

GB 2405
.R4
Copy 1

GB 2405
.R4

ON THE

DRIFT ICE AND CURRENTS

OF THE

NORTH ATLANTIC:

WITH A CHART SHOWING THE OBSERVED POSITIONS OF THE ICE
AT VARIOUS TIMES.

BY

AUG 12 1918

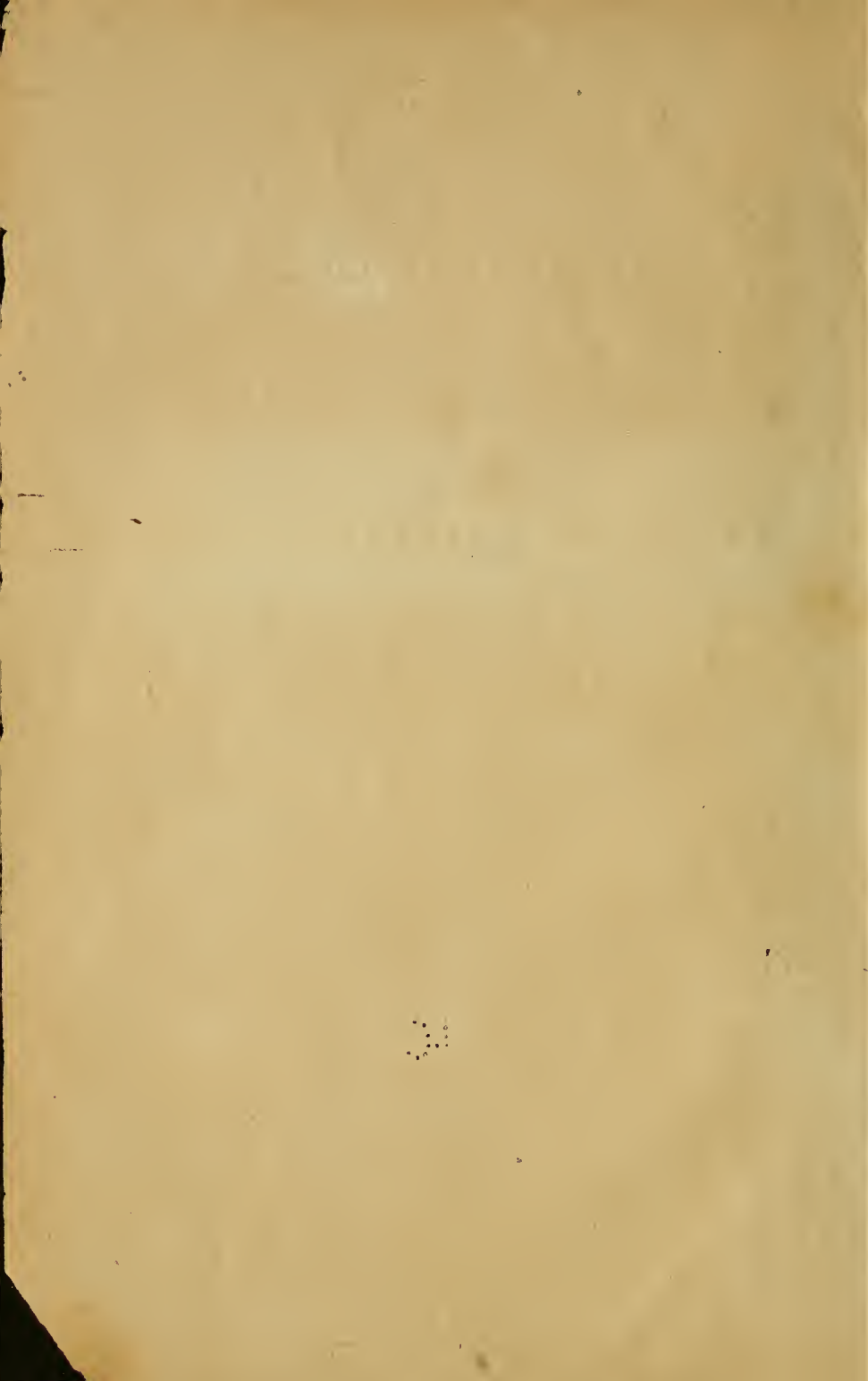
W. C. REDFIELD.

EXTRACTED FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XLVIII.

NEW HAVEN:

PRINTED BY B. L. HAMLIN.

1845.



