

African Bamboo, the Sugar-Cane Disease, Substitutes for Vegetable Ivory, and Paper Materials.

As regards the plants under cultivation, it should be stated that great pains are taken to name them conspicuously and correctly, a matter of extreme importance to students, and one which every day engages the unwearied attention of the staff at the Herbarium. Without almost unlimited means the collection could scarcely be much extended. The admission, however, of Mr. Peacock's unequalled collection of succulent plants for a limited but sufficiently extended period should not be passed without notice. The proposal was a happy one, and the acceptance much to the credit of the authorities. The groups of hardy economic plants and of those of a similar character which require a higher temperature than our country can offer are of especial interest to the student. The plants of peculiar botanical importance which have flowered during the past year are duly recorded, while an especial report, accompanied by a figure, is devoted to a new tropical fodder-grass which grew and flowered under store treatment. At Singapore, Adelaide, and elsewhere the hopes conceived of it are very great, and seeds of it have been widely distributed from Kew. Nor are matters of cognate interest at home neglected. A notice is given of that form of the prickly comfrey which is likely to be a valuable fodder plant in Great Britain and Ireland. It seems to be a hybrid between *Symphytum officinale* and *S. asperinum*; we have seen it lately in great perfection and in full usage, where it is greedily consumed by cattle, which thrive upon it immensely, while they will not touch the common comfrey.

The ravages of insects amongst plants are of no less interest than those which are produced by fungi. A very small bug, for example, is highly detrimental to the tea plantations in India, and Mr. McLachlan has given a great deal of valuable information on such subjects, information of such importance that the want is suggested of a consulting entomologist, at the disposal of the different Government offices, who should receive a retaining fee in return for investigating and reporting upon the various questions respecting which the residents in our various British dependencies apply for information.

At the commencement of the report there is a notice of the condition of the tropical fern house as regards the decay of the rafters, which the late storm has too sadly confirmed, and it is in consequence suggested that some hard wood like teak or blue gum should be substituted. The suggestion is one of great importance to all who are interested in the sustentation of their stoves and conservatories. Foreign deal is often dangerous. Every one who has watched the progress of decay in imported wood as used in railway construction, must have seen how soon they become infested with such fungi as *Lentinus lepidus*, *Trametes pini*, and *Lenzites sepiaria*, of course, from spawn contained in the wood. But home-grown wood is no less subject to decay from fungi. Where oak is grown from old stools, the wood is apt to have a tint, which, to persons well skilled in such matters is known as foxy. Such wood would at once be rejected in our naval yards, but we have seen a case in which it was used in the construction of a range of hothouses, where the whole in a few years was destroyed by *Dadalea querina*; and deal, whether of home or foreign growth, is soon infested with *Polyporus medulla panis*, which is, we believe, a condition of one of our commonest fungi. It is not always possible to say whether any mycelium is present in wood; it is better, therefore, as Sir Joseph Hooker suggests, to use some material less liable to decay.

It remains only to notice the acquisitions to the herbarium during the past year. One of the most important is a collection of fungi containing more than 10,000 species, a great portion of which are typical. That of Mr. Dazell is important from its containing type specimens of the Bombay flora. Messrs. Cosson, Miers,

and Casimir De Candolle have sent collections of greater or less magnitude and value, while the list of contributors either in specimens or drawings occupies more than three columns. The botanical publications prepared in connection with the work of the herbarium have been of an importance equal to that of former years, while the third volume of Hooker and Bentham's *Genera* now in the course of printing, is the result in great measure of last year's studies, which have never wavered.

M. J. BERKELEY

NORDENSKJÖLD'S ARCTIC VOYAGES¹

NORDENSKJÖLD'S next visit to Spitzbergen was made in 1868, in a "small weak steamer" the *Sofia*. The main object of the expedition was to penetrate as far north as possible, but as we have said already it was not very successful in this respect. The other objects of the expedition included an examination of the flora and fauna of Bear Island, the single remaining fragment of an extensive polar territory which probably at one time connected Scandinavia with Spitzbergen, the flora and marine fauna of which was still almost unknown, though fitted to throw important light on the animal life not only of the Scandinavian peninsula, but also of the northern shores of Britain which are washed by the Gulf Stream; a careful examination of the strata on Bear Island and at Ice Fjord and King's Bay which contain fossil plants, and a search for post-miocene strata on the peninsula between Bell Sound and Ice Fjord, which might afford some information as to the transition from the warm climate of the miocene period, which produced a luxuriant forest vegetation, to the ice masses of the present time; a more thorough examination of the Saurian strata at Cape Thorsden; an examination of the fragments of skeletons of whales found on the shores of Spitzbergen; a continuation of the collection and examination of the land and marine fauna and flora; dredgings at the greatest depths; magnetic and meteorological observations; geographical determinations of position, &c.

