

is here indicated by the thick arrows. Two measurements were made at 1830 metres (Nos. I. and IV. in the figure), and two at 915 metres (Nos. II. and III.), and at the same time observations were made at 10 metres with another apparatus. The time by the watch is noted in the figure. The arrows in V. show the currents thus found at 10 metres after allowing for the assumed drift of the vessel, and it is seen that the variations both in velocity and in direction are large. This method is, however, uncertain so long as the currents in deep water are unknown; if these are considerable, the thick arrows in Fig. 178, V., do not give the actual currents at 10 metres, but only the relation between these currents and those in deep water. Still one thing is at least clear from the figure: the thick arrows alter their direction regularly, and the change is counter-clockwise. A continuous alteration of set is one of the characteristics of tidal currents, and the conclusion is in all probability admissible that our measurements at Station 49 C prove the existence of tidal currents in the Atlantic Ocean, even where it is very deep.

Tidal motion in the sea is due to the attraction exercised by the sun and moon on the water-masses, which varies from place to place. It would take us too far to enter into the theories of the tides here, and besides, we have not yet a clear solution of the problem, because, among other reasons, we have no observations from the open sea, but only those from the coasts. The rise and fall of the surface, known as tides, are accompanied by currents, and the study of these currents in the open sea would be of great importance for the comprehension of tidal phenomena. In the "Michael Sars" Expedition, as mentioned above, we made a number of current-measurements, the principal object being to find out if it were possible to make trustworthy observations of the velocity and direction of tidal currents in the ocean. This has not been done before in deep water. Buchanan in 1883 made some interesting measurements on the Dacia Bank, off the west coast of Morocco, and found marked tidal currents during the couple of hours the observations lasted. Afterwards R. N. Wolfenden discovered tidal currents on the Gettysburg Bank. Beyond these and a few other observations, we have no observations from the open ocean far from land and none at all in deep water.

We usually figure to ourselves the attraction of the moon and the sun producing a tidal wave which can develop freely in the Southern Ocean, where a zone of water encircles the

Tides and
tidal currents.

Buchanan.

Wolfenden.

Tidal waves.