GB 2405
H4

ON THE
DRIFT ICE AND CURRENTS
OF THE
NORTH ATLANTIC.*

OF the various dangers which beset the path of the mariner, perhaps there are none which excite to more vigilance than the known or expected proximity of ice. In some frequented portions of the Atlantic Ocean the ice appears almost every year, in the various forms of field ice, floes and massive ice-islands, drifted from the arctic regions by the constant action of the polar currents. These ice-bearing currents, in flowing towards the south, must necessarily incline towards the western limits of the ocean, owing to the increased velocity of the diurnal rotation of the earth's surface as we depart from the poles; a law well understood as regards the currents of *air* which form the trade winds. Hence it is that on and near the Banks of Newfoundland these ice-currents are found to cross the usual track of vessels bound from the ports of Europe to northern America.

The quantity of ice which appears on this route of navigation in different years, is exceedingly various. It is sometimes seen as early in the year as January, and seldom later than the month of August. From March to July is its most common season. It is found most frequently to the west of longitude 44° , and to the eastward of longitude 52° ; but icebergs are sometimes met with as far eastward as longitude 40° , and in some rare cases, even still further towards Europe.

Experience has shown that the proximity of ice is far less hazardous than rocks and shoals; and this floating danger would be still less formidable were it not for the fogs and mists which it often causes. The *thermometer* has been often held up as affording sure indications of an approach to ice, by the reduction of temperature shown both in the air and water, and these indications are important and should by no means be neglected. But there may be many cases of approach to ice where a reliance upon the thermometer alone could not afford security.

On the ice chart, which is annexed, we have indicated numerous positions in which ice has been seen and reported on the

* From the forthcoming "Memoir" of Messrs. E. & G. W. Blunt on the Dangers and Ice of the North Atlantic Ocean.

common route of navigation, chiefly since 1832. This will serve to show the region where it is most often encountered.

Although little or no ice be seen in one passage, or even in many times crossing the Atlantic, yet it has been frequently met in such quantities as seemed to indicate a vast, or indefinite extension of the ice-fields, towards the polar seas. And from the inexhaustibility of the sources of supply, and the permanent character of the polar currents, we may infer that there is no spot of ocean within the influence of these currents which has not, at some time, been covered with ice.

A recital of the various authorities and marine reports from which our ice-chart has been compiled, might prove more tedious than useful. The following, however, selected from many others, may serve as examples of the cases in which the ice has been noticed by navigators.

Ship *Eli Whitney*, *Harding*, April 7, 1836, sea account: wind S. S. W. and thick fog; ordered the temperature of the water to be tried every half hour; at 6 P. M. water 36° ; passed a small ice-island; ship going west all night three knots; 6 A. M. water 34° , at 8 A. M. water $31\frac{1}{2}^{\circ}$, passed considerable quantities of ice. At 10 A. M. saw a large field of ice ahead, which extended to the north and south as far as the eye could reach; entered it in expectation of finding an opening to westward. After proceeding a cable's length, wore round and stood out as we went in, and then hauled the ship on the wind to the S. E. Longitude by account, $47^{\circ} 06' W.$, latitude by account, $44^{\circ} 41' N.$ —April 8, wind S. S. W., stood to the S. E. till 5 A. M.; water 46° ; tacked ship to the westward. At noon water 44° , latitude by observation, $44^{\circ} 35'$, longitude by chronometer, $46^{\circ} 56'$.—April 9, wind S. S. W. and foggy. At 4 P. M. water 34° ; wore ship to the S. E. At midnight water 44° ; tacked ship to the westward. At 8 A. M. wind shifted N. W. and cleared off the fog; three large islands of ice in sight; water 44° ; latitude by observation, $44^{\circ} 17' N.$, longitude by chronometer, $47^{\circ} 50' W.$ —April 10, wind N. W.; passed six large islands; water in vicinity of the ice 40° , latitude by observation, $43^{\circ} 09'$, longitude by chronometer, $48^{\circ} 55'$.—April 11, passed four large islands of ice this day; at 8 A. M. sounded and found bottom with 42 fathoms; water 35° ; latitude at noon by observation, 43° ; longitude by chronometer, $50^{\circ} 36' W.$

Ship Samuel Wright, Allen, March 18, 183-. Latitude 43° , longitude $48^{\circ} 43'$. At 3 p. m. very foggy, came nearly in contact with a very large island of ice, about 150 feet high and one mile in length; the weather extremely cold, kept the ship under easy sail. At 5 p. m. fell in with an English brig, and were informed we were standing for more ice, and that she had been for five days surrounded with it, extending from latitude 45° to 43° , and found no opening to the westward. Kept company during the night, and fell in with more ice; in the morning no ice in sight.

