of the variations in north-eastward penetration of relatively saline water along the eastern margin of the ocean. Shallow tongues of northern and southern water are traced on numerous charts, the region being broken up into six subdivisions. As far as possible the observations from different years in each area are considered in relationship to the periodicity of the transgressions of Atlantic water.

Such a thorough exposition of the evidence for periodicity in the sea is undoubtedly of major importance, because this is a phase of the circulation problem which has not yet received much attention. Not only is this question of commercial importance from the standpoint of the fisheries, but also it should be seriously considered in relationship to our present understanding of ocean currents. The obvious criticism which will be applied to Le Danois's work is that he has failed to take into account the structure of the ocean which results from the effect of the earth's rotation on water arranged in stable layers. In other words, we now know that the day is long past when currents can be successfully studied by means of surface observations alone. In the eastern North Atlantic especially, the wind must play an all-important part in the superficial movements and these frequently differ in direction from the deeper lines of flow. However, in spite of the fact that these important aspects of the problem have been neglected by the author, he has put forward a fresh point of view which, at least in part, can be incorporated without serious difficulty into the modern accepted theory of ocean circulation. *C. I.*

A. Defant und **O. v. Schubert.** "Strommessungen und ozeanographische Serienbeobachtungen der 4-Länderunternehmung im Kattegat 10.—17. August 1931." Veröff. Inst. Meereskunde. N. F., Reihe A, H. 25. Berlin, 1934.

These two memoirs are concerned with the analysis and discussion of the observations taken in the southern part of the Kattegat during August 1931, according to a programme arranged by the Conseil International pour l'Exploration de la Mer. Five ships, viz. two German ("Hunte", "Poseidon"), one Danish ("Japetus Steenstrup"), one. Swedish ("Skagerak") and one Finnish ("Nautilus"), took regular observations at frequent intervals from positions at anchor, and special observations were also taken at certain Danish and Swedish lightvessels and coastal stations. This is the first occasion on which so many ships have worked simultaneously in so small a region.

The objects of study were the interchange of water between the North Sea and the Baltic, the mixing of the different kinds of water, and the phenomenon of internal waves. The observations were all good and without serious gaps, but they were made with dissimilar instruments and their interpretation is not always free from uncertainty. The work of analysis under review was carried out at the Institut für Meereskunde, Berlin. It shows that the region is one of great mixing and that it is not well adapted for a first study of some of the questions at issue. It has proved impossible to separate errors of observations from irregular oscillations and turbulent motions.

The first memoir is by A. Defant and is on the observation of currents and surface-levels. The observations taken on the "Hunte" are first considered separately and then all the other observations bearing on each topic are considered together. The oscillations in the direction of the "Hunte" itself are examined, but it is assumed that they have little influence on the

readings of the current-meters. These readings were taken at every five metres down to the bottom, which is at a depth of about 30 m. At each depth the chief tidal constituents and the residual current are isolated. For the variations of the residual current at the "Hunte", the wind is regarded as an important factor. Except near the level of the maximum density-gradient the vertical distribution of residual current is very similar to the theoretical distribution of Ekman for a landlocked sea. The residual current, however, shows great changes from ship to ship. The vertical distribution of semidiurnal tidal current shows rapid changes near the level of maximum density-gradient, and the phase becomes progressively earlier as the bottom is approached. The mean distribution for all ships is used to determine the magnitude of the internal waves (in phase with the surface elevation but 100 times as great), and an effective coefficient of turbulent viscosity ($\nu = 100$ cm.^{2}/sec.). The mean tidal current between surface and bottom shows good agreement from ship to ship. It is this mean which is associated with the oscillation of the surface, and the latter part of Defant's memoir is concerned with these ordinary tides. Co-tidal and co-range lines are drawn for the M_2 constituent over the whole of the Kattegat and then a satisfactory dynamical explanation of this constituent is given by the method for narrow seas which is now familiar.

The second memoir is by O. v. Schubert and is mainly on the observations of salinity and temperature, of which there were well over 20,000. The meteorological situation, however, is first considered and the non-tidal changes in the surface-elevation are attributed chiefly to the action of wind. The currents through the Great Belt and the Sound are studied, both from surface elevations and from meter observations, and it is shown that though the direction of these currents changed from time to time, it practically never changed between surface and bottom at the same time. The calculations of large scale water-movements appear to be quite satisfactory, but the current observations taken at the individual ships are so different one from another, as to indicate a very complicated circulation system. The changes of salinity and temperature, both with position and with time, are very great and the vertical distributions of the two elements show different structures. The S-T diagram indicates the presence of water of three different kinds, one near the bottom from the North Sea, one near the surface from the Baltic and a third in the intermediate layers, which is not a simple mixture of the other two. Non-periodic changes are separated from periodic changes and both are studied in great detail. The diurnal oscillations have the same order of magnitude as the semidiurnal oscillations, but the only oscillation not attributed to tidal causes is the diurnal oscillation of temperature near the surface. The maximum amplitudes of the semidiurnal oscillations of salinity reach the value 0.88 $^0/_{00}$ and those of temperature the value 0.41° C., but the two do not occur at the same depths. The phases of these semidiurnal oscillations become earlier with increasing depth, and in fact, the phases at 30 m. are, on the whole, 6 hours earlier than those at 15 m., the change being gradual. Both for non-periodic and periodic changes, vertical circulation systems are postulated, in which there are opposite circulations in the upper and lower layers, as it is concluded that these changes cannot be directly attributed to horizontal oscillations of masses of water.

The diurnal oscillation of surface temperature is found to have a mean amplitude of 0.29° C. with its minimum at 7 hr. and its maximum at 15 hr.

J. P.