PROF. BACHE ON THE GULF STREAM.

ITS HISTORY AND CHARACTER.

How the Rhode Island Merchantmen Used to Beat the New York Packets a Fortnight.

DR. FRANKLIN AND THE NANTUCKET SKIPPER

THE HOT STREAM AND THE COLD WALLS.

COAST SURVEYS—THEIR RESULTS.

Beautiful Tribute to Lieut. Bache,

&c., &c., &c.

On Thursday evening, on the anniversary of the Geographical Society, Professor Bache delivered a lecture in the chapel of the New York University. Mr. Henry Grinnell introduced the lecturer who, he said, would make some remarks on the Gulf Stream. Dr. BACHE then said:—

The Norwegian peasants who found upon the coast strange fruits or grains of kinds which the earth in that region did not produce, and carefully preserved them as curiosities—[Geographic Botanique. Alph. De Candolle, p. 616, Causes de Transports, &c.]—were in possession of evidence that the waters of those seas had at some time washed the shores of the tropics. The fishermen of the coast of Scotland had, in the logs of cotton wood thrown upon their shores, the same proof. The route by which the fruit or the tree came were in a degree conjectural, but the botanist knew that it had grown in a more genial clime than that to which the current had brought it. Such facts were early known and commented upon, and even pressed into the service of the hypothesis of a Northwest passage. [Phil. Trans., (London), abridged, vol. x. (orig.) 1675.] They were, however, generally recognized as proving the presence of the waters of Southern North America upon the shores of Northern Europe.

The great part which the heat of the sun plays in disturbing the equilibrium of the surface of our globe is well understood. Wherever he shines upon the surface the air resting upon it is set in motion, so that the circle of the sun's illumination as it advances over the earth is a circle of disturbance.

It is beautiful, on some calm summer's morning just as the day has begun to dawn, to look from the top of a high hill upon the quiet of the plain below. The air has gradually cooled during the night, and the valleys are filled with dense cool air, quite quiet, with fog hanging over every stream and lake, and pond, showing the secret course of the stream along the landscape and the hidden places of the lake. The light grows stronger, and as the first rays of the sun touch this peaceful scene it is thrown into movement. The fog clouds rise and fall again; they spread, covering the hill tops, which just now were bare, thinning out as they rise, with the rising of the sun, and become at last a thin haze spread over the whole scene. The masses of fog serve to show that the air has been in motion, for they have risen and fallen with it. The currents, mingling air of different densities, light no longer penetrates directly and easily through it, but objects are seen waving to and fro. Dimness and distortion are the results, or the light is lost, and objects disappear entirely, as if unilluminated. In the great belt of the earth within which the sun travels in his annual course, standing still and turning back when he reaches its limits, this action has a form and regularity which to us of the temperate regions has no parallel. The coaster and the landsman of the temperate regions are used to consider the wind as something uncertain, the laws of which it may be well for men of science to study and endeavor to explore, but which may be "past finding out."

Strange the emotions of such men when in the tropics they first find themselves hopelessly to leeward. The constant blowing of the eastern trade is invariable as the progress of the sun, showing his position almost as the hands of a watch the time—his daily, weekly, monthly, annual progress. These currents of air carry the waters forward with them from East to West, and when they meet the land great currents are produced, and taking their direction from the land carry the waters of the equatorial regions to the North and South temperate seas, to be returned in these great systems of circulation, some of which have long been known to navigators and geographers, and others of which remain yet imperfectly developed. (Carte Theomale des Globe, par H. Nicolet—Project Dierne Carte des Courant Malus, par M. Duperry: Library Smithsonian Institute.) Two of the most important of these—one of the North Atlantic and the other of the North Pacific—will form the subjects to be brought before you on successive evenings, the one the American Gulf Stream, and the other the Asiatic stream—the first making, as is most probable, the circuit of the Gulf of Mexico, its name indicating the view of geographers as to its origin issuing through the straits of Florida, gradually leaving our coast, and seeking that of Europe, the main stream to return by a counter current to the tropical regions in which it was first produced the branches recognizable in the Northern seas of both America and Europe. The second, as traced by Lieut. Bent, from the notes of our Japan expedition under Commodore Perry, deflected to the North by the shores of Formosa, passing along the coast to the Northward and Eastward, and leaving it at the projecting portion of the coast of Japan, as our stream does the coast of North Carolina at Hatteras.

I do not propose in this address to attempt a complete history of the progress of the discovery in regard to the Gulf Stream; nevertheless, a brief notice of it is almost essential.

Ponce de Leon, in 1512, sailed through the channel between Florida and Cuba, passed through the strait, and followed the Gulf Stream as high as St. Augustine. In 1519, the famous pilot of Cortez, Antonio de Alaminos, passed by the same route, and keeping for the greater part of the voyage in the stream, carried the news of Cortez's conquests to Europe. 'He must be regarded as the real discoverer of the Gulf Stream as a great oceanic highway.' [Letter of Dr. J. G. Kohl to Superintendent Coast Survey, January, 1856.]

The first delineation of which I have any knowledge, though it is altogether probable that there were attempts made to show different parts of it at an earlier date, was that made by Dr. Franklin, in 1769-70, from the information communicated by Captain Folger, of Nantucket, commanding a whaling vessel from that port. The details are so interesting, that I insert it as a remarkable instance of practical sagacity on the part of the fisherman and the philosopher:—

"Vessels are sometimes retarded and sometimes forwarded in their voyages, by currents at sea, which are often not perceived. About the year 1769-70, there was an application made by the Board of Customs at Boston to the Lords of the Treasury in London, complaining that the packets between Falmouth and New York were generally a fortnight longer in their passages than merchant ships from London to Rhode Island, and proposing instead of New York, that for the future they should be ordered to Newport. Being then concerned in the management of the American Post Office, I happened to be consulted on the occasion; and it appearing strange to me that there should be such a difference between two places scarce a day's run asunder, especially when the merchants ships are generally deeper laden, and more weakly manned than the packets, and had from London the whole length of the river and Channel to run before they left the land of England, while the packets had only to go from Falmouth, I could not but think the fact misunderstood or misrepresented. There happened then to be in London a Nantucket sea captain of my acquaintance, to whom I communicated the affair. He told me he believed the fact to be true; but the difference was owing to this, that the Rhode Island captains were acquainted with the Gulf Stream, which those of the English packets were not. 'We are well acquainted with that stream,' said he, 'because in our pursuit of whales, which keep near the sides of it, but are not to be met with in it, we run down along the sides, and frequently cross it to change our side; and, in crossing it, have sometimes met and spoke with those packets, who were in the midst of it, and stemming it. We have informed them that they were stemming a current that was against them to the value of three miles an hour, and advised them to cross it and get out of it; but they were too wise to be counselled by simple American fishermen. When the winds are light,' he added, 'they are carried back by the current more than they are forwarded by the wind; and if the wind be good, the subtraction of seventy miles a day from their course is of some importance.' I then observed that it was a pity no notice was taken of this current upon the charts, and requested him to mark it out for me, which he readily complied with, adding directions for avoiding it in sailing from Europe to North America. I procured it to be engraved, by order from the General Post Office, on the old chart of the Atlantic, at Mount & Page's, Tower Hill, and copies were sent to Falmouth for the captains of the packets, who slighted it, however; but it has been since printed in France, of which edition I hereto annex a copy.