Ship Fama, Winsor, March 183-, in latitude $44^{\circ} 30'$, longitude 48° , fell in with an immense field of ice; tacked ship to the eastward and stood off and on two days. Wind changed to N. E., and run 45 miles S. W. and passed the point of ice in latitude $43^{\circ} 25'$, longitude $48^{\circ} 50'$.

The British Tar, Hanby, left the Gulf of St. Lawrence 29th June, and passed through the Straits of Belle Isle. On the 3d of July, about 15 miles eastward of Belle Isle, found the passage quite blocked up with very heavy fields of ice, which obliged us to put back to an anchorage. On the 6th again made the ice, and found it more open: passed through about seventy miles of it. On the eastern edge, fell in with nine brigs, a ship, and a barque, standing off and on, waiting for a passage into the straits. The icebergs were very numerous and immensely large, as far to the eastward as longitude 48° .

Ship Oneida, Funk, May 4th, 1841, latitude $43^{\circ} 40'$, longitude 50° , passed a number of large icebergs; saw ice as far west as longitude 53° .

The brig Anne, of Poole, William Dayment, master, sailed from Greenspond, Newfoundland, [N. E. coast,] 19th of January, 1821, and in the evening encountered several floating islands of ice. On the following morning, at sunrise, the ship was so completely enveloped in ice that there appeared no means of escape, even from the tops of the masts. The ice, in its whole extent, rose about fourteen feet above the surface of the water; it drifted towards the southeast, and bore the ship along with it twenty nine successive days. On the 17th of February, Capt. D. being three hundred miles east of Cape Race,* in latitude $44^{\circ} 37'$

* That this position was ascertained by chronometer appears doubtful.

north, perceived an opening to the southeast, and succeeded in disengaging himself. From the 29th of January to the 3d of February, the brig only made four miles a day; and during the twenty nine days this navigation lasted, he descried near one hundred very extensive mountains of compact ice.

Ship *Isabella*, Meredith, struck an iceberg on 9th May, 1841, in latitude $42^{\circ} 2'$, longitude $43^{\circ} 45'$. The iceberg broke through the bows, and caused the ship to fill with water so fast that the crew had barely time to take to the boats, without water, provisions or clothing: the ship immediately went down, or disappeared in the fog. The crew continued in the boat until the afternoon of the 11th, when they were picked up by the *Kings-ton*, of Hull, bound to Pictou.

Ship *Lowell*, on the 10th of March, 1842, at 9 A. M., latitude $44^{\circ} 15'$, longitude $48^{\circ} 30'$, came in contact with a field of ice; was at that time steering W. N. W., with the wind. Tacked and stood to the eastward two hours, when she again tacked to the westward. At 2 A. M. again fell in with the ice. Continued beating to the southward, and falling in with the ice on the west tack till March 13th. Passed the southern extremity of the field in latitude 42° , longitude $49^{\circ} 15'$, having seen it extending in a N. N. E. and S. S. W. direction, nearly 150 miles.

A letter from Capt. Hosken, of the steamship *Great Western*, says: "April 18th, 1841, the ship steering west, at 6 P. M., first saw one iceberg on the starboard bow, at 7 30 passed it; at that time four or five others in sight; at 9 15 P. M. passed several small pieces of ice—slowed the engines. In a few minutes after, the ship was surrounded with light field ice, which appeared similar to a field I ran through on the 11th of February, 1839. This induced me to go slowly, with the hope of getting through, as I had done on that occasion; but by 9 30 finding it closely packed, and much thicker, prudence dictated our escape by the same channel we had entered. I then stopped and attempted to get the ship's head to the eastward, by turning ahead and astern until there was room for her to come round; in the course of this operation the ship had occasionally (at least) two streaks heel given by either wheel passing over large masses of ice. At 10 15, succeeded in getting the ship's head to the eastward, and by 11 P. M. entirely clear. From that time went slowly, passing several icebergs; the night at times very clear, the aurora bo-

realis very bright. At 3 30 A. M. of the 19th, again got embayed in the ice; stopped, hauled short round on our keel, and steered out E. by S., coasting the ice for five or six miles. At 4 20 kept her to the westward, running through innumerable icebergs until 8 30, when we passed the last iceberg and field of ice."

"When the sun arose the ice was visible as far as the eye could reach, in an unbroken line from N. E. by E., by the northward to N. W. by W.; at the same time, icebergs innumerable in every direction, forming one of the most magnificent sights I ever beheld."