It was on this occasion that a week's stay was made at Bear Island, which lies about half-way between the north coast of Norway and Spitzbergen, and of which we should have liked to see a map and some views in Mr. Leslie's volume. Some of the results obtained in this visit are thus given by Mr. Leslie:—"Bear Island forms a pretty level plateau, two to three hundred feet above the sea, rising here and there into inconsiderable elevations and furrowed by small valleys, in the bottoms of which little streamlets seek their way among the naked stones. In the south-east the appropriately named Mount Misery rises perpendicularly from the sea to a height of about 1,200 feet, and in the south the Fuglefjeld is about the same height. On neither of these, however, is there any glacier or perpetual snow. It is not the formation of the island which gives it so desolate and forbidding an appearance, but the monotonous grey colour of the whole landscape. No trace of any grass turf is to be found in the interior, far less of any trees or bushes; only the Polar willow (*Salix polaris* and *herbacea*) with its thread-like stalks creeping in the moss, and two or three leaves, scarcely the size of a finger-nail, raised above it. Green patches in hollows where water has collected and formed a sort of marsh consist principally of mosses with scattered specimens of the Polar ranunculus (*Ranunculus sulphureus*) and a few other plants and grasses sparingly mixed with them. Except in these marshy places, the ground is nearly everywhere without the slightest trace of covering. By the combined action of water and frost the rocks have been literally frozen

¹ "The Arctic Voyages of Adolf Erik Nordenskjöld, 1858-1879." With Illustrations and Maps. (London: Macmillan and Co., 1879.) Continued from p. 611.

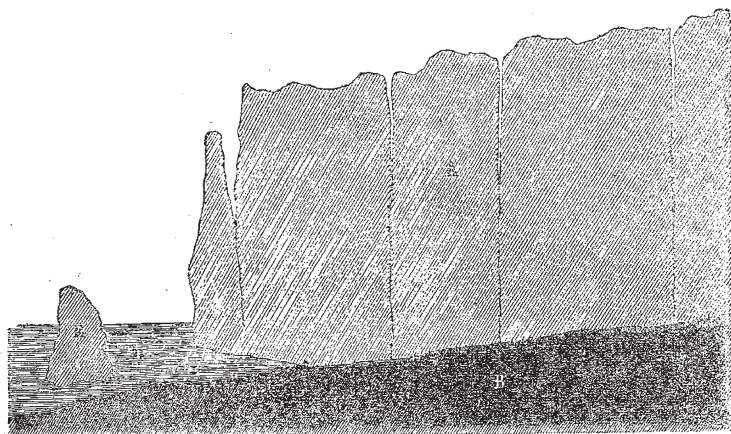
asunder, the limestone to small angular fragments, and the sandstone to larger or smaller blocks heaped one upon another. Such collections of stones cannot of course afford nourishment to higher plants, the more especially as any little mould that may be formed is immediately swept away by the wind or washed away by the rain. At long intervals in this wilderness of gravel and limestone there are found solitary specimens of the Arctic poppy (*Papaver nudicaule*), *Saxifraga*, *Draba*,

are banished. The exterior of the island is more attractive. The rocks rise perpendicularly out of the sea, and as they consist of the looser formations, they have, in course of time, been shaped by the waves into the forms of arches, grottos, towers, columns, &c. The projecting rocky promontories are in some places found to be clothed with turf, and the perpendicular cliffs are richly hung with luxuriant *Cochlearia*.

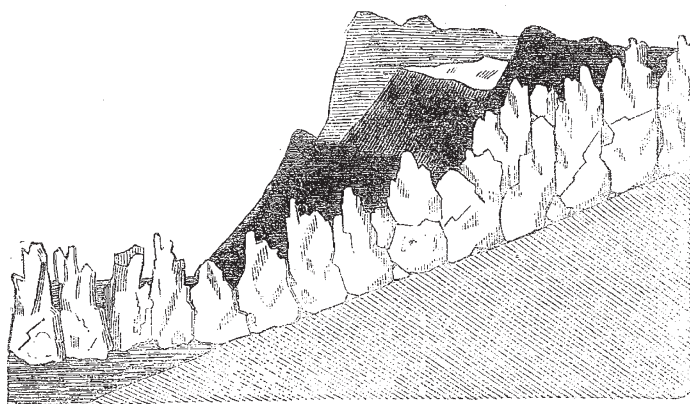
"The explanation is easy. It is only the ledges where the sea-fowl sit that are thus ornamented, and it is only in the rich mould originating from these fowl that the plants can attain such luxuriance. This leads us to the most remarkable thing about Bear Island, its fabulous richness in sea-fowl. Indeed it may be said that the fowl are the proper inhabitants and owners of the island. There are, it is true, some mountain foxes, but they are very scarce, and the greater number only make a visit during winter, resembling in this the Polar bear, from which the island is named, as it cannot, at least now, support itself here in summer. During that season the walrus, which soon after the discovery of the island was found upon its shores in unheard-of numbers, and a little flock of which Keilhau had an opportunity of observing, is now sought for in vain. Even in winter, according to the latest observations, the Polar bear is an unusual guest here. . . .