"This stream is probably generated by the great accumulation of water on the eastern coast of America between the tropics, by the trade winds which constantly blow there. It is known that a large stream of water, ten miles broad, and generally only three feet deep, has, by a strong wind, had its water driven to one side and sustained, so as to become six feet deep, while the windward side was laid dry. This may give some idea of the quantity heaped upon the American coast, and the reason of its running down in a strong current through the islands into the bay of Mexico, and from thence issuing through the gulf of Florida and proceeding along the coast to the banks of Newfoundland, where it turns off towards, and runs down through, the Western Islands. Having since crossed the stream several times in passing between America and Europe, I have been attentive to sundry circumstances relating to it, by which to know when one is in it; and, beside the Gulf weed with which it is interspersed, I find that it is always warmer than the sea each side of it, and that it does not sparkle in the night. I annex hereto the observations made with the thermometer in two voyages and may possibly add a third. It will appear from them that the thermometer may be a useful instrument to the navigator, since currents coming from the northward into southern seas will probably be found colder than the water of those seas, as the currents from southern seas into northern are apt to be warmer." (American Philos. Trans., vol II., Old Series.)

The quaint device which bears the title of the map in one corner, shows the American philosopher, (an unmistakable likeness,) chiding Neptune, the index finger raised with much authority, while the sea god, though holding fast to his trident, is plainly crest-fallen.

The chart drawn by Franklin expresses exceedingly well the inner limits of the Gulf Stream, as we now know them. We shall see that the passage from cold water to warm on the inner side is so abrupt at the depths most sought by the whales, that the indications from their frequenting the region would have been somewhat of the same order of accuracy as that of the thermometer at the surface.

The observations of Franklin that the water of the stream was warmer than that of the ocean near it, introduced the use of the thermometer in navigation. His results were consigned to the very unpretending little manuscript book which I have now the honor to show to the members, and which I found many years ago in a trunk of miscellaneous papers, where it had lain neglected for one generation. The interest awakened by Franklin in this subject was so great that Col. Jonathan Williams, (American Philoso. Trans., vol. iii, 6 8) afterwards chief of the Corps of Engineers of the United States, William Strickland, (Ibid, vol. v, 6 8) and John Hamilton, (Ibid, vol.) with several others, followed in his wake, and collected many careful observations in voyages between the United States and Great Britain and along a part of our coast. These observations were directed to the limit of the stream, its temperature as compared with the air above it, and with the ocean water adjacent to it, at different seasons of the years, and in different years, the direction and force of its current, &c. The observers also embraced other results in their researches, which it is not at present necessary to dwell upon.

The observations of numerous British and American navigators in private and public vessels, observing either from motives of interest and curiosity or by official instructions, were collected and digested by Major Rennell, in his "Investigation of the Currents of the Atlantic Ocean," published in 1832, after his death, from his notes, by his daughter, Lady Rodd. (An "Investigation of the Currents of the Atlantic Ocean," &c., by the late Major James Rennell, F. R. S., &c. London, 1832.) This work is accompanied by an atlas containing elaborate charts of the currents of the North Atlantic, and representing the observations of different navigators, chiefly in the service of the British Admiralty. All these observations, with few exceptions, were confined to the surface or to very moderate distances below it, and it is easy to see that the surface does not present the best conditions for investigation. Major Rennell was aware of this, and recommended deeper explorations.

Berghaus' Physical Atlas, an edition of which by Alex. Keith Johnson, of Edinburg, is best known in our country, contains a *resumé* in his map of what was known in regard to this stream up to 1848, which, though quite incomplete, seems to give a general idea of the direction, extent and velocity of the current.

Copious materials have been collected by Lieut. Maury, in his current charts, and deductions from them have been presented at different times in his sailing directions, in the proceedings of the American Association for the advancement of science, in his address before this society two years since, and in other publications. A memoir by the same officer, containing many ingenious suggestions, is among his early papers in the *Southern Literary Messenger*.

I might, perhaps, be expected here to pass in review the claims to have advanced our knowledge of the Gulf Stream covering the same period of time, with the researches of which I propose to give you an account; but this history cannot be written now, nor perhaps at all by me. The best mode to arrive at truth is fairly to state facts, and this done by each one, to leave to others to adjust the merit or demerit of the several suggestions, plans, discussions and developements.

As the temperature of the Gulf Stream is one of its most striking and important features, so it was to the investigation of it that I determined first to direct the attention of the officers of the Coast Survey. The current was to be observed—its direction and force; the density, color and other peculiarities of the water; the vegetable and animal productions were to be collected; the meteorology to be studied; but these were to be subordinate to the main object of inquiry, namely, the temperature of the water.

