The Snellius Expedition.

By

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In Volume V, No. 3, 1930, of this Journal, Professor VAN EVERDINGEN has already given some extracts from the reports of the Expedition to inform the readers of the "Journal" about the work carried out by the Snellius Expedition in the Dutch East Indies during the first and second cruise. Now that the last cruise is finished and more preliminary results are known this communication may be concluded.

In mid-August we left Surabaia for the last time and investigated in succession the Banda Sea, the southern part of the Molucca Sea, the Halmahera Sea and the Ceram Sea. After having made additional oceanographic observations in the Savu Sea, we investigated once more the adjacent region of the Indian Ocean in order to be better informed about the configuration of the sea-bottom and the connection between the deep Java and Timor Trench. Herewith our task in the Archipelago has been accomplished.

It was possible to carry out the oceanographic investigations approximately according to the programme that had been fixed by me beforehand. This is largely due to the valuable co-operation of the personnel of the Royal Navy. On the annexed chart 1 the whole track of the ship has been indicated with the various stations where serial observations or wire soundings have been carried out (black dots among which the larger ones indicate the anchor stations). As the depth of the entrances to the various basins determines the properties of the sea water within, these entrances have been sounded more thoroughly. In connection with the scale and the distinctness of the chart, however, these parts of the track have not been drawn.

During 16 months a distance of about 33,700 sea miles has been covered. On this track 32,450 echo soundings have been made and plotted, after

corrections, on large-scale depth charts. It appears from these observations that the configuration of the sea bottom was in several places in the field of research more complicated than had been known hitherto and

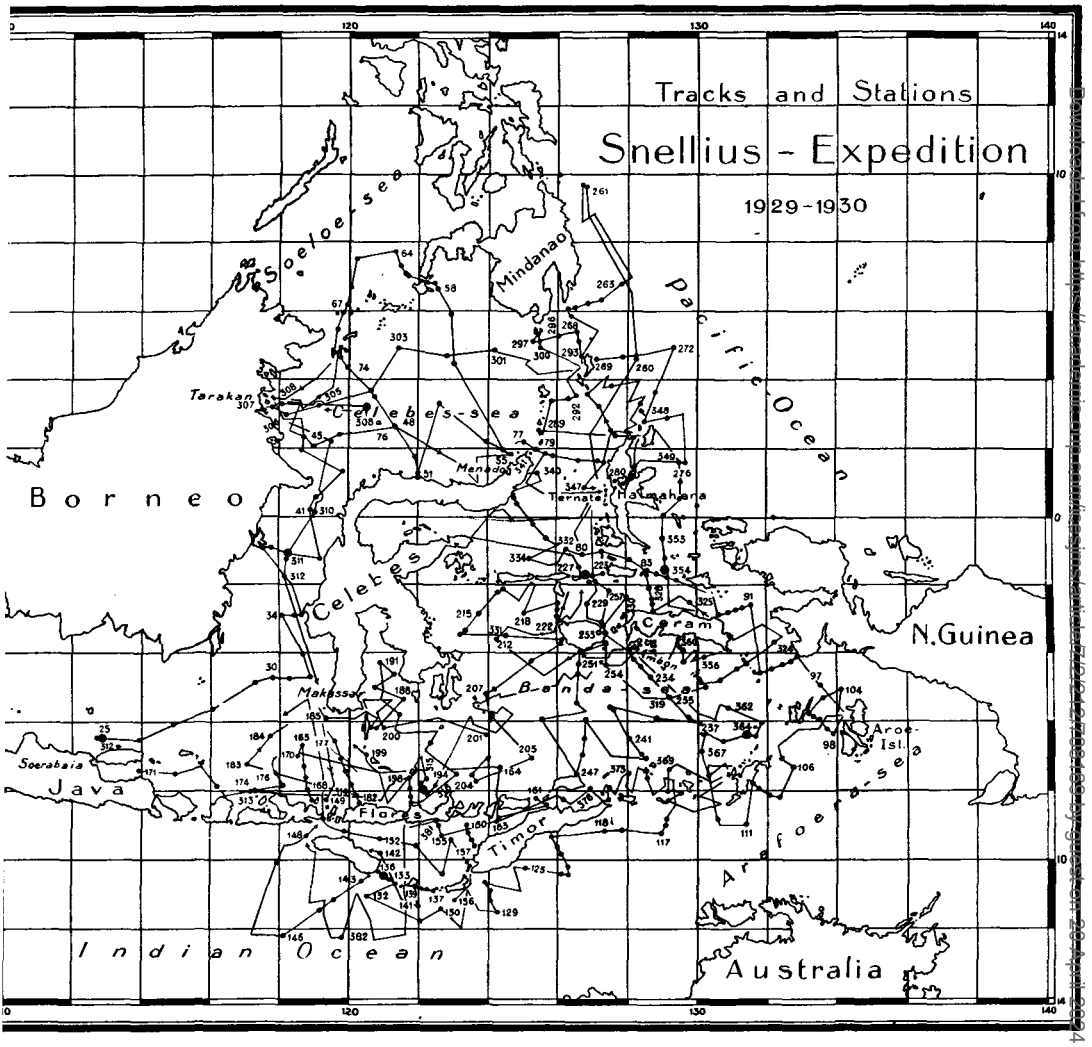

Chart 1. Tracks and Stations of the Snellius Expedition.

that the new depth chart will differ sensibly from the existing one. Especially in the Banda and the Ceram Sea important ridges have been found of which there was no previous indication.