"The number of plants found by the botanists of the expedition was thirty-three, which, with the other five formerly observed, but not now found, makes the whole number of phanerogamous and higher cryptogamous plants found on Bear Island thirty-eight. The number of species of insects found was twelve. The number of marine animals was unexpectedly small in consequence of the unsuitable nature of the bottom. A great part of the island consists of strata belonging to the Mountain Limestone, in which are found in abundance mussel shells, corals, &c., showing that in times long past quite a different animal world lived in an almost tropical ocean. Two and a half centuries ago seams of coal were discovered on the north coast of the island, showing as black parallel bands on the perpendicular cliffs facing the sea. As the coal that occurs on Spitzbergen had been proved by the preceding Swedish expeditions to belong to the comparatively recent tertiary period, it had been considered probable that this was the case also with that found on Bear Island. But on examination being made impressions of plants were found, partly in the coal, partly in the sandstone separating the seams, which afforded indisputable evidence that the strata here belong to the true coal formation. Splendid *Sigillaria*, *Lepidodendra*, *Calamites*, and other characteristic fossils of the Coal period were taken, not without danger to life, from the perpendicular sea-cliffs on the north side of the island, and it was with deep regret that others had to be left behind because there was not time to cut them out of the rock."

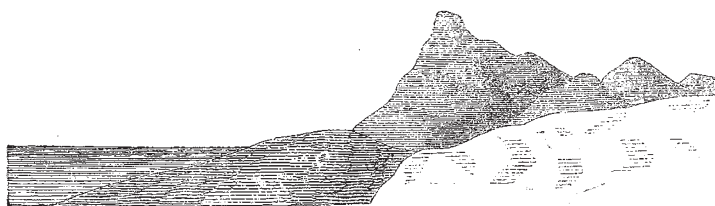
Ice Fjord was again explored and much new geological data obtained, and various parts of the north coast examined. Of this expedition, the distinguished *savant*, Prof. Oswald Heer of Zürich, declared—"In my opinion



I.



II.



III.

I. Inland Ice (A) extending into the Sea (B) and terminating in a steep front, 100 to 200 feet high. II. Inland Ice abutting on the bottom of an Ice-fjord, i.e., a Fjord in which real Icebergs are formed. III. Inland Ice abutting on a Mud-bank.

Sagina, &c. Lichens, especially the larger species, occur here very sparingly and badly developed, though in spots the ground is almost covered by species which are exceedingly rare in the flora of Scandinavia. Where sandstone is the prevailing rock, the view is still more unpleasing. There is a considerable extent of surface where the only method of progression is by jumping from one block of stone to another, from which blocks all the higher plants, with the exception of a grass or two,

the Swedish Expedition, by the rich collections it has brought home, has achieved more, and more widened the horizon of our knowledge, than if it had returned merely with the information that the *Sofia* had hoisted her flag at the North Pole."

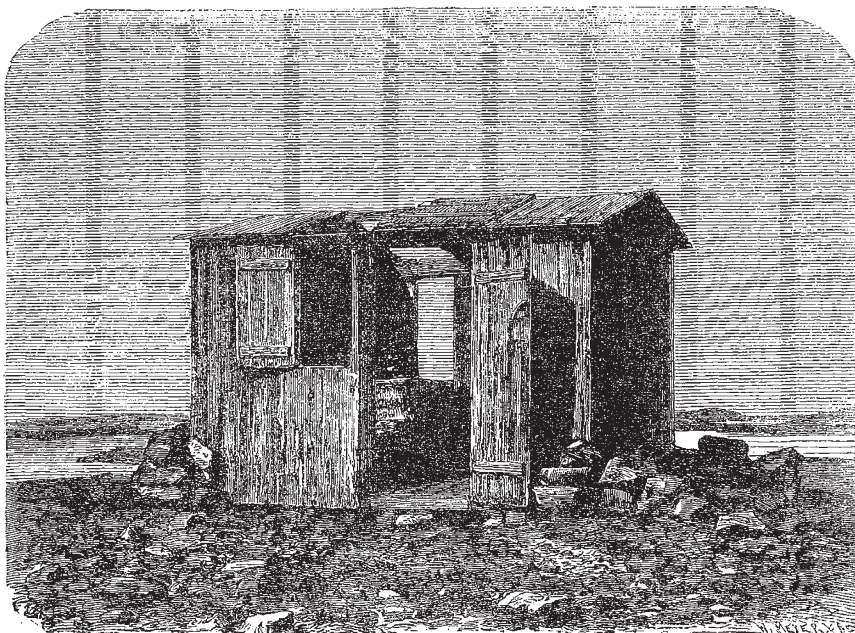
Nordenskjöld's last expedition to Spitzbergen was made in 1872-3, when a winter was passed in the island, with the intention of pushing north by the Seven Islands by means of sledges. As a preliminary to this, he paid a visit to Greenland in 1870, for the purpose of ascertaining



Glacier in Fair Haven.

the suitability of the Eskimo dog for sledging purposes. After careful observation Nordenskjöld came to the conclusion that reindeer were much better adapted to the work than dogs, and so it was decided to use the former

in the contemplated expedition. While in Greenland Nordenskjöld made a journey of a few days into the interior and brought back some interesting results. He succeeded in penetrating only a distance of thirty miles,



Astronomical Observatory at Mussel Bay.

