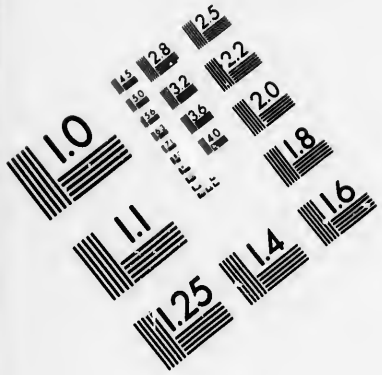

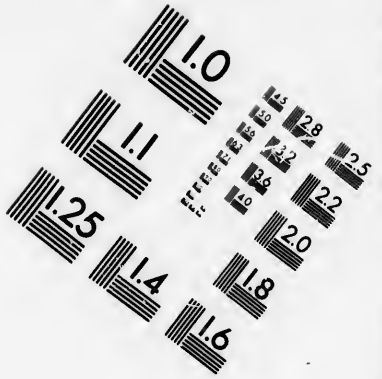

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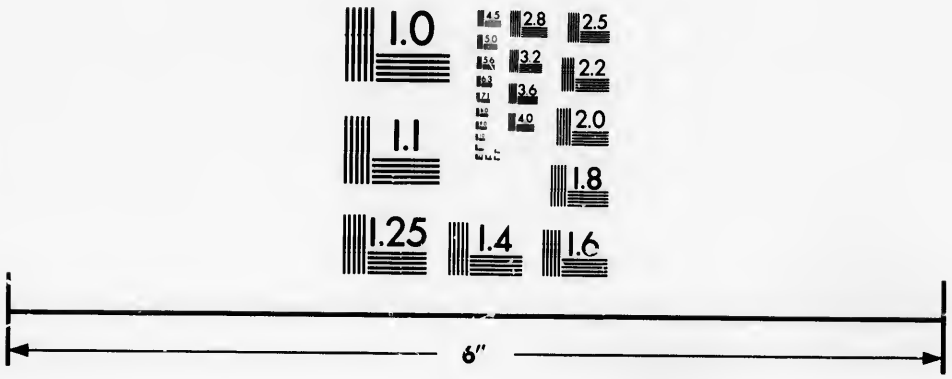

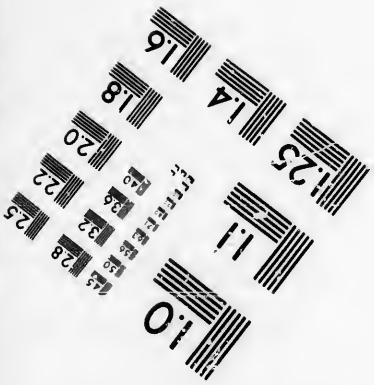

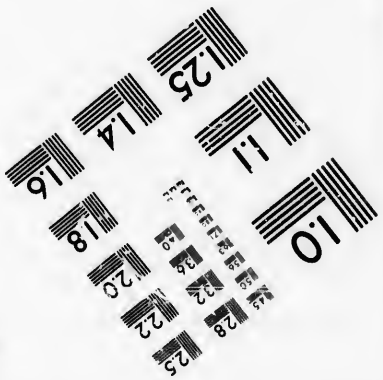

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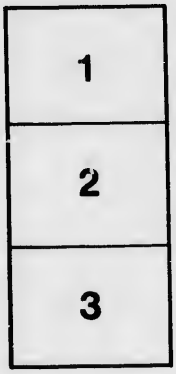

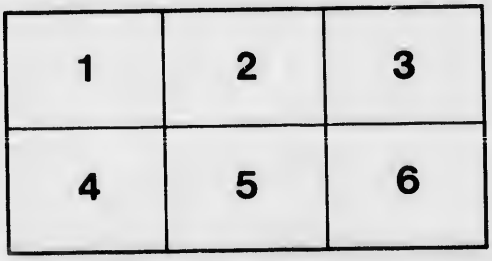

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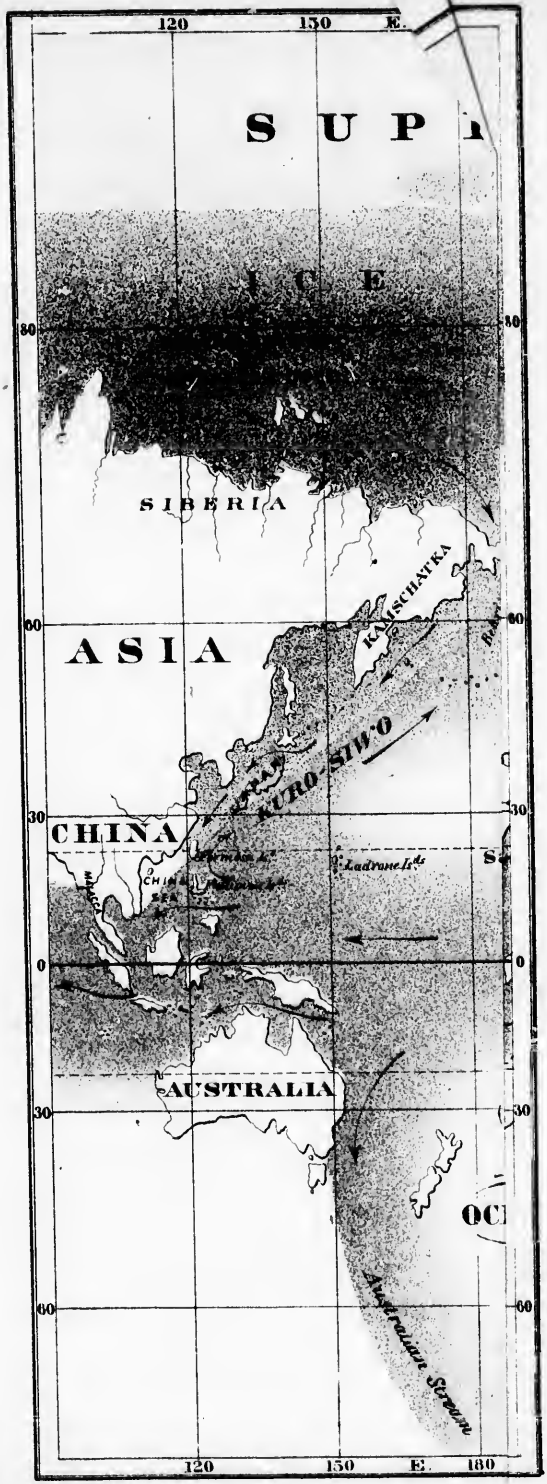
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AN ADDRESS

DELIVERED BEFORE

THE ST. LOUIS MERCANTILE LIBRARY ASSOCIATION,

JANUARY 6th, 1872,

UPON THE

THERMAL PATHS TO THE POLE,

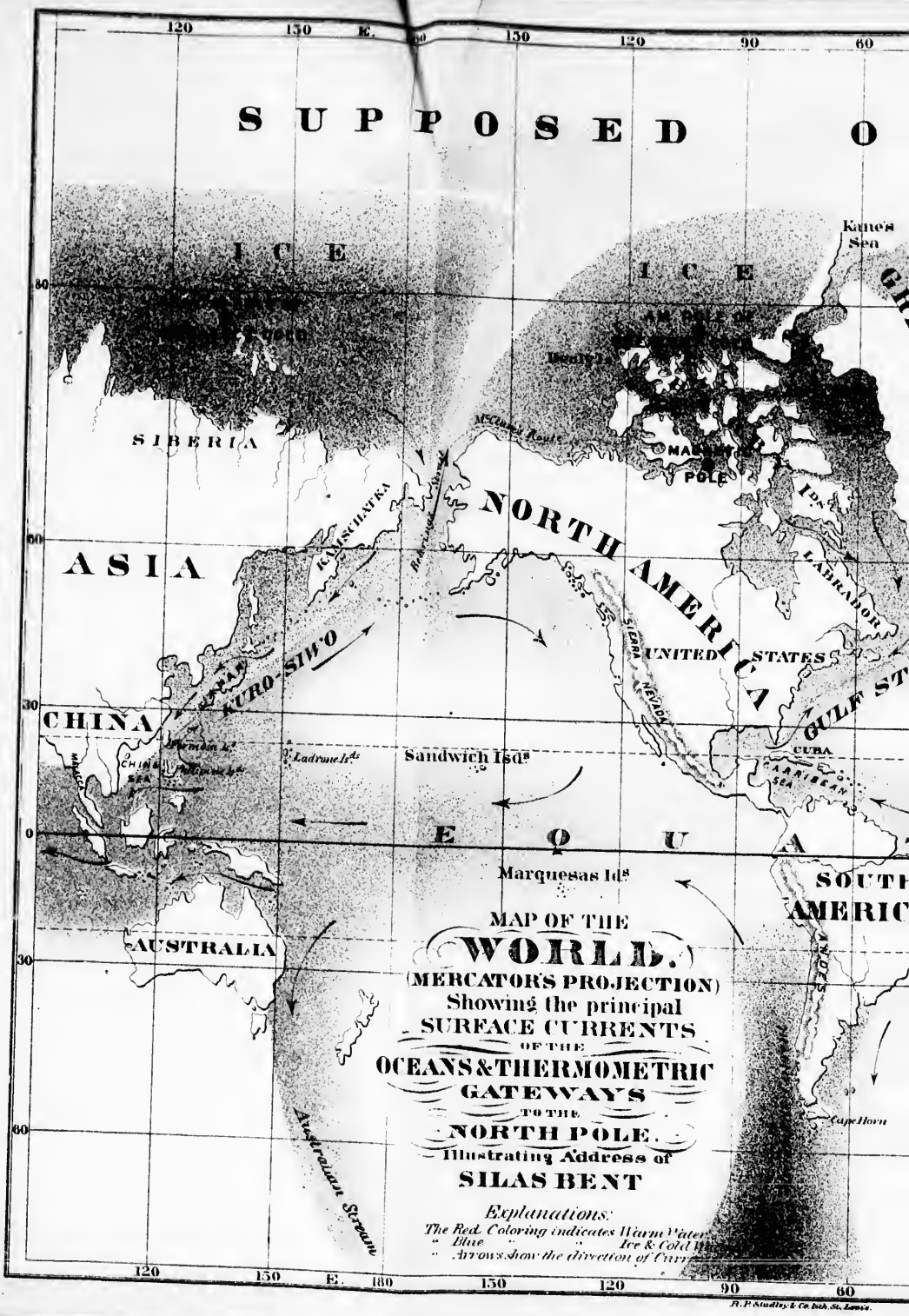
THE CURRENTS OF THE OCEAN, AND THE INFLUENCE OF THE LATTER UPON THE CLIMATES OF THE WORLD.

BY SILAS BENT.

SAINT LOUIS:

THE R. P. STUDLEY CO., PRINTERS, LITHOGRAPHERS, AND BINDERS.