"The first iceberg we saw was in latitude 43° , longitude $48^{\circ} 30'$; and the last in latitude $42^{\circ} 20'$, longitude 50° . I am quite sure there was an unbroken field of that extent; and from what I heard from Capt. Bailey, of the packet ship *South America*, I have no doubt the field ice extended, with very little break, to latitude $40^{\circ} 30'$, where Capt. B. fell in with it on the morning of the 18th. Several other ships also fell in with it in the same longitude, and were completely stopped, giving them an opportunity of killing seals, which were on it in great numbers. Some of the icebergs I estimate at little, if at all less than a mile long, and from one hundred and fifty to two hundred feet high. This field of ice was in large masses, some of them not less than twenty feet square by six feet thick or more."

"The temperature of the water, when within two miles of the first iceberg seen, fell suddenly from 50° to 36° ; air 40° to 36° . When in the ice, the water was 25° , air 28° ; during the remainder of the night and following morning the water was not higher than 30° nor the air higher than 32° . Immediately after passing the last ice the water became 36° and the air 42° ."

Brig *Cynosure*, on the 23d, 24th, and 25th of July, 1842, latitude 42° , longitude $49^{\circ} 30'$, saw large icebergs, and was two days among the ice. Saw an island of ice that was estimated to be two hundred feet above the water, and saw several other islands in longitude 54° .

Ship *England*, Bartlett, April, 1842, latitude $41^{\circ} 29'$, longitude 49° , saw a large number of icebergs.

Brig *Byron*, Pierson, April, 1842, latitude $41^{\circ} 18'$, longitude 50° , saw four large islands of ice, one about 200 feet high and three miles long. Saw it 30 miles off.

British brig *Peace*, Robson, May 9th, 1844, made the ice in latitude $46^{\circ} 52'$, longitude $46^{\circ} 30'$, being bound to the Gulf of St. Lawrence, and was soon so completely imbedded in a large field of fragments that escape was impossible. She remained fast until the 13th, without injury, when in the night a gale of wind set in, crowding the large cakes down fast upon the sides and bulwarks of the vessel, which, from being in ballast, was soon stove in by the immense weight. On the 14th the small boats were got out and stocked with provisions, &c., and in the night of the same day the brig was abandoned. Captain R. with crew and boats remained upon the ice until the 18th, being unable to get into clear water, and on that day were taken off, in latitude $46^{\circ} 50'$, longitude $45^{\circ} 42'$, by the ship *Copernicus*, after much suffering.

Ship *Burgundy*, Wotton, in May, 1844, from the latitude $45^{\circ} 30'$, longitude 45° , to latitude $43^{\circ} 30'$, longitude 48° , was completely surrounded by icebergs and drift ice; lay to four nights, owing to the density of the fog; saw an iceberg two miles in length; no ice seen on the Banks.

Ship *Virginia*, Allen, latter part of January, 1844, was 34 hours fast in the ice. On the Banks, in a hurricane, lost foresail and main-topsail—saw large quantities of ice.

Ship *Swanton*, Heath, from 18th to 21st July, 1842, experienced thick foggy weather, latitude 43° and longitude 49° to 54° , passed upwards of 300 icebergs, some of them very large; came near being wrecked on them, having run between two large islands in the night, which nearly rubbed the ship on each side before we discovered them, notwithstanding all hands were upon the lookout.

Captain William Wier, bound eastward, gave the following account. On the 9th of March, 1787, latitude 42° N., longitude $55^{\circ} 40'$ W., was called by the mate to see a large ridge of breakers: altered my course from E. S. E. to S., the appearance of breakers being N. N. E., and trending from E. N. E. to W. S. W. March 11th, latitude $43^{\circ} 34'$, found myself in the midst of a large body of ice, trending E. N. E. and W. S. W.; soon got through. March 13th, latitude $44^{\circ} 03'$, at 8 A. M., made a large body of ice, extending beyond view from mast-head, and trending N. E. by E. and S. W. by W. At 10 P. M., met a larger body of ice, which entirely stopped the ship's way. On the morn-

ing of the 14th, found myself enclosed, and could see no water from mast-head, except one small hole, into which I pressed the ship; in 23 fathoms water on the Grand Bank. In this dismal situation lay with my sails hauled up, till 21st March, seeing no sea from main top-gallant-mast head. On the 17th went on the ice to take a view of an island of ice which bore from us W. S. W. We set out at 12 o'clock, and travelled one hour and thirty five minutes before we reached it. We found it aground in 25 fathoms, the main body passing fast by it, setting S. E. two and a half miles an hour, as I judged. On our return, having been absent three hours, the ice island bore W. N. W., having altered four points.

On the first day of January, 1844, Captain Burroughs, in the ship Sully, met with an iceberg in the Atlantic, in latitude 45° , longitude 48° . This is earlier in the winter than any other case which we have met with. Captain B. states that he had met with ice near this position on the first of February, on a former voyage.