To have observed the surface temperatures merely, with instruments carefully prepared, would have been a step forward, for without such comparisons the results could only be considered as rough, and merely to be employed in the absence of better ones. At the surface, too, the heating effects of the sun, the effects of the temperature of the air, of wind and of rain, are the greatest. It was necessary, in a systematic exploration, to go below the surface. At a certain distance these disturbing actions might be expected to diminish, and at certain seasons to cease altogether. Besides, it was likely that this stream extended only to a certain depth, and that part of the return northern current followed the bottom of the sea. The interest in the deep sea temperature proved in fact most absorbing, and every effort was directed towards obtaining an instrument for their ready investigation. The great pressure to which such an instrument would be subjected rendered this no easy matter. The instrument must register its indications; it must be easily used, and therefore of the class requiring a simple observation: not a philosophical experiment. The ordinary self-registering thermometer was first tried, and to secure it from pressure it was placed in a globular case. This thermometer required quite a long time to take the temperature of the sea around it, the case keeping it from immediate contact with the water. Besides, at quite moderate depths, the envelope, unless of unwieldy thickness, was crushed—and this was true, when to diminish the size of the apparatus we resorted to small metallic thermometers, like those made by Jungersen, of Copenhagen, and by Montardon, of Washington. There must be an opening to introduce the thermometer into the envelope, and this opening—however tightly it might be made to close by grinding or by the interposition of India rubber, or other material fulfilling a similar purpose—changed its figure under pressure, and the costly thermometer inside was crushed, or salt water was forced into it, destroying its delicate parts. It would detain you too long to note the various contrivances which the ingenuity of our hydrographers and mechanicians produced, and how the modes which succeeded best with one observer came out only second or third best with another. We must reach depths beyond which Six's self registering thermometer would give way, or their indications become erroneous. After many experiments Saxton's self registering thermometer superseded all others, and the attention of its ingenious inventor was turned to perfecting its details. It consists essentially of a coil of two metals, like Breguet's metallic thermometer—the more expansible placed in the interior—its form, scale, covering, and, in short, all its details, being adapted to the use for which it is thus designed. The coil, fastened at one end, unwinds when the heat increases, and tightens when it decreases; so that by placing upon the free end of the coil a hand, like that of a watch, to move upon a dial plate, the temperature is seen. It registers, by the simplest of all contrivances, either the highest or lowest temperature to which it has been exposed, or both the highest and the lowest. The case is merely to protect the instrument from external injury in use and to support the spiral coil, the scale and hands or indicators. A spiral four inches long of silver and platinum serves to give a sufficient sensibility to the instrument, so that two-tenths of a degree of Fahrenheit can easily be read upon the dial. The brass and silver parts of these instruments require to be coated thickly with gold, which is readily done by the electrotype process, requiring, however, great care and thoroughness to be effective. Their use demands certain precautions which it would be out of place to state here. No instrument should be made answerable for the want of skill or care of an observer. I can truly say that in the hands of many observers, and used at great depths, these instruments have given entire satisfaction. They have in the Coast Survey observations superseded all others.

It would seem an easy thing to ascertain the depths to which a thermometer attached to a sounding line had gone. I recollect well that the triumphant objection was made to Ericsson's and to Ogden's leads for sounding, that it was quite simple to measure the length of the line to which the lead was attached. The fact is, however, that at considerable depths the length of the sounding line not only does not give the depth to which the lead at the end of it has been, but does not give even an approximation to it within twenty to thirty per cent of the truth; under different circumstances not even a constant proportion to the true length of the line. We have found Ericsson's and Ogden's leads very convenient for moderate depths, and Massey's, slightly modified, for greater depths. This is on the principle of Woltman's wheel, which has been applied to similar purposes long ago, and yet leaves something to be desired on the score of sensibility and convenience. The wheel turning as the line descends, and prevented from turning by a catch when rising, the turns are registered by wheel work, and thus the depth to which the lead has descended is marked upon its scale.

The general features of the Gulf Stream being known, it was a natural idea to refer it to a medial line or axis, on each side of which it would be more or less similar in its temperatures, and therefore to run sections perpendicular to this line across the whole breadth of the stream. To set out from points on the coast of well ascertained position, and determining by the best means known to nautical astronomy the place of the vessel, at the shortest interval practicable; to check it necessary these results by returning to the same or another known point; to occupy positions at which the temperature at different depths would be determined, the frequency of which would depend upon the greater or less rapidity of the change of temperature; to determine at the several positions the temperatures at depths varying more or less rapidly as the temperatures themselves were found to vary, attaching several instruments at moderate intervals for observations at small depths, at larger intervals for greater depths—such was the general plan of exploration pursued in the Coast Survey.

In regard to the seasons for explorations, the summer was of course on every account to be preferred for the greater part of the stream. The season of cold and storms, which renders navigation perilous, and interferes with work, is also that when the stream, cooling rapidly from the air above it, the surface water descends, and, mixing with the warm water below, disturbs essentially the equilibrium of temperatures.

Sounding in stormy weather is a very difficult, if not impracticable operation, yielding with much labor very inaccurate results. Of course a complete exploration requires that the changes of the seasons be investigated, but to add to the essential difficulties of the unknown features of the stream those of navigation in storms, would have been to task the observers beyond endurance. It has turned out that if we had braved the winter season in our early work, the confused state of the temperatures at different depths below the surface would have impeded the study of the results, and have caused us probably to miss some of the most beautiful and striking of the generalizations.

Important as is the Gulf Stream to the navigator of our coast, and forming as it does one of its most marked hydrographic features, still it was only a part of the work of the Coast Survey, and to have given an undue share of means and attention to these researches at the expense of the soundings of the harbors, bays, sounds and sea coast, would have been manifestly injudicious. Hence these researches have been prosecuted by piecemeal, and from time to time, but always with a steady aim, so that even partial results contributed to the accomplishment of the general design.

It would be of more personal than general interest to speak of the instructions for making the observations of those in regard to instruments, to the mode of representing the results in tables and diagrams, to the phenomena that were to be looked for, and to the mode of study of the observations.

