

organisms, will explain a flat floor, without bringing in the action of the sea at considerable depths. In a subsiding peak with a barrier reef, there cannot be sufficient wave-action to level a large lagoon. In a bank rising by growth, why should it become level over its whole surface?

A further point remains. Can coral settling on a bank, 30 fathoms or so beneath the surface, form an atoll? Mr. Darwin limits this possibility to "some fathoms submerged," and considers that "it is an assumption without any evidence that at a depth at which the waves do not break, the coral grows more vigorously on the edges of a bank than on its central part."

I think that the experience of the years since Mr. Darwin wrote that, has given us evidence that this is not an unwarrantable assumption.

The instances of shallow narrow rims, or of isolated patches of coral on the edges of such banks, are now innumerable.

It is so well recognised that the edge of such a bank is the place to expect shoal patches, that in carrying out hydrographic surveys in coral regions it is the edge that is most minutely searched. On such edges are found evidence of coral colonies in every stage; complete ridges, broken ridges, and mere patches here and there.

Always, where means have permitted, is evidence brought up that such colonies are alive. There may be dead rims, but they are the exception.

The fact of a current, whether tidal, or otherwise induced, being accelerated on meeting a submarine bank is, I think, sufficient to account for this. The water pours over the edge of the bank, and brings abundance of food to those corals which settle on it, to the disadvantage of those settling further in.

The phenomena of coral patches and ridges on the edge of these submerged banks is so frequent, that I know not how they can be otherwise explained. The great Seychelles Bank is lined all round its edge, so far as examined, with such coral ridges and patches. The small islands, in this case of primary rock, in the centre of this bank are lined with fringing reefs; and if the whole bank, 150 miles in length, has uniformly sunk, they must have sunk too, and the fringing reefs would be beneath the surface.

Given these edgings of vigorous living coral on submerged banks, of which I consider we have indisputable proof, they will certainly grow to the surface and form the complete atoll. In the earlier stages calcareous organisms of all kinds will settle all over the bank, giving it a coating more or less thick according to circumstances.

The only other point that need be mentioned is the steep slope that characterises some atolls. As to this, I believe that masses with irregular projections like broken coral, falling down in water, will entangle themselves, and lie at a steepness of slope unknown in similar falls on mountain sides, and though the aid of subsidence may be needed for the almost vertical walls which occasionally occur, that the slopes of most atolls can be explained without it.

There seems no necessity to call in the aid of Murray's theory of deepening and widening of the lagoon by solution, but I am not contending that it may not so act. What I am concerned to show is that without it, and without subsidence, deep and large atolls may be formed, and that we have abundant evidence of atolls so forming.

I am not arguing that there has been no subsidence; indeed, I think that a volcanic cone, from the nature of its loose material, will frequently subside, and that some of the deeper lagoons may owe their depths of 50 fathoms or so to such a movement, quite apart from subsidence of large areas which we know occurs. Nor do I say that volcanic mounds that have failed to reach the surface, may not be built up to a sufficient height for corals to flourish; nor that all foundations and atolls

have been formed in the same way; but I put forward the hypothesis that the cutting down of volcanic islands by wave-action and currents, has had a greater share in providing suitable bases for coral atolls than any other process of nature.

I may further suggest, in defence of my views, that it tends to explain why, over vast groups of atolls, no central summit is left.

W. J. L. WHARTON.

FRIDTJOF NANSEN'S "FARTHEST NORTH."¹

WHEN Gerrit de Veer published his "True and perfect description" of Barents' voyages for the discovery of a North-east passage, "so strange and wonderful that the like hath never been heard of before," he justified himself for doing so by several reasons:—

"And also to stoppe their mouthes, that report and say, that our proceeding therein was wholly unprofitable and fruitelesse; which peradventure in time to come, may turn unto our great profite and commoditie. For he which proceedeth and continueth in a thing that seemeth to be impossible, is not to be discommended; but hee, that in regarde that the thing seemeth to be impossible, doth not proceed therein, but by his faint-heartedness and sloath, wholly leaveth it off."