In September, 1822, Captain Couthouy saw an iceberg aground on the eastern edge of the Grand Bank, in latitude $43^{\circ} 18'$, longitude $48^{\circ} 30'$. Sounding three miles inside of it, the depth was found to be 105 fathoms. In the month of August, 1827, the same observer, while crossing the Banks in latitude $46^{\circ} 30'$, longitude 48° W., passed within less than a mile of a large iceberg which was stranded in between 80 and 90 fathoms water. He was so near as to perceive, distinctly, large fragments of rock and quantities of earthy matter imbedded in the sides of the iceberg, and to see, from the fore yards, that the water for at least a quarter of a mile round it was full of mud, stirred up from the bottom by the violent rolling and crushing of the mass.

On the 27th of April, 1829, Captain Couthouy passed, in latitude $36^{\circ} 10'$ N., longitude 39° W., [probably south of the Gulf Stream,] an iceberg, estimated to be a quarter of a mile long, and from 80 to 100 feet high. It was much wasted in its upper portion, which was worn and broken into the most fanciful shapes. In 1831, at daylight of the 17th of August, latitude $36^{\circ} 20'$ N., longitude $67^{\circ} 45'$ W., upon the southern edge of the Gulf Stream, he fell in with several small icebergs, in such proximity to each other as to leave little doubt of their being fragments of a large one, which, weakened by the high temperature of the surround-

ing water, had fallen asunder during a strong gale which had prevailed from the southeast.*

Ship *St. James*, Meyer, July 12, 1844, latitude 44° , longitude $47^{\circ} 12'$, passed 12 large icebergs; July 20, passed 25 do.; and July 21, passed 30 do; latitude $43^{\circ} 50'$, longitude $52^{\circ} 26'$, saw the last of it.

John L. Hayes, Esq., in the *Boston Journal of Natural History*, states that Capt. Crocker, of New Bedford, measured with his sextant an iceberg which was aground on the Bank of Newfoundland, and found it to be half a mile long and two hundred and forty four feet high. Also, that Capt. Matthew Luce, of New Bedford, saw an ice-island of one hundred feet in height, aground in forty eight fathoms, on the Bank, and that the fishing vessels had sailed around it for thirty days.

Ship *Switzerland*, Knight, May 5th, 1844, in latitude 47° N., longitude 46° W., at 5 A. M. met with a perfectly solid field of ice, and the wind being N. E. hauled out to S. E. After coasting the ice forty miles, found it turned to E., and that the ship was embayed. Tacked to N., and after four tacks of one hour each, the wind hauled to S. W.; steered east a short distance from the ice. Afterwards turned to the south, and the wind hauling to the westward, steered S. S. W. for forty miles more, when the ice became broken, and very soon was entirely clear of it, having sailed eighty miles along an unbroken coast of ice, exactly in appearance like low land covered with snow. The wind continuing to the westward, saw more or less ice for three following days, but none south of latitude $44^{\circ} 43'$, nor west of longitude 49° .

Ship *Formosa*, Crawford, June 18th, 1842, latitude $38^{\circ} 40'$, longitude $47^{\circ} 20'$, saw an iceberg 100 feet high and 170 feet long.

On the passage out in the *Acadia*, on the 16th of May, in latitude 46° , longitude 47° , there were seen about 100 icebergs, some of them of large size, and one from 400 to 500 feet high, bearing so strong a resemblance to *St. Paul's*, that it was at once christened after that celebrated cathedral. The dome was perfect, and it required no extraordinary stretch of imagination to supply the turrets, pinnacles, and other parts of the building.

* See this Journal, Vol. XLIII, 1842.

On the homeward passage of the Acadia, on the 6th of June, the same object was seen, and the immediate exclamation on board was, "There's our old friend, St. Paul's." In the interim between the two views, the iceberg had drifted about seventy miles.*

An immense ice-island was seen on the 10th July, 1841, in latitude $43^{\circ} 54'$, longitude $58^{\circ} 12'$, by Captain Ricker, of the Apollo, at Boston. He reports that his thermometer fell when near it forty degrees.

It may be proper to state here, that many ice observations have been placed on the chart without a reference to the date or the vessel which reported them, and the want of room for the references has rendered this in a degree unavoidable. In compiling the chart, one hundred and fifty seven separate reports have been consulted, the general character of which may be estimated by the foregoing examples. Many other accounts might have been obtained, but it is believed that these are sufficient for an approximate estimate of the course and positions of the ice in various seasons, so far as relates to the routes of vessels coming from European ports.

On the Westerly tendencies of the Polar Ice-currents, and their Influence on the Gulf Stream.