1872.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MAP OF THE
WORLD.
(MERCATOR'S PROJECTION)
Showing the principal
SURFACE CURRENTS
OF THE
OCEANS & THERMOMETRIC
GATEWAYS
TO THE
NORTH POLE.
Illustrating Address of
SILAS BENT
Explanations:
The Red Coloring indicates Warm Water
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" Arrows show the direction of Curr
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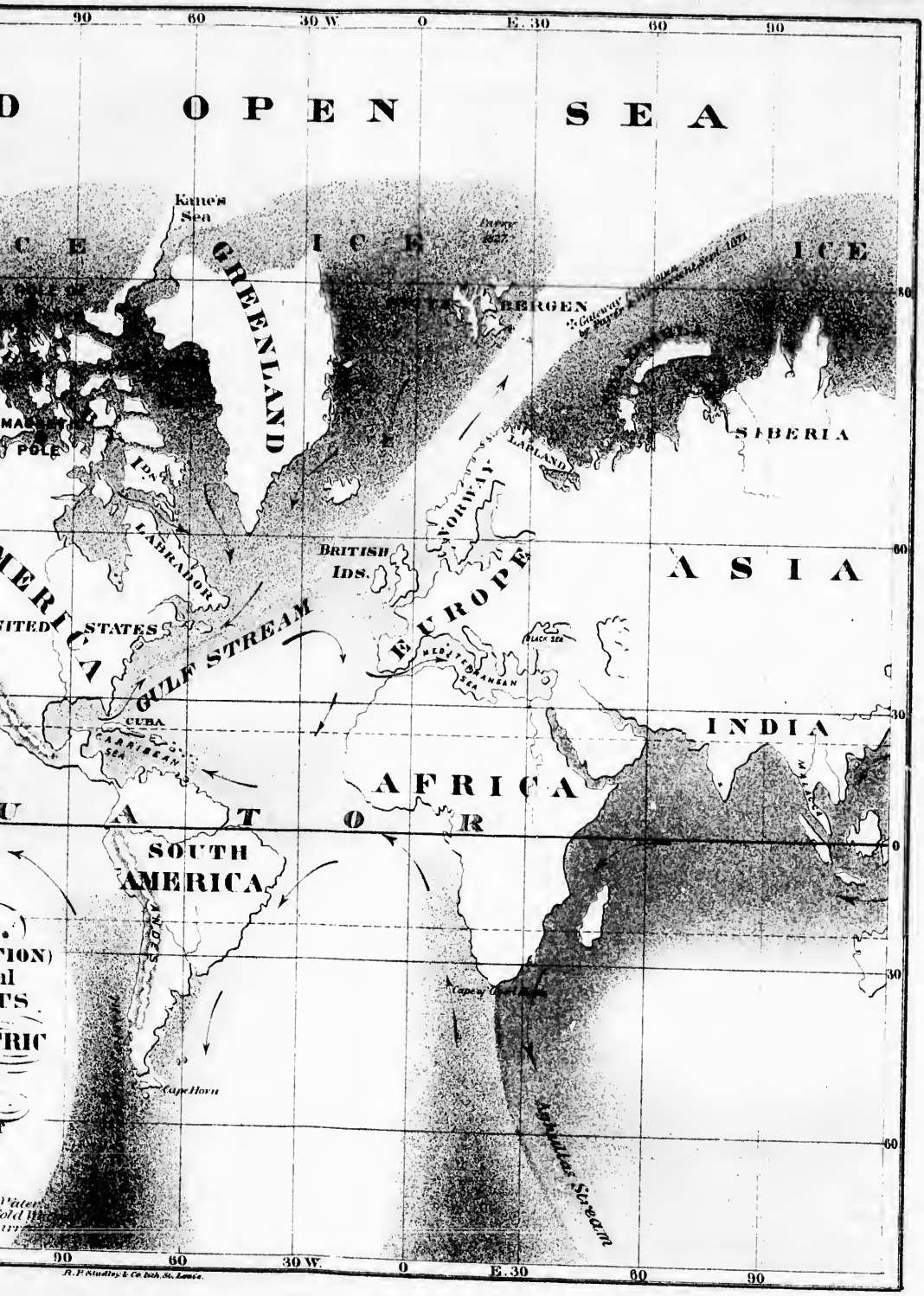
R. P. Studley & Co. lith. St. Louis.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ADDRESS.

Mr. President, and Ladies and Gentlemen:

When De Soto discovered the Mississippi river, let us suppose he had remained on and about its borders for months and years—had traversed its width—had sounded its depths—had measured the velocity of its current—had recorded its temperature—had floated a thousand miles to the southward on its turbid bosom, and had still found, that, whilst its apparent volume continued the same and its temperature changed but slightly, its current became somewhat less rapid, but its course was still onward, towards the south, through the alluvial soil and interminable forests that formed its banks. Suppose now—just when his mind was absorbed in speculations as to the mission in the earth's economy this great "father of waters" was intended to fulfill, whither it went and where it ended—he should have been told that, only a couple of hundred miles beyond, the Gulf of Mexico spread its broad basin directly across its path, and I think you will agree with me, that it would have required no great effort of genius nor stretch of imagination to conclude that this was the reservoir into which the river poured its waters.

Now this is but a fair illustration of the sum and substance of the origin of the theory of the "Thermometric Gateways to the Pole and Surface Currents of the Ocean" that I had the honor of first submitting to this Society in the winter of 1868–9.

THE GULF STREAM,

In its general character, has been known for a century or more, and until 1855 it was supposed to be the only great "river in the ocean" that existed on the globe. But about that time it was my good fortune, in the course of my official duties, to discover and trace out another similar stream in the North Pacific, of even grander proportions than the Gulf Stream, and to deduce a system of inter-oceanic circulation between the Arctic Ocean and the Atlantic and Pacific, which is necessary to complete and harmonize the separate systems found to exist in these two latter oceans, and which were then, for the first time, discovered to be so completely alike.

THE BEAUTIFUL SIMPLICITY

of the law developed by this theory seems to have so commended itself to the judgment of others, that, without an exception so far as I am aware, the press everywhere accepted it, and but few persons have attempted to controvert the hypotheses.

In the treatment of my subject this evening, I shall endeavor to be as brief as possible consistent with

AN INTELLIGENT REPRESENTATION

to your minds of the various points that have necessarily to be considered, before a just conclusion can be drawn as to the results and of their importance. To do this I have divided the address into three parts, viz:

1. Explanations of the hypotheses of oceanic circulation and of the thermal gateways to the pole, as given to this Society on former occasions.

2. Short extracts from some of the reviews of these theories and other discussions that their publication has given rise to; and

3. A sketch of the explorations and discoveries made in the Arctic Seas since 1868.

I will begin by stating to you that there is

A CIRCULATION IN THE OCEAN

which is governed by laws as fixed and beneficent as are those of the animal and vegetable kingdoms, and which are as interesting to the student of nature, and perhaps as important—for aught we know—to the well-being of the human race, as the latter have proven to be.

Place under the microscope the web of a frog's foot, and hither and thither we shall see varied currents of blood, crossing and recrossing each other, apparently without order and without law. Examine the capillary vessels of the human body, and there, in the most tortuous ramifications, passes and repasses the life-giving fluid from one set of vessels to the other, to all appearance without any governing cause.

Look into the bosom of the mighty deep, either when the storms of heaven are lashing the white-topped waves, or when the serene sky breathes a beautiful calm over the face of the waters, and here, seemingly with the utmost incongruity, are found currents and counter-currents, meeting each other at all variety of angles, above, below, near and far, over the whole surface and depths of the waters.

Further scientific investigation, however, teaches us that as, in the human system, one variety of vessels pass from one side of the heart, carrying the pure blood to every portion of the body, that another set of tubes of wonderful conformation carry back the impure blood to the heart, where, in obedience to the inexplicable laws of nature, it is sent into the lungs, there to be purified, and again to go through the body with its life-giving and healthful influence. And, moreover, as this purifying process is being accomplished, animal heat is generated. So it is with the currents of the ocean, which it will be my endeavor briefly as possible to explain.

There is

AN EQUILIBRIUM IN ALL NATURE.

There is an unseen power, that, while it utterly forbids annihilation of matter, constantly so alters the forms, appearances and uses of the molecules, that loss in one portion of the universe is counterbalanced by a gain in another; and thus, by that inscrutable power of adaptation, the earth revolves within its orbit and the stars sing together in harmony, while the dew upon the blossom—the rain—the ice—the snow—the heat and cold—all conspire to perfect those laws of compensation and adaptation, thus indicating to the student of physical science *that* perfect harmony, law, and order in nature, which, to the uninitiated, are obscure, incongruous, and undefined.

The sea, the atmosphere, and the sun are to the earth, what the lungs, to behold, and the heart are to the animal economy.

The process of evaporation is provided by an all-wise Providence to purify, renovate, and vivify the surface of the globe; and in this great and continually recurring action may be seen one of the causes of those currents which are found in the ocean.

Let me here quote to you a single passage from one of the most beautifully written works upon the subjects of which we are now treating. I allude to that on "The Physical Geography of the Sea," by Commodore M. F. Maury. He says:

"THE MEAN ANNUAL FALL OF RAIN

on the entire surface of the earth is estimated at about five feet. To evaporate water enough annually from the ocean to cover the earth, on the average, five feet deep with rain, to transport it from one zone to another, and to precipitate it in the right places at suitable times and in the proportion due, is one of the offices of the grand atmospheric machine. This water, bear in mind, is evaporated principally from the Torrid Zone.

"Supposing it all to come thence, we shall have encircling the earth a belt of ocean three thousand miles in breadth, from which this atmo-

sphere evaporates a layer of water annually, sixteen feet in depth; and to hoist up as high as the clouds, and lower down again, all the water in a lake sixteen feet deep, three thousand miles broad, and twenty-four thousand miles long, is the yearly business of this invisible machinery."

THE EFFECT.

Now, I ask you, understanding as we do the constant effort of nature to restore equilibrium, and the laws of adaptation, what must be the effect upon the ocean of the removal of this immense mass of water of twenty-four thousand miles in length, three thousand miles in width, and sixteen feet in depth? Certainly an endeavor on the part of the water to occupy this enormous space; and to do this all the waters north and south of this space, or zone, are at once set in motion to restore the equilibrium; and were there no continents and islands, or inequalities in the bed of the oceans, this flow would be uniform round the whole earth; but by these local obstructions they are divided into many streams, and diverted into numerous channel-ways, through which they pour their volumes to form

THE GREAT EQUATORIAL CURRENTS

of the Atlantic and Pacific. "Regard it as proved," wrote Columbus in the diary of his third voyage to the New World, when seeking to enter the tropics near the meridian of Teneriffe, "that the waters of the sea move from east to west, as do the heavens; that is to say, like the apparent motion of the sun, moon, and stars."

However we may explain

THE WESTERLY FLOW

of the vast watery masses in the equatorial seas, the fact remains as one of the best attested and most unquestioned of oceanic phenomena. Over the torrid and liquid waters, both of the Pacific and Atlantic, sweeps this mighty and majestic stream, steady and perennial, and as unfailing as the stars in their courses. In the Pacific, notwithstanding it must find its impeded way through the meshes of the Polynesian Archipelagoes, it yields to no resistance, but presses on to the palmy Philippines and Formosa, whence it passes its floods, in part to the north, along the coasts of Japan, and in part through the China, Celebes, and Java seas, into and through the basin of the Indian Ocean. Some have supposed that, originally, these channel-ways to the south and west were made by the westwardly washings of the water rending Australia from the continent of Asia.

The width of the equatorial current of the Pacific exceeds 3,000 miles.

THE ATLANTIC CURRENT.

The equatorial current of the Atlantic has its genesis on the west coast of Africa, where it is formed by the great ocean flow from the Antarctic regions on the south and the recurvation of the Gulf Stream on the north. It sets out in its movement to the west with no obstacles in its way; but when it reaches the coast of South America, only a small portion of it is deflected to the south-west by Cape St. Roque, the greater mass being crowded to the northward and westward until reaching the West Indies, when it passes into the Caribbean Sea and Gulf of Mexico. But you can readily perceive, by looking at this map, that this northward pressure must force much more than half of the whole volume of the equatorial current to the north of San Domingo and Cuba.

Some eighteen months ago, Professor Thompson B. Maury, in a very interesting and able article, advanced the hypothesis that that portion of the equatorial current which here passes to the northward of the Greater Antilles, and which must be a hundred fold greater than that which returns to the east from the Gulf of Mexico through the Bemina Straits, forms the great mass or body of the Gulf Stream, and that that which issues from Bemina is but a small portion of the tropical waters that pass Cape Hatteras on its flow to the northward.

Notwithstanding these obstacles, however, enough water is forced through the passages between the Lesser Antilles to form a strong current to the west through the Yucatan channel, and which was sufficiently great to lead Sir John Herschel to "assert, that the excavation of the Gulf of Mexico and the Caribbean Sea is an evident effect of the continued and powerful action of the set of the great South Atlantic current, and *which, unless counteracted by other causes, must, sooner or later, cut through the Isthmus of Darien.*" This smaller Caribbean current, making the circuit of the Mexican basin, and gathering heat from a tropical sun, unrelieved by the cooling trade winds—which are broken by the islands at the mouth of the Gulf—is compressed into the narrow passage between Florida and Cuba, and on emerging from which, with concentrated velocity, it is met obliquely by the northern portion of the equatorial current before spoken of, and turned sharply to the north, to become a part—instead of forming the whole—of what is known as the Gulf Stream.

This is the beginning of that marvelous flow of tropical waters, which for more than a century has been, and is still, such

A WONDER TO MAN.

Arsted describes it as "a great and wide stream of water, larger than all the rivers of the world together, running in a definite channel, through colder water of a different color, so that, when a ship enters

the stream in smooth water, one may see the bows dashing the spray from the warm and dark blue waters she is entering, while the stern is within the pale green and cold waters of the banks of Newfoundland." "Clear as this description is," says Prof. Maury, "it gives us but a poor conception of the reality. The Gulf Stream, indeed, beggars all efforts at portrayal. To see it rolling in grandeur is not enough to enable the beholder to understand its wonder or conceive its power. The mind can take these in only when it can weigh and measure those facts and forces which are concealed below the surface, and over which even the oldest seaman may sail all-unconscious and unconcerned." Our knowledge of the sea, even in the limited area we are now considering, is by no means perfect or exact. Yet, after all, we are not shut up to skepticism or imagination.

THE NICELY CHARTED RESULTS

of the arduous labors of the United States Coast Survey, in the thermal and deep sea surveys of the North Atlantic, have long since been published. These results, like seed long sown, are now beginning, under the hands of able workmen, to bring forth fruits.