When under way, approximately 2,000 samples of surface water have been collected and salinity and temperature determinations made. The

temperature of the surface, moreover, has been continually registered by a resistance thermometer, fitted outside the hull of the ship.

By means of serial observations at 373 stations the temperature has been measured between surface and bottom at approximately 8,000 points and at the same time an equal number of water samples from these levels has been collected and examined in the ship's laboratory. Including sur-

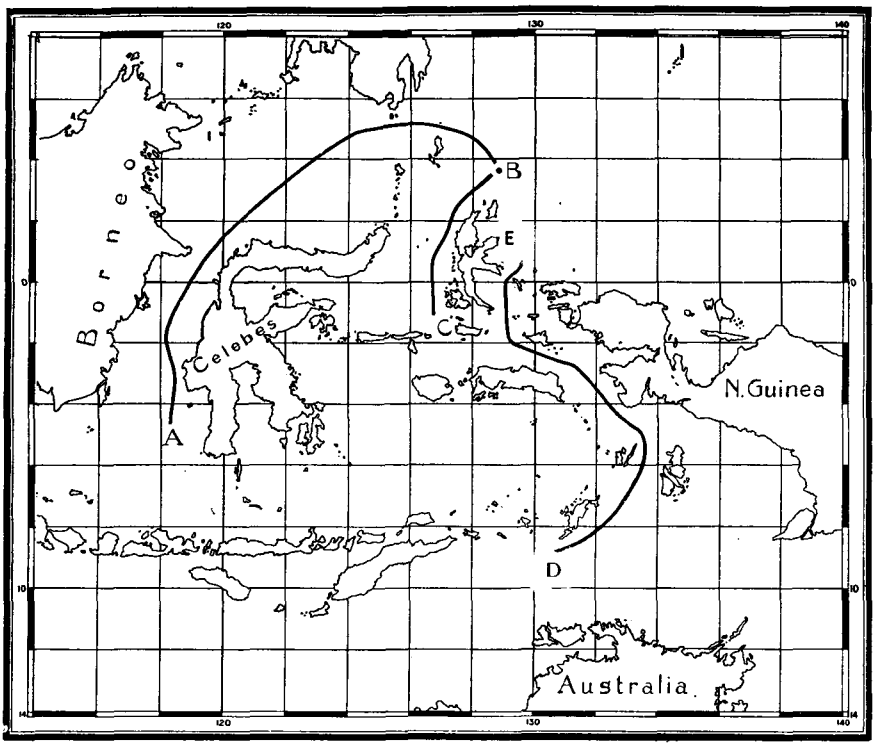

Chart 2. Lines along which the three vertical sections of fig. 1 have been plotted.

face samples, 10,000 and 5,000 samples have been titrated for salinity and oxygen respectively. The number of other chemical determinations amounts to nearly 7,000 (p_H, alkalinity, phosphates and H_2S).

At eight stations we anchored in the inland seas at great depths down to a maximum of 5,000 m., and on the sills between the deep basins, principally in order to obtain current observations (deepest layers 3,000 m.). Moreover, serial observations at the anchor stations have been repeated in the upper strata during more than 24 hours in order to study from temperature, salinity and oxygen curves the fluctuations caused by internal disturbances.

Plankton samples have been collected from the surface and also from deeper layers at nearly every station and under way between the stations.

A great number of coral samples and animals has been collected from the reefs and the beaches.

The wire soundings produced 282 bottom samples, the maximum length of which amounted to 206 cm. The greatest depth from which a sample has been obtained is more than 10,000 m. (Mindanao Trench, 9°40′ N. Lat.).

The ordinary meteorological observations have been made and, in addition to these, observations of humidity and the sun's radiation.

Owing to the zeal of the naval personnel the correction and the plotting of the large number of soundings on large scale charts has been done for the most part on board during the cruise. These charts are now being used in the preparation of a new depth chart on a scale of 1:2.5 millions (mercator projection) of the region between lat. 10° N. and 13° S. and long. 115° and 135° E. The working up of the oceanographic, geological and biological material will occupy several years.

To the preliminary results which have already been published in volume V, we may add some interesting facts about which nothing was known till now. One of the questions to which much attention has been paid during the Snellius Expedition is the interchange of water between the inland seas and both oceans. As far as concerns the Pacific Ocean a short communication will be given below, based on the salinity distribution in three vertical sections, along which the interchange of water with the Pacific Ocean is possible (chart 2, lines A B, C B and D E.)