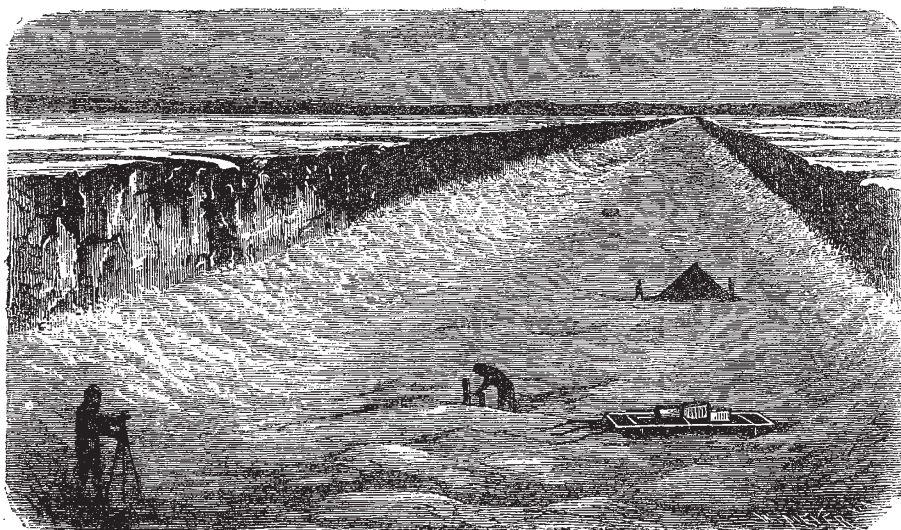
and that with great difficulty on account of the rough nature of the inland ice and the frequent crevasses that had to be passed.

"On the surface of the inland ice no stones were met

with at a distance of more than a cable's length from the border; but everywhere there were to be found vertical cylindrical holes, a foot or two deep, from a couple of lines to a couple of feet in diameter and so close

to one another that it was impossible to find between them room for the foot, much less for a sleeping sack. . . . In these holes in the ice, filled with water and in no way connected with each other, Nordenskjöld found everywhere at the bottom of them, not only at the border but in the most distant parts of the inland ice which he visited, a layer some few millimetres thick, of grey powder, often conglomerated into small round balls of loose consistency. Under the microscope the principal substance of this remarkable powder appeared to consist of white angular translucent grains. There could also be observed remains of vegetable fragments; yellow, imperfectly translucent particles, with, as it appeared, evident surfaces of cleavage, possibly felspar, green crystals (augite), and black opaque grains, which were attracted by the magnet. 'The substance,' says Nordenskjöld, 'is not a clay, but a sandy trachytic mineral, of a composition (especially as regards soda) which indicates that it does not originate in the granite region of Greenland. Its origin appears to me, therefore, very enigmatical. Does it come from the basalt region? or from the supposed volcanic tracts in the interior of Greenland? or is it of meteoric origin? The octahedrally crystallised magnetic particles do not contain any traces

of nickel. As the principal ingredient corresponds to a determinate chemical formula ($2\text{RSi}^2 + \text{A}^1\text{Si}^3 + \text{H}$), it would perhaps be desirable to enter it under a separate class in the register of science; and for that purpose I propose for this substance the name Kryokonite (from *κρύος* and *κόνις*). 'When I persuaded our botanist Dr. Berggren, to accompany me in the journey over the ice,' he continues, 'I joked with him on the singularity of a botanist making an excursion into a tract, perhaps the only one in the world, that was a perfect desert as regards botany. This expectation was, however, not confirmed. Dr. Berggren's keen eye soon discovered, partly on the surface of the ice, partly in the above-mentioned powder, a brown polycellular alga, which, small as it is, together with the powder and certain other microscopic organisms by which it is accompanied, is the most dangerous enemy to the mass of ice, so many thousand feet in height and hundreds miles in extent. This plant has no doubt played the same part in our country, and we have it to thank, perhaps, that the deserts of ice which formerly covered the whole of northern Europe and America have now given place to shady woods and undulating cornfields. Of course a great deal of the grey powder is carried down in the



Canal in the Ice of North-East Land.

rivers, and the blue ice at the bottom of them is not unfrequently concealed by a dark dust. How rich this mass is in organic matter is proved by this circumstance among others, that the quantity of organic matter in it was sufficient to bring a large collection of the grey powder, which had been carried away to a distant part of the ice by several now dried-up glacier streams, into so advanced a state of fermentation or putrefaction, that the mass, even at a great distance, emitted a most disagreeable smell, like that of butyric acid.'