Leaving the tropics with a temperature of 88°, the Gulf Stream loses but 2° in every three hundred miles; and Admiral Milne, of the British navy, reports that when he ran into it off Halifax, in the man-of-war Nile, the bow of his ship plunged into water of 70°, whilst at her stern the thermometer showed 40°.

Mathematical calculations show that the heat actually set free in a winter's day by the Gulf Stream is "enough to warm up the whole column of atmosphere" resting on France and the British Islands from the freezing point to summer heat; and, as Commodore Maury says, "is sufficient, if utilized, to keep in constant flow a stream of molten iron as large in volume as that of the Mississippi river"; and "that the latent heat, set free by precipitation, over England, in one day, when the wind is from the westward, is equal to that created by the combustion of all the coal consumed in the island throughout a whole year.

THE THERMAL EFFECT.

Observations of the Scottish Meteorological Society show that the winter temperature of the Shetland Islands is raised 36°, and that of London 20°, by the influence of the Gulf Stream upon their climates, and that the Norwegian coast is still more greatly affected by its contact. The isochimenals, or lines of equal winter temperature, are curved from their normal position sixteen hundred miles northwardly, over the regions covered by the Gulf Stream. "It clothes Ireland with its robe of emerald," whilst the harbors of northern Norway, in latitude 72°, are kept open throughout the year by its genial warmth.

SOUTHWEST DIRECTION.

By the earth's rotation on its axis, objects on its surface between the tropics are carried from west to east at the rate of a thousand miles an hour, whilst, as we advance towards the poles, this rate decreases with the decrease in the circumference of the parallels of latitude, so that when we arrive at points where the circumference is only twelve thousand miles, instead of twenty-four thousand as it is at the equator, this velocity of rotation is but five hundred miles an hour, and so on, decreasing until reaching the pole.

Now, an object set in motion towards the equator, from the polar regions,—where the velocity of the rotation is small,—will constantly be arriving at points on the earth's surface where the velocity is greater, and, not at once acquiring this greater velocity, its direction will tend obliquely to the westward. Hence we find those streams or currents which flow from the pole towards the equator, always taking a southwestwardly direction, whenever the continents and islands will permit.

These streams from the northern and southern hemispheres, meeting at the equator, form and give direction to the equatorial currents, the waters of which are thrown to the westward; but, interrupted by the continents which lie across their paths, and changed in their specific gravity by the expansive heat of the sun, they throw off hot streams to the north and south, like blood from the heart in the animal system, to carry their life-giving warmth and nourishment along their paths to the earth's extremities.

FIVE "GULF STREAMS."

Of these streams, there are two in the northern hemisphere, and probably three in the southern. It is only to the former, however, that we have specially to call your attention on this occasion, and these are known as the Gulf Stream of the Atlantic and Kur-Siwo of the Pacific. Their striking resemblance, as traced upon the chart, in size, form, and direction, is apparent to the eye. The Gulf Stream was delineated from observations made by the United States Coast Survey, and the Kur-Siwo from observations made upon it by the Japan expedition under Com. M. C. Perry.

The analogy between these streams is as complete as it is striking. By looking at this chart, on which they are traced, you will see that they both spring from the northern edge of the equatorial currents in latitude 22° N.; that they both, at first, start directly north, and then curve gradually to the eastward; that neither of them (except the Gulf Stream at its origin) touch the eastern shores of America or Asia, but that, after sweeping obliquely across the vast oceans in which they lie, they bathe the western shores of those continents; that when striking these continents they are both split into two unequal parts; that the

larger portions of each, impinging upon the land, are reenrved to the southward, and finally fall again into the currents of the eqnator; that the smallest portion of both, however, continue their courses to the northeast into the Arctic Ocean—that of the Gulf Stream by the way of Spitzbergen, and that of the Kuro-Siwo by the way of Behring's Straits; that they both have cold counter currents intervening between them and the continents near which they rise, and which run in directly opposite directions to their own courses, and with eqnal rapidity; that they both have the same high mean-temperatnre of eighty-six degrees, preserving in the dead of winter the heat of summer; that they are both cushioned in beds of cool water, which, from want of affinity, robs them of none of their warmth; that this warmth, after having been carried for thousands of miles through the waters of the ocean, is (the moment these streams touch the land) thrown out with such freedom and diffused so far, by the conductive power of the earth, as to change the climates of nearly half of both continents; and that they both, in their never-ceasing and unchanging beneficence, are fit symbols of the wisdom and goodness of Him who "created the heavens," "formed the earth and made it," and "created it not in vain," but who "formed it to be inhabited."

It is a hydro-dynamical law, that currents of water in the ocean retain their peculiarities, and will not mix freely with waters of different density, temperature, and saltness.

To those whose pursnits in life have not rendered them familiar with nautical matters, it may be well to explain certain technicalities which are necessary to a thorough appreciation of the subject.

First, I must explain what is understood by the

"NORTHWEST PASSAGE,"

as contradistinguished from the "Passage to the Pole."

Many European nations, in early times, accepting the theory of the rotundity of the earth, and seeking for a shorter route to India than that by the way of the Cape of Good Hope, endeavored to sail thence by directing their course westward, across the Atlantic. Christopher Columbus entertained this idea, and, even after the success of his voyages, believed that he had accomplished the desired result, and died supposing that he had reached the islands lying off the east coast of Asia. Hence, the name India Islands was given to the group lying at the month of the Gulf of Mexico. But, after a time, when it was discovered that a vast continent and mighty ocean lay between these India Isles and the shores of Asia, the term "West Indies" was applied to them, in contradistinction to the "East India Islands," found to the southward of the eastern hemisphere. Thus, it will appear, that the continent of America, blocked up the western route

to India; that the ronte by Cape Horn, besides being more distant, was even more dangerons, than that by the Cape of Good Hope, and the idea became prevalent, that there might exist and be practicable for commerce, a passage rounnd the northern extremity of America; and this passage, lying in a *northwest* direction from Europe, gave rise to the expression of "Northwest Passage."

The first attempt that was ever made to discover or effect this passage, was undertaken by John Cortereal, a Portnguese, in the year 1563. *He failed; and so has all the marvelous intelligence, enterprise, and energy, that have been expended in that direction, by every maritime nation of the world, from that time to this.*

SIR JOHN FRANKLIN'S EXPEDITION.

The early expeditions, being but poorly provided, and having no succor nor supplies to fall back upon—when so unfortunate as to be caught in the ice for the winter—were usually completely destroyed by the scurvy, starvation, and intense cold; and that those of the past century have not shared the same fate, is, in a great measure, to be attribnted to the timely assistance rendered them by other expeditions, whenever they have met with disasters.

Of this, we want no more fearful illustration than that afforded by the terrible fate of Sir John Franklin's party.

This expedition sailed from England in 1845. The vessels—Erebus and Terror—were probably lost in 1846, and notwithstanding the millions of money that have been spent in expeditions of relief, and a heroism of self-sacrificing energy displayed by those composing the *personnel* of those expeditions which the history of the world scarcely affords a parallel, yet the American explorer, Hall, who recently returned from a five years' sojonrn among the Esquimanx, brought reliable intelligence that Captain Crozier, Franklin's second in command, with the last survivors of that expedition, died only some seven or eight years ago! Can the mind picture a more frightful fate than the imprisonment of these people for twenty years, in such a region of frozen desolation as must have been the scene of their wanderings?

OTHER EFFORTS.

In addition to the many expeditions made in this direction, to the west of Greenland, there have been others, equally fruitless, so far as the main object of the enterprise was concerned, that have been sent to the northeast from the Atlantic, to find a ronte round the north of Europe and Asia to India; and still others, though comparatively few, that have penetrated Behring's Straits, with the special purpose of passing either to the east or west, as opportunity might offer, from the Pacific to the Atlantic. Of these, Cook, Clerke, and Beechy may be

named. The former reached latitude 70°, in longitude 161°, 40′ west, and Beechy to Cape Barrow. Capt. McClure, of the British navy, passed these Straits in 1850 to coöperate with Sir Edward Belcher, who went by Davis Straits, in search of Sir John Franklin. Capt. McClure, by clinging to the shore, where a fringe of water is kept open in summer by the drainage from rivers and the warmth of the land, succeeded in reaching longitude 177° west, where his ship was frozen in, and which he abandoned in 1853, and, with his crew, traveled one hundred and seventy miles over the ice, to join the Resolute, which was also frozen in at Dealy Island, and which, in turn, was abandoned; and afterwards, in September, 1855, was found by an American whaler, in Baffin's Bay, still securely wedged in a field of ice, covering an area of hundreds of square miles, by which she had been safely carried twelve hundred miles to the southward and eastward from the point where she had been abandoned.

THE GALLANT M'CLURE

is justly entitled to the distinguished credit of having been the first to pass from ocean to ocean round the continent; yet he cannot be said to have *circumnavigated* the north end of the continent, since a part of the passage was made on foot over the ice.

TOWARDS THE POLE.

Henry Hudson reached 81° 30′ northwest of Spitzbergen in 1607. Phipps 80° 37′ N., in the same locality, in 1773. Buchanan and Franklin 80° 34′ N., near Spitzbergen, in 1818, and then, sailing westward along the ice barrier, lost ground as they receded from the path of the Gulf Stream. Parry, in 1827, after reaching the ice north of Spitzbergen, took to his boats mounted on sledges, and, after one of the most laborious journeys on record, in which he traveled 568 miles, yet made only seventy-two miles on his course to the north, when he came to *rotten ice*, and had to abandon the attempt, having reached latitude 82° 45′ 20″ N.

Admiral Wrangel, of the Russian navy, in 1823, made an attempt also to reach the pole, by traveling north from Siberia, over the ice in sledges; but on reaching latitude 70° 51′ N., longitude 175° 27′ W., was stopped by rotten ice, beyond which lay an open sea, boundless to the vision toward the North Pole.

Dr. Kane's vessel being frozen in at the entrance of Smith's Sound, in 1854, he sent an expedition over the ice, to the north, which, after traveling some 200 miles, reached the open sea in latitude 81° 30′ N. Dr. Hayes followed in the same locality, in 1861, found the same open sea, and ascending a few miles further north than Morton had done, saw land extending north for a degree or so beyond. Parry's latitude stands the highest as an authentic record.

THREE CENTURIES OF FAILURE.

For three hundred years, explorers of every description, whether national or individual, have been, and are still, in my opinion, trying every avenue but the right ones, to reach the Pole and circumnavigate the northern extremities of the continents. The failures and disasters of these expeditions are familiar to you all, as they are to every one who has read their narratives. But, like most others, I had never given the subject any special attention or study, until it so happened that the materials were placed in my hands which led to the delineation of the Kuro-Siwo, and

THE DISCOVERY

that it formed a part of a great system of currents in the Pacific, identical in all its essential features with that of the equatorial current, Gulf Stream, and counter-current in the Atlantic.

To inform you how this occurred, I may state that after the close of the Mexican war, in 1848, the sloop of war Preble, to which I was attached, was sent on special service from California to China. She followed the equatorial current, after leaving the Sandwich Islands, which carried us from thirty to eighty miles beyond our reckoning, every day, by its westward flow. In the winter of 1848-9, the Preble was sent to Naga-saki, in Japan, to rescue a number of American shipwrecked seamen, imprisoned there by the Japanese. The monsoon was blowing at its height, directly against us, from the northeast. After a severe struggle, of some eight or ten days, we doubled the south end of Formosa, having crossed the strong current from the north, which runs down between that island and the coast of China, and at once fell into the current, which, it was well known, flowed north along the east side of Formosa. It was also equally well known, that only a short distance to the south of the south end of this island, the great equatorial current poured its volume, directly to the west, into the China Sea. Each of these currents was running at the rate of five or six miles an hour; but their limits or extent—except of the latter—was not at all known, and just as we were in the critical juncture of these currents, we were overtaken by a severe storm, which, with its blinding rain and spoon-drift, obscured everything beyond the distance of a few hundred feet, and continued for three days without intermission. That region of the sea was imperfectly charted, and sprinkled with dangerous islands and coral reefs, upon which many stanuch ships were almost annually wrecked. As navigator of the vessel, the responsibilities and anxieties of the occasion bore heavily upon my mind. At the close of the gale, in which—had there been no current—we should have drifted, or been driven, about a hundred miles to the southwest; and if still in the strong southerly current down the Formosa channel, near five hundred miles in the same direction; you may imagine

OUR SURPRISE,

on the breaking of the gale, to find that the ship had been carried nearly a hundred miles to the north, directly *against the wind*.

Running over to the Loo Choo Islands, we passed out of this northerly current, and in going thence to Japan again crossed it, but found it inclining to the east at that point. Accomplishing the object of our mission, we returned from Naga-saki by the way of Shanghai, and other ports on the east coast of China, finding the southerly current down the Formosa channel still running with the same velocity.

CONFIRMATION.

