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THIRD SUPPLEMENT

TO THE

PAPERS ON THE NORTHERN AND EASTERN EXTENSION

OF

THE GULF STREAM.

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[From Dr. Petermann's "Mittheilungen," vol. for 1872, p. 315 et seq.]

## I.

### RESULTS OF THE OBSERVATIONS OF THE DEEP-SEA TEMPERATURE IN THE SEA BETWEEN GREENLAND, NORTHERN EUROPE, AND SPITZBERGEN, BY PROFESSOR H. MOHN, DIRECTOR OF THE NORWEGIAN METEOROLOGICAL INSTITUTE AT CHRISTIANIA.

The annual fluctuation of the temperature of the sea at the surface amounts to  $9^{\circ}$  and more, and decreases with the depth, but not everywhere at the same rate, as the observations have shown. In the deep trough beyond Lindesnes, for instance, there appears to be but a very small fluctuation at a depth of one hundred and fifty fathoms, while beyond the west coast, and on the banks of the Romsdals coast, it amounts at that depth to some degrees. In the sea west of Spitzbergen there is, according to Scoresby's observations, considerable fluctuation in the temperature at a depth of two hundred fathoms, and it appears (increasing from May to June) to be quite perceptible even at a depth of seven hundred fathoms. It may be inferred from the observations that the temperature reaches its highest point later at depths than on the surface; how much later could, however, not be ascertained on account of the meager observations in the autumn. The lowest temperature in the spring appears also to be a little later at depths than on the surface.

Thus but a slight change takes place in the temperature at depths; in the upper strata, however, the fluctuation is so different in the summer and in the winter months, that a graphical representation of the temperature relations in the two seasons will hardly bear comparison. I shall begin with the temperature relations in the summer, as the greater number of deep-sea temperature observations were obtained in that season.

In general the temperature decreases in the summer with the depth, more rapidly in the upper strata which are exposed to the action of the sun's rays, than in the lower. The Porcupine expedition observed in July, 1869, in the deep descent of the Atlantic ocean, off the English Channel, the fol-

lowing temperatures: at the surface  $62^{\circ}.6$ ; at 45 fathoms,  $53^{\circ}.6$ ; at 75 fathoms,  $51^{\circ}.8$ ; 275 fathoms,  $50^{\circ}$ ; 400 fathoms,  $48^{\circ}.2$ ; 550 fathoms,  $46^{\circ}.4$ ; 650 fathoms,  $44^{\circ}.6$ ; 700 fathoms,  $42^{\circ}.8$ ; 800 fathoms,  $41^{\circ}.0$ ; 900 fathoms,  $39^{\circ}.2$ ; 1,400 fathoms,  $37^{\circ}.4$ ; and at the bottom of the sea, at a depth of 2,435 fathoms,  $36^{\circ}.5$ . Thus the temperature decreases very rapidly in the upper stratum of 50 fathoms depth; below that the decrease is slower, down to 700 fathoms, when it becomes more rapid again; but from 900 fathoms to 2,435 fathoms the decrease is only  $2^{\circ}.7$ . The first quick decline is caused by the action of the sun on the surface stratum; the second is consequent upon the immense volume of cold water resting on the bottom. From this it will be seen that in that deep descent of the ocean the temperature of the water approaches the freezing-point in a similar manner as in other parts, inclusive of the tropics, where still lower temperatures were found.

In the Rockall trough which branches off from the deep descent of the Atlantic ocean, and, passing east of the Rockall bank, trends towards the trough between the Faroe and the Shetland Islands, the same temperature is found at all depths greater than five hundred fathoms, as in the principal descent of the ocean, while at depths of less than five hundred fathoms the temperature is somewhat lower in the latter than in the former. Southwest of Iceland and west of Rockall an even temperature of  $44^{\circ}.6$  was observed down to a depth of three hundred fathoms; at that depth it was higher—about  $48^{\circ}$ .

Deep-sea temperature observations have not been obtained in the deep channel between Greenland and Iceland. As, however, it has at the surface in the summer a temperature of not more than  $44^{\circ}$  to  $46^{\circ}$ , a current from the Arctic setting to the southward through it, and as, farther south, on the sixtieth parallel, the temperature of the sea at three hundred fathoms is lower than on the same parallel farther east, it may be assumed that this channel (the Danish strait) contains cold water coming from the Arctic basin, along the east coast of Greenland.

There is a plateau with from two hundred to three hundred fathoms water over it, between Iceland and the Faroe Islands. Judging from the relations existing in the strait between the Faroe and the Shetland Islands, the temperature at the bottom of this part of the ocean can hardly go down to the freezing-point, the water not being exposed to cooling by cold lower

strata. In the Faroe-Shetland channel, and northeast of Iceland, however, water of a temperature of  $32^{\circ}$  F. is found at the depth of from two hundred to three hundred fathoms, while in the adjoining part of the Atlantic Ocean the temperature at the same depth is  $46^{\circ}$  and more. Whether there is cold water from the Arctic Ocean, or warm Atlantic water in the narrow and deep trough between Iceland and the Faroe Islands, depends on whether this trough has its source in the Polar Sea or in the Atlantic Ocean. This incision, however, is so narrow that the water running through it cannot essentially cool down the strata above it, even if it were icy cold. In the absence of definite observations it may therefore be assumed that the Iceland-Faroe channel contains warm Atlantic water. The stream sets on the surface to northeast.

If, in the southwestern corner of the Faroe-Shetland channel, which has been thoroughly examined by the Porcupine expedition, a cross-cut is made through the Holtenia ground from northwest to southeast, the two parts will show very different temperature relations. Icy-cold water will be found on the northwestern side, at a depth of less than three hundred fathoms, as if it were pressed against the Faroe bank; the temperature at the bottom being  $30^{\circ}.6$ , and the stratum from two hundred to three hundred fathoms also much cooled down. In depths of less than two hundred fathoms the temperature is  $45^{\circ}.5$ , little less than in the vicinity. Between the Faroes and the Holtenia ground the water at the bottom is some degrees above the freezing-point, and in the southeastern part of the strait, in the vicinity of the Hebrides, the temperature at 200 fathoms is  $47^{\circ}.3$ ; at 300 fathoms,  $46^{\circ}.4$ ; at 520 fathoms,  $44^{\circ}.6$ ; at 600 fathoms,  $42^{\circ}.8$ ; and at the bottom, in 650 fathoms,  $41^{\circ}.4$ . Thus, in the extreme part of the channel, towards the Atlantic, the warm Atlantic water preponderates, being, however, somewhat colder than in the corresponding depths of that ocean, while the northern mouth of the channel contains, at greater depths, partially cold water. Other relations exist not far to the east of this northern mouth. The warm water is by degrees pushed to the surface and the entire lower stratum contains icy-cold water, which, farther to the east, extends from the bottom to the depth of three hundred fathoms. Otherwise the relations are similar to those at the mouth of the channel, north of the Holtenia ground. In the center of the northeastern extreme, about half-way between the Faroe and the Shetland Islands,  $46^{\circ}.4$  has been observed at a depth of 25 fathoms,  $44^{\circ}.6$  at 125 fathoms,  $42^{\circ}.8$  at 160 fathoms,  $41^{\circ}$  at 180 fathoms,  $39^{\circ}.2$

at 200 fathoms,  $37^{\circ}.4$  at 220 fathoms,  $35^{\circ}.6$  at 240 fathoms,  $33^{\circ}.8$  at 260 fathoms,  $32^{\circ}$  at 320 fathoms,  $30^{\circ}.2$  at 500 fathoms, and on the bottom, in 640 fathoms,  $29^{\circ}.8$ . The entire lower stratum has a temperature below the freezing-point, the influence of which is shown by the rapid decrease of the temperature of the strata at depths from one hundred to three hundred fathoms. The warm water of the Atlantic is proved here to be compressed into a stratum of but three hundred fathoms in depth. On the southern side, toward the Shetland bank, the curve of  $44^{\circ}.6$  descends rapidly to the depth of three hundred fathoms, showing a preponderance of oceanic water in that region, while at the Faroe Islands the icy-cold water is found at a depth of less than three hundred fathoms. In general the English explorers have found that the water at the bottom is on an average of the same temperature as that of the high sea at the same depths.

The North Sea and the English Channel contain, on account of their limited depth, only warm water. The western part of the Greenland Sea, the surface of which is nearly throughout the entire year covered with drift-ice, while farther north firm ice remains for a number of years, contains probably only cold water, from the surface to the bottom. In the entire space between Scotland, Iceland, Spitzbergen, and Norway, the warm water of the Gulf Stream preponderates on the surface. At the southern extreme of this region, however, near the Faroe and Shetland Islands, icy-cold water is found at a depth of three hundred fathoms. The deep-sea temperature observations do not extend off the Norwegian coast so far into the high sea, and not to such a depth, as to meet the cold polar water beneath the Gulf Stream. The observations to a depth of two hundred fathoms, however, do not point to as rapid a decrease of the temperature at greater depths as has been found in the Faroe-Shetland channel. The banks off the coast evidently contribute to sustaining a high temperature of the sea. The higher north, the colder is the water at the same depth, but even in the latitude of the North Cape the icy-cold water does not appear to reach up to a depth of three hundred fathoms. There is icy-cold water of an almost even temperature at depths from two hundred fathoms downward, late in the spring, northeast of Iceland, on the left border of the Gulf Stream, where the latter probably forms a sharp wall to the northwest. North and west of it are the cold waters of the Arctic Sea, which farther south descend beneath the Gulf Stream and partially find an outlet in the lower half of the Faroe-Shetland channel.

West of Spitzbergen, in the open trough extending along it, Scoresby made in the month of June the remarkable observation that the temperature increased downward, being, at 200 fathoms,  $36^{\circ}.3$ , and at 761 fathoms,  $38^{\circ}.1$ ; this was in latitude  $79^{\circ}$  N.; about twenty-five miles west of Spitzbergen. There the cold water of the Arctic Sea ascends to the surface, while warmer water remains beneath it. No decrease of the temperature was observed there, even at a depth of seven hundred and sixty fathoms, and still less was there any indication of the vicinity of icy-cold water. However, as the depth of the sea is there about one thousand five hundred fathoms, it is not improbable that a great stratum of cold water may be beneath the warmer. From this it is evident that the lower border (the bottom) of the Gulf Stream, accepting as its temperature that of the freezing-point, after having been, beyond the Faroe-Shetland channel, pressed to the surface, descends again, on its further course north, toward the western side of Spitzbergen. This corresponds well with the results of the temperature observations on the coasts of Norway.

North of Spitzbergen, in latitude  $81^{\circ} 20'$  N., longitude  $18^{\circ} 42'$  E. of Greenwich, Captain Ulve observed, September 11, 1871, at the surface,  $34^{\circ}$ ; and at a depth of 300 fathoms,  $42^{\circ}$ ; the water being blue. The Gulf Stream may therefore be followed in the lower strata, west and north of Spitzbergen, up to the border of the polar ice, which has not yet been penetrated.

In the shallow Nova Zembla Sea the greatest depth of water, obtained by sounding, on the plateau between Bear Island and Norway, is two hundred and seventy fathoms, up to which the cold polar water would hardly ascend. The warm water spreads over the surface of this shallow part of the sea, and, thinning out, extends more and more to the north and the east until finally it occupies the entire sea between East Spitzbergen and Nova Zembla. That this warm stratum retains its temperature so long, notwithstanding its small volume, is evidently the result of the shallowness of the sea, which does not permit a large, cold stratum to penetrate beneath it.

Combining these features, we see, first, the deep basin of the Arctic Sea filled from the surface to the bottom with an immense mass of cold water, bounded south and east by the warm waters of the Gulf Stream, beneath which it penetrates as far as the European coast. The principal outlet of this to the lower strata of the Atlantic Ocean is by the deep Greenland-Iceland channel. Between Iceland and the Faroe Islands the shallow sea

prevents its progress, and only the narrow lower part of the Faroe-Shetland channel enables it to push along. Outlets southward are barred by the banks around the British Islands, the shallow North Sea, and the banks off Norway; to the eastward they are opposed by the banks between Bear Island and Norway.

On the other hand we see an enormous mass of warm water pushing onward from the deep Atlantic Ocean, and extending over the shallow sea between Iceland and the Faroe Islands, and over the Faroe-Shetland channel, thence passing the Norwegian coast and continuing in two branches, of which the narrower but deeper flows along the west and north coast of Spitzbergen, while the other, the shallower but wider, expands over the entire Nova Zembla Sea. The left border and the bottom of the Gulf Stream are formed by the icy-cold waters of the Arctic Sea; the right border consists of the bottom of the North Sea, with the shoals in connection with it, and of the Norwegian coast from Cape Stadt to the Russian boundary. The temperature of the Gulf Stream is highest on the surface, close to the Norwegian coast, decreasing in shell-shaped strata downward, as well as toward the Arctic Sea, until it reaches the freezing-point. This formation is borne out by my observations on the coasts, where, in the summer of 1871, I found at the bottom of the harbors the same low temperatures which are met seaward only in depths of two hundred fathoms.

The deep-sea observations in several Norwegian Fjords which, like the Skagerak, are very deep and protected by outlying banks against the water of the deep Atlantic, prove that they contain water from the Gulf Stream; they appear to be filled with it down to the bottom, even if this lies deeper than the icy-cold bed of the Gulf Stream outside of the coast region. The water of the West Fjord had, in the summer of 1868, when it was examined by the steamer *Hansteen*, at depths from 100 to 320 fathoms, an even temperature of  $44^{\circ}.6$ , while outside of the Lofotes the observations of the corvette *Nornen*, in July, 1871, showed, at a depth of 35 fathoms,  $44^{\circ}.6$ ; and at 215 fathoms,  $39^{\circ}.2$ . At about the same time I found on the bottom of Bodö harbor, at the depth of 9 fathoms, a temperature of  $41^{\circ}.7$ . In the innermost branch of the Hardanger Fjord, Professor Sexe found, August 23d, 1871, the temperature  $43^{\circ}.7$  at a depth of from 100 to 200 fathoms. The steamer *Hansteen* observed, southwest of Lindesnes and Lister, from June to August, 1871, at depths of 150 fathoms,  $44^{\circ}.6$ , and at 250 fathoms,  $42^{\circ}.8$ , which is but a small decrease downward compared

with the Faroe-Shetland channel, where the temperature decreases at the same depths from  $42^{\circ}.8$  to  $33^{\circ}.8$ . The Norwegian Fjords are evidently protected against the cold water of the Arctic Sea by the banks; otherwise the temperature of the water of the Fjords would be considerably lower, and Norway would not possess its happy mixture of land and sea climate.

The temperature relations of the deep sea in the winter are less known than in the summer. In the winter a constant cooling process takes place from the surface downward, and the quantity of heat is much diminished by it. On the whole, however, the same relations will exist at the greater depths, as in the stratum from two hundred to three hundred fathoms the temperature appears to be the same throughout the year. In the north-western part of the Greenland Sea, and in the stratum beneath the Gulf Stream, there is exclusively icy-cold water, while the Gulf Stream flows between Iceland and Scotland, and along the Norwegian coast. On the polar side it is probably somewhat compressed, especially on the surface, where the water, cooled down at night, rests on the warmer sub-surface water. On the coast of Norway the cold temperature of the land acts upon the surface and the upper strata of the sea the more powerfully the nearer to the shore, so that the temperature of the sea increases with the depth, as has been proved by observations, through several years, on the banks of Aale Sound, and by last year's observations on the herring grounds, north and south of Bergen, and in the trough off Lindesnes and Lister. On the Aale-Sound bank the temperature was found to decrease again at greater depths. The axis of the higher temperature of the Gulf Stream is, by the cooling influence of land, pushed to the surface from the land seaward. As soon, however, as this axis is approached, various indications point, according to the observations obtained on board the steamer *Bienenkorb*, in 1870, to an increase of the temperature with the depth, as it was found to be  $1^{\circ}$  to  $2^{\circ}$  higher at the depth of one hundred and fifty to two hundred fathoms than on the surface. Similar results were obtained in December, 1870, near Aasw ar, in the Northland. Scoresby observed, in the Spitzbergen Sea, in April, at depths of from 40 to 230 fathoms, a nearly even temperature of a little more than  $32^{\circ}$ , increasing but slightly with the depth.

