at this depth the seasons were reversed: it was "winter" in the water in the middle of the summer, and "summer" in the middle of the winter. Murray's observations in Upper Loch Fyne in 1888 gave similar results. At 300 metres at the "Michael Sars" Station there were hardly any variations at all, the temperature being very much the same as the mean annual temperature of the air, as Nordgaard has shown to be the case with regard to the bottom-water of the Norwegian fjords.

Vertical circulation of ocean waters.

When sea-water is cooled its density increases, and it often happens in winter that the surface-water becomes heavier than the water below. The surface-layer then sinks, and the underlying water comes to the surface. By this vertical circulation the conditions are equalised, so that exactly the same salinities and temperatures are found as far down as the vertical circulation extends; wind and current aid in the process. This takes place especially from January to March; in April the weather again becomes warmer and the temperature begins to rise at the surface. A very good example of this phenomenon is afforded by the "Michael Sars" observations taken to the westward of Plymouth in April 1910; at the very surface the temperature had risen slightly, but otherwise practically the same salinities and temperatures prevailed at every station down to a depth of 150 metres or more. Later on in spring the surface temperature gradually rises, and a marked discontinuity-layer is formed. In many places near the coast, where the salinity is low at the surface and high beneath the surface, a brisk vertical circulation cannot be set up; the comparatively fresh water on top is so light that, even when considerably cooled, it does not change places with the salt and heavy water below. But farther out to sea the vertical circulation may extend down to a depth of 200–300 metres or more.

Effect of heat given off by the sea.

It is thus not only the surface-water that may give off heat to the air, but a great body of water extending to several hundred metres in depth, and hence the great influence of the sea on winter climates. The capacity for heat of water is very great compared with that of the air. Supposing that we have 1 cubic metre of water giving off enough heat to the air to lower the temperature of the water one degree, this heat would be sufficient to raise the temperature of more than 3000 cubic metres of air by one degree. An example will show the importance of this. Suppose a body of water, 700,000 square kilometres in extent and 200 metres deep, to give off enough heat to the air in winter to lower the water-temperature one