In further noticing the westerly and southerly progress of the cold currents from the arctic regions, we avail ourselves of the researches of Rennell, who states that "a current from Greenland and the Arctic Sea joins the Gulf Stream on the east of the Grand Bank of Newfoundland, somewhere about latitude 44° , and between the meridians of 44° and 47° ." In the month of May its direction has been found to be between S. W. by S. and S., and its temperature [apart from the ice] 43° to 47° of Fahrenheit. The temperature taken not far to the eastward of it was 62° to 63° , and an easterly current of 30 miles [per day] of the same water (i. e. gulf water,) was found at a distance from the eastern edge of the S. W. by S. cold stream. This is, doubtless, the current that brings down the ice from Greenland, &c., to the east of the bank of Newfoundland, and ice has been seen in the line of this very current, by different persons in different

* English paper.

years. The navigators to Newfoundland and New England place the junction of these currents in about latitude 41° , longitude 49° , which shows how erroneous their ideas are on this subject."

Rennell likewise states that "there is also a smaller [?] current that passes down the coast of Labrador, and eastern side of Newfoundland, and carries ice in sight of the coast." He also says, that "it appears both from *his own* and other people's observation, that two distinct streams of ice exist; one on the east of the Bank, the other ranging along the coasts of Labrador and Newfoundland; and then obliquely across the Bank in a S. by E. direction; whilst that from Greenland, &c., runs between S. by W. and S. S. W. This last current appears to fall into the Gulf Stream about the latitude of 43° or 44° ; and between the meridians of 45° and 50° W. The ice is, of course, carried into the Gulf Stream, where, from the warmth of its temperature, it must rapidly dissolve."* Rennell also states that many ice islands are found to the westward of the above, "in the line of the route from Halifax," and that they are often seen in the Strait of Belle Isle." We quote also the following:

"An experienced commander, long in the Newfoundland trade, has said that the branch current which appears to come from Hudson's Bay, always sets to the south-westward (perhaps S. S. W.,) off the eastern coast of Newfoundland: sometimes at the rate of two miles an hour; its strength, however, varying with the direction and force of the wind. Passing down the eastern coast of Newfoundland, it turns about Cape Race, and sets thence along the south side of the island, until it meets with the current from the St. Lawrence, [through the Strait of Belle Isle,] a little to the westward of St. Pierre and Miquelon Islands.

* I have not sufficient knowledge of that portion of the Greenland current which lies north of the Banks, to enable me to determine if its course from the coast of Greenland be directly towards the Flemish Cap and the eastern side of the Grand Bank, or whether it may not fall in with the Labrador current in longitude 48° to 51° off the Strait of Belle Isle, or the southern coast of Labrador, running from thence southeasterly parallel to the coast of Newfoundland and outside of the Labrador current, carrying with it the belt or stream of ice which it brings from the Greenland seas. It is hoped that this point may be satisfactorily determined, and in the mean while I have ventured to indicate on the ice-chart, hypothetically, the more direct route to the eastern ice region, as being that of the Greenland current.

(2)
“When the Virgin Rocks, lying about 80 miles W. by S. from Cape Race, were surveyed in July, 1829, the current set over them to the W. S. W. at the rate of one mile an hour. E x S

“It is probable that this westerly current impinges on the easterly one, and continues its course, with diminishing velocity, towards Breton Island, where it blends with that branch of the St. Lawrence stream which sets to the S. W. between Sable Island and Nova Scotia.

“The sea between the Grand Bank of Newfoundland and the Banks of Nova Scotia is distinguished by its drifts of *cold* water, varying with the wind and seasons.”*

In further proof of the westwardly pressure of the polar current upon the American coast, we may state, on the authority of Captain Bayfield, the able officer who surveyed the Gulf and River of St. Lawrence, that “in spring the entrance and eastern parts of the Gulf are frequently covered with ice, and vessels are sometimes beset for many days;” and that “the reality of a current inwards through the Strait of Belle Isle, is confirmed by the presence of icebergs, which it transports into the Gulf in summer, against the prevailing S. W. winds, frequently carrying them as far as Mecatina, and sometimes even to the neighborhood of the east point of Anticosti.” This last position is nearly 300 miles from the entrance of the strait, and almost half way to Quebec.