The Preble, returning to California a short time after this, pursued the same route, and found the same currents about the south end of Formosa. We carried the one flowing northwardly, until reaching latitude 35°, longitude 145° E., when we had to leave it, on account of a severe epidemic that had broken out among the crew, and which was aggravated by the fogs and mists that overhung the current.

The experience of this cruise, and its confirmation of the permanent existence of these two great currents, running in opposite directions, side by side, while the equatorial current was flowing with nearly equal velocity at almost right angles to them, made a strong impression upon my mind, and set it to work to find out

THEIR ORIGIN AND WHITHER THEY LED.

Sailing again for China and Japan in 1852, in the expedition under Commodore Perry, I fortunately had assigned to me such subjects for scientific and professional investigation, as enabled me to have such instructions issued to the various vessels of the squadron as would insure their keeping very accurate and full meteorological records.

After our return to the United States, these records were placed in my hands for the purpose of tracing, as far as possible, the location, direction, and force of the currents in that part of the Pacific and adjacent seas lying within the cruising grounds of the sixteen vessels that comprised the expedition.

The result of this work was the discovery of the system of currents in the Pacific, to which I have referred.

THE DEVELOPMENT

of these facts, as the data were placed in available form upon the chart, created no small degree of surprise and gratification, and naturally led to reflection and inquiry as to where the counter-currents of the Gulf Stream and Kuro-Siwo had their origin, and how far their

compensating influence kept up the equilibrium of the waters of the oceans. The prominent features of the subject, as it presented itself to the mind, were very marked, and, as before observed, were identical in almost all their parts, in both the Atlantic and Pacific Oceans.

Here were the two great currents of the world, one in each of these oceans, running to the westward along the equator, and known as the equatorial currents.

That in the Atlantic, after mostly passing into the Gulf of Mexico and finding no other outlet, has all that portion of its volume forced out to the eastward along the north side of Cuba, until passing the southern extremity of Florida, when it is deflected sharp to the northward, along, and not far distant from, the coast of the United States, and forming the Gulf Stream; whilst that in the Pacific, in great part passing through the Polynesian Islands and China Sea, has a *large shaving*, as it were, torn off its northern side by the south end of Formosa, which, with its current concentrated, is thrown, like the Gulf Stream, with increased velocity, short to the northward, and forming the Kuro-Siwo. These two currents, obeying certain physical laws, bend gradually to the eastward as they proceed north, but, meeting with local obstructions in the continents and islands that lie in their paths, are in great part turned to the southward—the one along the west coast of Europe and the other along the west coast of America, ameliorating the climates of both these faces of the two continents by their genial warmth, and finally falling again into the currents of the equator. Portions of both of these streams, however, pursue their courses to the northward and eastward into the Arctic Ocean; that from the Gulf Stream going between Spitzbergen and Nova Zembla, and that from the Kuro-Siwo by Behring's Straits. The accumulation of water about the Pole from these two off-shoots must, of course, have an outlet somewhere, and it is here that we find

THE ORIGIN OF THE COUNTER CURRENTS

in question, in the hyperborean currents that drain off this excess of water from about the Pole. The first, finding its way through the passages and channels leading from the Arctic Ocean into Baffin Bay and Davis Straits, runs thence down the coast of Labrador and wedges itself in between the Gulf Stream and the coast of the United States, making the counter current to the Gulf Stream; the second, finding but a narrow passage at Behring's Straits, is, by its greater specific gravity, forced under the warm water flowing to the north through these straits, and reappears at the surface again on the coast of Kamtschatka, and passes thence down the Japan Sea and Formosa channel, into the China Sea, forming the counter current to the Kuro-Siwo. There is also

A THIRD CURRENT

which flows to the south, along the east coast of Greenland, and which bears in its embraces the largest of the icebergs that are seen in the North Atlantic, and which underruns the Gulf Stream as the latter crosses the Atlantic.

KANE'S OPEN POLAR SEA.

Just as the work was completed upon these currents in the North Pacific, in 1855, the news was received in the United States that Dr. Kane had discovered an open sea near the Pole, and people began to ask how that could be possible, when it was well known that a belt or region of ice several hundred miles in width must lie to the south of that sea, and which was never dissolved.

The charts were upon my table, at which I was daily at work, showing the Gulf Stream and the Kuro-Siwo as they are now exhibited before you (except the coloring), with their warm branches or forks extending by Spitzbergen and Behring's Straits, and perfectly determined in both their width and direction, as far as this ice belt is supposed to exist. Now applying the axiom in the physical science of the sea, as laid down by Maury, "that whenever a current or stream of water is found flowing *from* any point in the ocean, other streams or currents of equal volume must flow *to* that point," and knowing that immense currents flowed constantly down *from* the Arctic Ocean by every avenue opening into the Atlantic and the Pacific, except along the pathways of these northern forks of the Gulf Stream and Kuro-Siwo, it was almost impossible that the idea should not occur to my mind, that these were the streams that not only carried this excess of water to the Pole, but also that the warmth they carried with them was

THE DIRECT AND SOLE CAUSE

of this open sea, and that their paths through the ice-belt offer the only highways for ships to that sea; and I so stated it in my official report on the Kuro-Siwo to Com. Perry.

DR. KANE

called at my office in New York on his return from this expedition in 1855, and I suggested to him that the open sea he had discovered most likely owed its existence to the Gulf Stream and the Kuro-Siwo. He seemed impressed by the facts presented to him, and in his narrative, vol. 1, p. 309, admits, not only the possibility of such being the case, but speaks of it as being altogether likely.

Still impressed with these facts in 1868, when so many expeditions for the Pole were spoken of, both in this country and in Europe, I addressed a communication to the Hon. Chas. P. Daly, as President of

THE AMERICAN GEOGRAPHICAL AND STATISTICAL SOCIETY

of New York, setting forth these facts and hypotheses in detail, and concluded by saying, that "if my theory proves unworthy the consideration of your learned association, why there the matter will probably end; but if it is correct, then I hope my humble suggestion may, in God's providence, be the means of arresting the recurrence of the sad calamities that have so often attended former expeditions, and perhaps facilitate the solution of the great geographical problem which has so long occupied the attention of men of science!" I also stated, that I had just learned from a newspaper telegram that a private yacht had sailed during the past summer for the Pole by way of Spitzbergen —that she was on the right track, and if she was a steamer, and followed the water thermometer, she would most likely accomplish her object, and her return might soon be looked for. I received

AN ANSWER FROM JUDGE DALY

as follows:

AMERICAN GEOGRAPHICAL AND STATISTICAL SOCIETY,
NEW YORK, Oct. 8, 1868.

DEAR SIR:

I beg leave to acknowledge the receipt of your communication. I have read it with a great deal of interest, and will place it before the Society at the earliest possible opportunity.

The yacht to which you refer, that attempted the passage by the Spitzbergen route, has returned to ~~Spitz~~bergen, but we are not advised of the cause.

I will see that you are duly advised of the opinion expressed upon your paper.

Very truly yours,

CHAS. P. DALY.

SILAS BENT, Esq.

REPLY.

I then wrote again to Judge Daly, thanking him for his courtesy, giving some additional suggestions, and said that I expected to hear that the failure of the yacht to penetrate the ice was owing to her having tried to go due north from Spitzbergen, instead of to the northward and eastward, along the path of the Gulf Stream, and, "that there is an open sea, with a temperature permanently above the freezing point, surrounding the North Pole, (and the South Pole too, for that matter,) *

* Sir James Ross, R. N., with the Erebus and Terror, in 1841, penetrated the South Open Polar Sea by unconsciously following the Australian Stream, indicated on my map, and reached latitude 78¼ S., near the meridian of 180° from Greenwich, the highest southern point ever attained; whilst the American expedition under Commodore Charles Wilkes, U. S. N., by having kept farther to the west-

I had no doubt; and that, if this is the case, to reach the Pole it must be done in ships, and the only avenues by which they can enter this polar sea is by following the Gulf Stream or Kuro-Siwo in their northeastwardly courses to that sea—these affording the only accessible channels or gateways through the ice surrounding that sea; and to find and follow these, the water thermometer is the only guide."

Instead, however, of laying my letters before that Society "at the the earliest possible opportunity," Judge Daly referred them to

DR. I. I. HAYES,

who, adhering to the old idea of reaching the Pole by the way of Baffin's Bay, and who was, at that time, endeavoring to get contributions for the fitting out of an expedition, to be placed under his command, very naturally did not wish public attention to be disturbed by any theory at variance with his own, and "was not," as Judge Daly says, "much impressed" with my views; and in an address delivered before the Geographical Society in November, 1868, in advocacy of his own project, when speaking of the Spitzbergen and Behring's Straits routes as the *least* practicable of all others, Dr. Hayes mentioned myself, among a few others, as being in favor of that by Behring's Straits.

INATTENTION.

A New York paper, containing a report of Dr. Hayes' address, being sent me by the Secretary of the Geographical Society, I saw that that was all the notice they intended to bestow upon my communications.

This not being the purpose for which I had prepared them, I concluded to take other means of giving publicity to my views, so that others, besides Dr. Hayes, might have an opportunity of passing judgment upon them.

I, therefore, prepared my address upon the Thermometric Gateways, but, before delivering it before the Historical Society of this place, in December, 1868, wrote to Judge Daly, calling his attention to his letter to me, and asking to be informed what action had been taken by his Society upon my letters. He gave me no answer; but in March, 1869, six months after receiving my first letter, and after the press throughout the country had taken up the theory with much earnestness, Judge Daly had my letters read before the Society, and expressed regret that I was not there myself to read them.

ATTENTION.

In January, 1870, Judge Daly devoted the greater part of his long annual address, as President of the Society, to what he evidently in-

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ward, and out of the influence of that stream, encountered the ice barrier in latitude 65° S., longitude 166° E., which he followed to the westward as far as the meridian of 95° E. without being able anywhere to get much beyond latitude 66° S. The Aghullas Stream, from its greater volume, would probably afford the best avenue to the South Pole.

tended to be a crushing criticism of my address, and of the very able and complimentary reviews of it which Prof. T. B. Maury had written for *Putnam's Magazine*.

THE HOSTILE STRICTURES.

It is impossible to give you these strictures of Judge Daly *in extenso*, as time will not admit of it. But whilst I acknowledge, that all the animus of his arguments is decidedly adverse, yet, I must say, that almost every fact he offers tends directly to the support of the thermometric theory; and whatever may have been the experience, which the Judge complacently claims for himself, in "sifting testimony," it requires, I think, no great familiarity with the "laws of evidence" to see that he has no very forcible way of putting his own testimony; for no sooner does he make a statement against the theory, than he refutes his own argument by facts in its favor; and in this he does not even spare his friends, whom he calls to his support; for after reading a letter from Mr. Geo. W. Blunt, written at his solicitation, in which Mr. Blunt says, "I send you my 'North Atlantic Memoir,' which contains all the accurate information—I am sorry to say, not a great deal—about that much misrepresented current of the ocean, the Gulf Stream, which body has to bear with the inventions of Maury, the stupidity of weather predictors, and the assumptions of meteorologists—enough, either of them, to crush out the vitality of anything which had not so perfect an organization as the Gulf Stream has." * * "Beyond the Western Islands, I believe that the Gulf Stream has no existence, and that the alleged effects of it on the climate of the British Islands are due to the assertions of the class I have spoken of in the first paragraph of my letter." * * "The Gulf Stream, as a current, I believe, entirely ceases and loses all its equatorial heat to the eastward of the longitude of 40° west." Then Judge Daly goes almost directly on to say, "that the German expedition of 1869, as I have already stated, found piles of drift-wood twenty feet high upon the southeast shore of Spitzbergen. Captain Torrell, in 1861, picked up a well-known bean on Shoal Point, that had found its way from the Gulf of Mexico, and the Swedish explorers of 1868 say: 'During our cruisings amid the ice, we collected a number of pieces of drift-wood and glass balls, of the kind used as floats in the Lofoden fisheries, showing that these arctic seas are not without these surface indications which serve as a guide to the mariner of the course of currents.'"

Did the time permit, or their importance warrant it, I could give you a dozen or more just such contradictions from this remarkable production; but I will content myself by commending the address for your perusal, to show how weak an argument an able man can make when treating a subject of which he is ignorant.

MISQUOTATION.

There is one paragraph, however, among others, in which Judge Daly misquotes me, that I must, in justice to my training as a seaman, not omit. He says, "Captain Bent's theory is this: that the Gulf Stream of the Atlantic and the warm Japanese current of the Pacific, are each prolonged to the vicinity of the Pole, where, he thinks, these currents unite, and, discharging their heat, produce an open Polar Sea. He is of the opinion that these currents are the prime and only cause of the existence of this sea, and that they constitute the only practicable avenues by which ships can reach it or the Pole; or, to use his own language, 'the way to the Pole is by following the course of these currents, which are water thermometers, and may be termed *the thermometric gateways to the Pole*.'"

