arise from another mode of disintegration of the newly formed helium nucleus according to the relation

$$D_1^2 + D_1^2 \rightarrow He_2^4 \rightarrow He_2^3 + \text{neutron},$$

an isotope of helium of mass 3 and a neutron being expelled in opposite directions. There is strong evidence that such an isotope of helium also appears when the lithium atom of mass 6 is bombarded by protons, and from this transformation it appears that the mass of this isotope is 3·0165. It is quite likely that the helium nucleus of mass 3 formed in this way is unstable and may possibly break up into H_1^3 and a positive electron. While the conclusions outlined above are to some extent provisional and require confirmation by other methods, there can be no doubt that the effects which follow the collisions of a swift diplon with another are of much importance and interest in throwing light on possible modes of formation of some of the lighter nuclei.

It is of interest to speculate why the heavy isotope of hydrogen appears in many cases far more effective, for equal energies, in producing transformations than the lighter isotope. On the general theory of transformation proposed some years ago by Gamow, it is to be anticipated that, for equal energies of motion, the diplon on account of its heavier mass would have a smaller chance of entering a nucleus than the swifter proton. It may be, however, that normally only a small fraction of the protons which actually enter a nucleus are able to cause a veritable transformation, the others escaping unchanged from the nucleus. On this view, the greater efficiency of the diplon in causing transformation may be due to the fact that a much larger fraction of those which enter the nucleus are retained by it, leading to a violent disintegration of its structure. It may be too that the diplon on entering a nucleus breaks up into its component parts. The appearance of the proton as well as the neutron in some of the transformations may be connected with the composite structure of the diplon.

Deep Water Circulation of the Atlantic

DR. G. WÜST, oceanographer in the German research vessel *Meteor*, has recently published the first part of vol. 6 of the reports of the German Atlantic expedition*. The report is not only a description of the *Meteor*'s results, but is also a history of the investigation of the Atlantic deep waters, and gives a critical summary of all the observations that have been made from those of H.M.S. *Challenger* (1873–1876) to those of the R.R.S. *Discovery II* (1929–1931). At the end of the report is a complete list of the observations used.

Dr. Wüst has made extensive use of the principle that if the water in a deep current sinks to a lower level, its temperature will increase as the water becomes adiabatically compressed; and conversely, that if the deep current rises, the water in it is cooled owing to adiabatic expansion. Any attempt to follow the path of a deep current in a vertical section showing temperature distribution is made much more difficult by these changes. It was first suggested by Prof. Helland-Hansen that the difficulty should be removed by using vertical sections showing the distribution of potential temperature—the temperature to which the water would be cooled if it were raised adiabatically to the surface. This report is a striking tribute to the advantage of this method.

In the report there are charts showing the actual temperature, the potential temperature, and the salinity of the bottom water (at depths greater than 4,000 metres) over the whole of the Atlantic Ocean. There are also vertical sections which show the distribution of potential temperature, and salinity, along the east and west Atlantic basins, on either side of the mid-Atlantic ridge. With their help, Wüst shows that the flow of antarctic and arctic bottom waters is much more asymmetrical than it was thought to be. Antarctic bottom water flows northwards along the sea bottom, mixing with the warmer North Atlantic deep water which is flowing southwards above it. The last traces of the antarctic water reach as far as 34° N. in the east Atlantic basin and to 40° N. in the western basin. The influence of bottom water of arctic origin can only be detected north of these latitudes as a very weak current.

From the relations between potential temperature and salinity, Wüst has been able to find the percentage of antarctic water at the bottom in both basins in all latitudes. These percentages are shown by two curves. The decrease of the antarctic water along the western basin is almost regular; it is hastened in about 5° S. where the Para rise obstructs the bottom current. In the eastern basin the northward flow is stopped at the Walfish ridge, which extends transversely from the African coast to the mid-Atlantic ridge. The antarctic bottom water north of this ridge enters the basin from the west through the Romanche channel, a break in the mid-Atlantic ridge near the equator. The bottom water flowing through this channel spreads southwards to the Walfish ridge and northwards to 34° N. By means of a chart showing the distribution of potential temperature at the bottom of the Scotia Sea, based principally on the observations made by the ships of the "Discovery" Committee, Wüst has been able to show that antarctic

* *Schichtung und Zirkulation des Atlantischen Ozeans.* Lief. 1: *Das Bodenwasser und die Gliederung der Atlantischen Tiefsee.* Von Georg Wüst. (Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf den Forschungs- und Vermessungsschiff *Meteor* 1925–1927, herausgegeben im Auftrage der Notgemeinschaft der Deutschen Wissenschaft von A. Defant, Band 6, Teil 1.) Pp. 107+8 Beilagen. (Berlin und Leipzig: Walter de Gruyter und Co., 1933.) 20 gold marks.

bottom water also flows westwards into the Pacific Ocean.