But even stronger proof of this inward pressure of the cold current into the gulf and estuary of St. Lawrence is found in the icy temperature of its deeper waters during the summer. Thus, in the middle of the estuary, off Matan, and more than 200 miles above the east point of Anticosti, on the 8th of July, Dr. Kelly found the temperature of the surface water 60°,—at 30 fathoms 35°,—at 50 fathoms 34°: the whole depth at that point being 132 fathoms. A subsequent trial in this portion of the river showed the surface water at 57°,—at half a fathom depth 44°,—5 fathoms 40°,—10 fathoms 38°,—100 fathoms 35°. At Tadousac, about half way to Quebec from the place of the last observation, Dr. Kelly found the temperature, in September, as low as 36°, after an easterly gale, which mingles the shallow stream of the surface with the deeper waters. Numerous other obser-

* Purdy, in Rennell.

vations made at different times and places, during the survey, confirmed these results. Hence it appears that the drainage waters received by the rivers were discharged by means of the surface current, which swept over the cold subjacent waters that were brought in by the polar current and the flood tide. These facts should be remembered in viewing the relations of the polar currents to the Gulf Stream.

In relation to the southern outlet of the Gulf of St. Lawrence, it has been common for navigators and others greatly to overrate the proper *river* current of the St. Lawrence, in its extension southward of Breton Island and Nova Scotia. This fresh-water current, when compared with the branch of the polar current which joins it through the Strait of Belle Isle, is but of insignificant volume; and the current through this strait, in its turn, is but an ocean rill, when compared with the great volume and force of the cold currents which pass to the eastward and southward of Newfoundland.

It appears that Rennell was embarrassed in his investigation of the polar currents of this region, by admitting the assumption that a portion of the cold water, eastward of Newfoundland, was caused by the Bank itself. This hypothesis had been sanctioned by distinguished writers, but the observations and facts on which it was founded can now be satisfactorily explained by the admitted influence of cold currents, either superficial or sub-aqueous. He appears, also, to have viewed the Gulf Stream as opposing a direct obstacle to the further passage of the polar currents, but it appears to us, that the streams of existing aqueous currents are found intersecting each other, much in the same manner as they would pass through quiet waters, and that they quietly impose or imbed upon each other like as stratified currents of air, or lateral currents from the forks of rivers, are found to accommodate each other, in their respective courses. In these river cases, as apart from the extraneous deflection by the shores, while the original momentum of each stream continues, one of these may be borne away from its original course, and thus be resolved to a new or modified direction by the further progress of the current in which it is imbedded; but in such cases, a diversion of the course of the lower current does not usually take place.

In the case of ocean ice-currents which intersect a surface cross current, while the common *surface ice* conforms more or

less nearly to the new direction of the current on which it floats, the deeply immersed ice masses, having probably their greatest bulk immersed in the lower or deeper current, are thus resolved, by a real conflict of impelling forces, into a still different course, which conforms more or less nearly to that of the lower or subaqueous stream, according to the respective areas exposed to the action of the two currents, and their respective velocities. The geographical course of the body of the Gulf Stream, according to our best information, commonly touches the southern point of the Grand Bank in latitude 43° N., but the overflow or outspreading portion of the Stream often sweeps over the southern part of the Bank, as a surface current, when unimpeded by the ice. When the ice appears in great quantities it is probable that the Gulf Stream current coming from the west, carries the ice more eastwardly, from its previous southwesterly course. In thus yielding to the joint influence of the two currents, the surface ice assumes a new direction, towards the south or southeast.

Grounded icebergs, when quite stationary, afford the best means for observing the course of the common ice fields. The course of the ice-drift, within the influence of the Gulf Stream, doubtless varies at different times and localities, and must be greatly influenced by the depth of the floating masses. For in the case of icebergs or islands, particularly those which come down from the Greenland seas and pass eastward of the Grand Bank, their great depth subjects them to the continued impulsion of the lower or arctic current after they arrive within the influence of the Gulf Stream, the main part of the cold current passing beneath the warmer one, by means of its deeper position as well as greater specific gravity.

This may be shown from the cases before recited, of immense icebergs which have been impelled into the body of the Gulf Stream, where, instead of being drifted off to the eastward, in conformity with its course and with the like tendency of the prevailing winds, some of these floating islands have been forced across the body of the stream, and in some cases even far beyond its ordinary limits, to a latitude lower than that of the southern boundary of Virginia; as shown in the two cases given by Capt. Couthouy. The most eastward of these, in longitude 39° , and south from the usual eastern limit of the Greenland icebergs that arrive in the latitude of the Banks, was near seven degrees lower

in latitude than the southern extremity of the Grand Bank. The other icebergs noticed by him, in like latitude, and longitude $67^{\circ} 35'$, probably passed near to Newfoundland, and their position shows, in a more striking manner, the strong westwardly tendency of the polar current.

No impulsion but that of a vast current, setting in a general southwesterly direction and passing beneath the Gulf Stream, could have carried these immense bodies to their observed positions, on routes which cross the gulf current in a region where its average breadth has been found to be about two hundred and fifty miles.