The chiefs of hydrographic parties of the Coast Survey, to whom the work has been entrusted, have, in most cases, been selected for it in consequence of some special aptitude, and generally as volunteers. The first officer who entered upon the field was Lieutenant (now Commander) Charles H. Davis, the present accomplished superintendent of the Nautical Almanac. Full of zeal according to knowledge, he made a most successful beginning, and from his observations in 1845 resulted the law of temperature with depths in the cold current between the earth and the Gulf Stream. Bottom was reached at 1,300 fathoms, and a specimen brought up by Lieutenant Davis, in October, 1845. This officer, who had previously been connected with the Coast Survey under Mr. Hassler, rejoined it soon after my appointment, to co-operate in the investigation of tides and currents, which was one of the first of the general hydrographic problems to which my attention was turned. To our joint labors, and those of my late brother, George M. Bache, also one of the hydrographic chiefs of the survey, are due the first elaborations of the system of tidal and current observations introduced into the survey. The early trials of the instruments, selecting those best adapted to the work, their improvement and the routine in the practical parts of the Gulf Stream exploration, were made by Commander Davis. I well remember the delight with which we both recognized in the distribution of heat in the column of water explored in his first voyage off the coast of Long Island and Nantucket, the law of distribution of heat in a fluid warmed at the top and slowly transmitting, by imperfect conduction, to the lower strata the heat from the surface. It was from no want of interest, but from the necessity for entering upon another and very difficult field of duty, and from a generous preferring of the supposed claims of another, that Lieutenant Davis left this field of research in 1846, after a season's work, and the charge was assigned to Lieutenant Commanding George M. Bache. Of this officer, whose early death, while in the successful prosecution of this work, we still deplore, I only speak in the terms recognized as strictly just by all his associates when I say that his turn of mind was peculiarly adapted to grapple with this problem, and that all his energies and resources were bent to its solution. Remarkably fertile in expedients for experiment, delicate in the use of instruments, careful in observations, ready in classifying facts, persevering in their accumulation, apt at generalizing, his mind glowed brighter and brighter as he entered into a course of experiment and observation. In this case his enthusiasm kindled and burned brilliantly. It is most interesting to follow his description of the trials of the instruments, of his methods of observation, and of his tentative results. To see how perfectly he identified himself with the investigation—now the navigator attending to his vessel; now the experimental philosopher, caring for, and watching and trying his instruments; now the man of science, looking at, connecting, generalizing the results. We owe to him the discovery of that sudden change of temperature from the inner cold current to the Gulf Stream, which became so marked at moderate depths as to deserve the name which he gave it, of the "cold wall." Writing to me, he says:—"I would like to be with you when you look at and admire this section—for admire it you must—and speculate on it with you. Here to the left we have the main current of the stream turned to the eastward by Cape Hatteras, and butting up against a bank of cold water, which it overflows, and on the right mingling with a vast reservoir of warm water, which is probably brought there by the eddies from the stream itself. How beautifully the line is defined to the left, or westward, and how well the observations of the 2d of August come in to verify the others! I hit upon this by having the marine thermometer going to the depth of thirty fathoms, and as soon as it brought up warm water, hove to and made the observation. The tracing of the cold wall from Hatteras up, will be highly interesting and will lead to useful practical results if it is permanent. And can it be otherwise? It will afford an excellent sea mark, and I think a near approach may be indicated by surface temperatures. At all events, a depth of thirty fathoms will do it, unless the stratum of warm water deepens, owing to wind or the season. Although we had worked pretty hard for the last three weeks, I hoped we might be able to get another section completed before returning to port. The principal reason for my abandoning this, is that the chronometers begin to differ, and I am afraid to trust to them too long; added to this, a gale sprung up on the 3d, one of the most violent ones we encountered. It was from the eastward, against the current, and we were in the strongest part of the stream. It blew very hard, and we came out of the stream at the rate of ten miles an hour, under close reefed topsails and reefed foresail."

We also owe to this officer the discovery of intrusive cold water in the midst of the hot water of the Gulf Stream, which seemed at first to point to a division of the stream, into two branches by a cold stream.

His observations have stood remarkably the test of subsequent researches, and with all the improvements since of nine years in methods and instruments, his investigations of the Sandy Hook, Cape May and Cape Henry sections, are admitted to be the very best and most thorough of those on record in the survey. A depth of 1,500 fathoms was supposed to be reached in these soundings without finding bottom, the temperature being 37 deg. Fahrenheit, and 2,100 fathoms with a temperature of 40 deg. just below the axis of the Gulf Stream. It was his zeal for this work, the desire to make two additional positions in returning to the coast, which his investigations showed to be necessary, that exposed him to the hurricane of Sept. 8, 1846, in which his vessel was nearly wrecked, and he was swept from her deck never to regain it. His coolness in this terrible emergency enabled him to take such precautions as ensured the safety of the records of his observations, and to perpetuate his name in connection with the history of the Gulf Stream explorations.

The work thus well begun was continued in 1847 and 1848 by Lieuts. Commanding S. P. Lee and Richard Bache, and with faithfulness and success. The results of Lieutenant George M. Bache were confirmed by their observations on the Cape Henry section, and valuable results were obtained in regard to the limits of accuracy in observing, and to the probable limit of change in position of the parts of the stream. To these results I shall have occasion to refer again. Lieutenant Bache had first the use of a steamer for the work; not a very efficient one it is true, but a vessel which enabled him in favorable weather to maintain a desired course, to manipulate readily with the sounding line and give him steam power to keep the vessel in position and to reel up the line in experimenting.

The exigencies of the Coast Survey suspended those explorations during the next four years, and in 1853 they were vigorously renewed by the detail of two parties for their continuance—that of Lieut. Maffitt, in a sailing vessel, and of Lieut. Craven, in a steamer. Lieut. Maffitt took up the survey where it had been left at Hatteras, running again, for comparison, the Hatteras section, then that from the Cape Fear, then that from Charleston. The labors of his party were rewarded by the discovery, on the Charleston section, of two ridges of hills beyond the main branch of the Gulf Stream, and furnished the observations from which I have drawn the conclusion as to the connection in that portion of the stream of the form of the bottom and the distribution of the warm and cold water. Lieut. Craven had been engaged in the sections across from Cape Canaveral, St. Augustine and St. Simons, Georgia. Upon the section, from Cape Canaveral, he had made the discovery of soundings on the other side of the Gulf Stream, and had tracked the banks, or more properly range of hills on the other sections, finding the same results as Lieut. Maffitt, on the Charleston section, within a few days after the party of Lieut. Maffitt had determined them. To these officers jointly the discovery of this important and interesting fact must be awarded. It is difficult to separate them in it.

Lieutenant Commanding Craven has since, with great skill and perseverance, re-examined the St. Simons and Canaveral sections. During the last summer he carried soundings across from Cape Florida to Bemini, proving that no greater depth existed than 370 fathoms, and refuting one of those fabulous ideas in regard to the bottom of the sea, which vague conjecture had first emitted ideas which would assign different general physical features to the surface of the earth, above and under the water. Lieutenant Craven also found at 370 fathoms, in the straits of Florida, a temperature of 35 deg. Fahrenheit, showing the existence of the Polar current beneath the warm water of the stream as low as latitude 25½ degrees North.

In the course of so long a series of explorations, in which so many willing minds have been employed, the methods, instruments, records, indeed all that pertain to the work, have been greatly improved, and the whole is now reduced to comparative system.

The greater part of the original records, when reduced to form, will be published through the liberality of Congress, monuments of the industry and intelligence of the hydrographic officers of the Coast Survey.

That this service is one of no small hardship and difficulty may easily be conceived; that it is one of great exposure, in the small vessels of the survey, necessarily encountering the most boisterous seas, may be realized by the fact that the exploration of one part of the stream has been attempted three times without success, such rough weather setting in as to deprive one officer of the instruments, and to damage the engines of the steam vessels in two other cases, so that their commanders were obliged to put back; by the danger run by Lieut. Maffitt in the steamer Legare, barely reaching port in safety by intense exertion of officers and crew to keep their vessel afloat; and by the sad disaster which deprived the Coast Survey and the Navy of the services of Lieutenant George M. Bache. The duty is most hazardous. Success most gratifying.

The deductions which I have made from time to time from the Coast Survey observations, and have presented to the examination of my scientific brethren, have occupied many months at intervals, and will be published in detail with the observations themselves. In the arrangement of this work and the comparison of results, in careful investigations and reductions, and in faithful and skilful tracing out of the phenomena on diagrams, I have derived much assistance from Professor Pendleton, U. S. N., to whom I desire here to make public acknowledgment.