Accepting as the form of the Gulf Stream that of isothermal planes, (planes of strata of water of the same temperature,) its form would approach nearest to that of a small flat-boat, widest at the stern, deeper in the middle, and running out to a rounded point. The stern-part of the

flat-boat, like the Gulf Stream, is formed by a vertical cross-cut from Iceland to Scotland, the longitudinal section by the axis of warmth running along the coast of Norway. The port side, toward the Arctic Sea, is longer than the starboard side along the Norwegian coast. In the summer the starboard side is pushed almost up to the latter coast, while the port side consists of vertical walls, inclining but slightly seaward, and the keel descending deeply at Spitzbergen. In the winter the starboard side is thirty miles in width, with borders, in the parts nearest to the coast, at the surface strongly inclined inward, while the strata of water in the center and on the borders toward the Arctic ascend almost vertically, and the keel, near the bow, almost represents a stem, ending in a point formed by the isothermal lines of this season at the surface. In general, only the part of the sea west of Norway, and partly of Spitzbergen, can be thus represented.

The warm waters of the Nova Zembla Sea may be compared with a horizontal wedge, the base of which lies between Spitzbergen and Norway, with the sharp edge toward north and east.

[From Dr. Petermann's "Mittheilungen," vol. for 1872, page 384 et seq.]

## II.

### THE NORWEGIAN CRUISES TO NOVA ZEMBLA AND THE KARA SEA IN 1871.

The cruises of Norwegian walrus hunters and sealers have been noticed preliminarily on page 17 of the first and page 22 of the second supplement to the "Papers on the Eastern and Northern Extension of the Gulf Stream." The following fuller accounts are from the journals sent by them to Dr. Petermann in Gotha:

1.—*Cruise of Captain F. C. Mack, May 22 to October 7, 1871—Circumnavigation of Nova Zembla.*

Captain Mack left Tromsö May 22, passed on the same day the North Cape, and met the Kolgujev ice-belt on the 25th, in latitude  $71^{\circ} 12' N.$ , longitude  $40^{\circ} 00' E.$  The ice, about three feet thick, lay close and was impenetrable. On this kind of ice the Norwegians find their prey; they therefore seek it instead of avoiding it. The temperature of the air had fallen, by degrees, from  $46^{\circ}.4$  to the freezing-point; that of the surface of the sea from  $39^{\circ}.2$  also to the freezing-point. Within the ice the lowest readings were, (on the 30th of May, in latitude  $70^{\circ} 42' N.$ , longitude  $44^{\circ} 34' E.$ ), air,  $24^{\circ}.8$ ; sea,  $28^{\circ}.4$ . On the 8th of June, near the same place, part of the day firmly incased in ice, and the rigging frozen stiff, the temperature of the air was  $28^{\circ}.4$ , that of the water,  $29^{\circ}.3$ . In latitude  $71^{\circ} 50' N.$ , longitude  $47^{\circ} 23' E.$ , about eighty miles from the coast of Nova Zembla, the ice disappeared.

After visiting Kostin Sharr, Mack followed the coast which, in part, was bordered by ice, southward to the Kara Strait which he passed on June 14, but had to re-pass again, on account of compact and firm ice, of from six to seven feet in thickness, blocking his further progress in the Kara Sea. He then sailed north, along the west coast of Nova Zembla, and reached Cape Nassau on July 2. In this stretch, of about five hundred miles, hardly any ice was met, near the shore or at sea. On the 24th of

June the inner parts of Cross Bay only were covered with firm ice, and a few pieces of drift-ice lay north of the Admiralty peninsula, in latitude  $75\frac{1}{4}^{\circ}$  N. Off Matotschkin Shar, on June 23, the air had a temperature of  $41^{\circ}.9$ , the water of  $32^{\circ}.9$ ; on the islands of Cross Bay forget-me-nots, butter-cups, and other flowers were found, notwithstanding the firm ice and the snow-drifts; and the temperature of the air rose there, on June 28, to  $46^{\circ}.4$ , and that of the water to  $34^{\circ}$ .

On July 3 Mack came to anchor at the Gulf Stream Islands, and remained there until the 2d of August. During all that time the ice drifted to northeast, with very great velocity during southwesterly winds. The temperature of the air rose, July 8, to  $46^{\circ}.4$ ; on the 9th, to  $50^{\circ}.9$ , (the ground-ice in the vicinity of the ship melting rapidly, above and below the water;) on the 19th, to  $57^{\circ}.2$ ; on the 20th, to  $53^{\circ}.6$ ; and on the 21st, to  $62^{\circ}.6$ ; the mean, from the 3d to the 31st, being  $38^{\circ}.8$ ,  $2^{\circ}.5$  higher than in Kamenka Bay on the southern coast of Nova Zembla, six degrees of latitude farther south, and about the same as at the meteorological stations at Shallow Bay and in Matotschkin Shar, which lie directly in the throat of the Gulf Stream. Mack found on these islands glass balls and other objects, drifted there from the fishing-places on the Norwegian coast, as also the bean of the West Indian plant *Entada gigalobium*—an unerring proof that the Gulf Stream of the Florida Strait reaches up to these islands, which were named by the Norwegians, very properly, "Gulf Stream Islands."

On July 23, the first mate, the harpooner, and two sailors were sent to Mack Harbor, at the head of which they ascended Lippert Mountain, two thousand feet high, from whence Cape Nassau, the Great Ice Cape, and the southern coast to the Kara Sea were in full sight. The sea, between Cape Nassau and the Great Ice Cape, appeared to be full of drift-ice.

August 3, Mack left the Gulf Stream Islands, rounded in a gale accompanied by thick fog the Great Ice Cape, passed the Orange Islands, and reached, on the 4th, Cape Mauritius, where the fog decreased, and farther on, east of Nova Zembla coast, entirely disappeared. No trace was left of the ice, seen from Lippert Mountain between the Gulf Stream Islands and Cape Mauritius, except in the inner recesses of Beautiful Bay. In the journal for July we find repeatedly recorded: "The ice disappears rapidly under the influence of the sun." The ground-ice also, two feet above and two and one-quarter feet below the water, had disappeared entirely on July 25."

Intending to push on a southeast course farther into the Kara Sea, Mack came, on August 5, with prevailing easterly winds, into extensive fields of drift-ice, compelling him to haul closer to the land, where he found an open channel of from sixteen to twenty miles in width; but farther south, to and beyond latitude  $76^{\circ}$  N., there was, at the end of August, much drift-ice; farther south however it disappeared entirely. Between the parallels of latitude  $76^{\circ}$  and  $77^{\circ}$  N., *thousands of white whale were seen going east.*

On the coast, near the Noltenius Creek and in Barents Bay, Mack also found Norwegian glass balls, proving that the Gulf Stream reaches even the easternmost shores of Nova Zembla.

On the 29th of August, while sailing from Barents Bay to Hooft-Hoek, the land was found to be entirely clear of ice, which, notwithstanding the prevailing easterly wind, had drifted E. N. E. and N. E. A heavy swell from southeast to south indicated that the Kara Sea was free of ice.

September 6, Mack sailed easterly to the meridian of  $71^{\circ} 38'$  E., finding the sea almost entirely clear. He says in his journal: "I cannot conceive where the ice, which lay here on August 24, can have gone; there must be here a strong current." The temperature of the air was  $39^{\circ}.9$ , that of the water  $37^{\circ}.4$ .

After having landed at Hooft-Hoek for flensing his animals, Mack sailed, on September 10, to the eastward, and made, thus late in the season, and in this so much decried and unknown sea, in less than two days, two hundred and fourteen miles, reaching, on the 12th, his easternmost point, latitude  $75^{\circ} 25'$  N., longitude  $82^{\circ} 30'$  E. *In this entire distance there was nowhere a trace of ice, and the temperature of the air rose to  $42^{\circ}.8$ , and that of the water to  $44^{\circ}.2$ .* He says: "It was my intention to sail to the mouth of the Päsina, in order to ascertain whether white whale and walrus resorted there. Having read, however, in Middendorff's book, that that river, like others of Northern Siberia, was covering with ice as early as September 8, and as the darkness of the night began to endanger the navigation in these waters, of which the charts are so very imperfect, and as, moreover, I was getting short of provisions, I deemed it prudent to turn back, *although there was no trace of ice to be seen, September 12, in the direction of the Siberian coast.*

Sailing north, on the 13th, *as high as latitude  $77^{\circ}$  N., the sea was found to be everywhere free of ice.*

From Barents Bay Mack started homeward, on the 15th of September, through the Kara Sea, in the direction of the Kara Strait, and met drift-

ice on the 27th, consisting partly of new ice of but two inches in thickness, which, with a strong wind, broke up and disappeared. East of the ship's course, through the center of the Kara Sea, the water remained clear to the last week of September, even with prevailing northerly and easterly winds, and Yugor Strait was reached on September 25. On the passage from Barents Bay to Yugor Strait, September 15 to 25, the temperature of the air fluctuated between  $41^{\circ}$  and  $26^{\circ}.6$ , and that of the sea between  $35^{\circ}.6$  and  $29^{\circ}.3$ . On the 20th, in latitude  $72^{\circ}$  N., rain fell for half the day.

After leaving Yugor Strait, some drift-ice was met in latitude  $70^{\circ}$  N., between longitudes  $51^{\circ}$  and  $55^{\circ}$  E.

On October 7, Mack came to anchor off Tromsö.

2.—*Cruise of Captain E. H. Johannesen to the northeasternmost coast of Nova Zembla and in the Kara Sea, June 10 to November 3, 1871.*

The journal of Captain E. H. Johannesen begins at sea, between Tromsö and Nova Zembla, on June 10, 1871. On the following day he reached the coast at the Southern Goose Cape; from thence to the 28th he sailed along the west and north coast to Bear Cape, visiting numerous bays, nowhere molested by ice. Cape Nassau he passed on the 25th. In order to ascertain how far off the coast the drift-ice lay, he sailed north to latitude  $77^{\circ} 10'$  N., meeting it at a distance of from forty to fifty miles from the coast. He then cruised between Cape Nassau and the Orange Islands, when, finding firm ice beyond, he came to anchor on the 2d of July. On the following day he made, with Captains Tobiesen and Dörma, an excursion to the coast, and ascended a mountain 1,400 feet high, which he named Dörma Peak. Another mountain, southwest of the former, ascertained to be 1,072 feet high, was named Tobiesen Peak. Around the Orange Islands, and about ten miles northeast of Cape Nassau, the ice lay quite thick; between the two points it was more or less diffused, and was navigable, as it was found to be by Captain Mack. In this part Johannesen obtained good observations and bearings of the principal points of the coast, and also numerous soundings with the deep-sea lead.

From the 30th he followed the western coast southward, without meeting ice, and entered, on the 9th of August, Matotschkin Strait, where he met Rosenthal's expedition in the *Germania*, with von Heughlin on board. Finding the eastern outlet blocked by ice, he left the strait and sailed south,

reaching Kara Strait on August 26th, where he also encountered drift-ice. He then beat along Vaigat's Island to Yugor Strait, where he anchored on the 31st, as the eastern part of it was likewise blocked by ice which, driven by easterly winds from the Kara Sea, had accumulated off the three straits.

After cruising the entire month of September off the Kara Strait, Vaigat's Island, and Yugor Strait, Johannesen sailed, although so late in the season, for a third time along the west coast of Nova Zembla as high north as Russian Harbor, beyond Cape Nassau, where he came to anchor on October 15. Along the whole distance the sea was free from ice; the shore, however, from the Northern Sulmenjev Bay (latitude  $74^{\circ} 25'$ ) downward, was everywhere covered with snow. On the return southward, from Russian Harbor to Suchoi Noss, (October 16 to 19,) there was no trace of ice seen; only at about five miles north of Cape Nassau, was "a snow-cover over the sea," and "an ice-horizon" at the Hump Islands, (latitude  $76^{\circ} N.$ )

A distance of two hundred and thirty-five miles, sailed in the three days, from October 16 to 19, in a small craft, is a sure proof of a clear sea.

On the 28th of October the vessel passed the North Cape and entered Tromsö November 3.

Johannesen has, by this bold cruise, proven the fallacy of the prejudice that navigation in this high latitude, so late in the season, is impracticable, not only on account of the formation of new ice covering the sea firmly, but also from the autumnal gales.

### 3.—*Captain Tobiesen's Explorations of the sea between Nova Zembla and Spitzbergen. June 11 to September 7, 1871.*

Captain Tobiesen's cruise is the most important of all in 1871, as he not only traversed the Nova Zembla Sea, in an arc toward the north, for weeks earlier than Wyprecht and Payer, but also reached the northeast coast of Nova Zembla as early as the 26th of June, earlier than any navigator before him.

The journal begins on the 11th of June in the Kolgujev belt of ice, from whence he cruised in the open sea up to latitude  $75^{\circ} N.$ , then sailing north. He made the two hundred and forty-eight miles, from the bay south of the Admiralty peninsula to Cape Nassau, in two days, (June 25 and 26,) a remarkable passage for so small a craft thus early in the season, and in that respect one of the most important in the Arctic Sea. He then

anchored in Beautiful Bay, east of the Great Ice Cape, where he remained from the 27th of June to the 6th of July. Although considerable ice was around the ship, the mean temperature of the air was, even here, and under such circumstances, from June 27 to 30,  $32^{\circ}.2$ , and from July 1 to 6,  $33^{\circ}.5$ .

On his return west, Tobiesen kept nearer in-shore, sealing in the ice which, on going north in June, lay between his course and the land, from which it had parted in the beginning of July, and had now drifted around into this region. This ice became, between Bear Cape and the Gulf Stream Islands, so close as to beset the vessel completely, (on the 12th,) although the temperature was in the mean  $36^{\circ}$ , rising for a few hours to  $44^{\circ}.6$ . The vessel remained stationary until the 18th. On the 19th, still beset in the ice, she drifted with it ten miles, in a northeastern direction; on the 20th four miles farther, nearly close to Bear Cape; on the 22d, eight miles to the north, until, on the 23d, she was set free; the temperature in the meanwhile rising steadily, for a time as high as  $48^{\circ}.2$ . On the 27th Cape Nassau was again passed, and on the 29th Maschigin Bay entered, but little ice having been met with in the last two days.

After leaving Maschigin Bay, Tobiesen made, in the short time from the 7th to the 15th of August, the brilliant passage to Spitzbergen, on an arc extending to latitude  $78^{\circ} 07' N.$ , nearly as high as Weyprecht penetrated, ( $78^{\circ} 43'$ ), five hundred and ninety miles in eight days, in a small fishing-craft. Only once (latitude  $78^{\circ} N.$ , longitude  $40^{\circ} E.$ ) he met drift-ice. The temperature of the air during these days rose as high as  $57^{\circ}.2$ , and that of the sea to  $41^{\circ}.9$ . *Such is the nature of this sea, which for centuries was believed to be absolutely unnavigable and always replete with immense walls of ice.*

After cruising, from the 16th of August to the 7th of September, around Hope Island and within the Thousand Islands, Tobiesen closes his journal.