Now, Judge Daly may not know the Gulf Stream or Kuro-Siwo from a water thermometer; but I beg he will believe me, that I have been too often buffeted by the waves of the former, and have served too long an apprenticeship in the use of the latter, ever to be misled into the statement that these mighty ocean currents are such portable instruments as water thermometers. Nor do I call them "Thermometric Gateways to the Pole" either, though I do so designate the *avenues* which these streams make through the ice-belt surrounding the Pole.

In the light, however, of the results of the explorations and discoveries made since Judge Daly and the Geographical Society entered upon the dangerous course of denouncing a theory before it had been tested, if these gentlemen can find any sustaining comfort, I sincerely wish them joy in its possession.

DIGRESSION—OCEAN AND CLIMATE.

I will here interrupt the thread of the discourse for a few moments, to lay before you another hypothesis or theory, taken from my former address, and which is incidental to, or has grown out of, my reflections upon the other, and though possessing none of the romantic interest which attaches to polar discussions, yet which, for the interests of navigation, the safety of commerce, and the advancement of meteorological science, is, I consider, of vastly greater importance than the other, even though the gateways to the Pole might be found open for six months out of the twelve.

EGOTISM.

As this hypothesis is the result of personal experience and observation, you will, I hope, pardon the egotism of a brief recital of the scope of that experience, both as to its extent and the duration of the time that I have passed in various regions of the world.

Of the twenty-five years that I was in the navy, two years and a half were spent in the Gulf of Mexico and the West Indies—eight or ten

months on the east coast of South America—I have been once round the Cape of Good Hope, stopping at Madeira, St. Helena, Cape Town, and Mauritius—doubled Cape Horn four times—was four years in the Pacific and at the various ports stretching from Patagonia to Oregon—twice across the Pacific Ocean: once by the equatorial current and again by the path of the Kuro-Siwo—nearly three years in China, Japan, and the East Indies—passed up the Red Sea into Egypt—spent fifteen months cruising in the Mediterranean, visiting all important points from Gibraltar to the Black Sea—eighteen months traveling on the continent and in the British Islands—have crossed the Atlantic five times, and was engaged four years on the survey of our Atlantic coast.

During this time, when afloat, it was a part of my duty either to take observations myself, or to receive reports of them from others, upon the temperature of the air and water, force and direction of the winds, and general character of the weather, which are habitually recorded, at least, every two hours, and which, in that way, compel these matters to become an ever-present subject to the minds of naval officers, as well as an important part of their professional education.

CLIMATIC CHARACTER.

A contemplation of this chart, with all these great currents of the ocean, made apparent to the eye at one glance, and recalling to mind the climates, as I have experienced them, in almost every portion of the earth bordering on the oceans, between the latitudes of sixty degrees north and sixty degrees south, I cannot divest myself of the conviction that all countries so situated derive their climatic character (whenever that differs from what is due to the latitude) entirely from the ocean currents that wash their coasts, and not at all from those which, though flowing near them, do not touch their shores. To show you the grounds upon which I base this conclusion, I will occupy your attention for a few moments whilst I endeavor to lay them before you. We will start with what is known as

THE HUMBOLDT CURRENT,

which, coming from the Antarctic Ocean, and splitting on Cape Horn, flows with its greatest volume to the northward, along the whole west coast of South America. The climate there is cool, and, as you approach the equator, the temperature is so much below what is due to the latitude, that at Lima, in twelve degrees south latitude, woolen clothing is necessary for comfort during several months of the year, and the heat is never oppressive. The common belief is, that this is owing to the close proximity of the Andes; but, as like causes produce like effects, if this were the case, the Sierra Nevada, which lies quite as near to the coasts of California and Mexico as the Andes do to those of Chili and Peru, would give similar cool climates to those countries; but

this they do not possess, but, on the contrary, they have warm climates, derived, as before stated, from the influence of the Kuro-Siwo. The Kuro-Siwo, from having been in contact with the land in high latitudes, which robbed it freely of its warmth, reaches the equatorial belt with a comparatively low temperature, but still not so low as that of the Humboldt current from the south; consequently, we find the Sandwich Islands, in twenty-two degrees north latitude, with very nearly the same climate as the Marquesas group, lying only ten degrees south of the equator, both being within the immediate region of confluence of these two streams, where they form the great equatorial current of the Pacific, and these islands stand unrivaled, in their delightful climate, by any other spots on the earth's surface.

CUMULATIVE HEAT.

We will now start west with the equatorial current, the waters of which are but just brought under the direct rays of the sun, from which they continue to accumulate heat so long as they remain within the tropics.

We come first to the Ladrone Islands, which have a much warmer climate than the two groups just spoken of; then to the Philippine Islands, where the heat is quite oppressive even in winter, but which increases in fervor as we reach Malacca, is all aglow in India, and becomes stifling in its intensity as these waters—after traveling fifteen thousand miles and been fully three hundred days under a vertical sun—are thrown against the eastern shores of Africa. Here this current is deflected to the southward to the Cape of Good Hope, from whence it starts with its burden of heat to keep an "open sea" about the South Pole. It does not double round this cape and flow to the northward on the west coast of Africa, as usually represented on maps, although there is a current there running in that direction; for Sir James Ross, in 1842, discovered that these were two distinct currents—that to the east of the cape, flowing south, being a hot current from the tropics, as just described, whilst that to the west of the cape, flowing north, is a cold Antarctic current. And this has been confirmed by more recent observations, taken at the instigation of Commodore Maury, and also, more fully, to my mind, by the marked difference of climate found on this west coast, when compared with that we have just left on the east side of Africa. This polar current continues north until reaching the Torrid Zone, and meeting the reflux of the Gulf Stream, when, the two uniting, form the equatorial current of the Atlantic. DuChaillu, in his work on Africa, gives the mean temperature in latitude 1° 30′ south, from October to June, and embracing the warmest part of the year, as 77°, the highest range being 88°, and the lowest 66°. These observations extended from the coast two hundred miles inland. This charming climate, directly under the equator, is, I am satisfied, owing to this cold current from the south. Now, continuing west again from this

point some two thousand miles, brings us to Brazil, with its fervid climate; but as the waters of the equatorial current, when reaching there, have been comparatively but a short time directly under the sun, the thermometer shows no such intense heat as that on the east coast of Africa. This current, now dividing on Cape St. Roque, the larger portion flows into the Caribbean Sea and Gulf of Mexico to form the Gulf Stream, whilst the other is deflected south along the east coast of South America, and so elevating its climate, that, at the Falkland Islands, 52° south, cattle subsist by grazing throughout the year.

CURRENT AT CAPE HORN.

We now come to Cape Horn. And here, again, some of the standard atlases have fallen into another error in supposing this current to double round the cape and form the Humboldt current, first referred to in this digression, for the water thermometer tells a different story; and, as an additional proof that the current flowing north into Atlantic comes from the Antarctic Ocean, I have, myself, seen an iceberg brought by this current to 60°south latitude, which, in size, was far beyond any I have ever seen described in the northern seas; and, on one occasion, in passing from the Atlantic to the Pacific, in one of the finest frigates in the navy, we were twenty-one days beating and struggling against this current and the wind before we doubled the cape; and on another, it was a fortnight before we thought it safe to stretch away into the Pacific, and both times ran as far as 60° south latitude. In the absence, therefore, of more positive data than I have here given, I think it is not unreasonable to believe that the same phenomenon of currents will be found to exist here that has been described at the Cape of Good Hope; and that whilst the Humboldt current comes from the Antarctic Ocean, and flows north along the west coast of South America, the warm branch of the equatorial current of the Atlantic, which we have followed down the east coast from Brazil, probably continues its course to the southward and eastward into the South Polar Sea. But, whether the Humboldt current is a recurvation of the Australian stream, or comes from the inter-Polar Ocean, we have no data to determine.

The same general system of currents, I am satisfied, will be found to exist in the southern hemisphere that has been described in the northern; modified, of course, to conform to the widely different geographical character of the southern extremity of the earth from that of the northern. In crossing over from the south side of Australia to New Zealand, Sir James Ross found the Australian stream to be three hundred miles in width at that point, with a high temperature, and setting strongly to the southward and eastward. Vessels bound from Australia to Cape Horn, or from the Cape of Good Hope to Australia, keep well to the southward, about the parallel of 50°, in order to avail themselves of the eastwardly currents known to be there, and which, I have no

doubt, are the recurvations of the Australian and Good Hope streams; they, like the Gulf Stream and Kuro-Siwo, throwing only portions of their volume into the Polar Sea, whilst the rest recurves and falls again into the equatorial currents on the opposite sides of the oceans from whence they spring.

THE CLIMATE OF ITALY.

Of the oceanic coasts of the northern hemisphere I have before spoken, but not of those of the Mediterranean, and to which I will now call your attention. Naples, in southern Italy, is in the same latitude as New York, and Genoa and Marseilles about the same parallel as Toronto—yet, at Genoa I have plucked ripe oranges from the tree early in February, and Naples has even a much more vernal climate. This is attributed to the warm winds from Africa; but, as you will observe, these winds have to cross the Mediterranean at its widest part, a distance of near four hundred miles. Now, if these winds have such influence as this, why should not those from the perpetual snows of the Alps give a severe climate to the plains of France and Italy, which lie directly at their feet, and not fifty miles from this snow? Yet these plains, in the latitude of Maine, are verdant with a perennial summer. The winds, therefore, are not the agency that produces this, but rather the warm waters of the Gulf Stream, which, as a surface current, flows constantly into the Mediterranean through the Straits of Gibraltar, and with such velocity, too, that when the wind is from the westward, sailing vessels are unable, sometimes for weeks together, to pass out into the Atlantic. But, even admit that the winds from Africa are the cause, then whence does northern Africa, with its latitude of 34° north, obtain such an excess of heat, as to be able to throw off enough across the whole width of the Mediterranean to change so materially the climate of such an immense region as this? It cannot be derived directly from the sun, for DuChaillu, as before shown, found a lower average of temperature within one degree of the equator than is enjoyed in Italy. But, it may be said, northern Africa being a desert, will account for its being so much hotter than the region visited by Du Chaillu. This, no doubt, has its effect, but not to the extent necessary to produce such results; for I have been in this desert, and also in the jungles of Ceylon and India, where the rank growth of vegetation was so dense that the sun's rays never reached the soil, yet the latter were hotter than the former, because, as before shown, the waters of the Indian Ocean are hotter than those of the Mediterranean. The latter, however, are sufficiently warm, when bathing the shores of Spain, France, and Italy, to diffuse heat enough to give them the delicious tropical climates they enjoy.

Pursuing these reflections, this matter presents a phase of

which, were it not for the inhumanity of exercising such a power, might place the whole of Europe at the mercy of this country. For, admitting that Europe derives its mild climate from the Gulf Stream—which few now dispute—then, to divert this stream from its present direction, would be to bring the whole of Europe at once, so to speak, to its normal climatic condition—that is, France and Austria would have the climate of Canada, and England, Germany and northern Europe would become a frozen wilderness, such as British America and Labrador. To accomplish this, the possession of the Isthmus of Panama and the expenditure of half the cost of the recent war between France and Germany in the excavation of a sufficient width and depth of the rock, only, that intervenes between the Carribbean Sea and the Pacific, and the opening of a small sluice through the soil to afford a beginning for the passage of the water from ocean to ocean, and but a short time would probably elapse before the channel would be large enough to give a new outlet to the equatorial waters of the Atlantic and cut off that excess which now goes to make the Gulf Stream.

VERIFICATION.

Let us now see how far this hypothesis is sustained by the known climate of prominent places, to only a few of which I will call your attention.

Hammerfest, in Norway, is in latitude 71° N.; but its shores being bathed by the tepid waters of the Gulf Stream, its climate is raised so much above that due to the latitude, that the harbor was never known to have been closed by ice, and its fisheries are continued throughout the winter. Following this parallel of 71° to the westward, across the Gulf Stream, and we get into the cold currents from the north, and, on reaching the islands to the west of Baffin's Bay, we find ourselves in the midst of those regions of frightful cold in which Franklin perished, and Crozier was for so many years imprisoned, and who ultimately died, beyond the reach of succor.

Liverpool, in latitude 53° N., has, by the ameliorating influence of the Gulf Stream, a winter temperature as high as that of Norfolk, in latitude 37° N.; whilst the parallel of Liverpool crosses America through the frozen wilderness of Labrador and British America, until after passing the meridian of 100° W. the climate begins to partake of the warmth of the Kuro-Siwo, from the Pacific; on the coast of which we again find a climate so mild, that at Sitka, in latitude 57° N., ice can never be stored for the summer. Crossing the Pacific, however, on the parallel of Liverpool, we reach the cold current from Behring's Straits; and in Kamschatka and Siberia we again find a climate only so much less severe than that of Labrador as the volume of this latter current is less than that from Davis' Straits.

