

against pressure, and consequently it came to be generally believed that in all open seas the water below a certain depth maintained a uniform temperature of 39° F. right down to the bottom. Ross lays special emphasis on the fact mentioned by earlier observers that the temperature of the surface water falls rapidly as the depth of the sea diminishes; he cites one instance when in a single day the temperature at the surface fell from 70° F. where the depth was 400 fathoms, to 51°·5 where it was only 48 fathoms,¹ a fact now known to be of local, but not universal, occurrence, being apparently limited to windward shores.

In 1843 Aimé introduced reversible outflow thermometers to ascertain the temperature in deep water, but, although ingenious, they were not simple enough nor sufficiently handy for ordinary observations. Maury about 1851 made some observations on the temperature of the deeper waters of the sea.² For this purpose he used cylinders made of non-conducting material, discarding the ordinary thermometer with an index, as the index might move during the ascent, or in great depths the thermometer might be broken by the pressure; neither did Maury approve of Sexton's metallic thermometer with silver or platinum spiral, which was very expensive; besides, he preferred simplicity in all instruments intended for this branch of research. Commander Rodgers, of the U.S.S. "Vincennes," made a few interesting observations on deep-sea temperature in the Arctic Ocean in 1855.

FIRST USE OF
PROTECTED BULB.

MILLER-CASELLA,
NEGRETTI AND
ZAMBRA.

VIEWS AS TO
TEMPERATURE OF
DEEP SEA AND
OCEAN CIRCULA-
TION.

The first self-registering thermometer with bulb protected from pressure was made use of by Captain Pullen in 1857, on board H.M.S. "Cyclops." Shortly after this time protected thermometers of the Six pattern (Miller-Casella),³ and Negretti and Zambra's protected inverting thermometers, were introduced and improved in various ways. These thermometers were employed during the "Porcupine" and Challenger expeditions, and are now universally used in deep-sea investigations with excellent results.

Péron, a French naturalist, who went round the world about 1805, and made many temperature observations, held that the bottom of the sea was covered with eternal ice, consequently life was there impossible. Sir James Clark Ross, as we have said, believed the temperature of the deeper water of the ocean to be 39° F., a belief shared by many of his successors, apparently because it was thought that this was the temperature of maximum density, as in fresh water, although Despretz and others had previously shown that the maximum density point of sea-water and of salt solutions might be below zero Centigrade. This view as to the temperature of deep water was supported by Leonardo da Vinci, Lenz, Arago, and Humboldt, who maintained that circulation was produced in the ocean by the heated and lighter water of the equator flowing to the poles over the surface, while the colder and denser waters of the poles sank and flowed along the bed of

¹ J. C. Ross, *A Voyage of Discovery and Research in the Southern and Antarctic Regions during the years 1839-43*, London, 1847.

² See Lee, *Cruise of the Dolphin*, Washington 1854.

³ See Thomson, *Depths of the Sea*, p. 289, London, 1874.