#### 4.—*Captain H. Ch. Johannesen's cruise to the North coast of Nova Zembla.*

*June 9 to August 8, 1871.*

The journal begins in the vicinity of Vardö, on June 9, with an observation of the temperature of the air of  $49^{\circ}.3$ , and of the sea of  $45^{\circ}$ . The first ice was met on June 10, in latitude  $71^{\circ} 43' N.$ , longitude  $41^{\circ} 57' E.$ , and on the 17th the coast of Nova Zembla was reached at the Southern Goose Cape. Johannesen then followed the entire west coast without seeing any ice. On the 25th he reached Cape Nassau, and on the 27th the

Gulf Stream Islands. From the latter he sailed northeast to within ten miles of the Great Ice Cape, near which, in latitude  $77^{\circ}$  N., he again mentions ice, which had not been seen anywhere else on the north coast, agreeing with Tobiesen's records of the preceding day. On the return "Ice all around" is recorded in the diary, close to Cape Nassau, on the eastern side of it. On the western coast, however, ice was not seen until the 8th of August, but high temperatures were observed, for instance, August 6, in latitude  $74^{\circ}$  N. air,  $65^{\circ}$ ; sea,  $43^{\circ}.3$ . On the 8th of August Jöhannesen anchored in Matotschkin Shar, where the journal closes.

This cruise also is an evidence of the possibility of easy navigation to the northeasternmost coast of Nova Zembla as early in the season as June, and proves that the sea there may then be completely free from ice.

5.—*Captain J. N. Isaaksen's cruise to the Northeast coast of Nova Zembla.*  
*June 6 to October 6, 1871.*

Captain Isaaksen left Tromsö June 6, observing at Sorö Island (latitude  $70\frac{1}{2}^{\circ}$  N.) a temperature of the air of  $57^{\circ}.2$ , and of the sea of  $44^{\circ}.4$ . The first drift-ice he encountered June 11, in latitude  $71^{\circ}.5$  N., longitude  $45^{\circ} 37'$  E., with a temperature of the air of  $34^{\circ}.3$ , and of the sea of  $29^{\circ}.7$ . On the 22d he reached the Southern Goose Cape, from which he sailed along the west coast to Cape Petermann, reaching it in six days, and on the 28th he came to anchor in Richthofen Bay.

This excellent journal proves, even with greater certainty than the others, the absence of ice, at that time, along the extensive west coast of Nova Zembla; only at a single point, north of the Admiralty peninsula, "now and then small bay-ice strips" are recorded. On Cross Island (latitude  $76^{\circ}$  N.) Norwegian glass balls were found, evidently drifted there.

After rounding, on July 2, Cape Petermann, the vessel came to in a small bay, near the Barents Islands, (probably between Scheda and Höfer Islands,) where she remained to the 22d, occupied with sealing. There the following observations in regard to the ice were recorded:

Evening of July 3: "Great flakes of land-ice drifting with great rapidity to northeast."

July 4, forenoon, to July 5, afternoon: "Some ice to seaward; again great flakes are drifting northeast."

July 5 at midnight: "Wind W. N. W. Close ice all around and over the entire sea. At 4 a. m., beset by the ice."

From then to July 10, it is recorded in all watches, "the packed ice consists of great land-ice flakes."

July 13: "Temperature  $37^{\circ}.6$ ; the firm ice in the bay begins to melt."

July 15: "The ice somewhat moving."

July 16 and 17: "The ice packed again, the wind having changed to N. W."

July 20: "The pack-ice begins to part."

July 21: "The firm ice in the bay becomes weaker and thinner."

July 22: "The ice leaves the land slowly."

July 23, 8 a. m.: "Free from ice, we left the bay."

Notwithstanding the immense mass of ice in the bay and all around outside, the temperature of the air was, from July 2 to 22, in the mean,  $39^{\circ}$ , and it was probably mainly this high temperature which thinned, by degrees, the packed ice, and finally caused it to diffuse and disappear.

The remainder of July Isaaksen cruised between the Barents Islands and Nordenskiöld Bay, the temperature remaining as high as, "air,  $50^{\circ}$ ; water,  $41^{\circ}$ ." He then sailed again north and returned to Barents Island, where he remained from the 3d to the 5th of August. From the latter date to the 10th he cruised between Cape Petermann and Cape Nassau, where he still found a few pieces of drift-ice; and after passing Cape Nassau came to anchor east of it on the 11th. The mean temperature at this anchorage on the 11th and 12th was, air,  $45^{\circ}$ ; water,  $34^{\circ}.2$ .

On the 13th and 14th Isaaksen sailed through "a sea free of ice" to Beautiful Bay, east of the Great Ice Cape, the mean temperatures being, on the 13th, air,  $48^{\circ}.2$ ; water,  $35^{\circ}.2$ ; and on the 14th, air,  $41^{\circ}.5$ ; water,  $33^{\circ}.6$ . No drift-ice was seen, only a few pieces of glacier-ice. In the bay the mean temperature of the air on the 15th was  $43^{\circ}.7$ ; of the water,  $34^{\circ}.5$ .

In the evening of the 15th Isaaksen started east. At the northeasternmost point of Nova Zembla (Cape Mauritius) he found "a current setting east with great velocity." Off Begheerte Hoek, where he remained at anchor from the 17th to the 21st, no ice was seen on the shore, but, according to other accounts, considerable ice was lying at a distance of from twelve to sixteen miles from the shore. On the 22d he sailed to Hooft Hoek, remaining there until the 24th, and then in a southeast direction to an ice-border, trending north and south. From the 3d to the 6th of September, however, no trace of ice was seen between Hooft Hoek and Begheerte

Hoek, notwithstanding the steady E. N. E. and east winds, accompanied by a heavy swell from N. E. The temperature of the air rose to  $50^{\circ}$ , that of the sea to  $39^{\circ}$ ; the means being, on September 3, air,  $39^{\circ}.7$ ; water,  $36^{\circ}.5$ ; September 4, air,  $44^{\circ}.4$ ; water,  $38^{\circ}.1$ ; September 5, air,  $36^{\circ}.9$ ; water,  $38^{\circ}.7$ ; September 6, air,  $38^{\circ}.1$ ; water,  $38^{\circ}.1$ . On September 6 Isaaksen started homeward. After rounding Cape Mauritius, he remained on the parallel of latitude  $77^{\circ} 10' N.$  to the meridian  $64^{\circ} 00' E.$ , thence he steered toward Trost Cape (east of Russian Harbor,) rounded Cape Nassau, entered a second time Richthofen Bay, where he remained from September 11 to 19, when he sailed on a southwesterly course directly for Tromsö, where he arrived October 6. Off the Orange Islands he again records, September 7: "The stream sets uninterruptedly northeast. Temperature of air,  $43^{\circ}.5$ ; of water,  $38^{\circ}$ ." There was no trace left of the immense masses of drift-ice, which had in July covered the region between Cape Nassau and the Great Ice Cape; neither was there any new ice. In Richthofen Bay the temperature of the air fell, between September 11 and 19, from  $41^{\circ}.9$  to  $27^{\circ}$ ; that of the water from  $41^{\circ}.9$  to  $34^{\circ}.3$ ; the mean of the nine days being, air,  $32^{\circ}.4$ ; water,  $37^{\circ}.8$ ; nine snow-squalls are recorded after September 13. The sea remained at a high temperature up to Tromsö, it even rose to  $43^{\circ}.3$ ; that of the air, however, did not rise higher than  $41^{\circ}$ .

On the 23d of September, in latitude  $74^{\circ} N.$ , longitude  $43^{\circ} 25' E.$ , with a temperature of the air of  $37^{\circ}.6$ , and of the sea of  $39^{\circ}.2$ , "a great number of whales and herrings all around" are recorded.

Auroræ boreales were not seen before September 24, after which they are recorded on October 1, 2, and 3.

6.—*Captain Sören Johannesen's cruise to the north coast of Nova Zembla and the Kara Sea, June 10 to October 27, 1871.*

In this cruise the Kara Sea was traversed twice in a meridional direction, beyond the parallel of latitude  $77^{\circ} N.$ : first in the beginning of September, from south to north, and again in the end of September, from north to south.

The journal begins on the 10th of June, in latitude  $70^{\circ} 07' N.$ , longitude  $35^{\circ} 42' E.$  Johannesen met the first ice in latitude  $69^{\circ} 37' N.$ , longitude  $40^{\circ} 26' E.$ , and reached the Southern Goose Cape on the 22d, whence he sailed along the west coast, past Cape Nassau, anchoring in Russian Harbor on the 30th, where he remained to the 13th of July. On the 5th the ice set into the bay, which was full of it from the 8th to the 13th.

On the 14th he started from Russian Harbor southward, first through diffused ice to the Hump Islands, and then in clear water to Matotschkin Shar, where he arrived on the 8th of August and remained to the 21st, when he followed the coast southward, entering Kara Strait on the 26th. There, and on his further course through the Kara Sea, in a northeast direction, he had to work through ice until the 2d of September, in latitude  $72^{\circ}$  N., longitude  $67^{\circ}$  E., after which he saw no trace of ice to September 20, in latitude  $77^{\circ} 15'$  N.

After beating, on the 3d and 4th of September, along the Samojede peninsula to its northwestern point, and then passing White Island, he sailed to latitude  $75^{\circ} 34'$  N., longitude  $72^{\circ} 54'$  E., and from there he made, in a single day, the 8th of September, through a sea entirely free from ice, the distance of one hundred and twenty-two miles, to the vicinity of Begheerte Hoek.

From there he cruised, between the 8th and 17th of September, along the northeast coast, eastward to longitude  $72^{\circ} 40'$  E., southward to latitude  $76^{\circ}$  N. and northward to  $77^{\circ} 15'$  N., not seeing anywhere a trace of ice, and he had prepared to return homeward around the north coast of Nova Zembla, when, on the 18th, a gale from the west, and drift-ice, which he encountered near the Orange Islands, prompted him to prefer the return through the Kara Sea. This he traversed in eight days on a course first southwest, then along the coast to the Pachtussov Islands, thence southeast into the open water, through which Captain Mack had sailed three days previously, then south, and finally, on September 27, into the Kara Strait.

His course and the observations prove that the fields of ice, along which Mack had sailed, on a southerly course, from the 18th to the 22d of September, consisted of broken and navigable drift-ice.

The Kara Strait was passed in a gale and Tromsö entered on the 27th of October.

7.—*Captain Simonson's cruise to Nova Zembla and in the Kara Sea. May 13 to September 14, 1871.*

Captain Simonson left Tromsö on the 22d of May, the temperature of the air being  $47^{\circ}.3$ , and that of the sea  $41^{\circ}.9$ , and sailed first to Vardö, where he remained from the 24th to the 26th. The mean temperature at the latter place for the three days was, air  $38^{\circ}.7$ , and water  $38^{\circ}.7$ . On the 30th of May he encountered the first drift-ice of the Kolgujev ice-belt, in latitude

70° 20' N., longitude 38° 40' E., into which he penetrated, cruising and partly drifting within it, throughout the month of June, up to the west coast of Kolgujev Island and the Kanin peninsula. The observations, obtained six times each day, proved the highest temperature of the month to be: air, 57°.2, (on the 13th in a calm;) water, 34°.3, (June 1;) and the lowest: air, 29°.1, (6th;) and water, 30°.2, (13th.) From Kanin peninsula he sailed on the 1st of July north, first along the west coast of Kolgujev Island, and then along its north coast to Nova Zembla, reaching the latter, at Meshdusharskij Island, on the 8th of July. The ice ceased twelve miles north of Kolgujev Island, and no trace of any was seen to the coast of Nova Zembla.

Thence sailing south, Simonson found Kara Strait so closely blocked by ice that he could not pass through it; there was also much ice farther southward, toward the Pechora mouth, "thicker than the ice at Spitzbergen," retarded by which he did not arrive at Yugor Strait until the 26th. After passing through the latter, he pushed, on the 27th, about sixty miles into the Kara Sea. The ice there was, however, as yet quite compact, some fields being a mile square, and so thick that it lay on the ground in ten to fifteen fathoms, so that he was compelled to return to Yugor Strait and to try another course farther north, on which he succeeded, until the 8th of August, in working through the thick pack-ice which extended twenty miles from the shore, and on the 11th, in latitude 70° 26' N., longitude 64° 50' E., he was "almost free from ice."

On the 14th of August, in latitude 71° 30' N., longitude 66° 16' E., twenty miles from the Samojede peninsula, the journal records: "The ice here is completely rotten, lying on the sea in thin shells, resembling foam." North and west of this point no ice at all was seen, with the exception of a small, thin strip, just dissolving, toward the coast. In this vicinity Simonson cruised to September, when he returned to Yugor Strait.

The gradual decrease and final disappearance of the ice off Yugor Strait, and from there, in a northeasterly direction, toward the mouth of the Obi, and the corresponding temperature relations, are striking and interesting. The farthest point reached by Simonson (August 17) was, latitude 72° 14' N., longitude 67° 18' E., only one hundred and eighty-six miles from the northeastern outlet of Yugor Strait, between which points he cruised, the entire month of August, hunting walrus. On investigating all the temperature ob-

servations, the following means are obtained between the various parallels of latitude and meridians. Temperature of the air: south of  $70^{\circ}$  N.,  $39^{\circ}.4$ ; between  $70^{\circ}$  and  $71^{\circ}$  N. for each degree of longitude from west to east, respectively,  $39^{\circ}.2$ ,  $42^{\circ}.6$ ,  $41^{\circ}.9$ ,  $42^{\circ}.1$ , and  $37^{\circ}$ ; between  $71^{\circ}$  and  $72^{\circ}$  N.,  $43^{\circ}$ ,  $43^{\circ}$ , and  $43^{\circ}.9$ ; north of  $72^{\circ}$  N.,  $48^{\circ}$ . Temperature of the sea at the surface: south of  $70^{\circ}$  N.,  $34^{\circ}$ ; between  $70^{\circ}$  and  $71^{\circ}$  N.,  $34^{\circ}$ ,  $34^{\circ}.5$ ,  $34^{\circ}.3$ ,  $35^{\circ}.4$ , and  $36^{\circ}.9$ ; between  $71^{\circ}$  and  $72^{\circ}$ ,  $37^{\circ}.4$ ,  $32^{\circ}$ ,  $38^{\circ}.1$ , and  $37^{\circ}.6$ ; north of  $72^{\circ}$  N.,  $37^{\circ}.6$ .

From latitude  $71^{\circ} 21'$  N., longitude  $56^{\circ} 30'$  E., (September 1,) it took Simonson four days to reach Yugor Strait, and he met ice again forty-five miles north of it. It had not disappeared entirely in this region throughout the summer. The temperatures on this track decreased gradually from  $43^{\circ}.7$  (air) and  $38^{\circ}.9$  (sea) to  $35^{\circ}.6$  (air) and  $35^{\circ}.4$  (sea.)

There was so much ice in Yugor Strait that Simonson labored in vain from September 5 to 14 to push through it, and in the night of the 14th and 15th the vessel was driven by a gale on a bank, where she broke up. The crew, papers, and instruments were saved.

8.—*Captain Carlsen's cruise, May 22 to November 4, 1871.—Circumnavigation of Nova Zembla.*

Captain Carlsen left Hammerfest May 22. After having to contend against gales and snow-storms from the N. and N. N. W., while rounding the northern coast of Norway, he passed Vardö on the 28th, and met the first ice on June 10, in latitude  $68^{\circ}$  N., longitude  $40^{\circ} 36'$  E., at the northern mouth of the White Sea.

On the 13th of June he passed Kanin Noss, and on the 16th he met two other ships, one of which had killed 500, the other 1,000 seal. The ice-border, near which seals generally are found, trended from Kanin Noss north. The first appearance of walrus is mentioned in the journal on the 22d of June, at a short distance northwest of Kolgujev Island, where firm ice lay on the 26th. Russian vessels were employed sealing near the island, and there were always some vessels in sight. Seal were plenty.

On July 9 Carlsen reached the coast of Nova Zemla at Meshdusharrskij Island. Thence he sailed north along the coast, meeting again with drift-ice on the 22d of July, in latitude  $75^{\circ} 38'$  N. On the 27th he was in latitude  $77^{\circ} 05'$ , longitude  $60^{\circ}$  E., where he found Jan-Mayen seal in great numbers.

