the westward of the Cape Verde Islands; a slight seasonal variation of the anticyclonic eddy which constricts the Antilles Current before its junction with the Florida Current; the line of convergence of the polar front situated a little further north in summer than in winter and remaining clear to roughly between 40° and 35° west longitude; and cyclonic eddies on the south-east and south sides of the Great Banks subject to greater variations in winter, smaller in summer, the existence of the latter being only a certainty from March to October.

Like the wind, the current is more regular in summer than in winter and has fewer eddies.

With regard to the Gulf Stream, an examination of the component of the current due to the wind (pure impulsion current) shows clearly that this component, which apparently acts towards the south, then to the south-east and east, is dominated by the component of the slope current acting towards the north. Only in the narrow band between longitudes 70° and 50° do the directions of the two components coincide. It follows that the Gulf Stream is certainly rather a gradient current than a current due to the wind.

The ramifications of the Gulf Stream running towards the French and Spanish coasts are week and irregular; starting from about the 20th meridian, they flow east- and south-eastwards.

A great line of sub-tropical convergence crosses the Atlantic; it undergoes a few seasonal variations, shown on a special plate.

The Canaries Current north of the parallel of 28°, which is particularly stable, appears in spring and winter to be at the same time a drift current (due to the trade winds) and a compensation current; while in summer and autumn it is entirely a drift current.

P. V.

STROMMESSUNGEN UND OZEANOGRAPHISCHE SERIEN-BEOBACHTUNGEN DER 4-LÄNDER-UNTERNEHMUNG IM KATTEGAT : 10-17 AUGUST 1931.

(CURRENT MEASUREMENTS AND OCEANOGRAPHICAL OBSERVATIONS OF THE COMBINED OPERATION OF FOUR COUNTRIES IN THE KATTEGAT : 10th-17th AUGUST 1931).

by

A. DEFANT and O. v. SHUBERT.

Berlin, E. S. MITTLER und Sohn, 27 × 18 cm. - 144 pp. - 1 pl. - 74 fig.

This book contains the results of the current measurements and oceanographical observations carried out in the Kattegat in August 1931 by five ships belonging to four countries: Germany (2), Denmark, Finland and Sweden. The observations have been published in full in the Hydrographic Bulletin of the International Council for the Exploration of the Sea, Copenhagen, and the methods of measurement and apparatus used will be found described in that Bulletin. (1)

The region concerned in the observations is the southern part of the Kattegat off the entrance to the Sound.

This very interesting collaboration was noteworthy for the high level of its scientific conception and for the learned utilisation of the observations by highly qualified technicians. The phenomena studied, although somewhat complicated in that district, nevertheless lend themselves to the most interesting verifications of various dynamical theories; and in spite of the limited extent of the region investigated it is possible to affirm once again how little data is available, compared with the complexity of the phenomena.

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(1) *See also* Die Hochseepegelbeobachtungen im südlichen Kattegat im August 1931 *by Dr. H. Rauschelbach ; Hamburg,* Annalen der Hydrographie 1934, *pp.* 177 *and* 233.

In the first part of the book Professor A. DEFANT examines the results of the current measurements at various depths, distinguishing between the influence of tide and wind on their strength and direction. The current due to the wind at various depths on the same vertical showed a striking degree of agreement with EKMAN'S theory.

During the same period two lightships were also taking current measurements in the Sound and the Belt. The residual current which is not due to the tide (*Reststrom*) was at all depths making northward in the Sound and southward in the Belt — an important fact emerging from the study in question.

The influence of the *semi-diurnal* tide on the current was practically the same in the case of all five ships as far as direction, phase and greatest speed were concerned, with a clockwise direction of rotation. In the Sound and the Belt, the direction of the semi-diurnal tidal stream is naturally that of the channel, with a greatest intensity in the Great Belt; which proves that it is through this strait that the tidal energy of the Kattegat is transmitted to the mass of the Baltic water.

Having shown the distribution of the current at the various depths and determined the coefficient of friction, the author examines the weaker and more obscure action of the diurnal wave, and analyses the variations in the sea level. The latter was observed every hour by the five ships; the *Poseidon* made observations also with the RAUSCHELBACH Recording Tide Gauge. The variations of level are clearly due to the tide, with a few slight modifications due to long-phase non-periodic oscillations.

The amplitude of the semi-diurnal tide was about 18 cm. (0.59 ft.), that of the diurnal tide 3 cm. (0.10 ft.), during the period of the observations. The author was able to produce a chart of the phases and amplitudes of the M_2 wave in the Kattegat, which is practically the same as that which had already been drawn up by R. WITTING. He compares his results with the tide and the tidal stream which may be expected, on theoretical grounds, in a narrow and comparatively shallow channel, and explains the divergences in matters of detail by the influence of the local configuration and by the action of the rotation of the earth.

In the second part, Dr. O. v. SHUBERT studies the results of the oceanographical observations. He reviews the meteorological conditions, the mean level during a lunation, and the effect on this level of the wind and atmospheric pressure. It is chiefly the wind action that makes it possible to explain the variations. In the Kattegat it was possible to establish the existence of a slope rising from north and south towards the middle.

The author determines the mean components of the current in the Belt and the Sound for this lunation and at various depths; he gives also the mean velocities of the water, and the volume transported in 25 hours, for the Belt, the Sound and the Kattegat. He concludes that the current measurements taken, while they allow the tidal streams to be clearly determined, do not give a thorough insight into the complicated field of the residual current (*Reststrom*).

The remainder of this study is devoted to the composition of the masses of water and the periodic or non-periodic variations in their salinity and temperature. Large unexpected differences are found in the temperatures and salinities at single points from hour to hour, and also between points distant by few miles. They are evidently due to turbulence of the complicated field of the currents, but cannot easily be deduced from it.

In contradistinction to what goes on in the ocean, the changes of salinity and temperature are nearly always opposed to one another so that their effects on the density cancel out. As far as the periodic oscillations of these elements are concerned, those of the salinity show a distinct maximum between 15 and 20 cm. (0.49 and 0.66 ft.) while they are very slight at great depths; those of the temperature are weak down to about 18 cm. (0.59 ft.) and stronger but very irregular from there to the bottom. It seems possible to explain some of these results theoretically by the principles of double circulation, by V. BJERKNES' theory of unstable interior waves, and by friction on the bottom.

The topmost layer, under the influence of solar radiation, is discussed explicitly for its daily variations and other periodical oscillations of temperature and salinity.

Down to a depth of 5 metres (16.4 ft.) the daily variation of the temperature is remarkably well in agreement with the numerous perturbations. The tidal currents modify the conditions somewhat and, among other things, retard the minimum by about three hours.

The salinity of the topmost layer is influenced rather by the tidal stream and is subject to a diurnal oscillation.

P. V.