This might not inappropriately be taken as an apology for Nansen's popular account of his great Arctic journey, which in many ways finds its nearest prototype in the classic adventures of the Dutch explorers three hundred years ago, when the lifting of a ship on the ice without being nipped was first observed, and the nature and effects of ice-pressures were first clearly described. For an example of a Norse Arctic explorer visiting England and receiving a Royal welcome, we must go back a thousand years to the time when King Alfred entertained Othar, and gave in a gloss on his Orosius the first record of Arctic discovery ever written in the language of the English. But between the visits of Othar and Nansen the progress of Arctic discovery has been due mainly to our countrymen, who have purchased with their lives much of the experience on which the safe and successful voyage of the *Fram* was planned.

These large and handsome volumes, giving the full narrative of the voyage, have been very rapidly prepared, too rapidly for the careful reader, who has been sacrificed to allow the eager public to revel in a story of adventure. More leisurely preparation might have left the book no less readable, and made it much more valuable, by including at least a few preliminary reports on the results of the voyage which must necessarily be of "great profite and commoditie" in many branches of knowledge. The revision of the text might have been more complete, the cumbersome title-page might have assumed a pleasing form, there might have been a preface note acknowledging the author's debt to the translators, whose work certainly deserves recognition, and the maps might have been of a less provisional character. Scientific readers will, however, be content to await the full discussions by specialists, which are doubtless in preparation, and meantime they cannot dip into the narrative of the most successful of all Arctic voyages without becoming absorbed by its peculiar fascination. The glamour of the Arctic regions has been felt by almost every explorer, and not a few have succeeded in passing it on to the readers of their books, but none so perfectly as Dr. Nansen. Too often the tale

¹ Fridtjof Nansen's "Farthest North," being the Record of a Voyage of Exploration of the Ship *Fram*, 1893-96, and of a Fifteen Months' Sleigh Journey by Dr. Nansen and Lieut. Johansen. With an appendix by Otto Sverdrup, Captain of the *Fram*; 120 full-page and numerous text illustrations, 16 coloured plates in facsimile from Dr. Nansen's own sketches, etched portrait, photogravures and maps. 2 vols. Pp. 1200. (Westminster: Archibald Constable and Co., 1897.)

of human suffering, and the tragedies of the retreat towards relief expeditions which have missed their mark, darken the records of Arctic travel. But here there is no tragedy. The necessary killing of the sledge-dogs to support the life of the rest is the harshest feature, and that seems to have seriously disturbed the equanimity of the kind-hearted explorers. To any but hardened sportsmen the pathetic display of maternal and filial affection between polar bears or walruses and their young, brings the cruelty of hunting man into painful relief; but happy, indeed, is that Arctic expedition in which sympathy for suffering is enlisted on behalf of the lower animals alone.

The pictorial power of Nansen's descriptions of the Arctic night, or the mysterious solitudes of the ice-fields, need not be dwelt on here, nor shall we linger on the psychological aspect of the expedition, the alternations of hope and doubt, the reminiscences of home as familiar anniversaries came round again and again, but proceed rather to point out some of the practical deductions to be made from the voyage. The preliminary scientific results having been already referred to in *NATURE* (vol. lv. p. 352), need not be repeated; but it is interesting to compare the actual experiences, detailed in the Book,



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FIG. 1.—Cleaning the Accumulators before stowing away.

with the original project as described in the *Geographical Journal* (vol. i., 1893, p. 1) and summarised in *NATURE* (vol. xlvii. p. 65).

The ship answered the purpose for which she was designed exactly. The rudder was unshipped through the rudder-well, and kept on board during the greater part of the drift; but it was not found necessary to unship the propeller, which sustained no damage from the ice. Despite the great strength of the ship, and the wonderful freedom from strain, even during the severest ice-pressure, a good deal of water found its way on board during the summer months, but the leakage was found quite insignificant when the ship was floated after her three years on the ice. The lifting of the vessel by ice-pressure took place exactly as predicted, and she lay on the ice on a nearly even keel almost all the time, recovering her position spontaneously after being heeled over by heavy pressures. The non-conducting walls of the saloon entirely obviated the bugbear of all former expeditions—the condensation of moisture on the roof and sides, which, running down, saturates the cushions and bedding. With the fire lighted, the saloon was perfectly dry, and so warm that the fire was usually dispensed with. The arrangement for the supply of light was not quite so satisfactory. The engine was taken to pieces when the *Fram* was fairly beset, and the

dynamos were worked for the first two years by a windmill, which gave good results. Early in the third winter the windmill wore out, and Sverdrup took it down; the accumulators were cleaned (see Fig. 1) and packed away. The men on board had so much necessary work to do with observations, shifting the boats and emergency stores, which were always kept on the ice, and had to be closely watched on account of the appearance of cracks, that there was no time to work the dynamo by means of a capstan and multiplying gear, as originally planned, and so for the longest and darkest winter of all there was no electric light.