The continued southwestern, and even more westwardly course of that portion of the polar current which is found southward of Newfoundland and Nova Scotia and west of the Gulf Stream, is conclusively shown by the two icebergs met with by H. M. packet Express, July 7, 1836, on the southern edge of the Sable Bank, about seventy-five miles southwest from Sable Island. The highest of these, estimated at 180 feet, was in latitude $43^{\circ} 14'$, longitude $61^{\circ} 17'$, the other, 150 feet high, in latitude $43^{\circ} 09'$, longitude $61^{\circ} 26'$. Owing to the great depth of these ice islands, they could not have passed through the Strait of Belle Isle, but must have been carried by the main current eastward and southward of Newfoundland to their observed position, which, by the nearest course, is near 500 English miles from off Cape Race, the southeast point of that island, in the direction S. 63° W., true meridian, or W. S. W. $\frac{1}{2}$ S. Of the further extension of this portion of the polar current, in diminished force, along the coast of the United States and the western border of the Gulf Stream, as far as Cape Hatteras, if not to Florida, we have formerly spoken, in another place.*

The finding of a low temperature on the southern part of the Grand Bank, or even to the southward of latitude 43° , is not sufficient evidence of the entire absence of the Gulf Stream current: for the recent presence or proximity of floating ice must necessarily cause a great reduction in the surface temperature, and there is no natural process by which the cold water of the surface stream can be changed for warmer with a rapidity sufficient to preserve a temperature at all corresponding to the warm portions of the Gulf Stream.

* This Journal, Vol. xxxii, p. 349.

It is well known that vessels in the northern part of the Gulf Stream, while steering parallel to its general course, have met with successive and striking changes in the temperature of the water and sometimes with ice, to the southward of Nova Scotia and Newfoundland, and in the proper line of the polar current. This is well shown in the journals of the ships *Eliza* and *Grand Turk*, as published in some former editions of the *Coast Pilot*. In latitude $41^{\circ} 53'$, longitude $56^{\circ} 52'$, the *Eliza* found the water at the depth of 70 fathoms two degrees warmer than that at the surface, the temperature of the latter being 40° , and an ice island bearing S. S. E., distant seven miles. S. S. W. and S. of the Grand Bank, and in nearly the above latitude, the *Eliza* again met with cold water and passed several ice islands. Rennell has also recognized these cold veins or bodies of water in the Gulf Stream. It appears, therefore, that in this portion of the Gulf Stream, neither its presence nor its actual limits can be determined with certainty by the thermometer, during the ice season.

It appears in the pages of the *Coast Pilot*, that Capt. Billings, in June, 1791, found the temperature of the water in the Gulf Stream to have fallen ten degrees, in latitude 39° , southward of the Bank, and that the like had been observed by Dr. Franklin and Col. Williams, in the same region. But, judging from the latitude, it is not improbable that these observations were made to the *southward* of the true border of the Gulf Stream. If this be the true solution, it is indicative of the partial re-appearance of the polar current, after passing beneath the Gulf Stream; and there is evidence of its further course to the S. W. and W. S. W., near the border of the Stream.

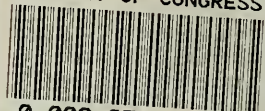
This leads us to notice a probable, if not a principal cause of the great variations, which have been reported, in the position and limits of the Gulf Stream, in its eastward progress. Rennell, we conceive, rightly supposes an *overflow* or outspreading of the Gulf Stream upon the ocean waters, as it proceeds in its course. Now we know, from well established cases, that overflowing streams, upon denser waters, are often very shallow; and Capt. Bayfield has shown, in the case of the estuary and Gulf of St. Lawrence, that the effect of a storm is to break up, for the time, this superficial current and amalgamate it with the deeper and colder waters. Hence we may infer, that in good weather and a smooth sea, the thermometric breadth of the Gulf Stream may

be far greater than in rough weather; and that it is most straitened in its limits immediately after the occurrence of a great storm.

Perhaps too little consideration has hitherto been given to the character and effects of the polar currents. These appear to be well worthy of the attention of both the navigator and the philosopher. We have seen that the moderate but unceasing flow of these currents often interposes an icy barrier in one of the most common routes of navigation. The observing geologist will also discern in the courses of the ice-currents of the Atlantic, both before and after their contact with the tropical stream, a striking coincidence with the directions of the two systems of striæ which mark the abraded surfaces of the continental rocks; the origin of which must be referred to the early and prolonged period when these rocks were situated beneath the ceaseless flow of the ocean currents.*

New York, December 30th, 1844.

LIBRARY OF CONGRESS



0 002 056 859 8