There is no mention of the ice in this locality, other than that at midnight the vessel was made fast to a great block of ice.

On July 28 he returned southward to the Pankratjev Islands; he then passed Cape Petermann and Cape Nassau, sighted the Gulf Stream Islands and entered Beautiful Bay, after which, following the coast, he rounded Cape Mauritius, and on August 18 he anchored off Hooft Hoek. Much rain is recorded about this time in the journal. On the 24th, while pushing south beyond the parallel of latitude  $76^{\circ}$  N., considerable drift-ice was met at a distance of ten miles and more from the land, and Carlsen returned on the 29th to the anchorage off Hooft Hoek, where he remained to September 3, collecting fire-wood on the shore and hunting walrus; four were killed in one day; in another, two seal and two polar bears; again, five seal, &c.

The discovery of the winter-quarters of the Dutch expedition of 1597, from the 7th to the 14th of September, has been narrated in the First Supplement to the Papers of the Eastern and Northern Extension of the Gulf Stream, page 17.

September 14 Carlsen started from Ice Harbor homeward through the Kara Sea, along or near the east coast of Nova Zembla. The first day he passed "some-icebergs;" on the 16th, about twenty-four miles from shore, "a great quantity of ice, which probably had parted from the shore with the westerly and northwesterly winds;" on the 17th, in the forenoon, "much drift-ice coming from the shore, new ice forming between the floes;" on the 18th, in the evening, "the water froze so that the ice had to be cut through." On the 19th is recorded, "The ice so close that we could hardly move; a breeze springing up in the afternoon from the S. W., we began to work toward the land, cutting through the ice at the bow;" and on the 20th, "we cut through the ice, which was so thick as to bear our weight; by 8 p. m. we succeeded in reaching an open place nearer the shore."

On the 21st, in about latitude  $74^{\circ}$  N., a gale blowing from the N. E., the vessel was completely beset, and drifted with the ice S. W. during the following two days; open water, however, was seen from the cross-trees to the N. E. and E. On the 24th and 25th she partially drifted or was towed southward, whenever the ice opened, and progress was made in the same manner up to the 30th, when, in about latitude  $72^{\circ} 25'$  N., open water was reached, only sixty miles, however, in width, when there was again drift-

ice up to Kara Strait, which was passed on October 3. Farther south, near Vaigat's Island, walrus were seen in great numbers. From the latter island Carlsen followed the coast of Nova Zembla to Meshdusharrskij Island, whence he stood west for the open sea. He reached Hammerfest on November 4.

9.—*A. Rosenthal's exploring expedition to Nova Zembla, July 8 to November 3, 1871.*

Although this expedition was, in the main, a failure, as it did not succeed in entering the Kara Sea, the following account of it by Von Heuglin, the naturalist, (published in the *Geographische Mittheilungen* for 1872, p. 21,) will be found interesting and instructive.

Prevailing strong northeasterly winds detained the expedition several days in the harbor of Hammerfest. On the evening of the 26th of July, with a remarkably high temperature of the air, it fell nearly calm, enabling the *Germania* to steam out (at 10½ p. m.) on a northerly course. Soon the northwest point of Kualö (the island on which Hammerfest lies) was rounded, when we hauled to the N. E. for Rolfsö Sound; thence we steered through the Breed Sound, between Havö and Hjelmö, then through the Mösö and Magerö Sound, E. by N., for Svärhottsklubben and toward Nordkyn. The channels are mostly narrow, and the straits bordered by steep and bald, but not high, primitive mountain-rock; there are but few valleys, with small groups of fishing-huts or farm-buildings. Flotillas of fishing-boats lay in the more narrow and shallow places. This region had a very wintry appearance, drift-snow lying deep on some of the plateaux, and especially in the ravines. About midnight of July 27 and 28 we doubled the point of Nordkyn, latitude 71° N. The breeze from N. by E. had freshened considerably and the sea was uncommonly high, boarding the vessel frequently. Notwithstanding this, we had to cease steaming in order to save coal.

In two days the gale and sea moderated; polar birds swarmed around the vessel, especially gulls, petrels, and ducks, and, singly, the *Lestris pomatorhina* and *longicauda*. The wind, however, remained adverse until the 2d of August, when it veered for a short time to the northwest. On that day the vessel crossed, on the parallel of latitude 73° N., the meridian 35° E., and on the following day, 40° E. The air remained, for the most part, rough,

foggy, and wet; the temperature of the beautiful Labrador-blue water fell at the surface from  $46^{\circ}.4$  to  $39^{\circ}.2$ . Several sword-fish and fin-back whales came near the vessel.

At noon of the 7th we should, by our reckoning, have passed east of the meridian  $50^{\circ}$  E., and the depth of water should have been about 100 fathoms, while soundings with the Bulldog lead gave no bottom at 110 fathoms. The air was clear, so that observations could be obtained. Soon the fog set in, but it cleared again at 3 p. m., when the snow-covered mountain-tops were seen in the east, appearing, on account of the refraction, higher than they really are, and of strange formations.

Steam had been again used for the last days. Many thousand *Uria Bruennechii*, with smaller flocks of polar swallows and sea-gulls, covered the smooth surface of the sea. At midnight of August 5-6th observations of the sun were again obtained, while the great pale moon rose from behind the mountains of Nova Zembla.

Twenty-four miles west of Lütke's "first-seen mountain" (Perwousmotrennaji Gora) the lead gave seventy fathoms dark-gray sticky clay. From there it decreases pretty gradually. Steaming through Mushroom Bay, N. by E., we found the dirty-olive colored water of a temperature as high as  $46^{\circ}.4$ .

A uniform flat coast, apparently without vegetation, extends from Mushroom Bay northward to the strait which divides Nova Zembla. We had not met thus far any drift-ice; only along the borders of the west coast were here and there piled up masses of ice of considerable size. Higher up the mountains, and in the valleys and ravines, were seen snow-fields of greater extent. Glaciers do not appear to exist on the western side of the South Island.

The entrance into Matotschkin Sharr is difficult to discover without a pilot. The landmarks mentioned by Admiral Lütke (Pankov Island and Pillar Cape) are hardly visible at a distance of eight miles. The terraces of the Mitjuschew Kamenj, three thousand feet high, the island of the same name, the isolated peaks on both sides of the Tschirakina River, and Walrus Cape can be distinguished more readily. Pillar Cape (Myss Stolbovi) is hardly higher than thirty-six to forty-eight feet, and is but the steep termination of the above-mentioned coast plateaux. Immediately in front of the cape stands, with some smaller rocks, a mass of rock resembling a *pillar*,

or a baker's oven, which has given to the small cape its name. Ram Cape (Baranji Myss) also is only a low head surrounded by shoals.

The *Germania* anchored in the evening of August 6 in the middle of the strait in twelve and one-half fathoms, opposite the eastern part of the mouth of Tschirakina River, which is six miles in width, but entirely barred by sand, and one and one-half miles E. by N. of Ram Cape. The current in Matotschkin Shar always runs west; and with easterly winds and the returning flood the velocity is as great as six miles. The anchorage proved secure against wind and sea, and the holding-ground good. Drinking-water and drift-wood are found at the mouths of several rivulets. Notwithstanding the late hour, we went in a boat to the Tschirakina. Two attempts to enter one of the branches failed, on account of shallows, and we kept eastward for the wreck of a Russian vessel, surrounded by the bones of reindeer, foxes, and seal. From there the coast ascends in terraces formed by hills to the coast-mountain ridges, one thousand five hundred to two thousand feet in height. The ground consists of mold mixed with sand and fragments of rock, especially quartz and slate. Here and there a bank of the latter, of mica-graywacke, extends to the shore. Pankov Island, with some rocks near the western arm of the Tschirakina mouth and at Ram Cape, belong to this formation. There are probably also mountains of the stratum formation in the vicinity, as indicated by a decomposed belemnite, (*Belemnites obsoletus*,) which we found near Black Cape, (Tschornoi Myss.) The foreland is serrated by deep water-ravines, but nearly dry. There are no peat-fields. A comparatively very rich, many-colored, and variegated vegetation develops on the lower land, especially in protected places where humus has accumulated. Compared with the Spitzbergen flora, lichens and moss are here inferior. Abundantly represented, and generally in groups, are the *Saxifragæ*, *Drabæ*, *Ranunculi*, *Caltha*, *Dryas*, some fine *Cruciferae*, a splendid *Polemonium*, two species of *Myosotis*, some *Oxytropi*, a great *Composita* (*Nardosmia*,) several creeping willows, and a rich growth of grass, which extends for miles. As regards lower animals and fishes, the strait is comparatively poor; the variable temperature of the sea-water and the violent current may be the cause.

Of water-fowl, numerous flocks of geese were seen, and their excrements covered large stretches of the shore. Long strings of ice-ducks (*Harelda glacialis*) fished for worms and mollusks in the mouths of the river, and in

the shallow, more quiet parts of the sea. Eider-geese (*Somateria spectabilis* and *Somateria mollissima*) in company with *Cephalus Mandtii* hatched on isolated rocks or carried small fish to their young brood. The higher rocks, at Silver Cape, were swarming with *Uria Bruennechii*. Among them were burgomaster and ivory gulls as well as the sharp and flat tailed prey-gulls. On the wet parts of the shore and around the snow rivulets were various plover, sea-strand snipe, and on the wet meadow dwarf-snipe, (*Tringa minuta*.) Flocks of snow-birds flew around the rocks on the shore; and on the dry meadows and heath were the alp-larch, (*Otocorys alpestris*.)

Of sea mammalia there are here, besides several species of seal, the walrus and the white whale; of land mammalia, the white bear, the ice-fox, the reindeer, and a species of leming, (*Myodes torquatus* or *pallida*,) living in families in caves dug by themselves; they are hunted by the fox and prey-gull.

I could not make extended excursions from Ram Cape, as it was important to proceed east as soon as the wind would permit; we visited, however, Black Island, the region around Silver Cape, the ruins of the winter station of Pachtussov, on the steep shore near the western branch of the mouth of the Tschirakina, and a lake some miles south of them.

In the mean time three vessels of the brothers Johannesen, of Tromsö, had arrived from Cape Nassau. They had not as yet been successful in hunting, being prevented by heavy drift-ice from pushing northeast, and it was now their intention to attempt reaching the Kara Sea by the Matotschkin Shar; they anchored a few cables north of us. Smaller masses of packed ice had, on the 8th of August, drifted through the strait to westward. At noon of the 10th a field of drift-ice, about half a mile in width, came from the east directly toward our anchorage. Luckily steam had been started an hour before; there was not, however, a sufficient quantity for going ahead; and, on account of the stormy weather and the narrow channel, the master did not dare to make sail. The ice caught hold of the chain, and, although more was payed out, the vessel was carried by the ice more than a mile, and we could not free her by steam before we were compelled to slip the chain.

An attempt, in the evening, to sail farther into the strait failed on account of the head wind and the strong current, the engine not being powerful enough to stem it, while the other three vessels succeeded easily in beating east. One of them grounded, but soon got off without aid.

On the following morning the wind slackened down enough to permit us to proceed. The farther east, however, the vessel went, the thicker became the drift-ice. High mountains of bald, bluish-gray and light-brown slate, in wavy layers, approach here close to the shore. Great masses of snow lay everywhere in the higher valleys, and a small glacier comes down from the north directly to the sea, in a deep ravine east of Walrus Cape; it is split on the surface in branches and runs out on the high back of a moraine. The two side walls are quite steep, and near the eastern part of the foot, separated from it by a rivulet, are banks of moraine débris which testify to the glacier having been of considerable width. A smaller glacier was seen in a high valley near Crane Cape.

A large mass of ice was fast between this and Turn Cape, at a place where the depth of the narrow channel is but from five to seven fathoms, while farther fifteen fathoms can be carried close to the shore. Through this ice we had to break by force, where we could not navigate around it.

It soon became foggy, with rain, after Sulphur Cape (Myss Sserny) was sighted. Frequently sounding, we entered Seal Bay (Saliw Tjulenji) at 6½ p. m.; this is a branch of the extensive Belushja Bay (Saliw Beluschja) on the north shore of the Shar. Seal Bay is an excellent harbor, protected on the south by a low, sandy bar, and W. by N. by a peninsula, one and one-half miles in length, of an irregular mass of slate and graywacke, the point of which must not be approached too close. The depth of water is from seven to fifteen fathoms, the bottom being firm clay and slate débris.

On the peninsula are the ruins of a winter station with some graves, probably of Rosmyslow's expedition. From it the deep Belushja Bay extends about four miles inland. In its center are several rocks of compact mica-slate, with quartz leads, which contain beautiful crystals, lime-spar, sparry iron ore, and rhomb-spar. Mr. Stille, my companion, who examined and sounded the entire bay in a boat, found at its northwestern end the wide mouth of a river, through which he passed into a second basin, large enough for a number of ships. Belushja Bay was quite free from ice, while one of the mates, who was sent to examine the eastern mouth of the Matotshkin Shar, reported that it was completely barred by a firm wall of ice, between Bull Cape (Myss Byck) and Outlet Cape, (Myss Wychodnoi,) and that also the Kara Sea was covered with ice as far as could be seen from the heights near the coast.

Expecting that the wind would finally veer from the northeast quarter, from which it had blown so long, to another, we remained in this vicinity until the 20th of August, visiting Gubin Bay and another bay to the west of the latter, in which the Tarassowa empties. The rough weather did not prevent excursions and researches. Messrs. Aagard and Krogh fished and botanized diligently. I made repeated excursions inland, especially in an eastern and northeastern direction from Seal Bay, where I found numerous lakes with small fish and crabs. We killed some reindeer, seal, and foxes, discovered the remains of a wolf, caught collar lemmings, and came to two fresh roosts of snowy owls, which stately birds are by no means rare on Nova Zembla. Besides these species of animals, in addition to some polar gulls, and of plants a species of *Chrysosplenium*, of *Taraxacum*, of *Rhodiola*, and a beautiful *Epilobium*, we collected but little new. One of our men reported having seen a grouse, the existence of which in Nova Zembla is corroborated by previous visitors.

On the morning of the 15th the brothers Johannesen, who had not succeeded in pushing into the Kara Sea, attempted to return west. But a great quantity of ice had drifted meanwhile from the east into the strait, by which one of the yachts was thrown on the strand and the two others compelled to return to Gubin Bay. The stranded vessel was dragged off after three days' hard labor by all of the crews, but she had lost her anchor and chain, and her keel and starboard side were damaged.

Several attempts of the *Germania* to push east failed completely, even after the wind had veered to the west for a short time on the 18th. Two days later we landed between Wood Cape (Myss Drowänoi) and Bull Cape, not far from the winter hut of Rosmyslow, where an immense quantity of drift-wood lay piled on the flat shore; of this as much was collected as could be stowed. Mr. Stille and myself followed the coast to the south of the quite well preserved hut, about three miles, to the mouth of a rivulet flowing in a very deep ravine. A dense, cold fog prevented a view seaward; near the shore lay or drifted large blocks of drift-ice, between which one of the yachts tried to beat, but returned after a short time. At 4 p. m. the sky cleared and numerous ice-floes of various size could be seen, especially from the direction of Outlet Cape, which appeared to be beset, drifting into the Shar and filling the strait in a short time between Gubin Bay and Sulphur Cape. The masses of ice appeared to have been put in motion very

quickly, but the possibility of entering Kara Sea was still very uncertain, while, on the other hand, the retreat out of the strait might be barred within a few hours. We therefore adopted what we saw the brothers Johannesen doing, and steamed west as quickly as possible.

Not without difficulty and great labor we succeeded in reaching Crane Cape, whence we sailed unmolested past Pillar Cape and Pankov Island, southward through Mushroom and Nameless Bays. The peninsula between the latter and Moller Bay appears as a long, low table-land close down to the sea. The land around Moller Bay shows the same character, but instead of one there are several plateaux separated by valleys. It was impossible to distinguish from the ships with the naked eye the promontories of Cape Dimitrijev, the two Karmakuli, and Chramzow Island.

