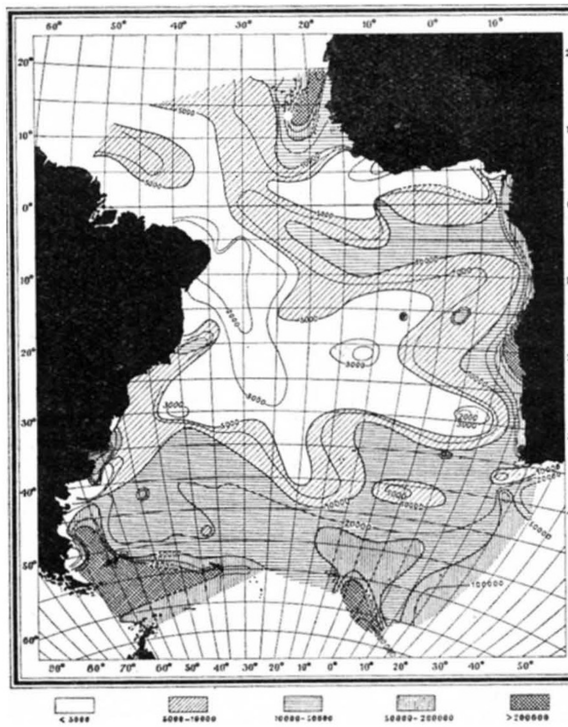

FIG. 1.—Plankton content of the surface-water of the Atlantic, showing number of organisms per litre of water. From "Verhandlung der ozeanographischen Konferenz."

The distribution of dissolved calcium carbonate in the sea is peculiar. In the upper water layers of the tropics values indicating 50 per cent over-saturation are indicated; below this the main mass of water is under-saturated; less so near the bottom, where calcium carbonate is apparently dissolving out from the calcareous skeletons of dead organisms. The actual quantity of calcium in solution, however, is considerably less in the upper layers, where it is utilised to build up the skeletons of such organisms.

[1] "Verhandlungen der ozeanographischen Konferenz veranstaltet von der Gesellschaft für Erdkunde zu Berlin anlässlich ihrer Hundertjahrfeier." Berlin, 1928.