Submarine Measurements of Gravity.

RECENT years have witnessed great advances in our knowledge of the gravitational field near the earth's surface on land, but in spite of many efforts the extension of these determinations to oceanic regions has until quite lately proved a very intractable problem. It would now seem that substantial success has at last been achieved, as the result of trials of a specially designed apparatus and method during a voyage of a submarine from Holland to Java in 1923. The apparatus used is a development of one which was devised to overcome difficulties experienced in ordinary pendulum determinations in Holland, where the unusual mobility of the soil had made it impracticable to eliminate slight movements of the supports. These motions were rendered innocuous by suspending from the same plate several pendulums, having very nearly equal periods of vibration, and causing them to vibrate in different phases. The success of this device led to its trial at sea also, on a steamer of 1200 tons, but the weather was bad and the pitching and rolling of the vessel spoilt the attempt. Prof. van Iterson, Director of the Netherlands State Mines, then suggested that these disturbances might perhaps be avoided, or sufficiently reduced, by making observations on a submerged submarine instead of on a floating vessel. Preliminary trials confirmed the value of this proposal and arrangements were then made for a more exhaustive test.

Dr. Vening Meinesz, who was responsible for the investigation, has recently published a provisional account of the work.[1] The apparatus (made by Stüchrath) consisted of two pairs of pendulums suspended from the same plate, oscillating in opposite phases, two by two in planes at right angles. Their oscillations were recorded photographically. The pendulums were of brass, which led to difficulties in connexion with their large temperature corrections, since the temperature in a submerged submarine quickly rises; invar pendulums could not be used because of their susceptibility to magnetic fields, which are scarcely avoidable in a submarine. Dr. Meinesz suggests that errors arising from this source should be reduced in future experiments, either by the use of quartz pendulums, or by shielding the instrument from changes of temperature. The apparatus was mounted on a large wooden stand, which was not so firmly fixed as not to require watchful guard against shocks. It was placed as near to the metacentre of the submarine as possible.

Successful experiments were made in the Mediterranean and in the Indian Ocean. The pendulums were swung for periods of fifteen to twenty minutes, but rather longer periods, up to thirty or forty minutes, are recommended in future work. The various sources of error are discussed by Dr. Meinesz, who concludes that the mean error of a determination of the time of oscillation of a pair of pendulums in calm weather was 2 to 3 units of 10^{-7} second, and in rough weather, with the submarine at a depth of 20 or 30 metres, about 10×10^{-7} second.

This work by Dr. Meinesz was recently described by Colonel Lyons at a Geophysical Meeting of the Royal Astronomical Society, and it was urged that similar work should be carried out by other countries. Sir Gerald Lenox Conyngham discussed the results obtained (in Dr. Meinesz's provisional report this is not done, nor is any chart or topographical description of the observation points given, except latitude, longitude, and the depth of the ocean). The observed values of gravity far out at sea differ sufficiently little from the computed normal values to indicate that there must be isostatic compensation. Near land the compensation seems to be less complete, and it was stated that Dr. Meinesz infers a greater extension of the compensating layer below the mainland than is required by the theory of isostasy.

[1] "Observations de Pendule sur la Mer pendant un Voyage en sous-marin de Hollande à Java, 1923." Publication Provisoire par Dr. F. A. V. Meinesz.

Factors influencing Growth in Trees and Plants.

THE Carnegie Institution of Washington has recently published the results of a further very interesting series of investigations on growth in trees and massive organs of plants.[1] Prof. D. T. MacDougal's dendrographic measurements provide considerable additional information on the behaviour of tree-trunks. The investigations, which were conducted chiefly on conifers, but also on broad-leaved species, cover the duration of the growing season, seasonal activity, the increase of wood and of roots, the path and rate of movement of liquids in stems and the general use of the dendrometer for measuring the yearly increase in the circumference of stems. In addition, auxographic records are obtained of the growth of Opuntia stems and flowers, Mesembryanthemum leaves, potato tubers, and the fruits of Cucurbita. The experiments were conducted principally on plants grown in the open and under the full influence of their habitual environment so that the normal activity of the plants was not disturbed. Amongst the interesting conclusions to which Prof. MacDougal directs attention in his summary the following may be noticed.

In the investigations on the Monterey pine (*Pinus radiata*), it is observed that the duration of seasonal growth is longest in young trees, whilst wide differences are exhibited by older trees. The thickness of the woody layer shows a general correlation to the length of the growing season but no constant relation to the total amount of rainfall; it is more likely to be due to the favourable conjunction of a number of factors in which seasonal relative humidity may be an important agent. The flow of solutions, as shown by the use of dyes, is found to be much greater late in the season than in the stage of rapid growth, and confirmation is obtained that the sap travels chiefly in the wood of the two previous years. Several other interesting associations of facts in connexion with the movement of liquids and variation in girth of stem are also recorded.

In general, it is found that practically all organs or members tested with the dendrograph show daily equalising variations in size and volume in direct relation to their water-balance, and that these daily equalising variations are characteristic of each species. Further, the results of these investigations show that the amplitude of the daily variation is not dependent upon the softness of the wood and the character of the bark.

The development of potato tubers, as recorded by auxographic apparatus, shows that the period of enlargement may be estimated at 90 to 100 days, and that their behaviour is comparable to that of nuts and fruits.

The second part of the bulletin contains Dr. Forrest Shreve's records on the growth of trees. A series of

[1] "Growth in Trees and Massive Organs of Plants. Dendrographic Measurements," by D. T. MacDougal "The Growth Record in Trees," by Forrest Shreve. (Publication 350.) Pp. 116. (Washington: Carnegie Institution, 1924.) 1.50 dollars.