The land gradually rose, and at their turning-point they had reached a height of 2,200 feet above the sea. During this visit to Greenland Prof. Nordenskjöld made some interesting observations on glaciers. "It is," he says, "a common error among geologists to consider the Swiss glaciers as representing on a small scale the inland ice of Greenland, or the inland ice which once covered Scandinavia. The real glacier bears the same relation to inland ice which a rapid river or brook does to an extensive and calm lake. While the glacier is in perpetual motion, the inland ice, like the water of a lake, is comparatively at rest, excepting at those places where it streams out into the sea by vast but short glaciers.

If one of these glaciers, through which the ice-lake falls out into the sea, pass over smooth ground where the bottom of the ocean gradually changes into land without any steep breaks, steep precipitous glaciers are produced from which indeed large ice-masses fall down, but do not give rise to any real iceberg. But if the mouth of the fjord be narrow, the depth of the outlying sea great, and the inclination of the shore considerable, the result will be one of those magnificent ice fjords which Rink so admirably describes. No. II. in the diagram on p. 632 illustrates this more clearly.

"True icebergs are formed only in those glaciers which terminate in the manner indicated in No. II., though pieces of ice of considerable dimensions may fall from a steep precipice (No. I.). These various kinds of glaciers occur not only in Greenland, but in other ice-covered polar lands, e.g. in Spitzbergen, though on so much smaller a scale than in Greenland that one never meets in the surrounding waters with icebergs at all comparable in magnitude with those of Davis Straits.

"In Spitzbergen, and probably also in some parts of Greenland, the ice passes into the sea, as in No. III.

It was in this expedition that Nordenskjöld obtained

the two famous meteors, one of which, weighing nineteen tons is now in the Riks-Museum at Stockholm, and the other, nine tons, in the Museum of Copenhagen.

For the expedition of 1872-3 the Swedish government provided a steamer, the *Polhem*, and a brig, the *Gladan*, which were accompanied by the *Onkel Adam* as tender. Tromsø was left on July 30, and Ice Fjord was again visited, where a search was made in Coal Bay. Some little time was spent at Fair Haven, on the north of the island with the view of finding the place where the Dwarf Birch had been discovered in 1870 by Nathorst and Wilander. After a long fruitless search, and when all hope of finding it was given up and the return to the boat commenced, its dark green leaves were at last observed projecting from the surrounding moss. The dwarf birch found here, the *Betula nana*, var. *relicta*, Th. FRIES, is believed to be a survival from the time when Spitzbergen possessed a finer and warmer climate than now. Its height, as found here, did not exceed two feet, the thickest stem being from two to three lines in diameter. After the return to Sweden it was found by the help of the microscope that a stem of this thickness was about eighty years old. The yearly rings were exceedingly thin and faintly marked in several specimens, and in some parts of the stem, altogether indistinguishable. A well grown beautifully flowering specimen of the *Cardamine pratensis* also rewarded the search of the botanist, a *find* which was specially welcome, because this plant, though pretty widely distributed, is seldom found in flower on Spitzbergen.

Leaving Green Harbour on August 4, the *Polhem* proceeded on her voyage with the *Gladan* in tow, passing through the sound between Prince Charles Foreland and the mainland and anchoring on the 7th in Fair Haven for the purpose of regulating the chronometers at the place where Sabine and his companions spent three weeks in 1823, carrying on a series of physical and astronomical observations. The place which is situated on the south-western shore of the inner Norway island still bears the name of Sabine's observatory, and is distinguished by a great number of stones collected in a circle. While here, Wijkander carried on a series of magnetic observations at Sabine's observatory. Astronomical observations were also made; and two and sometimes three boats were at work dredging from morning till night. It ought also to be mentioned that on the drift-ice which the *Polhem* had encountered a short time before, Nordenskjöld had found small quantities of dust similar to that which he had discovered in the snow during a snow-storm at Stockholm in December 1871. This dust, which he believes to be of cosmic origin, contains metallic iron, cobalt, nickel, phosphoric acid, and a colloid organic substance. "However small and inconsiderable the quantity of this substance may be in proportion to the snow or water falling at the same time," he writes, "it may yet play an important part in the economy of nature; for example, by means of the phosphoric acid which it contains it may restore the fertility of the soil impoverished by repeated harvests. This observation ought also to be of great importance for the theory of meteors of the aurora, &c. Perhaps we should inquire whether in this phenomenon we are to seek the explanation of the abundance in which magnesia, which occurs plentifully in meteorites, is found to exist in certain distinct geological districts, and if an increase of the earth's mass, which is certainly minute, but which is going on continuously, ought not to produce very considerable changes in the geological theories now prevailing, which proceed on the supposition that the globe is as nearly as possible unaltered in mass since the first occurrence of plants and animals, and that the geological changes have always depended on changes of distribution in the mass over the surface of

the earth, never upon the arrival from without of new constructive material for our globe."