The health throughout seems to have been perfect. The weight of all the members of the expedition increased. We read of Nansen suffering from lumbago for a day or two, of Sverdrup being laid up once with intestinal catarrh attributed to a chill, of a few slight frost-bites, a little snow-blindness, but nothing worse. There was no threatening of scurvy, and the doctor had no professional work to do beyond weighing himself and his companions, and counting the red blood-corpuscles once a month. All the food taken proved perfectly satisfactory, except some pemmican prepared with coconut fat, which even the dogs declined after once trying it.

In every particular the equipment and provisions of the expedition were in excess of the actual requirements, and nothing not taken, except a long sounding-line, seems to have been wanted. Dr. Nansen attributes the good spirits and harmony of the expedition largely to the fact that all thirteen members lived together, eating the same food at the same table, and sharing the same work; he was much gratified with the complete success of this novel social experiment.

The *Fram* left Vardö on July 21, 1893, embarked a number of Siberian sledge-dogs at Khabarova, and entering the Kara Sea on August 4, coasted along the north of Asia, discovering many new island groups, and encountering no serious difficulty until September 25, when in latitude 79°, north of the Lena Delta, she was frozen into the ice-floe and commenced her drift. The first two months were spent drifting in various directions, but mainly south-east. Then a change occurred, and a north-westerly drift set in very slowly and irregularly, with many diversions to southward, while the ice under the *Fram* steadily increased in thickness.

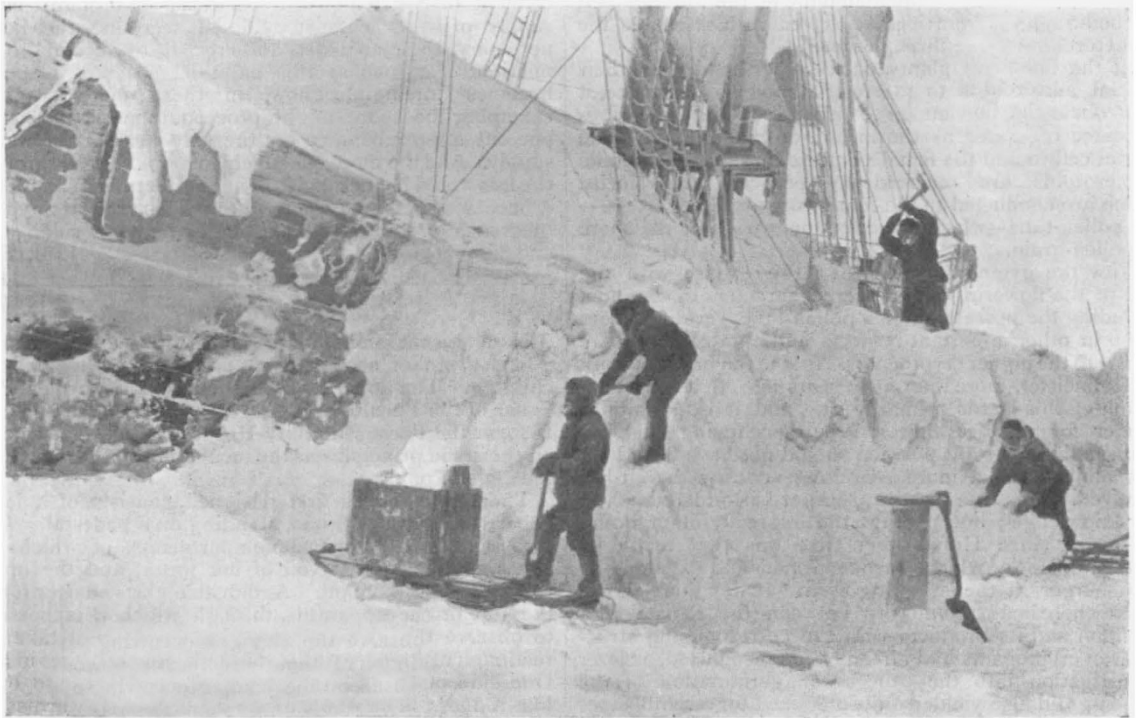
On February 2, 1894, the crossing of 80° N. was celebrated; on May 15 81°, on October 31 82°, and on December 25 83° were successively attained. On January 6, 1895, the *Fram* was further north (83° 34') than any previous expedition had reached, and it was a year and a half before she returned again to recorded latitudes. March 3 brought her to 84°, due north of Cape Chelyuskin, and on September 22 she crossed 85°, going north-west. For four months she remained north of 85°, and the sun remained invisible below the horizon for five and a half months—from October 8, 1895, to March 24, 1896. This was the longest and darkest winter ever experienced by man; but Sverdrup, in his record of it, makes light of its tedium, and notices no decline in the general health of himself and his ten comrades. On November 15, 1895, the northward component of the westerly drift ceased to act in latitude 85° 55', longitude 66° 31' E., and from that date there was a southerly component, increasing until the drift was due south in April. On May 19, 1896, steam was got up for the first time, and the fight to escape from the ice-floe commenced. Sverdrup blasted the vessel free, and worked her slowly through the lanes, as they appeared in the breaking pack, for 180 miles, at length reaching the open sea and sighting