The diagrams in which the results are represented, and upon which it has been found convenient to study them, are of a simple form. On the ordinary chart, such as is now presented, are delineated the line of the section referred to by the name of the nearest cape, or other well known locality, near which it passes, and the positions at which the temperatures at different depths have been ascertained. The law of change of temperature with depth is shown by the next diagram in which the depths are figured at the side, and the temperatures in degrees of Fahrenheit's scale at the top. The changes of temperature at the same depth and in different positions are given in the next diagram, where the scale of temperature is at the side, and the positions are plotted in nautical miles from the coast at the top. In this the different curves show the changes of temperatures at the same depths, rising and falling on the diagram as the temperature rises and falls. The curves showing the temperature at the surface, 50 fathoms, 100 fathoms, &c., are distinguished severally from each other. The depths at which the temperatures are the same are shown in the next diagram, which also serves to give the form of the bottom of the sea, where it has been ascertained. The depths are written at the side, and the positions, as before, at the top, the distance from the coast in nautical miles being expressed by the scale. The curves for each five degrees of the thermometer are marked so as to distinguish them from each other. When the results are generalized by these diagrams they are ready to be entered upon the general chart, upon which the section was already marked and the position of observation placed. This all seems very plain, but not a little study has been expended to bring it into so simple a shape.

The law of the change of temperature with depth is expressed, more or less perfectly, in all the observations. Suppose the temperature ascertained by observation as in the diagram, at the surface, at ten, twenty, fifty, one hundred, two hundred, three hundred, five hundred, one thousand, fifteen hundred fathoms, the depths marked at the sides, the temperature at the top, and vertical lines drawn through the points of temperature observation downwards until they reach these depths on the scale, the intersections being marked and the curve drawn. This shows at once to the eye the law of change. There are two classes of curves which are expressly typical of the cold current, (the polar current) between the Gulf Stream and the coast, and in the Gulf itself. The first is shown on the first diagram, descending almost vertically from the surface. It expresses that the temperature changes very little to five or ten fathoms; then rounding it shows a moderate decrease of temperature to some ten or twenty fathoms, then running rapidly towards the vertical line on the left of the diagram, which corresponds to a temperature of thirty-two degrees Fahrenheit; as it descends it shows within the next thirty fathoms a very rapid rate of decrease of temperature, gradually slackening as it approaches the left hand line, the sweep begins to approach that line very slowly so that between 200 and 1,000 fathoms it has passed in but a few degrees. The first portions of the curve are those where the waters mix, a region of disturbance, where, only under very favorable circumstances, nicely rounded lines are found, the worst possible places to study the phenomena, the rapidly varying parts of the curve correspond to the overflow of the Gulf Stream water which seeks the sides as it flows onward, turning to the coast on one side and to the broad Atlantic on the other. The long tongue is that water from the Gulf; the cold water slowly following at the bottom of the sea, and which, when it reaches Cape Florida has only a temperature of 37 to 40 deg., is the polar current, slowly heating up from the warmth above it, as it flows towards the tropics. The intermediate portions may be considered as between two strata, one of warm and the other of cold water, and as slowly transmitting the heat downward.

Now, we know when heat is slowly transmitted downward in a mass of fluid by conduction, that as the depths increase in arithmetical progression the temperatures decrease in geometrical progression. The curve representing this logarithmic, and the number expressing the conduction of the fluid, is the modulus of the system of logarithms.

I know that some doubt was thrown by certain experiments upon this law, but really the beautiful results of Despretz, by which it was proved, could admit of no doubt. It requires patience to verify, and care and well chosen processes to get rid of sources of error from the envelope of the liquid. These given, the law comes out, as has been proved since the doubt was raised.

Here we have upon a beautiful scale, and with ample time for equilibrium to take place, the whole story told of conduction through a mass of salt water. The curves are from a certain depth unmistakably logarithmic, and the observations thrown into the form for computing by the most impartial of methods, that known to mathematicians as the method of least squares, give results differing less than the unavoidable errors of observation from those directly observed, and yielding, when the averages of several curves are united, a modulus by which the conducting power may be expressed. In this slowly moving cold current from the polar regions, seeking the bottom, as being the denser, capped by an overflow of the warmer tropical water, you would expect to find just such curves as those which first resulted from the observations of Davis, and were confirmed by George Bache and by his successors.

One feature in these results, of considerable interest, is this: that they were made by officers having no special hypothesis; collecting data from which hypotheses might be made, confirmed or refuted, fully convinced, no doubt, that law would come out of faithful results, but not particularly interested in the form which it might prove to have. Faithful laborers, it has often struck me when discussing these results, to laud them for many things, but never more than for their strict truthfulness.

Time and again this law had been repeated, when Lieut. Craven presented his winter results, with some discouragement that they were so much less regular than the summer ones. The form of curve, as shown in the next diagram, gives nearly the same temperature from the surface down to 100 fathoms. If we reflect that at this season of the year the stream is rapidly cooling by the colder air, we shall understand this, as the surface strata sink as they are cooled.

So in some of Lieut. Maffitt's results there were irregularities which marked the cooling action on the surface of the stream, and even a temporary shifting of the upper and lower strata, with respect to each other.

If the winter season had been the one chosen for our first experiment, the navigators would have encountered many difficulties and met with small reward.

If these results be compared with the elaborate observations of Professor Forbes and M. Quetelet for the determination of the law of change of temperature in the earth still more confidence will be inspired by them; for we have in these latter, differences resulting from the nature of the case itself much larger than that presented by the results of the Coast Survey officers. The advantage of the fluid medium in adjusting itself rapidly to changes of temperature is thus clearly manifested.

The next type curve is that which belongs to a position below the axis of the Gulf Stream, and is shown in the next succeeding diagram. It has the same features of the nearly vertical straight line, and the short curve, like an arc of a sixth of a circumference, as the other, and it begins to approach the vertical axis on the left hand but slowly, and passes down to a depth of some three or four hundred fathoms before it curves inward with rapidity. The curve almost at one time coincides again with a vertical straight line, giving a section which appears in comparison with the others to have a gentle swell, then suddenly turning towards the line of low temperatures, it begins to assume the appearance of the former curve. It has reached the cold water. Now this form of curve is not that which corresponds to equilibrium of temperature by conduction, nor ought we to find such in the moving mass of gulf water, which must cool chiefly by mixture of the cooler strata from the surface at one part, and by mixture with the under current in another. The tongue which we saw in the inshore diagrams is in these much thickened, and the lower part is deep below the surface. The thinning off as we go to the shore is due to the thinning off of the tropical waters on that side, and is marked chiefly as they overrun the polar current. On the other side they overflow a comparatively warm ocean. Although in a general sense it is thus easy to see the divisions of the water, if we scrutinize it more closely to define the limits we shall find it extremely difficult to do so.