It is interesting to note that the increase in temperature of the bottom water in the direction of flow can be accounted for solely by mixing with the North Atlantic deep water. No increase in temperature due to heat conducted through the earth's crust can be detected, and earlier attempts to measure the speed of the bottom current based on the assumption that the increasing temperature is the result of such conduction have been proved worthless.

The vertical distribution of potential temperature far south has changed Wüst's views on the origin of antarctic bottom water. He now believes that the coldest water is that which is cooled right through on the antarctic shelf in winter and sinks down the continental slope. This was the view held by Drygalski and Brennecke, but it could not be proved, because all the observations made in the open sea show that the bottom water is always covered with a layer of warm deep water through which the bottom water cannot be seen to sink. This warm layer is only absent from channels or basins adjacent to the antarctic continent which are cut off from the open sea by well-defined ridges rising above the level of the layer. In such basins there may be almost complete mixing from the surface to the bottom.

Wüst, in attempting to find a vertical series of observations which showed the cold water from the shelf sinking down the continental slope, has used a series (Deutschland St. 125) in such an enclosed basin, from which the water cannot sink because of a ridge. His failure to recognise this fact and the omission of the ridge makes the diagram on p. 45 misleading. He distinguishes a slightly warmer bottom water which he calls antarctic deep water; he believes it to be formed by the effect of strong cooling and formation of ice in autumn and winter on the surface water in a convergence region situated near the edge of the pack-ice between 60° and 66° S. In this theory, Wüst appears to be making a determined attempt to bring the views which he and Nansen have expressed on the formation of antarctic and arctic bottom water into accord with the known data regarding the circulation of the Weddell Sea. There is very little reason for believing that a convergence region exists; the deep water is probably bottom water which upwells in the middle of the cyclonic movement.

Wüst has shown that there is very close agreement between the distribution of antarctic bottom water and the distribution of sediments poor in calcium (particularly the red clay). North of 34°–36° N., where the streams of antarctic water die away, the bottom deposits are no longer poor in calcium. The antarctic water dissolves calcium and over each of these poor deposits it has been found to be enriched. The report shows that in such places the density of the water calculated from the usual chlorinity ratio is too low. By means of sections giving the distribution of potential density, it is shown that the density of antarctic bottom water calculated from the usual ratio is less than that of the North Atlantic deep water. This is because there is a chlorine deficit in the bottom water, or as there is some reason to believe, a chlorine excess in the North Atlantic deep water. Wüst points out that there is a pressing need of accurate physical and chemical determination of these small density differences, and of new tables and methods for the practical determination of density and salinity and the correction of densities calculated from chlorine contents. G. E. R. D.

Obituary

DR. F. A. BATHER, F.R.S.

FRANCIS ARTHUR BATHER, born in 1863, was the eldest son of the late Mr. A. H. Bather. From Winchester he gained a scholarship at New College, Oxford, where he graduated in 1886, taking first class honours in natural science. In 1887 he entered the Department of Geology in the British Museum (Natural History), where his care was chiefly the fossil echinoderms, and notably the crinoids. In 1892 he gained the Rolleston prize of the Universities of Oxford and Cambridge for research in biology. His first scientific publication of importance was on the Crinoidea of Gotland, in 1893. He was married at Stockholm in 1896; and in 1897 he was awarded the Wollaston fund of the Geological Society. On the retirement of Dr. Henry Woodward in 1902, Dr. Bather was appointed deputy-keeper, a position which he held until 1924, when he assumed the keepership vacated by Dr. (now Sir) Arthur Smith Woodward. He was elected fellow of the Royal Society in 1909; and in 1911 was awarded the Lyell medal of the Geological Society, and served as president of that body in 1926–28. He was also a member of several foreign scientific societies. Retiring from the Museum in 1928, he still visited the Department of Geology to pursue his researches on crinoids, which had been seriously interrupted by his administrative duties as deputy keeper and keeper. Though failing in health during the past year, he was active until the last; and when, after two days' illness, he passed away on March 20, the sad news came as a shock to his many friends.

Such, in bare outline, was the professional career of one whose many-sidedness was continually a surprise to those who knew him; and, of course, such a bald enumeration of facts can give no distinctive picture of the man, even as a professional palæontologist. Nor is it always easy, in considering Dr. Bather's many activities, to draw the line between his professional and other interests.