While at Fair Haven the expedition was visited by Mr. Leigh Smith in his yacht, who promised that he would be among the first to look them up next summer. After a long enforced delay in Fair Haven on account of the ice, the expedition got away in September 1, but failed in every attempt to reach the Seven Islands. Mussel Bay, then, a small inlet off the east side of the mouth of Wijde Bay was chosen as the winter quarters of the expedition, and here all three vessels were ultimately locked in the ice. One large building was erected on shore besides magnetical, meteorological, and astronomical observatories. During the whole of the stay of the expedition here regular observations were carried on in their observatories. Provisions were short, and all had to be put on allowances; though scurvy broke out there was only one death, and altogether the winter was a dreary one, in spite of every effort to keep officers and men constantly employed.

Wijkander remained whole nights in his observatory bravely defying the cold and patiently overcoming the many difficulties attending astronomical observations made in such circumstances. In the cold weather the work out of doors was not stopped and the dredgings still went on, it being of great importance to ascertain whether the severe cold and the long darkness exercised any special influence upon the marine animal and vegetable world.

With the arrival of spring preparations were made for the ice-journey to the north, but as we have said already they did not get beyond the Seven Islands. Nordenskjöld makes some interesting observations on the rugged ice which prevented him attempting to push further northwards. "The ice we thus passed is formed not of colossal blocks or icebergs, but of angular blocks of ice, not waterworn, piled loosely over each other, so as to form pyramids, or walls of ice, up to thirty feet high, which were so close to each other that the space between them was frequently not large enough for our tent. The cause of the formation of these ice-walls, which were also observed by Wrangel on the north coast of Siberia, is probably to be sought for in the changes of volume which ice undergoes when its temperature is changed. According to Plücker and Geissler, the linear expansion-coefficient of ice is $= 0.0000528$. If, therefore, ice of 0° C. be cooled to -15° C., cracks must arise which, for 1,000 metres, have a breadth of 32 inches. The cracks naturally freeze together immediately afterwards, and when the ice is again warmed, for instance to -5° C., a piling-up must take place of 21 inches per kilometre. During the course of the winter this phenomenon is repeated innumerable times, one layer of ice being piled upon another, till the whole ice-field forms a confused mass of blocks of ice heaped up against each other. Similar forces are also in operation in the crust of the earth, with less intensity, indeed, in consequence of the smaller expansion-coefficient of the rocks which compose it, and the inconsiderableness of the changes of temperature which occur in them, and the cracks thus formed may here come together again, provided no chemical or mechanical sediment has been deposited in them, as is, perhaps, often the case. On the other hand, the forces operate in the earth's crust during millions of years, and I doubt not that in the circumstances here noticed the cause of the strata being contorted, dislocated, and thrown over each other is to be sought for. This last, perhaps, to judge by the observations I had the opportunity of making on the polar ice, happens far oftener than we commonly suppose, and when it takes place there often occurs no considerable disturbance in the original horizontal position of the stratum. Certainly in most cases the veins filled with foreign minerals, by which the upper strata of the earth in particular are intersected in all directions, derive their origin from similar causes; that is

to say, from cracks which have in consequence of changes of temperature many times over opened and come together again, *provided they were not prevented by the falling in of débris*. This has, however, often taken place, considerable masses of sediments, formed chemically or mechanically, have frequently collected in the cracks, and during the immense duration of geological ages they have hardened and been metamorphosed to solid crystalline rocks—limestone, quartz, felsite, pegmatite, &c.”

To make up for the disappointment of not being able to push beyond the Seven Islands, Nordenskjöld made a journey round the coast of North East Land, and right across the island from east to west. “North East Land,” he tells us, “forms the most northerly of the four large islands, into which Spitzbergen is divided. Its extent from north to south is seventy-five and from east to west about ninety-two geographical miles. The whole interior is occupied by an ice-sheet 2,000 to 3,000 feet thick, to which the fall of snow (and rain) during summer and winter brings new material and which accordingly would be unceasingly increased, if the mass of ice did not, as is the case with all glaciers, flow out into the sea slowly but without intermission. The principal direction of the ice-stream in North East Land is towards the east, and the whole of the east coast is therefore occupied by a single precipitous ice-wall, insurmountable from the sea, which, being nowhere interrupted by rocky heights or tongues of land, forms the broadest glacier or skridjökell known to man. It is, for instance, considerably broader than the Humboldt glacier in Greenland described in such lively colours by Kane. Northwards, however, the ice-sheet of North East Land terminates with an even and gentle slope, which sometimes reaches the sea, but generally leaves a small stretch of ice-free land along the coast. On this side there is no obstacle to an advance into the interior, at least from precipitous slopes.”

With regard to the glaciers which cover the surface of this island, Nordenskjöld writes:—

“Like the glaciers of Switzerland, of Greenland, and of Scandinavia, the glaciers of Spitzbergen are interrupted by clefts or fissures which often extend perpendicularly through the whole mass of ice several thousand feet thick. The occurrence of these fissures stands in close connection to the motion of the glacier, and there is therefore a smaller number to be met with where the glacier is spread over an extensive level field without interruption from rocky heights. Accordingly we had reason to suppose that clefts or fissures would not in any specially great number intersect the way we had chosen and I hoped besides that all the crevasses would have been filled with snow during the snow-storms of winter. This supposition was so far correct, inasmuch as fissures do not here occur in such numbers or of such size as in that part of the inland ice of Greenland which I examined along with Dr. Berggren in 1870—but deep almost bottomless openings do nevertheless occur in numbers sufficiently large to swallow up us and our sledges. They were the more dangerous as they were for the most part concealed by a fragile vault of snow, so that even when we stood on the edge of the cleft, it was only by boring with an ironshod stick, very often first by ourselves falling in, that we could assure ourselves of neighbourhood, direction, and extent.”