On the 22d of August the *Germania* sailed along the Gooseland, (*Gussinaja Semlja*), which forms quite a uniform plateau, three hundred to four hundred feet in height, running southward. At 3 p. m. of the same day she doubled Cape Podressow; at 5 p. m. she sailed around the island of the same name, and an hour later, in a heavy squall, around the north point of Jarsow Island and into Kostin Schar, where she came to for the night, not far from the Iron Door, (*Schelesnyjie Worota*.) A boat sent out to reconnoiter found but little drift-ice and fished a full barrel of petroleum, evidently American, which doubtless had drifted there with the Gulf Stream.

At noon of the following day the ship passed a tongue of land near the northeastern shore of the Great Meshdusharrski Island, not laid down on the charts, from whence, leaving numerous rocky islets to the right, she kept for the Wassov Islands, which she passed to the west, and from Dolgoi Island steered N. E. by N. for the Nechwatowa mouth. The shore of this part of Nova Zembla is uniform, consisting of bald and frequently vertical cliffs with several small bights between them. To the N. E. a mountain-ridge is seen, of peculiarly serrated and steep contours, running down from north to south.

Farther east a number of Russian and Samojede vessels were met at anchor in the narrow cleft through which the Nechwatowa empties. The entrance is marked by an off-lying rocky islet, of grayish color, over which eight crosses are planted, and also by a mountain S. E. of it, six hundred to eight hundred feet in height, of reddish, earth-gray color, and readily distinguished by numerous rocks of sugar-loaf form rising above it, often in

groups resembling a ridge. We came to anchor outside of the harbor proper, between it and Nechwatowa Island. I immediately landed near a small bight where the Russian fishermen had staked their nets for catching salmon.

On the following morning we rowed through the mouth of the river into a great lake-like basin, in which also numerous nets were laid. Thence we followed for nearly a mile the many windings of a very narrow canal, formed by vertical cliffs, into a second basin, the extreme limits of which could not be seen even from the hills in the vicinity. This region is, in general, a flat and wavy table-land, with numerous valleys, ponds, and lakes. It was quite free of snow, and appeared, with the exception of isolated plains of morass and meadow, and a few favored spots, more bald than the shores at Pillar and Ram Capes. We found, however, numerous plants, not met with on the Matotschkin Shar: an umbellifera, several compositæ, blooming yellow and velvet-brown, various grasses, &c. In the alluvial hills is found the petruschka, (*Myodes obensis*), and a second and larger species of gnawer is said to live higher up the mountain. Of birds, besides those previously mentioned, are the hunting-falcon, (which I believe I have also seen on the Matotschkin Shar,) various species of ducks (among them *Anas fusca*) and the little singing swan, (*Cygnus Bewickii*.)

The Nechwatowa, the clear water of which is salty for several miles inland, the flood-tide entering its mouth with great power, is reputed to be one of the best places for taking the highly esteemed alpine salmon, (*Salmo alpinus*.) This beautiful fish, of a silver-gray ground-color, with a reddish-white belly and yellowish drops at the sides, generally weighs from four to eight pounds; the tender and fine flesh is also of a reddish-salmon color. The fish arrives in the mouth of the Nechwatowa principally in August and September, and many Russians and Samojedes assemble there at this time, catching them with large nets, consisting of several chambers. Seal and the white whale, which follow this fish high up the rivers, are also caught. In favorable summers a ship may obtain 18,000 pounds, which bring, salted, in the markets of Kem, Archangelsk, and Mesen, four to eight silver rubles (three and three-fourths to seven and one-half dollars) per pood, (thirty-seven American pounds.)

Of the vessels lying here at anchor, those from the White Sea were mostly fine schooners, while those of the Samojedes, likewise two-masted, were

much smaller and of very primitive construction, hardly giving any protection against cold and bad weather. The single parts, even planks, are connected by straps of walrus or seal skin, and iron is rarely found in them. Still less seaworthy are the boats of the Samojedes.

Samojede families winter sometimes on Nova Zembla for the purpose of hunting and fishing. After securing their vessel, (lodje,) they erect a high conical tent of reindeer-skin. The household goods consist of skins, cooking-utensils, and a few tools. A number of sleigh-dogs, which are also used for hunting, linger around the camp. These animals bear in their type some similarity to our Pomeranian or Spitz dog; they are, however, larger and more powerful, with thick, long, and somewhat shaggy hair, generally black; below white with yellow stripes. They are rather spiritless, obstinate, not much attached to their master, and by no means watchful; their hoarse barking is rarely heard. Refuse of fish is their food; if seal is plentiful, each of the dogs is tied to the skinned body of one of them until it is devoured.

All the Samojedes whom we met during our stay in Nova Zembla and in Vaigats Island, had genuine Mongolian features. They are small, but of strong build, and particularly broad-shouldered; they have quite low foreheads, extended cheek-bones, small and dark eyes, broad noses squeezed in the middle, large mouths, with a scant black moustache, and very little hair on the chin and cheeks; the hair on the head is long, thick, straight, and also of dark color. Squinting and other faults of the eye add frequently to the beauty of the yellow-brown face. Most of the men speak a little broken Russian. Their clothing consists entirely of seal and reindeer skin. A conical fur cap is worn on the head. Each wears over the lower garments and the long fur boots a shirt of the same material, reaching down to the knee, with a capote at the back part of the neck, gathered at the waist by a broad leather belt, with copper ornaments, in which they carry a knife with a copper-mounted handle and scabbard. The garments of the women, who are by no means attractive, are really tasteful. The head is generally uncovered. The color of the face is lighter, often even remarkably ruddy, as is also that of the children, many of whom have nice curly heads. The long black and bushy hair of the women is tied together over the crown and hangs unbraided, frequently ornamented with beads and metal buttons. The cut and kind of the garments are similar to those of the men, but the fur

is finer, and more care and ornaments are spent on the over-garments, which consist of a nice white-bordered fur-jacket and a longer coat, composed of three or four horizontal stripes of green, red, or yellow woolen stuff each laced by a wide band of white reindeer or bear skin.

Our sojourn in the Nechwatowa was but short, as we left on the evening of the 24th. The master intended to attempt entering the Kara Sea through Yugor Strait, and the vessel was steered S. by E. through the southern part of the Kostin Shar. South of the latter the temperature of the sea was, at the surface,  $41^{\circ}$  to  $42^{\circ}.8$ , and at a depth of sixty fathoms  $32^{\circ}.5$ .

On the evening of the 26th we should have been, by our reckoning, near Ssachanicha Bay, whence the favorable wind would have carried us in twenty-four hours to the mouth of the Pechora. Without sighting the land, although the lead gave but seven to nine fathoms, the master hauled around to N. E. and E. into from fifteen to thirty fathoms. Observations on the 27th, however, showed that the vessel had been set some degrees to the west, evidently by steering an erroneous course in consequence of a too great proximity of the steering-compass to the steam-chimney, which had been lowered to the deck for facilitating the maneuvering of the vessel. On the 29th a flat coast was seen to the southward. On the morning of the 30th we were north of Dolgoi Island, and in the afternoon the Great Vaigats Island came in sight, six days after leaving Kostin Shar. The color of the sea, which thus far had been greenish olive-brown, assumed a sea-green tint. Great flocks of wild geese traveled southwest along the coast. An extensive bay, (Ljamschina Bay,) with several groups of islands in it, opened before us, into which the Germania steamed. The water shoaling, the master reduced steam, but, before it could be checked, the vessel grounded on a bar of débris with so little water over it at high tide that each object on the bottom could plainly be distinguished. Only by hard labor, and after throwing overboard all the ballast and removing the provisions to a small, rocky islet in the vicinity, was she got off on the succeeding high water, which luckily rose from four to five feet higher than that previous. While the provisions were being shipped again, I visited a rocky islet on which I had seen, the evening before, some walrus. A great quantity of kelp and some mytilus, with remains of large crustaceæ, lay on the shore. The character of the islands, geological and landscape, is quite uniform. They consist of dark limestone of the coal-formation, almost without

organic remains, forming numerous caves in the cliffs to seaward, which generally are very steep, sometimes showing indistinctly a horizontal stratification and frequently interwoven by strings of hornstone and lime-spar, rhomb-spar, dolomite, and pearl-stone. The few petrifications found were corallinæ of the species *Michelinia* and *Favosites*. On the cliffs thrives a beautiful sedum, amidst compositæ, with yellow flowers. On moist places and over the layers of turf are fine pastures, with a luxuriant growth of grass; other places are covered by the cloud-berry, (*Rubus chamæmorus*), which, however, is but stunted, and bears fruit only exceptionally.

The master had made for Vaigats Island to collect drift-wood for fuel, of which but little was found in Ljamschina Bay.

On September 1 the vessel was headed for Yugor Strait. Cape Pyrkow soon came in sight, and then the cliffs of Cape Grebeni, overtopped by a Russian cross. The mouth of the strait is six miles in width, and through the middle of it runs a quite strong current to the west. Extensive ice-fields surrounded Cape Pyrkow, and near the west point of the island lay five Norwegian vessels at anchor, among them two of the brothers Johannesen. The latter had left Matotschkin Shar at the same time as the *Germania*; they had also sailed for Vaigats Island, and had entered the Kara Sea through the Kara Strait which they had found nearly clear of ice. But soon after, the ice advancing from the east drove them back; two were hardly able to save themselves, the third was separated. They had arrived off Yugor Strait three days before us, and found that the ice prevented all progress; they therefore intended to sail again north along the west coast of Nova Zembla.

In the afternoon of September 1 the *Germania* came to, one and one-half miles north of the mouth of the river Nikolskaja, which, like its neighbor the Ojo, has its source in the Pæ Choi, the northwesternmost spur of the Samojede Ural Mountain ridge. Northwest of our anchorage a low tongue of land makes out from Vaigats Island, covered apparently at spring tides. Many banks and shoals fringe this point. The island itself has no considerable heights. The foreland of the southern shore of the Yugor Strait is also flat, bordered behind by low plateaux ascending in terraces; only to the eastward and southward there are two apparently not very extensive mountain ridges trending northwest.

Rowing to the shore, we saw on the strand several log cabins and Samo-

jede tents, as also a number of high crosses. This small summer station lies close at the mouth of the Nikolskaja, on its western shore, on the edge of the Tundra, in a truly forbidding desert. One of the log houses is a small Russian chapel, consisting of two compartments, an ante-chamber and the church, the latter about eighteen feet in length, and as broad. The back wall is covered by ornaments, candelabra, wax candles, and pictures, the latter partly framed in wrought silver. Among the oil paintings is a fine old head of Christ. The other walls are bare, and there are no other church vessels or prayer-chairs. On the western part of the strand, among several crosses, stand three other log houses, roofed with bark and sod, and around them were a rope-walk, barrels, boxes, nets, reindeer-sleighs, &c. Near them on the meadow stood several groups of Samojede tents of reindeer-skin or birch-bark, surrounded by dogs, skins, sleighs, and a considerable number of reindeer, coupled together.

The Russian traders from the Pechora were almost all under the influence of liquor; they at first tried to prevent the Samojedes, who appeared to be their servants, from approaching us. To avoid difficulties we crossed the river, which is here about forty paces in width, and went along the shore eastward about two miles to a second water, nearly as large. Low, dark slate rocks approach here close to the sea. Here is a narrow and flat beach, partly sandy and partly marshy, bordered by a terrace twenty to thirty feet high. The Tundra proper is marsh land, with a variegated vegetation of a peculiar rusty-olive yellow tint, especially when seen from a distance. The flora is similar to that of Nova Zembla and Vaigats Island. I found, however, some species not indigenous there. Of mammals I obtained, besides many lemmings, one arvicola; marsh-birds (*Eudromias*, *Charadrius auratus* and *hiaticula*, *Tringa minuta* and *variabilis*, with other species, which I could not obtain,) were very numerous, as also water-birds, (the burgomaster gull, and a dark-colored species of the same size, broad-tailed prey-gulls, ducks, geese, and black-throated polar divers.) Of land birds, only one snow-owl, the rusty-throated piper, and the alpine lark, with small flocks of snow-birds, were seen.

On the 3d, the *Germania* being molested by drift-ice, we moved to the Vaigats shore, on which there were several groups of Samojede tents. The interior of the island is mostly marsh with innumerable water-pools, around which thousands of lemmings (*Myodes obensis*) were swarming; they

have furrow-channels in the light, always moist moss-cover of the Tundra, and little lairs lined with dry grass.

When we returned to the shore, the vessel had lifted her anchor in order to move out of the way of the ice, which drifted in increasing masses from the east, and threatened to close around her. Its violence broke one of the flanges of the screw-propeller, and we narrowly escaped being stranded. The engine had to be kept in motion until the morning, when we stood to sea, and again sailed for Ljamtchina Bay, where more drift-wood was gathered, an anchor repaired, and a spare propeller fitted.

In the mean time we made several excursions on Vaigats Island, where we daily obtained new specimens, especially plants, birds, (*Anthus cervicalis*, *Lestris pomatorina*, *Anas glaciales*, among them *Penelope*, *Mergus serrator*. *Calidris arenaria*, *Phalaropus cinereus*, several *Tringa* species, &c.,) and sea animals.

The Ljamtchina Bay is of considerable extent in a S. W. and N. E. direction; the northeasternmost cape, terminating in a small tongue of land, separates it from another bay. A number of greater and smaller creeks, outlets of lakes, empty into Ljamtchina Bay. The cliffs consist of the old limestone mentioned before, which forms interesting caves. The island has no stationary inhabitants, but there are everywhere traces of men to be found. Families of the migratory tribes of the Tundra cross each year the Yugor Strait with their reindeer, which find here luxuriant grazing-grounds; others come in their boats, (lodjes,) and even in canoes, for fishing or hunting seal and whales which visit the bays and mouths of the rivers in great number. In September, 1871, five hundred white whale were obtained by a few small boats within three days.

On the morning of September 7 we weighed anchor and sailed, with a clear sky and light breeze, northwest along the coast of Vaigats Island, and from Woronow northeast toward the Kara Strait. We soon came, however, upon ice, which, at first diffused but afterward in larger and firmly connected banks, was drifting west. Numerous sea animals were seen in the ice, especially Greenland seal in schools of five to fifteen head. There was also some pack-ice fringing the coast of Vaigats and the various rocks in the vicinity, while the masses floating through the Kara Strait increased in size so much that it became difficult to work among them. Several vessels were beating out of the Kara Sea, while we endeavored to keep steadily on

a northwest course. As we had not met any greater accumulations of ice, a week previously, off the southwest coast of Nova Zembla, or in the eastern part of the Russian Polar Sea, and only in Yugor Strait, it was evident that the ice now drifting through Kara Strait had packed off the eastern entrance of the latter, and having been loosened by the westerly winds which had prevailed for some time, was now carried away by the strong current. Under these circumstances an open road to the eastward might soon be expected. The Kara Sea is, as experience has proved, generally navigable at the end of July, and was so this year, as shown by the cruises of Mack, Carlsen, and others.

It had been the intention of the master of the *Germania* to make another attempt to enter the Kara Sea by the Kara Strait, and, if successful, to go to White Island, whence the vessel was to sail home, while he, in a boat, would ascend the Obi (the mouth of which he was instructed to reach) as far as Obdorsk, and then return home overland along the river and crossing the Ural. The vessel, however, having so disappointed expectations in her sailing and steaming qualities that a delay in her return homeward until the stormy month of November would have been hazardous, these intentions were abandoned, and the master withdrew from the ice September 9, steering W. by N. On the 11th and 12th land was repeatedly in sight to the north, and on the 13th we were, by dead reckoning, four miles south of Meshdusharsky Island, whence we proceeded west, at times under steam. Several flocks of birds, especially geese, some swans, snipe, and snow-birds, were seen flying southwest. We had at first to contend against head winds and snow-squalls, but in the night, from the 17th to the 18th, a strong breeze from E. by N. set in, which carried us in the forenoon of the 18th to Nordkyn, and two days after into Tromsö.