The last form of type curve is that in the straits of Florida itself, resembling the projecting part, or tongue, as I have called it, of the type curve inshore from the Gulf Stream, and of the Gulf itself. This one might have been drawn from previous inductions, such as it is presented in the observations made in 1854, by Lieutenant Commanding Craven, between Cape Florida and Bemini.

These type curves are variously modified, and there are others which seem in certain parts of the stream quite typical of their positions, but which are less general in their application than those forms. The changes are easily understood, and I have sufficiently dwelt upon this part of the subject.

I proceed next, to consider what the cross section of the stream presents, taking up as a first point of reference the diagram of the Sandy Hook section. The deep trough in which the warm water lies, with its large projecting lip towards the land, and a shorter one towards the ocean, are sufficiently marked. The curves show similar features after we leave those near the surface. The most remarkable of these is the sudden change of temperature, which in ten miles rises some fifteen degrees so suddenly that in the diagram of this, between the "cold wall," as Lieut. Bache called it, it is almost vertical. This same form presents itself to the greatest depth of the soundings, namely four hundred fathoms, though diminishing in sharpness, rising at a mean about twenty degrees in fifty miles, at least seven degrees in fifty miles, so perfectly distinct in all the curves that its determination upon any one would be pronounced satisfactory. When it is recollected that the observation at each depth is an independent one, having no connection between that above and that below it, the induction is complete. The overflow of the Gulf water is distinctly shown by the curves of 5 and 10 fathoms, every point being above the temperature of 65 deg. in this section at these depths. Passing from the Sandy Hook section to that off Cape May and to that off Cape Henry, the same result shows itself. There is a cold wall, as it were, confining the water of the Gulf. The polar current passes along the shore, modifying essentially the climate of the land and the character of the navigation of our coast. The warm water overlying this flows towards the coast, reaching it south of Cape Hatteras and sometimes north of it, superficial in depth, but sufficing to impart warmth to the shores which it reaches.

Does this cold wall extend to the southern sections of the stream? and if so, how far? I have drawn the comparative diagram of curves of temperature in the interior parts of the southern sections, to prove that, though the difference of temperature is less striking than to the north, it exists. The northwardly current, which must bring this water, thus really flows along the coast, always at certain depths, variable with the season and circumstance of wind and temperature, but always there. Sometimes the warm water near the surface bathes the very coast, as shown in the diagrams of the sections south of Hatteras.

The cold wall is with tolerable certainty traced by observations as far south as Canaveral. At times the southerly set of this inside current is decided, as was the case by Lieut. Maffitt's observations off Charleston in June, 1853. This set of the current further north has been long well established.

Returning to the diagram of the Sandy Hook section, we see that the curves rise and fall in successive waves, dividing the area across which they pass into well marked spaces. That, as a rule, the adjacent curves conform passing into different shapes, which present contrasts if we regard those at many fathoms distance, as at one hundred and five hundred fathoms for instance, but which, as shown by the intermediate curves pass gradually from one to the other. The law of division is best marked between twenty and two hundred fathoms.

Each position is independent of the former, as each observation in the position is independent, and thus the results obtained at one depth confirm those at another when they agree. The next diagram, that of Cape May, strengthens the former induction; then that of Cape Henry still further confirms it. We see, too, that the divisions into warm and cold bands, which are indicated on the Sandy Hook section, are not arbitrary or accidental, but that the same bands recur more plainly on the Cape May, and still more so on the Cape Henry section. Their distances from the coast are such as to connect them in these sections. In each we see a rapid rise of temperature from the cold wall into the Gulf Stream proper, a slow descent to cooler water, a second rise to a point not so high, a second fall, and a third rise not so well marked. At the depth of thirty fathoms on the section, we have a rise from the cold wall to the axis of the Gulf of 9⅞°, a fall to the axis of the first cold band of 8⅛°, a rise to the axis of the warm band of 6°, a fall of 3° to the axis of the third. The distances on this section are, to the cold water about 100 miles, the width of first warm band is 50 miles, of the first cool band 25 miles, of the second warm band 60 miles, making the width of the Gulf Stream proper about 135 miles. The width of the second cold band is 65 miles, of the third warm band 75 miles, but indefinite, giving for the whole width of the warm water 275 miles in this section. I have thrown the others into the form of a small table, as follows:—

Distances of the "Cold Wall" from the Shore, and the Widths of the Several Bands of Cold and Warm Water of the Gulf Stream, Measured on the Lines of the Sections:—

Section.	Distance of Cold Wall from Shore, Miles	First Maximum, or Hot Band	Second Minimum, or Cool Band	Second Maximum, or Warm Band	Width of the Three Bands or Gulf S'm.	Third Minimum	Third Maximum	Fourth Minimum
Sandy Hook	235	60	40	50	150	75	Ind	Indefinite.
Cape May	137	50	37	45	132	75	70	
Cape Henry	100	50	25	60	135	65	75	
Cape Hatteras	36	50	30	50	130	50	60	
Cape Fear	65	30	17	40	87	35	55	
Charleston	70	25	10	35	70	25	35	
St. Simon's	90	25	10	30	65	20	25	
St. Augustine	75	50	—	-	50	20	Ind	
Cape Canaveral	35	40	—	—	40	10	—	
Cape Florida	10	25	—	—	25	5	—	

They present a width of Gulf Stream proper of from twenty-five miles at Cape Florida, to one hundred and fifty miles at Sandy Hook, and of warm water at, say fifteen fathoms, of from thirty to three hundred miles wide. These principal divisions of the stream, as we pass southward, lose in their definiteness, and are limited to smaller spaces. We see, on the Charleston section and on the Canaveral the same features which were dimly shadowed forth in Sandy Hook, and must admire the sagacity which discerned in their germs these rich fruits. While we trace thus carefully, step by step, we must consider how far these results can be relied upon as exact, or capable of reproduction—how far are these bands permanent or moderately variable, and how far altogether accidental, the results of errors of observing or errors of place, of change in the stream itself. We have two modes of trying this—first, each series of observations was connected to the preceding one by running over the same section. We have thus the fact established that the same divisions of the stream were obtained in successive years. I need not remark that not only had the observers no reference to the results of their predecessors, except in position which they endeavored as far as convenient to make the same, but in general the examinations of the results were first made by myself from the rough notes of the hydrographic officers. The table in the diagram is as follows:—

Table Showing the Probable Uncertainty in Determination of the Maximum and Minimum Points.