In spite, however, of the innumerable concealed crevasses which they had to pass, the journey across the glacier-bound island was safely accomplished. The snow, he found, at a depth of four to six feet, passes into ice, being changed first to a stratum of ice-crystals, partly large and beautiful to the eye of the crystallographer, then to a crystalline mass of ice, and finally to a hard homogeneous glacier ice, in which, however, there could still be observed numerous cavities filled with air, compressed by the pressure of the overlying ice. When the ice-wall becomes on the melting of the ice too weak for the

pressure of the inclosed air, these holes break up with a peculiar crackling sound, which in summer is continually to be heard from the pieces of glacier ice floating about in the fjords.

Many other extremely interesting observations were made on this journey as to the nature of Arctic land-ice. For example Nordenskjöld says:—

“In many respects there is a very essential difference between the ice-field over which we now travelled and the inland ice-field in Greenland, which was visited by me in 1870. The reason of this may perhaps be in a great degree the fact that in North East Land we wandered over a kind of *nevé region*, that is to say, over a part of the glacier where the surface is occupied by a layer of snow which does not melt away during summer, while in Greenland at the beginning of the month of July the snow upon the surface of the glacier was on the contrary already nearly completely melted. No trace of the glacier lakes, the beautiful and abundant glacier streams, the fine waterfalls and fountains, &c., which occur everywhere on the Greenland inland ice, could be observed here, and the configuration of the surface showed that such forms never occur, or only to a very limited extent. The melting of the snow clearly goes on upon Spitzbergen on too inconsiderable a scale for such phenomena to arise.” Another curious phenomenon of this Spitzbergen ice was an area near Cape Mohn which was intersected by canals which for the most part ran parallel with each other, at some places at a distance of only 300 feet. The depth was up to 40 feet, the breadth 30 to 100. “Sometimes, also, there occurred other depressions, bounded in all directions by precipitous sides, of greater depth than the glacier canals, but of limited extent; these, perhaps, may most fitly be called by the name given them by the sailors—*docks*—or *glacier docks*.” With regard to the cause of these curious phenomena Prof. Nordenskjöld writes:—

“The inland ice of North East Land was at the time of our visit too much covered with snow for me to make out with complete certainty the way in which the glacier canals originate. That they were not river channels was clear. For they were much deeper than the river channels on the Greenland inland ice, where, however, the melting of the snow must proceed on a much more considerable scale than on Spitzbergen, and they occur in too close proximity at certain places (while at others they are completely absent) for them to be the beds of the channels of the streams, certainly very inconsiderable, which are produced here during the height of summer. There is a strong probability, on the other hand, that they originate from faults in the ice, strongly resembling those that are observed in the solid strata of the earth, and which, there as here, derive their origin from the alternate expansion and contraction of the strata or the ice in consequence of variations of temperature.”

While Nordenskjöld was out on this sledge journey the work at Mussel Bay was still carried on. Soon after Nordenskjöld's departure Wykander commenced a series of pendulum observations. The tidal observations were also extended. Five minute observations were carried on at least a whole hour twice a day, at ebb and flood. After the long, dreary, and trying winter, our readers can easily imagine how welcome was the sight of Mr. Leigh Smith's yacht the *Diana*, steaming into the bay on June 12, with an abundant supply of much-needed comforts and luxuries.

From what we have written it will be seen that Mr. Leslie has been able to bring together from the wealth of material which exists on these various expeditions of Prof. Nordenskjöld, enough to render his volume one of general interest and great scientific value. We need not follow him in his narrative of Nordenskjöld's two journeys in 1875 and 1876 to the mouth of the Yenissei, for the purpose of proving that a sea-route from Europe along the north

coast of Europe and Asia was perfectly practicable to that river. Some of the scientific results of these expeditions were published in *NATURE* at the time, and it is well known that so far as the immediate object was concerned the expeditions were completely successful. Full details will be found in Mr. Leslie's volume. From what we have said it will be seen that comparatively young as Prof. Nordenskjöld is, he has done an amount of work rarely accomplished even in a long lifetime. Appended to Mr. Leslie's volume is a long bibliography of the published results of these expeditions of Nordenskjöld, and from this it is evident that they have borne rich fruit in nearly every department of science.

HERING'S THEORY OF THE VISION OF LIGHT AND COLOURS¹

II.