The results of the expedition for meteorology and navigation are: regular observations throughout the cruise, of the temperature and pressure of the air, of the temperature and salinity of the sea, magnetic observations, soundings, specimens of the bottom with the Bulldog lead, current; observations, determinations of positions, of the tidal hour, &c.

As regards the mammal-fauna of the regions visited by us, but little new was found. Spörer records, from the accounts of Von Baer and the notes of Russian expeditions, that only two species of seal are indigenous there, *Phoca leporina* and *Phoca hispida*. We found three, viz, *Phoca barbata*, *Phoca*

*Grænländica*, and *Phoca hispida*. The Greenland or saddle seal is, in fact, at times so very abundant, that a single vessel obtained within a few days twelve hundred head in the border of ice lying between Kolgujev and Kostin Sharr. On the main, near the Yugor Strait, we obtained a peculiar gnawer, probably *Arvicola obscurus*, *Eversm.* Interesting observations were also made of the habits of two species of lemmings living on Nova Zembla, of which I brought two home. One of them is the petruschka, (*Myodes obensis*), of which probably two varieties will be distinguished. The other resembles the *Myodes torquatus* of the Taimyr and the Boganida, but differs in many respects, especially as regards the summer fur, from the description given by Von Middendorff of the latter. Even in Spitzbergen lives a species of *Myodes*.

According to the Russian accounts and Gillet (Newton, Ibis, 1870, p. 303) only twenty-six species of birds were known in Nova Zembla. We were able to raise the number of species to forty-three, inclusive of some which hatch on Vaigat's Island, and must therefore be found on Nova Zembla. Of those heretofore unknown I will name only the alpine lark, (*Otocorys alpestris*), which even hatches on the northern island, the red-throated piper, the *Calidris arenaria*, the alpine and the dwarf mud-sniipe, (*Tringa variabilis* and *minuta*), the narrow-beaked water-bird, (*Phalacrocorax cinereus*), the whistle-duck, the long-beaked sawer, and the dwarf swan, (*Cygnus Bewickii*).

The sea around Nova Zembla, and the rivers, are very rich in fish, especially in alpine and Omul salmon. Besides these, we collected several species of the genera *Gadus*, *Liparis*, *Cottus*, &c., as also a number of crustaceæ, sea-conchs, echinoderma, worms, and bryozœ, numerous mallophagi, and entozœ.

The climatic relations are favorable for a remarkably rich and variegated vegetation. Not only lichens, mosses, and fungi thrive luxuriantly, but are also numerous, and in the greater part very succulent and vigorous; leaf-plants shoot into blossoms and fruit. Several willows and one species of birch represent the wood. Great areas are covered, meadow-like, with tender grasses, and the bottom of the sea is in places grown over by sea-weeds and algæ, sometimes of really gigantic size. Some attention might also be had to the geological relations. Slate, richly permeated by mica, and dolomitic graywacke, are fundamental in the regions visited by us; they frequently

contain quartz-lodes, in which rhomb-spar, lime-spar, and mineral crystals of considerable size occur, as also spar-iron and other iron ore. The slate formations in Matotschkin Shar attain an absolute height of three thousand four hundred feet. In Southern Nova Zembla and on Vaigat's Island is found sometimes, in horizontal strata, a dark-gray limestone belonging to the coal-formation and devoid of petrifications. Among the rocks of a rivulet, near Matotschkin Shar, a belemnite was found belonging to the Brown-Jura formation. There are also traces of volcanic activity, especially in the southwestern part of the southern island. Bituminous marl-slate is found in Yugor Shar.

Everywhere on the coast there is drift-wood, with other objects drifted there by the current and the ice. The eastern coast of Nova Zembla and the shores of Matotschkin Shar especially, are covered with green or rotten trunks of all sizes and forms. A number of specimens, selected in the various localities, were collected for examination.

The sea and coast of Nova Zembla have been thoroughly explored of late by Russian expeditions, and especially by the bold Norwegian fishermen. Johannesen, Mack, and Carlsen have circumnavigated Nova Zembla and shown that the Kara Sea is nearly every year entirely free from ice. The Norwegian vessels penetrate from year to year farther east and north, and they may even succeed in opening communications with the mouths of the Obi, Yenisei, and Paesina, by which probably a less expensive and less difficult outlet for the rich products of Western Siberia will be gained than the roads by the way of Tomsk, Tobolsk, and the Ural.

### III.

#### THE CRUISES IN THE POLAR SEA IN 1872.

##### 1. *Count Wiltschek's Expedition to Spitzbergen and Nova Zembla.*

Count Wiltschek, intending to co-operate during the summer with the Austrian expedition in the *Tegetthoff*, (see second supplement, page 27,) and having obtained the *Isbjörnen*, Weyprecht's and Payer's vessel in 1871 left Tromsö June 19th and entered Horn Sound, in Southern Spitzbergen, (lat.  $77^{\circ}$  N.,) on the 30th, where he remained till July 5th. No ice at all was encountered so far on the west coast of Spitzbergen; the east coast also appeared to be perfectly free, with the exception of some drift-ice coming down the Wybe Jans water. There was, therefore, a fair prospect of reaching Cape Nassau by the direct route, on about the parallel of lat.  $76\frac{1}{2}^{\circ}$  N. The vessel reached northeast of Hope Island without difficulty; there, however, the border of thick drift-ice was met trending southeast, compelling her to retrace her way and to follow that border to latitude  $73^{\circ}$  N., until she was able, near Nameless Bay, on the west coast of Nova Zembla, to break through and gain the open coast water. After a short stay at Matotschkin Shar the vessel started north for Cape Nassau, where she was to land reserve-stores for the Austrian expedition.

The mountains around Matotschkin Shar, rising on the coast to a height of from 2,000 to 3,000 feet, and in the interior even higher than 3,500 feet, showed but little snow and ice, and only a single glacier reached into the sea; but north of Cross Bay, beyond lat.  $74^{\circ}$  N., the snow appeared to be deep, and immense glaciers extended from the broad valleys.

There was again a belt of drift-ice to be broken through, beyond which the sea remained completely free, showing only an ice horizon to the N. W. and N. N. W. The weather had been quite favorable thus far, the thermometer rising sometimes, at noon, in the sun, as high as  $78^{\circ}$  F.

The *Tegetthoff* could hardly have been able to gain the open sea under so very unfavorable conditions of this year's ice; the course was therefore shaped so as to meet her, and on the morning of August 12th she was seen at a distance of a few miles, separated from the *Isbjörnen* by drift floes,

through which, however, communication by boats was practicable. The next morning both vessels lay anchored to a floe extending half a mile north and south off Barent's Islands, (lat.  $76^{\circ} 17' N.$ , long.  $60^{\circ} 44' E.$ ,) with the flat coast of Nova Zembla, bordered by low mountain ranges, in the background. There they remained until August 21st, landing the reserve-stores in sleighs on a small islet, after which the *Tegetthoff*, taking advantage of an opening to the N. E., proceeded onward, and the *Isbjörnen* homeward. Count Wiltschek expects that the *Tegetthoff* will have to make winter quarters at the Ice Cape, as Carlsen, her pilot, states that he never has encountered in this region a more unfavorable condition of the ice. Her commander is fully satisfied with the performance of the vessel, and all on board look forward enthusiastically to the successful solution of the problem.

On the homeward voyage the *Isbjörnen* was favored by wind and weather. On August 25th Goose Cape was made, and soon after the Pechora was entered, whence she started directly for Tromsö, after landing Count Wiltschek, with some of his companions, who proceeded home overland through Russia.

The researches and collections of Professor Höfer, the geologist accompanying Count Wiltschek, promise to lead to important results. He found, near Matotschkin Shar, at a height of 3,000 feet, petrefactions identical with those of the Ural Mountains, proving thus the incorrectness, not only of the present theories regarding the geological age of these strata, but also of the assumption of Professor von Baer, indorsed by the Petersburg Academy, that Nova Zembla is not a spur of the Ural, but of the Pai Choi. Another important result is the establishment of the fact that reindeer are not confined, as heretofore believed, to the south of Matotschkin Shar, but that they range as high as the Barents Islands.

## 2. *The discoveries of Altmann, Johnsen, and Nilsen east of Spitzbergen.*

The reports in regard to the land seen at various times east and north-east of Spitzbergen were reviewed in the second supplement on page 27 *et seq.* The cruises of the Norwegian fishing masters Altmann, Johnsen, and Nilsen afford a clearer knowledge at least of that part which is represented on the charts of older date as Wiche Land, and on the recent ones as the Swedish Foreland, (Giles Land,) or King Charles's Land.

Wiche Land, as seen 1619 by the English whaler Wiche, was gener-

ally shown between the parallels of lat.  $75^{\circ} 45' N.$  and  $78^{\circ} 18' N.$ , of far greater extent than the land now has proved to be, and even with the northern border to the southward of it. In recent times the land was first seen in July, 1859, by Carlsen and Tobiesen, who placed the southern coast in lat.  $78^{\circ} 33' N.$  (by observed ships' position and estimated distance,) and again in the summer of 1860 by Carlsen, from a position in lat.  $79^{\circ} 34' N.$ , and two miles off the east coast of Northeast Land, where what he took for the S. W. part (but which probably was the highest point near the north coast, Mount Haarfagrehaugen) bore S. E. by S., distant about 8 Swedish (32 nautical) miles; this would place it in lat.  $79^{\circ} 09' N.$  Tobiesen saw, in 1860, the western promontory (Swedish Foreland) bearing from the S. E. point of Northeast Land, S. E. by S. The Swedish expedition under Nordenskiöld took the bearings of the same land from the White Mountain in East Spitzbergen, placing it between the parallels of lat.  $78^{\circ} 50'$  and  $79^{\circ} N.$ , in about longitude  $28\frac{1}{2}^{\circ} E.$ ; and von Heughlin, in 1870, took bearings from Mount Middendorff, on the southern coast of Freeman Strait, where the center bore N.  $66\frac{1}{4}^{\circ} E.$ , magn., at an estimated distance of 60 miles. Captain Ulve, lastly, having ascended the summit of Thumb Point on William Island, found it to bear from there E. S. E.

Combining these statements, the existence of an island, or of a group of islands, between the parallels of lat.  $78^{\circ} 33' N.$  and  $79^{\circ} 09' N.$  with the western promontory, (the Swedish Foreland,) about in long.  $26^{\circ} 40' E.$ , was established, the eastern limit of which, with the approximate configuration, has now also been ascertained, as shown on the appended chart constructed from the existing data by Professor H. Mohn, of Christiania.

Captain J. Altmann, of Hammerfest, commanding the yacht *Elvine Dorothea*, found the water east of Spitzbergen, which he had navigated for twenty years, in the summer of 1872 less obstructed by ice than ever before. Leaving, in the morning of July 25, the Ryk-Ys Islands, he sailed S. W. toward a mass of ice which lay near the King John glacier on the east coast of Edge Island, thence with a light breeze first E. by N., which increased as he proceeded north; he saw no ice after leaving the coast until, on the evening of the 27th, when a few floes appeared, and the color of the water became lighter, indicating the vicinity of land, which, however, he could not see, as snow fell thickly. The northerly course was continued, with light southerly wind, interrupted by snow-squalls, until the morning of the 28th, when land was

sighted, bearing N. E. by N., for which the vessel was now headed, and which, on approaching closer, proved to extend to the eastward, making out into several points. At 10 a. m., at the distance from the land of about two miles, an ice border was encountered, along which the vessel continued her course. On the 29th the eastern point was reached, and as there was no other land in sight to the north or east, with the exception of a small island close to the point, the vessel turned back to the southward, beating during the 30th along the coast which frequently was enveloped by fog. At 4 p. m. the west point of the land bore N. W.; the vessel was headed for it, but was soon stopped by the ice border trending from the S. E. point of the land in a S. W. direction. A broad sound appeared to divide the land into three large and some smaller islands. On the afternoon of the 31st Altmann left the S. E. point and steered along the ice-border, which extended nearly to the Ryk-Ys Islands, a distance of sixty miles, in a S. W. direction. The ice had quite a smooth surface, with but a few icebergs in it.

The diary of Altmann, received by Professor Mohn, was accompanied by an outline sketch of the discovered land, drawn by Lieutenant Matthiesen, of the Swedish navy, from the log and verbal communications of Captain Altmann, who had not obtained astronomical observations. It shows three large islands named, from east to west, Bear Island, Giles Island, and Firm-ice Island. The east point of Bear Island, with a small island off it, lies in lat.,  $79^{\circ} 02' N.$ , long.  $31^{\circ} 50' E.$  Off its S. W. point are also two islands, and a rock off the outer one. The southern point of Giles Island lies in lat.  $78^{\circ} 53' N.$ , long.  $29^{\circ} 30' E.$ , and the south point of Firm-ice Island in lat.  $78^{\circ} 43' N.$ , long.  $28^{\circ} 40' E.$  The latter position, however, does not agree with Captain Altmann's course from the S. E. point of the land to the Ryk-Ys Islands, and with the observations of Carlsen in 1859. The views accompanying the sketch represent Bear Island as a low hill sloping down smoothly on either side, Giles Island as high, with pretty steep walls, and Firm-ice Island of the same character, except that the southern hill resembles an obtuse cone, or nearly a cylinder.

Captain Nils Johnsen, of Tromsö, left that port in the yacht *Lydiana*, on May 8, 1872, for the White Sea. After cruising, in the latter part of June, E. S. E. of Ryk-Ys Islands, and in the middle of August east of Hope Island, he reached, on August 16, lat.  $78^{\circ} 18' 46'' N.$ , having obtained meridian observations; at 2 p. m. he sighted Giles Land, which he approached until 8

p. m. to within a distance of about twelve miles S. E. of it. The following day, at 3½ a. m., he came to anchor off the N. E. point of the land in order to explore it and collect drift-wood. At 7 p. m. he left the anchorage and sailed during the night and the following day, first beating and then on S. W. and W. courses, along the eastern coast of the land, until he encountered at midnight the ice-border. At noon of the 19th the N. W. point of the land bore north, but soon after the land disappeared. Johnsen returned to Tromsø September 12.

Observations on the shore of the discovered land were not obtained; the dead-reckoning carried from the observations obtained on board of the vessel on the 16th, the day the land was made, places the N. E. point of the land in lat.  $79^{\circ} 10'$  N. long.  $30^{\circ} E'$ . The S. E. promontory, bearing from the latter S. W., is from 1,000 to 1,200 feet in height, and terminates in two bold capes, which were named Cape Nordenskiöld and Cape Hammerfest. From the latter the coast trends a few miles west and then bends to the N. W. A low, sharp head, named by Johnsen Tömmernes (wood) Cape, covered with drift-wood, protrudes far into the sea, about ten miles S. W. of the northeast point, and at a short distance to the southward of it the sea was seen breaking over a rock. Between Tömmernes Cape and Cape Nordenskiöld is a broad bay which, however, appeared through the fog to extend into the land only a few miles. Several small, low, oblong islands were observed in it. No other fiords or deep indentations were seen anywhere. The land appeared quite flat and low, without any conspicuous peaks besides the three isolated mountain ranges which, from a distance, were thought to be three separated islands, until on a closer approach the low land between them could be seen. Near the northeast point lies a mountain, which has been named on the chart after Captain Johnsen; it is not very high, flat on the top, and hardly a mile long, with steep sides, but sloping gently at the two ends. From its top Johnsen saw, far to the S. W., a high blue mountain, evidently Nordenskiöld Promontory, and to the west the Haarfagrehaugen, probably the highest point of the land. Near Mount Johnsen the land is quite low and flat, and was only partly covered by snow. Great connected snow-fields were nowhere seen, and only one glacier on the south side of the northeast point. There was no ice on the southern and eastern sides of the coast, and also none to the E. N. E., but north of the point a firm border of ice ran out north. The N. E. point is low, partly sandy, and has several lakes which were (on August

17) entirely free from ice. Abundance of drift-wood lay on the coast, furnishing fuel enough to last until the return home. A quantity of old, mostly rotten wood, lay at a distance of several hundred feet from the shore, at an elevation of 20 feet above the level of the sea; some of the larger pieces were still quite sound, as, for instance, a part of a pine tree, of the thickness of a mast, the roots of which had taken hold of the ground; the greater part of this higher wood was pine or fir; from its position it might be inferred that the island has risen about twenty feet in a comparatively recent period. Close to the shore lay a piece of ship-timber, also a drawer made of thick oak plank, and divided in four parts.