The delightful climate under the equator on the west coast of Africa, as found by DuChaillu, is derived from the tempering influence of the great current which sweeps from the Antartic Ocean into the Atlantic Ocean laden with icebergs of such vast proportion as to dwarf into pigmies the largest that have ever floated in the northern hemisphere. One of these, which in 1854 reached the latitude of 40° S., was 60 miles long by 40 broad, and reaching an uniform elevation of from two to three hundred feet, showed that it had a depth of near two thousand feet below the surface of the ocean.

This cool equatorial climate of western Africa affords as striking a contrast with the fervid heat of the mouth of the Amazon, in South America, as has just been shown between the opposite shores of the north Atlantic—for the equatorial current, embracing the coasts of Brazil, stimulates the soil by its warmth and humidity to such a degree as to render the growth of vegetation so rank and rapid that, as Buckle says, "no energy of man is sufficient to subdue it."

Following the equator westwardly to the Pacific coast and we find the Galapagos Islands, a few hundred miles beyond, enveloped by the "Humboldt current," with a temperature so low that coralines, which inhabit waters of 66° F., cannot exist there.

Islands in the midst of great ocean currents have climates that correspond with the temperature of the water that surrounds them—the equatorial current at the Philippine Islands having a temperature of about 88°, gives to this group the climate that is so torrid even in mid-winter. And, if the open Polar Sea is as extensive as I suppose it to be, the climate directly at the Pole can never be of a temperature much below the freezing point. For, although all winds at the Pole must blow from the south, and—unless very local—must come directly from the ice-belt which surrounds that sea, (except where it is interrupted by the avenues made through the ice by the Gulf Stream and Kuro-Siwo.) yet, as the waters of that sea must always be above the freezing point, otherwise they would freeze, and the winds have to, necessarily, pass over five hundred miles of this warm water before reaching the Pole, they, no doubt, rob the water of enough of its warmth to raise them to very near, if not quite, the temperature of the surrounding sea. I think it may therefore be safely predicted that the climate at the Pole is far more equable, and much less severe, than our own winters are here at St. Louis.

DR. CARPENTER'S VIEWS.

A short time since, there was a lecture delivered in London by Dr. Wm. Carpenter, F.R.S.,F.L.S., upon "Ocean Currents," in which, while the Doctor endorses the general contents of my address—a copy of which he had received from America—he devotes his lecture to the refutation of that part of it in which I state, that if the Isthmus of Panama was

removed so as to admit of the equatorial current of the Atlantic passing freely into the Pacific, the Gulf Stream would be abolished, and the climate of England and Europe would be reduced to its normal condition, similar to that on the same parallels of latitude in eastern America; and denies that the mild climate of the British Islands and the northwest of Europe is due to the thermal effects of the Gulf Stream: he amusingly alluded to the very humane considerations by which America might consider herself deterred from meting out this dire fate to so large a part of the civilized world.

Dr. Carpenter's position is, that, in the first place, the obstructions offered by the Isthmus of Panama and Central America to the passage of the equatorial current from the Atlantic to the Pacific in no way contribute towards the production of the Gulf Stream; and, in the second place, that the heat from the Gulf Stream has no influence whatever in elevating the climate of Europe and the British Islands. Dr. Carpenter has recently made many developments, as results from his deep-sea dredgings and his chemical and thermal analyses of the waters in the Mediterranean and adjacent Atlantic, that have proven most valuable contributions to various departments of science. One of these is the satisfactory determination of the supposed cause of the vertical currents—for an *inflowing* of the surface water through the Straits of Gibraltar and an *outflowing* under current of equal strength and velocity—which is always found there. Dr. Carpenter attributes this to the greater evaporation that takes place in the Mediterranean Sea over that in the Atlantic, outside the Straits of Gibraltar, and illustrates it by a very pretty experiment, for which I have not the appliances to repeat, but will endeavor to explain to you orally.

Let us suppose that the waters in the Mediterranean and adjacent Atlantic were of a uniform depth of one thousand feet and were at rest. Evaporation now begins and a layer of ten feet is taken off the surface of the Mediterranean. This destroys the equilibrium of volume or quantity, and a surface current begins at once to flow from the Atlantic into the Mediterranean to restore that equilibrium. When this is done and the depth of the water in the Mediterranean again becomes one thousand feet, the equilibrium of weight is destroyed by the additional salt that is carried in by the new layer of ten feet of water and placed on top of that contained in the original thousand feet—all of which was left behind when the evaporation of the water took place—this greater weight pressing laterally against the lighter waters of the Atlantic, flows out, as an under current, to restore this disturbed equilibrium of weight.

Dr. Carpenter's opinion is, that the same phenomenon is produced in the circulation of the oceans by the disturbance of equilibrium from the expansion by heat of the waters in the tropics, and the contraction by cold of those in the polar and northern regions, and the currents

thus produced would continue to flow to and from the equator and the poles whether the equatorial or tropical belt was free from obstructions or not; and furthermore, that the warm waters which contribute heat for the amelioration of the climates of Europe and the British Islands come—in conformity with this law of circulation just explained—directly north from the tropics, along the west coast of Africa and Spain, on their way to the polar regions.

Now, I entirely agree with Dr. Carpenter, that these influences form the *basis* of the oceanic and inter-oceanic circulation, and that, if the earth was at rest, this circulation would be uniformly vertical, and as uniformly due north and south in all parts of the world. But Dr. Carpenter seems to forget that there are

OTHER GREAT FORCES

caused by the revolving of the earth upon its axis, which, if not of primary importance in the production of the currents, are, at least, very potential in changing the direction of this circulation, as I have before explained to you, in showing why the currents incline obliquely to the *east* when flowing from equatorial regions to the north or south, and obliquely to the *west* when flowing from the polar regions towards the equator.

Were it not for this obliquity of flow, the cold currents which, according to Dr. Carpenter's theory, must *always* be *under* currents, would never appear at the surface of the sea; but this, we know, is not the case, as every one who crosses the western limits of the Gulf Stream and Kuro-Siwo sees on passing through the heavy "tide-rips" that mark the chafing where they rub swiftly against the cold currents from the north that intervene between them and the continents to the west. There is

ANOTHER FORCE,

or law of mechanics, which has been well established and long known, with which Dr. Carpenter's position very strangely conflicts.

This law was demonstrated by Mr. William Ferrell, of Cambridge, in 1860, and is regarded as an extension of Hadley's explanation of the trade winds. Ferrell's demonstration is in the following form, viz:

"In whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern"—(p. 25 Farrell's Motion of Fluids and Solids Relative to the Earth's Surface).

It follows, from this law, that in the northern hemisphere every river current tends or presses more towards its right bank than towards its left, no matter which way its course may lie, whether east and west, like the Ohio, or north and south, like the Mississippi, or in any other direction.

So, too, a railroad train must always bear more heavily on the right rail of the track along which it is flying.

Without stopping to discuss this law of terrestrial mechanics, it may be enough to point out that it must be, in some degree, potential in giving direction to the trade winds and ocean currents. It *may* be counteracted, and is sometimes counteracted by greater forces, but always makes itself felt in the resultant motion. Dr. Carpenter and his co-theorists—of whom, however, there are but few even in England—bring the Gulf Stream to Newfoundland and there leave it. They forget that, if no other forces were at work to carry it to the north and east, this very law of the earth's rotation would carry it onward towards the British Islands.

THE GULF STREAM HEAT.

As to the amount of heat evolved by the Gulf Stream, Mr. James Croll says that "The quantity of heat conveyed by the Gulf Stream is equal to all the heat received from the sun by 3,121,870 square miles at the equator." Now, for the sake of argument, if we only take the half of this total, it is easily shown, as Mr. Croll does show, that the stoppage of the Gulf Stream proper (meaning simply the Gulf current at Bemina) would deprive the Atlantic of upwards of 77,479,650,000,000,000,000 (seventy-seven millions of trillions) foot-pounds, of energy in the form of heat, per day—a quantity equal to one-fourth of all the heat received from the sun, by nearly the entire area of the Atlantic Ocean embraced between the Tropic of Cancer and the Arctic Circle.

Now, if the Isthmus of Panama and Central America were removed so as to allow the equatorial current from the Atlantic to flow freely into the Pacific Ocean, the Gulf Stream would be—in my opinion—destroyed, and all this enormous amount of heat taken from the Atlantic; little or none of which comes to the American continent, but the most of which, either directly or indirectly, ensures to the amelioration of the climate of the British Islands and the continent of Europe.

Since my former address,

THE SUEZ CANAL

has been opened, and, as I had predicted, the current is reported as flowing through it from the Red Sea into the Mediterranean at the rate of from one to three miles per hour. That is, where the canal is confined between banks, the current is rapid; but where the water from the canal spreads out into lakes, the current is sluggish; and I venture the belief that if the cut of this canal was as wide and deep as the Red Sea, the flow of hot water from it into the Mediterranean would be sufficient to materially elevate the climatic temperature of the whole of southern Europe, and produce an outflowing current through the whole width and depth of the Straits of Gibraltar, thus destroying the inflowing surface current, as it now exists there.

For my pamphlet to be noticed at all by a man so eminent for scientific attainments as Dr. Carpenter, I accept as a compliment, even without the endorsement he gives the greater part of its contents; but I have to leave you to judge how far I have succeeded in maintaining the hypothesis he attacks.

I will now briefly refer to some few of the favorable notices and reviews that have appeared in regard to the theories advanced in my former address:

THE SOUTHERN REVIEW (QUARTERLY),

edited and published by Mr. A. T. Bledsoe, Baltimore, in its number issued April, 1869, contains an article on the "Atmosphere of the Ocean," which, after discussing the circulation of the atmosphere and of the ocean, says: "But the current which more nearly resembles the Gulf Stream in its origin, temperature and course, is the Kuro-Siwo, described by Mr. Bent. This is, indeed, the Gulf Stream of the north Pacific. Like the Gulf Stream of the Atlantic, it must have been long known to the trading vessels before it came under the observation of scientific men; and America has the honor of being the first among nations to generalize the facts observed in relation to this stream, and give them to the world in scientific form. * * * How often it happens that the greatest discoveries are the simplest; so simple, indeed, that everybody wonders that no one had thought of it before. It has been long known, ever since Dr. Franklin was a commissioner of the colonies at the British court, in anti-revolutionary times, that the Gulf Stream, or at least a branch of it, flowed to the arctic regions by the way of Spitzbergen; thus pointing out to the explorer the true way to the Pole, as unerringly as the wild buffalo of the West points out to the hunter, by its beaten paths, the easiest and best routes through the Rocky Mountains; and yet, strange to say, all the polar navigators from Parry to Dr. Kane have ignored this fact and sought passages to the Pole in vain, far to the westward by the way of Davis' Straits and Baffin's Bay. Whilst nature has been beckoning them, pointing out the true thermal gateway to the Pole, they have cast their eyes in a different direction, and wandered about in *culs de sac*, baffled and wearied, and driven back by impassable barriers of ice as often as they have made the attempt.

"Mr. Bent was the first to call the attention of the scientific world to this singular and fatal mistake of the early explorers, and every one wonders why no one had thought of it before."

IN PUTNAM'S MAGAZINE

of November, 1869, in an article reviewing the address, Professor T. B. Maury, with whom I have only become acquainted personally within the past year, and who has given a graceful beauty to the subject that I

had never conceived of before, says: "Enterprises have been tried under the most propitious auspices; most of them have been guided by the most expert seamen of the world, upheld by the most lavish outlays of moral sympathy and material wealth, and animated by a zeal which the eternal ices of the North could not chill. In vain have they endeavored every route save the one now suggested. Their failures and disasters have been most signal. The paltry successes they have reaped—paltry when compared with the means employed—have been reaped only by crossing immense plateaus and mountains of ice with infinitely more pains and perils than attended Hannibal's or Napoleon's passage of the Alps. And this fact alone, however it may shed lustre and glory on the heroic explorers, reflects none or but little light on the Arctic problem—unless, like the floating fragments of some noble ship that has foundered and gone down to tell a tale of warning, and to reveal the rocks on which the fairest hopes lie stranded. And yet, in the very gropings of these gallant spirits—such as Kellett and Kotzebue, and Parry and Kane—it appears that just so far as accidentally they were led to move towards these "thermometric gateways to the Pole" now pointed out, light has beamed upon their pathway. The moment they were called away from these routes and looked westwardly, that light grew dimmer till it was quenched, and some of them steering away from waters almost tepid and halcyon, furnishing a furrow for their keels, quickly plunged into cold and became entangled in icy desolation." * * * "If it is true, as this thermometric theory claims, that the Gulf Stream reaches the Pole with heat enough to melt its ice, it ought to follow, conversely, that the cold counter under-current from the Arctic Ocean, that offsets the Gulf Stream, will, in its long flow to the south, lose but little of its Arctic cold and reach the tropics with frigerific power. Such, at least, would be the demand of a remorseless logic. Anxiously we turn to ask, 'Is this demand satisfied? Do the nicest mean observations attest the fact indubitably?' Here is a gigantic balance, hung by the Creator himself, one scale at the pole, the other at the tropic. The first is, as yet, invisible; the other we can read. We know they must be in equilibrio. Let us go to the tropic, and with the deep sea thermometer drag up an answer from this unbiased and incorruptible witness.