Name of Section.	Uncertainty in Miles.						
	Cold Wall, 1st Min.	Axis 1st Max.	2d Min.	2d Max.	3d Min.	3d Max.	4th Min.
Sandy Hook	—	.75	00	3.94	7.99	—	—
Cape May	.82	1.25	2.54	1.67	—	4.03	4.87
Cape Henry (three years)	.84	.61	.55	1.70	1.06	.94	3.42
Cape Hatteras (three years)	—	6.77	6.36	9.31	5.69	6.23	—
Cape Fear	—	1.25	—	—	2.98	3.49	13.37
Charleston	1.25	1.57	.72	2.09	2.40	.82	—
St. Simon's	00	.74	1.27	.41	—	—	—
St. Augustine	.22	.51	.44	.44	.55	—	—
Cape Canaveral	.95	1.69	.39	—	—	—	—
Final value	.83	2.49	2.49	4.00	4.01	3.74	8.45

The table shows that the same results are reproduced in different seasons with less variation than those of the mean temperature of the sections themselves. On the Cape Henry section, which was run over three times, the positions of the cold wall and of the axis of the Gulf Stream were reproduced within five miles and a half of the succeeding maximum and minimum points within the limits of eight miles. Now, as the positions at sea were liable to an uncertainty of some three to five miles, this result must be held as proving conclusively the general permanency of these divisions, and the possibility of determining them within very moderate limits from year to year. But it not only proves this, but the accuracy of the different observers. The Cape Henry section was run over by Lieuts. Geo. M. Bache, Richard Bache and S. P. Lee; the Hatteras section by Lieuts. Richard Bache and J. N. Maffitt; the Charleston section by Lieuts. Maffitt and T. A. Craven.

But there is another test of the results. As each curve of temperature, at a given depth, is independent of any other, and as a general law is established by the comparison of the whole of the curves, that the cold wall and axis of the hottest water change their position from the surface to the depth of six hundred fathoms, slowly, and by an ascertained progression, and that the succeeding maximum and minimum points are at the same distances from the shore, or in a vertical line from the surface at all the different depths, the relative positions of these points (as shown by the observations at different depths) become thus the test of the permanency of their positions, and of the accuracy with which they have been ascertained. These show that the cold wall and axis maximum could be ascertained at the Cape Henry section to about one mile, and the other points to rather more than two miles. The test which they apply to the accuracy of the different observers, who used the same instruments, it would be invidious to employ where all the observations are so good. Tried in this way by observations below the disturbing influence of storms and ordinary meteorological changes of short duration, the permanence of these divisions, the fact that they can be ascertained with certainty from year to year, the same or similar results being reproduced, that the results can be had by different observers and with different instruments within moderate limits, are conclusively proved.

It is quite instructive that while the phenomena as related to the axis of the Gulf Stream vary so little, the temperature of the sections themselves change so much from year to year. Thus the average temperature between the surface and four hundred fathoms, beyond or outside the cold wall on the Sandy Hook section in 1846, was as high as that on the Cape Henry and Cape Hatteras sections in 1848, and as on the Cape Fear section in 1853, and within a degree of the St. Augustine section, in 1853, while the Cape Hatteras section in 1848 and 1853 differed two degrees. Again, the temperature from the surface to thirty fathoms, just below the axis of hottest water on the Sandy Hook section in August, 1846, was either above or as high as that on the Canaveral section in June, 1853. In general the Cape May section of 1846 and the mean of the Cape Henry section of 1846, 1847 and 1848 are warmer at the same depths than the sections south of it were in 1848 and 1853.

These results have only in part been carefully scrutinized. They serve to show that there are great changes in the mean temperature from year to year, and probably from season to season.

The connection of these with the weather changes of the Gulf will no doubt one day be made out. They will be studied with the changes of the season, of the great body of the stream, and by wind and storm of the surface and near it.

The depth at which the phenomena may be ascertained with considerable certainty turns out to be about twenty or thirty fathoms, and this is a depth which can be reached without injury by a thermometer in a strong case, and by Six's self-registering thermometer. That the surface gives in the midst of all its variations, at times, reasonably good results, our observations also clearly show, and invite rather than repel the comparison of the means of many observations.

These subdivisions of the stream serve to show how navigators have differed so much in regard to its extent and temperature, and how they have been baffled in changing position to find the temperature unconformable to their expectations. Cold water in the midst of the Gulf Stream has been set down more than once even in the earlier voyages, but it has been supposed an accidental or special occurrence, and not belonging to a general system.

It may be observed in passing that the different forms of this discussion have not given sensibly different results. I commenced it first by diagrams of the separate curves at different depths, next followed it up by averages in which the curves were grouped, then had the results independently worked over by Prof. Pendleton, and all with essentially the same conclusions, differing merely and moderately in numerical details.

The physical causes of these divisions of the Gulf Stream does not appear at the depths which we have reached in the more northern sections, but in that of Charleston, as developed by Lieuts. Maffitt and Craven, and in the more southern sections, as developed by the latter named officer, the same divisions appear, and the causes of them. Turning to the second class of sectional diagrams, in which the depths corresponding to the same temperature are shown, we take up the same series of facts in regard to the distribution of temperature which we examined before, the warm water passing to greater depths as we recede from the shore, rapidly thickening at the *Gulf Stream proper*, and *slowly thinning off again*. When we represent the bottom of these southern sections, we find that *after sloping moderately* from the shore it takes a sudden and quite steep pitch, continuing at a considerable depth in many cases below the limits of the deepest soundings on the section, then rises to a considerable elevation to descend again, and to rise and descend a second time; that, in fact, we have two hills—one one hundred miles from the coast, with a steep slope towards the Gulf Stream, and on the outer side with a slope of fifteen hundred feet in twelve miles; a second, with a slope of five hundred feet in height and a base of twelve miles towards the axis of the stream, and three hundred feet with a base of fifteen miles on the other side—the first a hill rising certainly more than two thousand feet above the general surface below the Gulf. On the next section to the south of this the same ranges appear, rising severally five hundred and two hundred feet above the adjacent valleys, and so on; and when we come to trace them from section to section, we find that they represent ranges of hills having a general parallelism with the coast, the distances increasing from fifty-five and eighty miles off Cape Canaveral, in latitude 28 deg. 30 min., to one hundred and one hundred and twenty-five miles off Charleston, in latitude 31 deg. 30 min. That the axis of the Gulf Stream keeps in the middle, or thereabouts, of the deep trough, that the cold wall is nearly over the first steep slope from the shore, the first cold band nearly on the top of the first range of hills, the second warm band nearly over the second trough, and the second cold band nearly over the second range of hills. Turning again to the section we see that the cold strata of the polar current must lie in the depths of the *first trough*, and must rise on the flanks and over the tops of the hills, conforming in a general way to the *slopes* of the hill sides and the valley depths; that this arrangement of the strata will give *just such divisions as we* have found in the stream.