The following animals were found to exist on the island :

1. The polar bear, (*Ursus maritimus*,) of which two were killed.
2. The ice-fox, (*Canis lagopus*,) not seen, but many tracks were found in the snow.
3. *Phoca barbata*.
4. *Phoca hispida*.
5. *Phoca groenlandica*, (Greenland seal,) very abundant.
6. The reindeer, (*Cervus tarandus*.) An uncommonly large and fat male animal, with splendid horns, was killed, and very numerous tracks of old and young were seen.
7. *Sterna arctica*.
8. *Larus eburneus*, (ivory-gull.)
9. *Larus glaucus*, (burgomaster-gull.)
10. *Larus tridactylus*.
11. *Lestris parasitica*.
12. *Procellaria glacialis*, (ice-petrel.)
13. *Somateria mollissima*, (eider-goose.) Seven or eight of these birds were seen, and a last year's nest, with eider-down, but no nests of this year.
14. *Colymbus septentrionalis*.
15. *Alca Bruenichii*.
16. *Mergula alle*.

As regards the flora, only lichens and some grasses, among them *Silene acaulis*, just budding, were reported; and on the specimens of mineral brought home *verrucaria* were growing, and showed also particles of *lecidea* and *lecanora*; the numerous reindeer-tracks, however, and the fine condition of the animal killed, prove that there must be considerable vegetation on this land.

The minerals brought home consist of quartz and clay, part of which was strongly intermixed with lime and a part free from it. The most interesting of the specimens, as regards geology, is a petrified stem of a plant.

Johnsen's report was also accompanied by a chart, prepared from the log and verbal information of the master by J. C. Hansen, teacher of navigation at Tromsö. This chart forms the basis on which that of Professor Mohn was constructed; it was modified only where it disagreed with the evidently correct data of the other authorities mentioned on the chart.

The third journal sent to Professor Mohn, narrating nearly a circumnavigation of the land by Captain J. Nilsen, of Hammerfest, in the yacht *Freia*, is brief and not clear in the most important part of the statements. On the 27th of July the vessel came in sight of land, which the master at first believed to be the east coast of Spitzbergen, but soon conceived that it must be the land which other Arctic navigators had seen east of it. It extended in a N. E. direction, and the description of the part first seen agrees well with that of the N. E. coast by the two other masters. On the 31st of July the *Freia* anchored off a small and round island, only about 15 feet high, close to the extreme eastern point of the land. A great quantity of drift-wood lay scattered all over the island, east and north of which the sea was free from ice to a distance of from twelve to sixteen miles, where a great number of icebergs of considerable size were visible trending E. S. E. Although there was a perfectly free sea between the shore and these icebergs, the master, intending to sail north, preferred to go around them in order to gain the high sea, where he expected to find the diffused ice which the walrus and seal frequent. But when, after having sailed at least forty miles E. S. E., he found the wall of icebergs still extending in the same direction, showing no passage between them, he turned back and stood toward the eastern islet mentioned above, and sailed from it, first a distance of about two miles north, and then in a northwesterly direction along the border of firm ice trending from the small island first N. W. and then W. by N. The land remained in sight on these courses for about sixty miles, but the ice extended now so far out that there was no certainty as to whether it terminated where it was lost sight of. The eastern part of the island Captain Nilsen estimated to be about eight miles broad. There was no sound between the parts named by Altmann Bear Island and Giles's Island; on the contrary, the low land connecting the higher parts was distinctly seen, as also a mountain with a glacier. The northern coast of the

land appeared to be more bold and rugged than the southern. The high mountain, free from ice, on the southeast point, was seen over the land. The channel north of the firm ice border remained perfectly open to the westward, but to the northward lay an immense number of icebergs, some of which were estimated to be two hundred feet high and two miles long; large pieces of ice tumbling down from them into the sea with great noise. There was no heavy sea, although a gale blew from the northeast on the return.

When the *Freia* had reached the northernmost part of the border, it was found trending down from there to the S. W., and was followed some miles farther in that direction, when the western coast was again sighted. The firm ice lay at a distance of several miles from the coast, forming a great arc to the southward, and then trending again north. The ice beyond the border extended as far as could be seen, probably to the border seen by Altmann and Johnsen enveloping the southwestern coast. August 3 the vessel reached, on her western course, the vicinity of Hinlopen Strait, close enough to see plainly Cape Torel and Thumb Point. The Hinlopen Strait appeared to be blocked by ice, and the master was compelled to return East. This time a more direct course (E. and E. by S.) was followed. The vessel remained until the 8th on the east side of the land in pursuit of seal and walrus; and proceeded thence, first to Cape Hammerfest, and then along the firm border of ice which ran out from the land beyond the cape in a S. W. direction to the Ryk-Ys Islands.

The master is of opinion that there may possibly exist a strait between the parts named by Altmann Giles's Island and Firm-ice Island. If it is not so, the connecting land can only be very low.

Five years previous Captain Niles had been able to sail from the Ryk-Ys Islands to Hinlopen Straits. The condition of the ice in this year was such as to indicate that it is not permanent, although it was quite compact, averaging two to three feet in thickness.

### 3. *The cruises of Mr. Leigh Smith and Captain David Gray off West Spitzbergen and East Greenland.*

Of the cruises in the western part of the European Arctic Sea during the summer of 1872, those of Mr. Leigh Smith and Captain David Gray are probably the most important for the knowledge of this water.

Mr. Leigh Smith remained four months with his schooner-yacht *Sam-*

son, (150 tons,) navigated during this time by Captain Wells, of the British navy. He started from the Shetland Islands as early as May 29; first for Jan Mayen, where he landed, and whence he attempted to reach the east coast of Greenland; not finding, however, the ice open enough so early in the season, he sailed for Spitzbergen, reaching, notwithstanding the unfavorable conditions of the ice, to lat.  $80^{\circ} 30' N.$ , long.  $12^{\circ} E.$ ; he then visited Wijde Bay, meeting, at the end of August, near the Norway Islands, the Swedish expedition under Nordenskiöld, and returned to Hull August 26.

His deep-sea temperature observations confirmed fully those of the preceding year, showing an increase of temperature with the depth. On September 11, 1871, in lat.  $81^{\circ} 20' N.$ , long.  $18^{\circ} 42' E.$ , (distant from the land thirty-five miles,) he had found the temperature at the surface to be  $34^{\circ}$ , and at a depth of 300 fathoms  $42^{\circ}$ ; in 1872, while beset in the ice from July 6 to 12, in lat.  $80^{\circ} 17' N.$ , long.  $9^{\circ} 46' E.$ , (thirty-two miles N. N. W. from the N. W. coast of Spitzbergen,) he obtained at the surface  $33^{\circ}$ , and at a depth of 600 fathoms  $64^{\circ}$ , (?) concluding from this co-incidence "that a current of warm and very salty water runs in the lower strata of the deep sea between Spitzbergen and Greenland to the northward."

Captain David Gray, of Peterhead, who from long experience in whaling cruises is very familiar with the Greenland sea, and has fully proven its navigability, found there this year the same ice conditions which Captains Altmann, Johnsen and Nilsen have reported to have existed east of Spitzbergen, viz, a sea uncommonly free from ice. He states in this respect as follows: "The general loosening of the ice in lat.  $78^{\circ} N.$  began June 11. I penetrated a considerable distance into the ice, finding everywhere much open water; the floes drifted rapidly to the eastward, and the open water increased from day to day; but, as there were no whales to be seen in the direction toward the Greenland coast, I sailed south. In latitude  $75^{\circ} N.$ , long.  $9^{\circ} W.$ , the water was likewise open; in lat.  $74^{\circ} N.$ , where I met whales and remained some time, I found that I had been set by the ice in four days thirty-four miles to the S. E. In lat.  $73^{\circ} N.$ , I again pushed into the ice, being able to sail in any direction I wished, as the open areas everywhere were greater than the ice-fields. The ice drifted here with much greater rapidity to the eastward. On August 3, being anchored to a larger floe, I observed the smaller pieces of ice drifting past the vessel to the S. E. with a velocity of two miles per hour, while the floe to which we lay fast also drifted in the same direction, as proven by astronomical observation, sixteen

miles in forty-eight hours, the ice-current thus having a velocity of fifty-six miles in a day. This great ice-drift to the eastward was caused by the southwesterly winds, which blew without interruption from the beginning of June. I did not come near enough to the coast to ascertain the conditions of the ice there, but I will not hesitate to say that a vessel might have followed, without difficulties, the east coast of Greenland as high north as the commander pleased, and even to the north pole, and that all this could have been accomplished, inclusive of the return, in the summer months.

Captain Gray made in the Greenland sea, between the parallels of latitude  $68^{\circ}$  and  $79^{\circ}$  N., from April 13, to July 3, deep-sea temperature observations to a depth of 400 fathoms, which will be published hereafter.

#### 4. *Edward Whymper's expedition to West Greenland.*

The following is from a letter addressed to Mr. R. H. Scott, F. R. S., published in "Nature" of November 7, 1872:

"When I wrote to you last from Copenhagen, I anticipated that my season would be very short, and my anticipations were correct. The season, however, in Greenland has been long and brilliant. In the middle of May floe-ice disappeared in Umenak Fiord, (lat.  $71^{\circ}$  N.,) which was fully six weeks earlier than usual; and in April, in Godhavn, men went about in summer attire. When I arrived (on July 6) the land was covered with flowers, the butterflies were beginning to appear, and almost all snow had vanished from the sea-level up to two thousand feet. Since then, with the exception of a bad week in the Waigat, I have enjoyed the most exquisite weather that it is possible to imagine. In this arctic region it has only frozen on two nights, and during the day-time the thermometer has ranged from  $50^{\circ}$  to  $70^{\circ}$ . Until recently we have also had a high barometer, and upon the whole very little wind.

I have been upon Hare Island for three days, and have also been to Umenak, but the chief part of my time has been spent in the Waigat, where you would be surprised, perhaps, to find that a great deal remains to be done. I have found a great valley leading into the interior of Disco, and have gone up it, a hard day's march. I have ascended one of the highest of the peaks on the Nour-soak side of the Waigat, and looked down upon the great valley which occupies almost the whole of its interior. The lakes, as given upon Rink's map, from report of Eskimos, do not exist, but there is one very large

lake which has a glacier or glaciers coming into it at perhaps two thousand feet above the sea. This valley is the most important one hitherto discovered in North Greenland. The river flowing down it has the character of a river and not of a torrent, and after descending through many windings, a course of at least one hundred miles, it pours into the sea a volume of water equal to that of the Rhone at the Lake of Geneva.

At half a mile from the shore I found the water fresh. In Umenak Fiord, I ascended a mountain of about seven thousand feet with five Greenlanders, and took my theodolite to the top. As you know the weight of the instrument, you will be partly able to appreciate this performance. The ascent, first over swamp then over basalt débris, which reposed insecurely upon solid basalt, and finally, at the top, up columnar basalt, was a sweet thing of its kind. The picture of your humble servant being lowered by a rope, dangling like a bundle from a crane, will perhaps be more interesting to some people than the results obtained by the theodolite. These, however, were not unimportant. My peak, an isolated one, commanded a view of almost the whole of the Umenak district, (which contains the highest mountains of Greenland proper,) and a magnificent view of the "inland ice."

I found the general elevation of the mountains exceeded, by about two thousand feet, the height previously assigned to them. Of the altitude of the inland ice I shall write on a subsequent occasion.

A large part of my time on the Waigat was occupied by the measurement of a base line. This was the most important piece of work that I undertook, and it was successfully executed. I find the Waigat to have in some places scarcely half the width which our maps give it. I find its mountains to be about double the altitude that they have been supposed to be; and Hare Island I find to be twice the length represented upon the Admiralty chart. Hare Island has some points of particular interest. I got from it a rather large collection of fossil plants, and went to its top, (one thousand eight hundred feet.) From the summit at midnight I distinctly recognized the mountain called Sanderson's Hope, near Upernavik, which was distant from me one hundred and forty miles.

I have made an excellent journey, full of interest. My collections are at least as valuable as those of 1867, though, as far as I know, they do not contain anything of the importance of the *Magnolia*. I have, however, even larger collections of fossil plants than before, and from localities which I did

not visit in 1867. My stone implements are very numerous and of good quality, and the natural history specimens are not few in number."

Mr. Whymper returned to Copenhagen November 11.

### 5. *The Austrian Expedition.*

The Austrian expedition in the *Admiral Tegetthoff*, (see second supplement, page 27,) left Bremerhaven June 13, 1872, and Tromsø July 14; the last account of it is that of Count Wiltschek, (see page 40) who saw the vessel steaming away from Cape Nassau to the eastward.

Lieutenant Payer describes her cruise that far in a letter to the "Neue Freie Presse," as follows:

..... Having completed the strengthening of the vessel's sides by filling timbers, the *Admiral Tegetthoff* left the commercial capital of Europe's extreme north at 12½ a. m. of the 14th of July, piloted by the fishing-master Carlsen, who, having twenty years' experience in the Polar waters, has been engaged for the cruise.

As soon as the open sea was gained, the fires were drawn in order to save the coal for emergencies.

On the 15th we sailed along the broken coast of Norway and came, on the 16th, in sight of the North Cape. The wind had been unfavorable for some time, and was still so. On the 23d a sudden fall of the temperature, with dark rainy weather, indicated the vicinity of the ice, which we had expected to find farther north, and in the evening of the 25th, in lat. 74° 15' N., long. 48° E., (temperature of the air 34°, and of the water 34°.2,) we came up with it; it was, however, light and much diffused; we had not yet reached the closed barrier, there being only single floes driven south by the prevailing northerly winds; but on pursuing, on the 26th, our course in a northeasterly direction, the ice, although of still lighter quality, grew more dense, proving that it was the connected Arctic ice against which we had now to contend, and not, as we at first thought, ice drifting from the Kara Sea through Matotehkin Schar into the Arctic Sea. The temperature of air and water decreased rapidly, remaining during the following two weeks below the freezing-point, with but little difference between day and night. Snow squalls, creating ice in the rigging, and the finest Arctic weather interchanged, (August 3 the radiating thermometer showed 113° F., the temperature of the air being 38°.7.)

On July 29 we could only with great difficulty push through the steadily thickening ice. During the following night (temperature of air  $24^{\circ}.1$ ) we had to break through compact, although thin, ice into an apparently open channel, which, however, soon closed by the ice pressing around the vessel from all directions and besetting her firmly.

On July 30 the *Tegetthoff* remained in her captivity; neither a current nor the slightest motion of the closed floes was perceptible; calm and fog prevailed. July 31, we made a futile attempt to break a large floe in front of the bow. August 1, it fell calm, with no change in the ice. On the 2d, warping was attempted, but the floes proved too small for it. In the evening a fresh breeze promised to aid us, but after having gone the distance of a few cables, a large floe again barred the progress and the wind lulled. Steam was then got up, when at last we succeeded in pressing through the broad barrier into the open water which, north of Matotchkin Shar, proved to be about twenty miles in width. We had thus pushed through an icy belt about 105 miles broad.