The Pacific water contains a layer of high salinity between 100 and 200 m., which is characteristic of the equatorial current. This current runs along the north coast of New Guinea to the west. East of the island of Halmahera we observed a maximum salinity of about 35.4 $^0/_{00}$ in 150 m. (station 335). According to the salinity distribution at 14 stations between the surface and a depth of 1,000 m. the isobaths of 34.5—34.9 $^0/_{00}$ have been drawn along the vertical section D E.

For the vertical sections A B and C B the observations of 17 and 6 stations have been used. From this salinity distribution some information concerning the water transport may be deduced.

Obviously the salty water of the equatorial current, running north of New Guinea, between 100 and 200 m. (see chart 1), turns, east of Halmahera, to the left, enters the Halmahera sea and runs through the Ceram sea to the east and south-east. The salinity gradually decreases but the influence of this current is felt at a distance of more than 1000 km. from

the Pacific between the Aroe and Kei Islands, where Pacific and Indian Ocean water of low salinity meet.

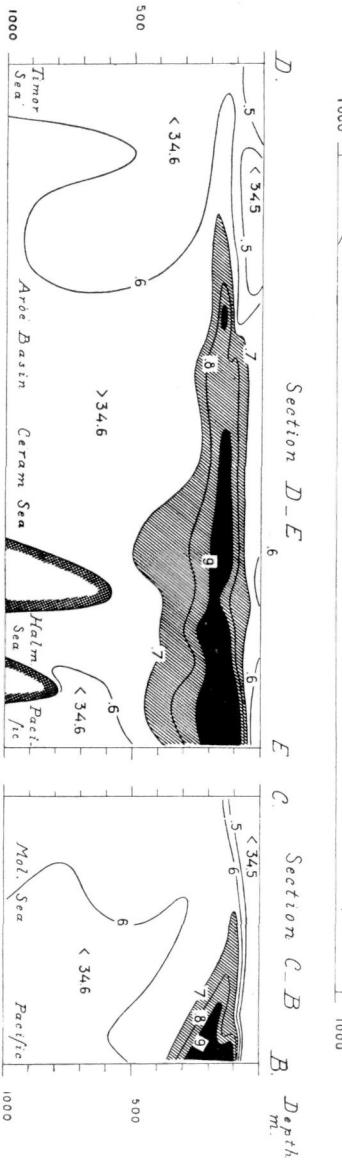

Fig. 1. Salinity distribution in three vertical sections, along which the interchange of water with the Pacific Ocean is possible.

A second important branch enters the Archipelago through the strait between the Talaud Islands and Mindanao (Section A B). In consequence we observed in the middle of the Celebes Sea in August a maximum salinity of more than 35.0 $^{0}/_{00}$ at 150 m., which decreases gradually to the

borders of this basin. Its influence is even felt in Makassar Strait between Borneo and Celebes.

The transport of salty water at 150 m. through the entrance between the Talaud Islands and Halmahera is of less importance (Section C B). Its influence does not reach farther than lat. 1° N. This is rather remarkable as we are concerned here with the widest entrance to the Archipelago. Nevertheless this passage remains very important, owing to the fact that the deepest sill, about 2,500 m., has been found here over which Pacific water may enter. And this depth determines, as already mentioned above, the properties of the water in the bottom layers of the deep basins.

The three sections show the great influence of the Pacific water on the tropospheric water masses of the Archipelago. The horizontal distribution of oxygen at 150 m. points to the same facts.

The serial observations below the level of minimum temperature showed interesting results, especially those in the Philippine Trench, east of Mindanao, where a minimum temperature has been observed at 3,500 m. instead of 5,000 m. as has been supposed hitherto. Obviously this trench forms part of a basin, separated from the open ocean by a ridge at a depth of less than 3,500 m. (the Bonin Ridge?).

In most layers below the level of minimum temperature of this trench and the inland seas stability calculations point to stable conditions, although the coefficient 10^8 E was so small that a slight alteration in salinity of a certain layer of about 0.02 $^0/_{00}$, which could be explained by inaccurate titrations, turned the scale for the corresponding layer to the other side.

That the renewal of the bottom water in deep basins with shallow sills is inadequate is betrayed by the values of oxygen content. This is for instance the case in the Sulu Sea, where the percentage of oxygen is far less than in the adjacent Celebes Sea, in consequence of the shallow sills at the entrances.

The renewal may be so bad that no oxygen is present in the deepest layers. This has been observed in the Kaoe Bay on the north-east coast of Halmahera. This bay has a maximum depth of about 500 m. and an entrance of not more than 50 m. deep. The unpleasant smell of the first bottom-sample hauled up betrayed at once the want of oxygen. The amount of oxygen appeared to be far less in the bay than outside the sill in the Pacific at the same level; the amount decreased rapidly with the depth and below the depth of 400 m. small amounts of H_2S have been observed instead of oxygen.