BEFORE propounding his theory, the author thinks it necessary to devote one memoir—the fourth—to an essay, the object of which is to define clearly the nature of the sensations of black and white and their mixture gray. He remarks that it is a habit to treat visual sensations rather according to their physical origin than by their own nature; and this peculiarly influences the ideas entertained about the sensations of black and white. We know that physically, white light is a combination of rays of all wave-lengths, and we have no physical notion of black except a negative one, namely, as an absence of light of any kind. Hence, transferring our physics to our physiology, we consider that our sensation of white is a positive one, but that our idea of black arises simply from the absence of all sensation; or, to use a metaphor drawn from painting, black is our canvas, or background, on which all our sensation-pictures are drawn in white or colours; as a result of this, all our reasoning is confined to the pictures, while the background receives no attention.

The author, as one of the main points of his theory, strongly objects to this view. He denies that the natural unimpressed state of the visual sensation corresponds with black, appealing to every-day experience in support of the opinion. Any one who carefully examines his impressions after being for some time in a perfectly dark room, will observe a dark field, it is true; but if he tries, in imagination, to compare this with his sensation of a piece of the blackest velvet, he will be obliged to admit that the field is nothing approaching the latter in darkness; it is, in fact, only dark gray. Or as an easier and simpler test, let him compare the black after-image of a white disk with the general field given by his closed and darkened eyes, and he will observe a similar contrast.

The author's view is that the impression of black, like that of white, can only be derived from external sources; and that consequently black is a perfectly independent visual sensation, which should be studied physiologically like those of white, or red, or blue. On physiological grounds it is no more reasonable to consider black as the absence of white, than white as the absence of black, or blue as the absence of yellow, or to consider a sphere as the absence of solids of every other form.

On this principle he proceeds to discuss the sensation of gray. He objects to the usual mode of defining different shades of gray as merely different *intensities of light*. He considers any sensation of gray as a combination of the two independent sensations, black and white, in certain proportions; he calls this accordingly a *black-white* sensation, and he proposes to express it in a mathematical form. The full and perfect extreme sensations are practically unknown, and therefore no positive quantitative expressions can be used for them. But it is quite permissible to give an algebraical idea of the difference between intermediate gradations, and this may be done in

the form of a ratio, or fraction, of which the two components express the assumed amounts of white and black respectively that are combined in the sensation. For example, there must be a practical gray (though we cannot identify its exact shade) which is intermediate between white and black, resulting from an equal force of each sensation. Here therefore if W = the force of the white sensation, and B = that of the black one, $\frac{W}{B} = \frac{1}{1}$ or $= 1$.

For a lighter gray in which there is twice as much white as black, $\frac{W}{B} = \frac{2}{1} = 2$. And for a darker gray, in which there

is twice as much black as white, $\frac{W}{B} = \frac{1}{2}$. On this principle

the pure white sensation would be expressed by $\frac{W}{0} = \infty$,

and the pure black sensation by $\frac{0}{B} = 0$.

It is possible, still retaining the principle, to give a more convenient expression for the brightness or lightness (*Helligkeit*) of any black-white sensation; thus, the degree of brightness may be expressed by the ratio which the *white element* bears to the *whole sensation*, or

$= \frac{W}{W+B}$. Thus the brightness of the medium gray will be $= \frac{1}{1+1} = \frac{1}{2} = 0.5$; and that of the mixture of two

white to one black will be $= \frac{2}{2+1} = \frac{2}{3} = 0.66$; and that

of the mixture of two black to one white $= \frac{1}{1+2} = \frac{1}{3} = 0.33$.

The brightness of pure white will be $= \frac{1}{1+0} = 1$, and

that of pure black $= \frac{0}{0+1} = 0$. This mode of definition

corresponds to the usual practical idea of the *intensity* of white in gray, but it differs from it by acknowledging the independent black element in the composition.

In the fifth memoir we at length get a statement of the fundamental features, of the author's theory, so far as the black-white sensation is concerned.

He begins by objecting to the treatment of white as a mixture of complementary colours, as blue and yellow, or red and green, or of all colours together, an idea which has arisen solely from physical considerations. No one, he says, can pretend that the least trace of any other colour can be distinguished in a pure white sensation; all that can be said is that the sensation of white is produced by a mixture of light of different wave-lengths. But the sensation is a perfectly independent one, like black, or red, and must be so considered in an investigation into the *rational* of the visual perceptions.

Since the physiologist considers all sensations as called into existence by physical processes of the nervous system (for otherwise every physiological investigation would be objectless), he must assume so-called psycho-physical processes or movements which correspond to the sensations of black, of white, and of all shades between them. In what part of the nervous system these psycho-physical processes are situated it is impossible to say; suffice it that, somewhere in the nervous apparatus of the eye and the parts of the brain standing in functional relation therewith, a substance must be sought, with the changes or motion of which the sensation is bound up; this substance may be called the "visual substance" (*Sehsubstanz*).

The action of this substance may be studied in two ways: either *a priori*, by considering the physical influences brought to bear upon it, or, *a posteriori*, by considering the sensations resulting from its changes. The former mode has hitherto been of little profit, for

¹ Continued from p. 613.