On the morning of the 3d not a particle of ice was visible north of us; there was a heavy swell, the air was uncommonly warm, ( $41^{\circ}$ ;) rain fell in the evening, followed on the 4th by thick fog and snow-squalls, which compelled us to beat off and on, west of the Admiralty Peninsula.

In the night from the 6th to the 7th of August snow fell thickly, covering the deck; compact ice appeared north and west of us, and, the temperature remaining below the freezing-point, even with southwesterly winds, it became evident that ice extended also in that direction.

On the 7th we penetrated into the ice west of the Admiralty Peninsula. Refraction, with its varying play, showed us, far to the north and beyond an immense barrier, the open water, and Tschorny Noss in distorted shapes. On the 8th, in lat.  $75^{\circ} 22' N.$ , the ice thickened around us, compelling us to resort again to steam; contrary winds, however, and the firm belt of ice, behind which we saw the open land-water of Nova Zembla and a schooner, thwarted all efforts to progress, so that we had to haul the fires and make fast to a floe. At  $10\frac{1}{2}$  p. m., the wind having lessened, and the ice becoming a little diffused, we started again in a N. W. direction, and, by hard labor, reached at midnight more open water which, on the 9th, became entirely free, with the exception of a few detached icebergs, 30 to 40 feet in height.

On the 10th light drift-ice appeared again, between which we beat north. In the forenoon we escaped only with difficulty being beset again, and continued on the 11th on the northern course in diffused drift-ice. We remained at a distance from the land of from 3 to 5 miles. The mountains, which so far had measured from 2,000 to 3,000 feet, decreased in height, to 1,000 and 1,500 feet, losing their picturesque appearance. Icebergs, increasing in size, grew numerous, some covered by rocks; many of them doubtless came from the five great glaciers, covered with moraine, which we had seen north of the Admiralty Peninsula.

On the 12th, having made fast, on account of fog, to a floe, we saw suddenly on the horizon a vessel which, seeing us, drew our attention by guns, and, showing the Austrian flag, proved, to our great joy, to be the *Isbjörnen*, with Count Wiltschek's party, which shortly after came on board. We agreed that the *Isbjörnen* should follow the *Tegetthoff* to Cape Nassau, but on the 13th, coming up in latitude  $76\frac{1}{2}^{\circ}$  N., about a mile from the shore, with thicker ice, which the fog and fresh wind from the S.W. prevented us to break through, both vessels made fast to the land ice a short distance from each other. Directly south of us, on Barent's Island, were the three curiously shaped hillocks, to which walrus-hunters have given the sombre name of "the three coffins," and an uncommonly high iceberg lay north of us in fulgent light.

As regards vegetation, nothing can be more barren than the low Barent's Island, and the west coast of Nova Zembla seems to be particularly favorable for the formation of glacier embryos.

Captain Wyprecht remarks in a letter: "The ice and temperature conditions here are this year the most unfavorable. While in other years the Norwegian walrus-hunters have pursued their trade without difficulty far higher north, not one has this year been able to enter this region. Of three vessels which three weeks ago made the attempt, two were crushed by the ice about forty miles below us. Since we came into the ice, the temperature has rarely risen above the freezing-point; there was also much snow which, not melting, added to the ice. Last year not a particle of ice had been seen for  $2\frac{1}{2}$  degrees higher north, and, under ordinary circumstances, we would at this time readily have passed Nova Zembla and be well on our route for the Siberian coast, where we had intended and still hope to make winter quarters."

6. *The Swedish expedition.*

The fifth great Swedish North Pole Expedition, under Professor Norden-skiöld and Captain Torel, of the Swedish navy, intended to winter on the Seven Islands, the northernmost border of the Spitzbergen Archipelago, and to penetrate early in the spring of 1873 in reindeer-sleighs to the North Pole, if possible.

A winter sojourn in lat.  $80^{\circ} 40'$  N. is in itself of highest importance for the physical geography of the European-Asiatic part of the Arctic region, as scientific observations in the winter have not been made thus far higher than in lat.  $78^{\circ} 37'$  N.

The expedition consists of three vessels of considerable size, and excellently fitted out: the iron steamer *Polhem*, the steamer *Uncle Adam*, and the sailing-brig *Gladan*, the two latter being supply-vessels which are to return this fall. The crews number 64 men, of whom 21 will remain as the expedition proper.

The expedition left Tromsö July 21st, visited in the beginning of August Green Harbor in the Ice fiord, and reached, about the middle of that month, the northwest coast of Spitzbergen.

The ice, driven by the prevailing southwesterly winds from the east coast of Greenland and Spitzbergen, had accumulated on the northwest coast of the latter in immense masses and joined so firmly as to prevent the expedition from reaching the Seven Islands. Until the 30th of August the ships remained at anchor near Hakluyt Head, having landed the sleigh-reindeer on the Norway Islands.

On September 1st the ice had opened sufficiently for an attempt to proceed, and in the night of the 2d the *Polhem*, with the *Gladan* in tow, passed Vertegen Hook, midway between Hakluyt Head and the Seven Islands. The *Uncle Adam*, after taking the reindeer again on board, followed on the 3d.

September and October passed away without the return of the supply-ships, as also of six Norwegian fishing-vessels, the latter carrying 62 persons, so that altogether 176 persons depended upon the 18 months' provisions provided for the 21 men intended to remain during the winter, not taking in account, however, the 8,000 rations left at the Ice fiord for cases of emergency.

Under these circumstances the Swedish government considered it prudent to dispatch as a relief the steamer *Albert*, under command of Captain

Otto, of the navy, aided by Captain Lauritz Hansen, an experienced walrus-hunter, (see below.) On the 18th of November, however, four hours after the vessel had left Tromsö, the *Pepita*, one of the missing vessels, entered Hammerfest with 18 men, and on the 26th another, the *Jacobine Tromsö*; with 20 men. These 38 men were the crews of four of the six vessels, while 28 other men were known to make their way in boats along the west coast to the Ice fiord, which was thought to be still open. Four of the vessels were abandoned frozen in at Gray Hook, on the north coast of Spitzbergen; the two which returned reported that the three vessels of the Swedish expedition were frozen in in Mussel Bay, and that all the sleigh-reindeer had escaped.

#### 7. *The winter cruise of the Albert.*

The *Albert* (see above) left Hammerfest on the 18th and Tromsö on the 21st of November, steering in a northwesterly direction in order to avoid the ice which is known always to surround Bear Island. At first the weather was pretty good, so that the vessel had reached, on the 27th, lat.  $73^{\circ} 25' N.$ , long.  $10^{\circ} 35' E.$  (to the southwest of Bear Island,) when the fresh breeze from the E. S. E., which thus far had blown, increased to a heavy gale. The weather was very thick, rendered almost dark by snow drifts, and the sea ran very high. In the evening of the 25th the rudder-pintles broke, and before they could be replaced the rudder worked heavily against the stern post, damaging it considerably. The gale and the sea were roaring all the time terribly, and the darkness was so intense that, even at noon, the hand could not be seen before the eyes.

The vessel had to lay-to until the 29th, when the wind abated a little and she could resume her course, but on December 1st the gale came on again. The sea rose still higher, and the barometer fell so steadily that a change for the better became very doubtful; on the contrary the gale increased to a hurricane, the sea was in a commotion never before experienced by any of the hardy sailors; the human voice could not be heard anywhere in the vessel and the ship would hardly obey the helm. This and the rapid decrease of fuel prompted the commander to call a council, which concluded that it would hardly be possible to reach the Ice fiord, and that prolonged attempts to proceed would place the vessel in imminent danger; Captain Otto therefore decided to return home. Although the gale abated somewhat, the sea remained very high. On the morning of December 7th

the vessel was about 10 miles north of the northern entrance of Tromsö, but then the gale increased again so heavy that it would have been hazardous to attempt to enter. A southerly course was taken, and on the 14th the vessel came to anchor at Christiansand.

This bold winter cruise is of great importance to the meteorology of the Arctic sea. The temperature of the water in this winter season was everywhere as high as lat.  $77^{\circ}$  N., and west of the meridian of Greenwich, *above* the freezing-point, and ice was not seen anywhere. East of that meridian, the temperatures of the water were  $33^{\circ}.8$ ,  $35^{\circ}.6$ ,  $37^{\circ}.4$ , and  $39^{\circ}.2$ . In lat.  $75^{\circ} 45'$  N., long.  $4^{\circ}$  E., 230 miles W. N. W. of Bear Island, where the temperature of the air averaged in November, 1865,  $22^{\circ}.3$ , and in December of the same year  $16^{\circ}.7$ , the temperature of the water was  $40^{\circ}.5$ .

#### 8. *The winter cruise of the Isbjörnen to Bear Island.*

The failure of the *Albert* did not dishearten the Norwegians from attempts of rendering assistance to the crews thought to be in the Ice Fiord, as the experienced arctic fishermen believe the west coast of Spitzbergen to be free from ice in the winter. The owners of the *Isbjörnen*, in which Payer, Weyprecht, and Count Wiltschek had made their cruises, concluded to make another attempt in that vessel, sailing directly to Bear Island, and thence to the southern Cape of Spitzbergen. The following is the report of this cruise by the master of the vessel, Captain Kjelsen :

We left Tromsö December 27, and reached Langesund the same day, where we remained till the morning of January 2, waiting for the abatement of the bad weather which had set in, when we entered the sea through Fuglö Sound, with a good southerly breeze.

In the first days the weather was variable ; rain and hail succeeded each other, and daylight shortened rapidly ; the nights, however, were not very dark, as the aurora broke even through the rain clouds.

On the 6th a gale blew from the N. E. with snow-squalls, and the cold increased. On the 7th, when the gale abated, the thermometer showed  $14^{\circ}$  F., and there was an ice-horizon to the N. E. The cold made the handling of the vessel very difficult ; the sails were covered all over with ice ; the running-gear froze to the blocks, and the water boarding the vessel became at once ice. The sail set had to remain, as it could not be taken in. The wind veered more easterly.

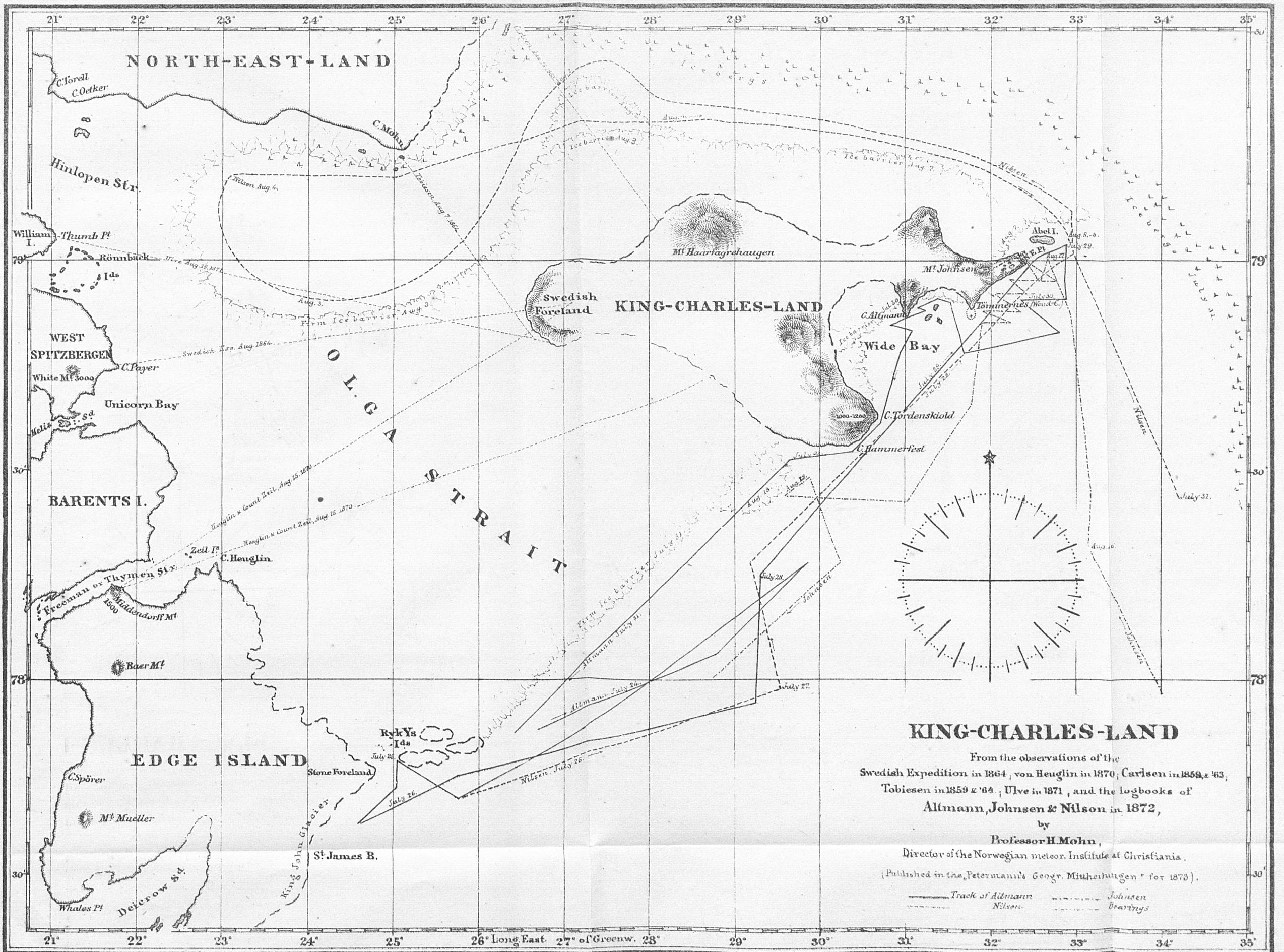
In the night, from the 7th to the 8th, we made Bear Island at a distance

of about three miles, seeing at the same time ice-blinks (the bright reflex of the air always showing over distant ice) to the N. W. and East of the island. We stood for the western side of the latter, intending to land some provisions there for ourselves in case we should be compelled to abandon the vessel, but we were soon unable to push through the thick masses of broken ice, beyond which we saw firm ice surrounding the island. We therefore worked back out of it and took a N. N. W. course through the extreme and thinner part of the ice. Although I could not read on deck at noon, we were able to distinguish, by the ice-blink showing itself N. and N. W., the island from a distance of several miles. The thermometer remained at  $14^{\circ}$ , and the ship was covered completely by ice from the water-line to the mast-head. As the gale again increased, it was very difficult to take in the sail which we had set for forcing through the ice.

Under these circumstances it became evident that we would not be able to reach Spitzbergen, and a council determined to abandon the attempt. In the afternoon of January 8 we turned south and had to contend against very boisterous weather all the way home, especially during the night of the 9th, when a very heavy gale blew from the S. W., creating a furious sea. On the 11th we gained the lee of the coast off Sörö, and entered Tromsö on the 17th.

#### 9. *Rosenthal's winter expedition.*

Mr. Rosenthal, of Bremen, hearing of the mishap to the Norwegian cruisers and the futile attempts for their delivery, tendered the splendid steamer *Greenland*, of the German Polar Navigation Company, for the rescue, and that vessel, manned by seventy men under command of Captain Melsom, left Tönsberg on the 28th of January. As she is well provided with fine instruments for observations of all kinds, the most important results may be expected from her winter cruise.



**KING-CHARLES-LAND**

From the observations of the Swedish Expedition in 1864, von Heuglin in 1870, Carlsen in 1859 & '63, Tobiesen in 1859 & '64, Ulve in 1871, and the logbooks of Altmann, Johnsen & Nilson in 1872,

by  
**Professor H. Mohn,**  
 Director of the Norwegian meteor. Institute at Christiania.  
 (Published in the "Petermann's Geogr. Mittheilungen" for 1873).

— Track of Altmann  
 - - - - - Nilson  
 - - - - - Johnsen  
 - - - - - Bearngs

A. Welcker autogr.