"We have the most exact observations, taken with a variety of exquisitely-constructed instruments, and continued, at vast expense of money and care, through many years. They all tell the same story, so that science may be said to have sat at the feet of this great aqueous traveler to the Pole and heard him recount its mysteries.

"PROFESSOR BACHE,

of the United States Coast Survey, records that 'at the very bottom of the Gulf Stream, when its waters at the surface were 80° in tempera-

ture, the instruments of the Coast Survey recorded a temperature *as low as* 35° *Fahrenheit!*' 'The cushion of water under this must have been even colder, and this cushion is the counter current whose testimony we are seeking. * * * The Arctic current that offsets the Gulf Stream and flows south, reaching the Tropic of Cancer at 35° temperature, could not have left the Pole colder than 28°, for then it would have been *frozen up*. In its transit to the south it only gains six or seven degrees in its temperature.'

"Is it, then, a thing impossible, that the Gulf Stream, this mighty 'river of the ocean,' may reach the polar region at 36°? Remember, it begins its race off Florida, at 86°. It might then lose fifty degrees of its heat, (against the gain of six or seven degrees of its counter-current,) flow on to the Pole, melt its ices, and yet have eight degrees of heat to spare before it would fall to twenty-eight degrees, the ice point.

"This theory before us claims that the Gulf Stream, whose dimensions we know, pours a part of its volume into the space around the Pole. If so, out of the same space there must flow an equal volume towards the equator. Is this found to be the fact? It is true, marine researches have not furnished information sufficient to speak here with mathematical precision. But, we have facts and light abundant to severely scrutinize the premises, and to detect any error in principle upon which Captain Bent's conclusion rests.

"There certainly issues, from the space around the Pole, a ceaseless and mighty flow of waters to the tropics. In its course, icebergs of huge proportions are carried off from the mainland. So vast are these ice masses, and often so numerous, in floating clusters, as to defy computation. Captain Beechy saw a small one fall from a glacier at Spitzbergen over four hundred thousand tons in weight. The Great Western, in 1841, in her trans-Atlantic trip met three hundred icebergs. The single drift of ice which bore on its Atlean shoulders the English ship 'Resolute,' abandoned by Captain Kellett, and cast it twelve hundred miles to the south, was computed to be, at least, three hundred thousand square miles in area, and seven feet in thickness. 'Such a field of ice would weigh 18,000,000,000 tons.' We say that this was a single drift through Davis Straits, only one of the avenues of this current from the Pole, and only a fractional part of the drift in the year. What a mighty flow of water from the south must that be, which, wedging itself into this space around the Pole, ejects such masses out of this space as quietly and easily as the steam-driven piston of the engine throws out its *jet d'eau!* We dwell upon the might and magnitude of this ice-bearing river from the Pole, because in gauging these we gauge the energy of the reciprocal heat-bearing 'river' from the tropics, *i. e.*, the Gulf Stream."

There is much more of such kindred facts as these in the papers of Professor Maury that I would like to give you, but am at a loss to select

judiciously from them, even if time suffered me to do so. In concluding, he says:

"This profound and beautiful hypothesis may boast no sanction of high authority, nor count as its advocates any arctic explorer. For a while it may have to rest its claims on deductions of science, and be ushered into notice on the quiet authority of mathematical calculations. Was it not so with the theory of Columbus? What of this? 'Galle, we know, with his powerful telescope, at Berlin, and aided by a host of astronomers elsewhere, was defeated in his search for a planet, when, with no other instrument but his pencil, it was found and triumphantly pointed out by the French mathematician.'"

LATE EXPLORATIONS.

This brings us to the consideration of the reports of the explorations that have come to the public since the delivery of my former address, in the winter of 1868.

These explorations having been made principally by northern Europeans, their narratives, as originally published, are generally in the German language; though the Hydrographic office of the United States Navy Department has furnished us with voluminous translations from Dr. Petermann's *Geographical Journal*, which no doubt contains the most important information in regard to their operations. To give you a general view of all these details would require too much time. I will therefore avail myself of a couple of circular letters, sent me by Dr. Petermann, upon the subject, which I will give pretty much in full.

THE GERMAN EXPEDITION.

The first of these letters is dated Gotha, November 5th, 1870, and says: "Since Herr von Heugelin has just returned from east Spitzbergen, and the latest news from the different Russian and Norwegian expeditions have been received, we are enabled to sum up the whole results of all the expeditions sent toward the North Pole during this year. In order to briefly recapitulate the results of the German expedition to east Greenland, I beg to remark that the steamer Germania proceeded on that coast as far as 75° 1′ north, and in sledges to 77° 7′ north; that they discovered a 'fiord,' which extends far into the interior of Greenland; and also Arctic 'Mont Blancs'; and further, that this coast can be easily approached. Henry Hudson first discovered this in June, 1607; and since then it has been visited by different vessels, more particularly about the years 1820–'30; by Scorsely, Clavering and Sabine. Herr von Heugelin and Earl von Zeil remained from July 15th till September 15th, on and near east Spitzbergen, which they explored and mapped from 77° north to 79° north—mostly in boats. They also discovered a large body of land east of Spitzbergen.

It is wrong, however, to identify these lands lying east of Spitzbergen with the fabled "Gillisland." Captain Gillis discovered, in 1707, land in 80° north. The Swedish expedition of the year 1864 saw from the mountains of Spitzbergen, land in an easterly direction, distant eighty nautical miles, and located it as a cape, on the map, under the parallel of 79° north; but whether it is connected with the continent under 80° north, or is to be considered identical with Gillisland, has not been decided up to this time.

"Now, however, Herr von Heugelin and Earl Zeil have discovered land reaching from 78° to 79° north, and lying thirty-six nautical miles east of Spitzbergen, having many sharp peaks, and which, if it does not connect with Gillisland, would at least rival Spitzbergen, and, under the circumstances, is the most important discovery made within quite a number of years. Herr von Heugelin has brought from east Spitzbergen fourteen boxes containing geological, zoological and botanical collections, among them numerous interesting vegetable petrifactions, viz., 'Anas Helleri'; besides this, he has cleared out of his hunting excursions the sum of $600; so that the whole cost of the enterprise, originally estimated at $1,800, amounts to only $1,200. This shows that Herr von Heugelin has first solved the question, to a certain degree, for the solution of which I and my friends have been working for the last five years, or since the geological congress in 1865.

THE RUSSIAN EXPEDITION,

under Prince Alexis Alexandrovitch, made in the corvette Warjag, and accompanied, amongst others, by the distinguished academist, Von Middendorf, has, this summer, made interesting scientific explorations in the Polar Sea lying between Nova Zembla and Iceland, and has found that the Gulf Stream up to Nova Zembla has the very high temperature of 10 Reaumer (or 54½ Fahrenheit). Herr von Middendorf, the author of the most extensive works on the polar regions that have ever been published, writes me, especially, about this expedition, and referring to an article published by me in June, as regards the Gulf Stream, and my views as to the thermometric knowledge of the polar region, says:

"On my return home I found on my table your memoir on the Gulf Stream. You have treated the subject most clearly, and carried the Gulf Stream eastward beyond the North Cape to Taimyr's region, and even into the New Siberian Polynia.

"'West of the North Cape, your array of figures is irresistible; but east of it your conclusions are very bold. With the exception of Bessehl's 41°, you had no direct proofs. I rejoice that I can not only confirm your suppositions, but even go beyond them. You have been daring; nature is more so. I have been able to-day to demonstrate before the Russian Imperial Academy that the corvette Warjag has

proved the extension of the Gulf Stream to the west coast of Nova Zembla, and that we find it on the meridian of Kanin Noss (43½° east) still of a width equal to two degrees of latitude, and of temperature of 54°, cooling down at depths of thirty and fifty fathoms, only four to six degrees.'" *

THE KARA SEA

was explored by a small sailing vessel, and found free of ice. Nova Zembla was also found to extend farther north than usually represented on maps, reaching latitude 77° 8′ north. Captain Johannesen found Norwegian glass balls at the Northern extremity of Nova Zembla, and, as Dr. Petermann says, "by this fact alone, the existence of the Gulf Stream is for the first time shown to reach even these remote shores, as they have not been visited by a civilized seaman since 1594, by a Dutchman named Barentz." "By these reports, it is shown that our knowledge of the polar regions has been much forwarded during the past year, and extensive coast lines on east Greenland, east Spitzbergen, east and north Nova Zembla, have been proven accessible; as, also, a wide range of the high sea has been found navigable, which had heretofore been considered inaccessible on account of being filled with ice."

DR. PETERMANN'S MAP

of the extension of the Gulf Stream represents the northern edge of that stream in summer as passing to the west and north of Iceland; thence east along the parallel of 68° to about 3° west longitude, whence it curves sharply northward to 75° north, and then a little eastwardly to latitude 81° 40′, in longitude 3° east, where it is blocked by ice. The remainder interdigitates with the polar current, running down on the east side of Spitzbergen, and with its north edge crosses the parallel of 75°, in longitude 24° east, and which terminates on the meridian of 30° east in longitude 77° north, where this branch remains unfinished for the want, I suppose, of observations. The eastern branch he makes extend from its separation from this last named one, in latitude 75° 10′, longitude 37° east, eastwardly to Nova Zembla, in latitude 75°, enveloping all the west side of that island to the southward of that point, the northwest coast of Russia, the White Sea, and Lapland. In other words, it has no unity of flow; but I expect that this outline is made from surface temperatures, and represents superficial drifts of warm water from the main stream, which latter most likely flows in uniform volume in a given path northward, between Spitzbergen and Nova Zembla, somewhat as I have here represented it.

PETERMANN'S SECOND EXPEDITION.

I sent my pamphlet to Dr. Petermann in the spring of 1869. In the following June he started his second North Pole expedition, consisting

* The two foregoing paragraphs are taken from the Hydrographic Office translation.

of the "Germania," steamer, and sailing vessel "Hansa." His instructions were, I believe, pretty much the same on this occasion as those given to Captain Koldeway the previous year, which were, to make Greenland the objective point and to endeavor to pass round that island by finding a channel open along its east coast, and thence to Behring's Straits, his idea being that Greenland trends off to the northwest, inclining southwardly and terminating near these straits. The Germania was frozen in in latitude 75° after reaching the coast, where she remained the winter, and was unsuccessful the following season also. The Hansa was beset by ice near the Greenland coast in latitude 73°, crushed and sunk. Her crew saved enough from their vessel, however, to protect and subsist them on the ice until, after terrible sufferings, they left it in May, 1870, in latitude 61° 12′, in their boats, having been carried two hundred miles to the southwest along the coast of Greenland during their sojourn upon the ice.

Dr. Petermann is still skeptical as to the existence of an open sea around the Pole as I have it here represented, and although he claims, I believe, the credit of having for some years past said that the best route to the Pole "is right up between Spitzbergen and Noya Zembla," yet he has also said that the best way to penetrate the ice-belt is to go *against* the current and not with it; and, in accordance with that belief, he sent both of his expeditions of 1868–'69–'70 to the east of Greenland, instead of to the east of Spitzbergen, to look for a route, and has written to Professor Maury, under date of Nov. 29, 1871, that "I am now, night and day, at work to get up a German or Austrian expedition for next year, to steam right along the Gulf Stream, past the northernmost cape of Asia, the New Siberian islands, to Behring's Straits." From this, you see, he thinks that the Gulf Stream does not go to the Pole, but passes off to the eastward, along the coast of Asia.

It is to be hoped, however, that Dr. Petermann will reconsider this plan before the sailing of his expedition, and for two reasons: first, because if this route is attempted, his vessels will run directly down into the ice-belt again and find it impracticable; and the second is, the shortest distance from the point reached by Payer and Weyprecht to Behring's Straits, is by following the arc of a great circle which runs northeast until near the pole and then southeast to where the Kuro-Siwo probably pierces the ice-belt on the meridian of 160° west.

SIGNAL COINCIDENCE.

You will perceive that none of these expeditions have attempted to follow the northeast branch of the Gulf Stream, as here suggested on my map, though they have been hovering all round it; but a small sailing vessel, hired by Lieutenant Julius Payer, of the Austrian army, and Lieutenant Weyprecht, of the German navy, sailed last June for the

purpose of reaching and exploring King Karl's Land, discovered by Von Heugelin, to the east of Spitzbergen.