the north-west point of Spitzbergen on August 13, 1896, after having been for 1041 days out of sight of land.

While the *Fram* was tracing out her intended path in comparative tranquillity the originator of the expedition, with one companion, was engaged on a far more adventurous journey. Nansen and Johansen left the comfort and plenty of their safe quarters on board on March 14, 1895, and pushed northward over the hummocky ice with dog-sledges carrying kayaks, until April 4, when the failure of the dogs made it necessary to turn in $86^{\circ} 14'$, N., nearly 200 miles beyond any former seeker of the pole. No land was seen, only an interminable floe. By May 19 they were back at $83^{\circ} 20'$, and but for the misfortune of allowing their watches to run down, and so losing their longitude, they would in all probability have reached Spitzbergen in the autumn of 1895. It was the one error of the expedition, and it was heavily paid for,

crushed is always greatest when the floating ice is driven against a resisting shore. Possibly the *Fram* would have resisted any pressure, for even in the severest trial to which she was subjected, when the advancing pressure-mound rose high on the rigging and the noise of the crashing ice was louder than thunder, she did not sustain the slightest damage. The photograph reproduced in Fig. 2 shows the crew of the *Fram* cutting away the pressure-mound of ice that had been hurled against one side of the vessel.

Little as either Nansen or Sverdrup makes of the dangers, and cheerily as their comrades bore themselves throughout, no one reading this book can fail to feel the profoundest respect and admiration for every one of them; and the public of this country has testified this to Nansen by a reception such as no scientific man or traveller has received before. This is a tribute to the calm and unswerving pursuit of an idea based on sound



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FIG. 2.—Digging out the *Fram*, March 1895.

for it involved the dismal wintering in a miserable hut on "Frederick Jackson's Island," living on bear and walrus meat from August 26, 1895, to May 19, 1896. A month's journey southwards in the spring brought them to Mr. Jackson's headquarters at Cape Flora, whence they sailed in the *Windward* on August 7, and returned safely to Vardö on the 13th.

The more one thinks over the details of this expedition the more remarkable does it appear. The strong current which Nansen believed to cross the polar area was not indeed found quite as he expected it, but there was an average drift due to prevailing winds in the predicted direction and of the predicted velocity. No land whatever was encountered, but a sea nearly two thousand fathoms deep. The resourcefulness of the leader is shown in his making a long sounding-line from one of his wire cables which was untwisted for the purpose in a ropewalk extemporised on the ice. The deep sea was fortunate, for the danger of a vessel being nipped and

reasoning, and carried into effect by the highest personal qualities of courage, faithfulness and brotherly kindness.

Many points invite special notice, such as the interesting descriptions of the formation of pressure-mounds (hummocks) and cracks in the ice, even during the coldest weather. The occasional spells of high temperature in winter are suggestive of föhn effects; but these will, of course, be duly discussed in the scientific report. One very extraordinary phenomenon, known as "dead water," was noticed in the Kara Sea, and we hope that such observations were made at the time as will enable its true nature to be discovered. It is described (vol. i. p. 174) as a layer of fresh water which is carried along by the ship, slipping over the surface of the salt water below, and retarding the progress of the vessel. How a steamer with the propeller working in strong sea water can fail to cut through a superficial layer of fresh water, is very difficult to understand.

HUGH ROBERT MILL.