ON THE EXISTENCE OF A SUB-SURFACE TIDE IN THE WESTERN MEDITERRANEAN.

by

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Experimental hydrodynamics readily make it clear that in a liquid mass formed of superimposed layers of different densities, an undulatory movement produced at the surface does not retain its characteristics when it is transmitted to the lower strata. If the density between the top layer and the lower is 0.03, the amplitude of an oscillation produced at the surface becomes thirty times larger when it is transmitted to the boundary surface of the lower layer. This theory provides a possible explanation of the phenomenon of "dead water" sometimes observed by navigators in polar seas, particularly by NANSEN on board the *Fram*. SANDSTRÖM has also shown experimentally that the action of wind on the surface water can result in internal waves of great height or in the formation of submarine seiches analogous to the well-known superficial seiches.

In the open sea, apart from these short-period undulatory movements (free waves, waves of "dead water" and sub-surface seiches), vertical displacements of the deep levels, of a more complicated type and longer period, have been recognised. Since 1908, PETTERSSON, while methodically studying the salinity of the water of the Gullmarfjord, on the west coast of Sweden, has shown the existence of internal waves whose period exactly follows the variation of lunar declination. In 1909, HELLAND-HANSEN and NANSEN showed the presence of vertical oscillations in various parts of the North-East Atlantic, attaining an amplitude of 200 metres and of a diurnal and semi-diurnal period. In 1927, after the *Meteor* Expedition, DEFANT confirmed the existence of internal tides in mid-ocean and found that the semi-diurnal tide wave is accompanied by free waves of very short period (about two hours only).

M. Martin NAVARRO, using the methodical observations made with a submarine thermograph by the Oceanographical Museum of Monaco and by the Oceanographic Laboratory of the Balearic Islands, has drawn up a comparative table of the thermal conditions existing in the Western Mediterranean at Palma and at Monaco, by plotting on graphs the temperature found at the surface and at depths of 25, 50, 75, and 100 metres during the various months of the year. The apparatus used was a light-weight compact IDRAC submarine recording thermograph, with a two-storied metal spiral system which is very sensitive and which very rapidly takes up a position of thermal equilibrium. This apparatus enables temperature records to be collected and to be compared on the graph with the phases of the moon and the astronomical coefficient of the tide. The graphs show a very distinct synchronism between the crests of the curves and the moon's meridian passages. On the graphs can be seen the principal half-daily wave accompanied by free waves of short duration. These phenomena would tend to prove by thermodynamics the existence of a tide wave in the western Mediterranean, where in certain cases, for example round about the equinox, the vertical displacement of the internal waters could be estimated to have an amplitude of some fifty metres. This new aspect of oceanography seems to impose a profound change on our method of working.

INTERNE GEZEITEN-WELLEN.

(INTERNAL TIDES).

by

O. PETTERSSON.

(*Rapports et Procès-verbaux des Réunions* of the *Conseil Permanent International pour l'Exploration de la Mer*, Vol. LXXXII, 26 pp. + 8-p. summary in English. Copenhagen, 1933 : Price, Kr. 1.75).

In a note presented to the ACADÉMIE DES SCIENCES of Paris on 30th January 1933, the distinguished Danish oceanographer O. PETTERSSON draws attention to a hiatus in the