THE GATEWAY FOUND OPEN.

They did not succeed in their mission, but, returning to Norway, telegraphed from Tromsoe, October 3d, as follows:

"In September, open sea, followed from 42° to 60° east longitude from Greenwich beyond 78° north latitude. Highest latitude reached was 79° on the meridian of 43° east. There found favorable state of ice towards the north—probable connection with the Polynia toward the east—probably the most favorable route to the North Pole." *

Now let us turn to these maps which were made to illustrate my address in the winter of 1868–'9, *and have not been changed in the slightest degree since*, and the largest of which was reduced and lithograph copies of it put in the pamphlet containing that address, published in the spring of 1869.

I have drawn the parallels of 79° north latitude and the meridian of 43° east longitude on both maps, and *the intersection of these lines falls here exactly in the path of the Gulf Stream as I represented it hypothetically in* 1868, AND IN THE VERY GATEWAY TO THE OPEN POLAR SEA.

I therefore *again* reiterate the convictions expressed in my communications to the President of the Geographical Society of New York, in 1868, and which are the same, substantially, that I expressed to Dr. Kane, in my office, in the winter of 1855–'6: "*That the Gulf Stream and Kuro-Siwo are the prime and only cause of the open sea about the Pole, with its temperature so much above that due to the latitude; that the only practicable avenues by which ships can reach that sea, and thence to the Pole, is by following the warm waters of these streams into that sea; that to find and follow these streams, the water thermometer is the only guide, and that for this reason they may be justly termed* "THE THERMOMETRIC GATEWAYS TO THE POLE."

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* See Appendix.

APPENDIX.

Since delivering the address I have received from Captain Wyman, the Superintendent of the Hydrographic Office of the Navy Department, a translation of Lieutenants Weyprecht and Payer's preliminary report, which is even far more confirmatory of the "Thermometric Gateway" theory than this telegram from Tromsoe would indicate. I cannot give it in full, but make the following extracts, viz:

* * "The weather in Finmark during the preceding seasons augured the very worst for the state of the ice in the high north. * * *

"On the 21st of August we pushed, on the meridian 28° E., further into the ice, reaching south of Gillis Land, the parallel of 77° 17′ N. The ice between the 28° and the 36° of longitude proved to be looser and thinner than, perhaps, in any other part of the arctic region, consisting of small fields of an average thickness of two feet (above and below the water), which closed up to long strips with fresh northerly winds. Flakes were nowhere to be seen, and the horizon appeared as a straight, unbroken line; one could believe himself to be on a fresh-water lake instead of the Arctic Ocean. A strong steamer could have taken a straight course through the ice, particularly between the meridians of 28° and 32° E, where it was thinnest. * * *

"We reached, on the 29th, 77° 30′ N., on the meridian 42° E. without meeting ice, and were still more surprised by its entire absence, even beyond the parallel of latitude 78° N., which we crossed on the 30th, on a northeastern course, near the meridian 41° 30′ E. When coming up, at last, in the night of that day, with the border, *it trended north instead of easterly*, as heretofore. At noon of the 31st we were in 78° 25′ N., 42° E., and at 8 p. m. in 78° 41′ N. within the ice, which now appeared *to trend northeasterly*. Toward the west, it lay quite close, with a strong glittering and some icebergs among it; toward the north, however, it was loose.

"At midnight of the 1st of September we attained, within loose drift ice, our highest latitude, by the log, in 78° 48′ N., or, by an indifferent observation obtained the succeeding noon, in 78° 37′ 3″ N., on the meridian 42° 30′ E. * * *

"The temperature of the water in 77° 30′ N. on the 3rd of September, was observed to be 37.6° F., and in 76° 30′ N., on September 8th, in sight of Cape Nassan, even 40.1° F. * * *

"A thick fog, with a strong head wind, prevented us from penetrating still further north; *the ice would not have been an obstacle.* * * *

"Other obstacles to a progress further north were, also, a want of provisions, the unwillingness of the crew, and a damaged stem. * * *

"It now remained a question whether the region thus free of ice, traversed by us, was only a bight in the ice, or an open Polar Sea. We believed it to be the latter, and in order to make sure of it, we now ran down on a southeasterly course to 75° 44′ N., 52° E. There was not a piece of ice to be seen on our course below the 78th parallel of latitude up to the coast of Nova Zembla. * * *

"The fact that a small sailing vessel could, without encountering great impediments, go almost beyond the 79th degree of latitude, which nowhere has yet been reached by a ship except at west Spitzbergen, *will, by itself, prove the Nova Zembla Sea to be the most favorable basis for attempts to reach the Pole.* * * *

"*The transition of the water from the higher to the lower temperature is, near the northern limit, a very rapid one, and nearly throughout occurs in closest proximity to the ice, so that we were able, in the thickest fog, to run close up to the barrier, guided by the thermometer.*"

Two weeks after this discovery by Payer and Weyprecht, Captain Mack, a Norwegian, in another small fishing vessel, ran about three hundred miles to the eastward in this open sea without encountering ice; thus showing that they had completely pierced the ice-belt on the path of the Gulf Stream, and were fully within the OPEN POLAR SEA—the periphery of which, at this part, you will observe, extends further south than my map hypothetically represents it, and which gives to that sea a larger diameter on the axes of the Gulf Stream and Kuro-Siwo than I had supposed it to have.

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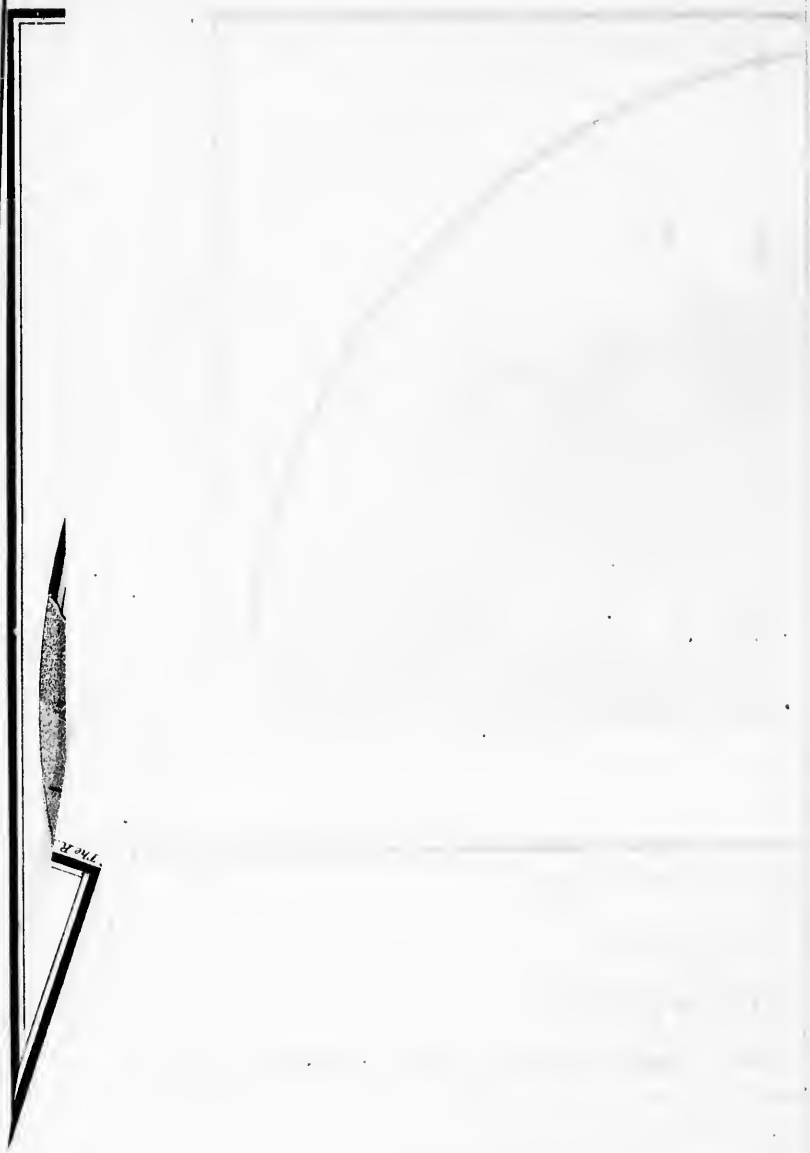

INTER-OCEANIC C

THERMOMETRIC GA

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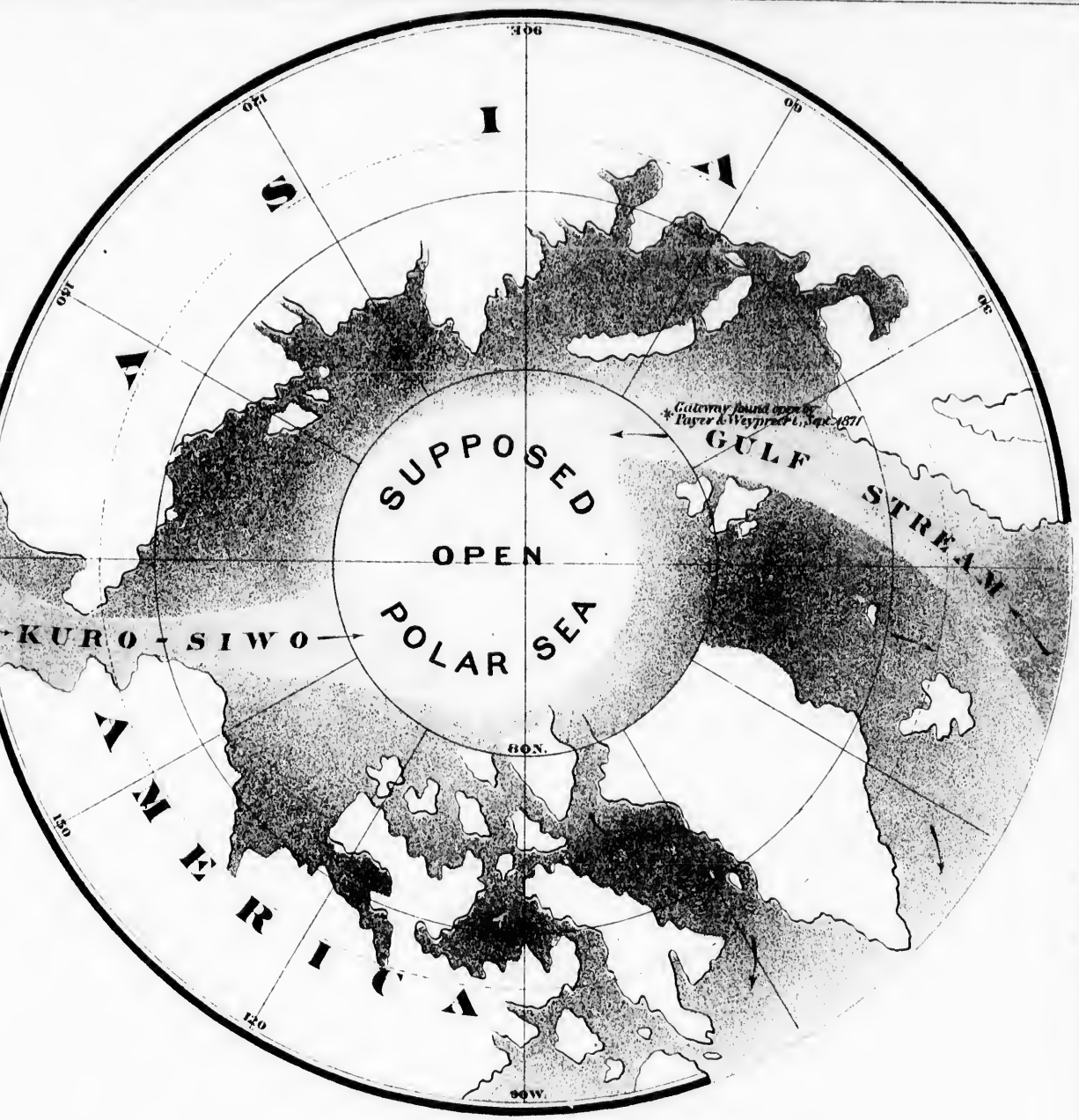

CIRCUMPOLAR MAP

EXHIBITING THE

INTER-OCEANIC CIRCULATION, as suggested in his report on the KURO-SIWO in 1855-6,

See U.S. Japan Expedition Vol. II. Pag. 369 & 370.

and to illustrate Addresses upon the

THERMOMETRIC GATEWAYS to the POLE" in 1868, and the "THERMAL PATHS to the POLE" in 1872

BY

SILAS BENT.

EXPLANATIONS:

The Red Coloring indicates Warm Water.
" Blue " " Ice & cold Water.
" Arrows show the direction of Currents.

Studley Co. St. Louis