That the connection of the sections by ranges of hills conforms strictly to nature, there could be no doubt from the numerous sections. It was a most interesting result, however, obtained by Commander Sands in coming north last summer from the Gulf of Mexico, to verify this by sounding constantly on the first range of hills, thus tracing them from off Cape Canaveral (pas. 8), in latitude 28 deg. 29 min. north, to off Cape Lookout, where he was obliged to leave this interesting research to look after the security of his vessel. The problem is yet to be determined, by the researches now in progress, how far north this range extends; and the question is yet to be answered whether their structure, which determines the distribution of cold and warm water on these southern sections, still continues northward, and is still the determining cause of the distribution; whether the changes in temperature from section to section are due in any part to the elevations and depressions along the axis—whether the ripples observed in certain localities are connected with them. These, and a crowd of suppositions which the learned Secretary of the Smithsonian Institution would class as "unverified speculations," crowd upon the mind, and if allowed to escape would only discourage some laborious discoverer by the chilling remark, "I predicted that this would be so" years ago.

These things must necessarily come out of a proper course of experiments, and it is not good to indulge in anticipating them further than is necessary for guidance in investigation.

The sudden falling off of the slope next the shore, is a common feature along our coast. It is seen in the sections upon the offshore chart, embracing what I have ventured to call the bay of the five States between Nantucket or the southern extremity of Cape Cod and Cape May, at the distance of 235 miles from the entrance of the bay of New York, and in the offshore soundings of the Gulf of Mexico, and in the intermediate sections which have been sounded between Cape Fear and Cape Florida. If the cold wall is connected with the sudden steep slope on the southern sections, why not on the northern, where we do not find such a connection? The answer is not difficult, but still it shows how cautious we should be in generalizing, since the very first attempt we make to transfer the generalization of the Charleston section to the Sandy Hook, fails.

Some interesting observations of Commander Sands show that comparatively cold water is to be found in the Gulf of Mexico in the bight between the delta of the Mississippi and some point on the peninsula of Florida or of the Keys, a comparatively shoal plateau, or rather gently sloping surface, lining the shores of eastern Louisiana, Mississippi, Alabama, and Florida. That outside of this is warm water.

In April, 1854, the difference of temperature in 150 miles, nearly off the Balize, was ten degrees. The temperature of the outer water was 78 deg., or nearly that of the Gulf Stream at this season of the year.

We are now prepared to collect and group on a chart, chiefly thermal, the facts relating to the Gulf Stream. I shall introduce what is known in a general way of its current incidentally.

Passing by the Florida keys, the stream was found last summer to have a temperature of 84 deg. This is 5 deg. above the mean temperature of the month of June at Key West, as given in the Surgeon General's reports.

The current here has little strength—enough, however, to make vessels seek its aid in working to leeward from Key West, and enough there to cause the steamers to seek it in their course by standing out towards the middle of the passage between the Florida keys and Cuba.

Issuing through the Straits of Florida and passing between the eastern coast of the peninsula and the Bahamas, it is turned northward by the land which confines and directs it. The direction of the stream here is nearly north by a little west or north. Its velocity varies from three to five nautical miles per hour, and its summer temperature (July and August) at fifteen fathoms below the surface is about — deg., varying with the season. This is an interesting section. It shows, instead of an unfathomable gulf, worn by the rushing waters of this great stream, quite a moderately deep passage, with two streams in it—one passing rapidly to the north and the other slowly to the south, one unmistakably tropical, the other as unmistakably polar in its origin—the ower saving the bottom of the sea from the great attrition assumed for it by theorists.

Follow now the course of the stream as it bends into the bight between Cape Florida and Cape Hatteras. Recollect that each one of these curves is the result of many data, all independent; that the cold wall, the axis, the second minimum, and second warm streams are four independent sets of observations; that the positions in each section, and in the several sections, are results of independent observations; that the results confirm each other remarkably, not only in passing from the surface to the greatest depths, but from position to position, and from section to section. The stream off Cape Canaveral has a northwardly set, and between that Cape and St. Augustine, begins to bend to the eastward of north. The stream between St. Augustine and Hatteras takes the general direction of the coast, making 5 deg. of easting in 5 of northing, curves to the northward, and then runs eastward so as to make about 3 deg. of easting in 3 deg. of northing. In the latitude of 38 deg., between Cape Charles and Cape Henlopen, it turns quite eastwardly, having then a velocity of only between one and two miles an hour.

That this general sweep follows the coast under water, (the coast line,) the curve of one hundred fathoms and the hill ranges of Maffitt, Craven and Sands, seem in a general way fully to establish. That it may be modified by other circumstances is not denied, but merely that it is not determined by them.

The after progress of this mighty stream and of its branches remain yet to be traced as this part has been, and the variations from the general conditions presented by changes of seasons, winds and storms.

These we may hope, unless the success which has hitherto attended these labors be for the future denied them, accurately to determine, and perhaps at some future day to present to your attention.

Col. Shaffner and the London Times.

[From the London Times, Dec. 23.]

Europe may feel satisfied that at length we have got upon the traces of the "Great Unknown" who discharged the duties of literary assistant to Mr. Barnum with such eminent success. Col. Tal P. Shaffner is the man. It would be hard indeed that he should be defrauded of laurels so justly won, but he may feel well assured that we all recognize the master mind and cunning hand which assisted in rearing the stately superstructure of his patron's fortunes. There is no evidence like internal evidence, after all. Testimony may be fabricated—stories may be forged; but it is only the same pen that achieved the former triumphs which can produce another masterpiece of the like kind. Our friend the Colonel has taken leave for a time of the Freje Mermaid and the Woolly Horse—he has abandoned the pretensions of General Tom Thumb for a yet loftier theme. From the service of Mr. Barnum he has passed into the service of the Russian Czar, and we are bound to say that Alexander has every reason to be satisfied with the new agent he has taken into his pay. Dr. Davega was a poor creature, after all. There was no light and shade in his system of lying. He went straight enough at his facts, to be sure, but he did not stop to fill up outlines—he had no notion of delicacy in his coloring—it was beyond him to produce an harmonious whole. Besides, he committed the enormous blunder of permitting himself to be caught in a steamer some hundred miles away from Sebastopol at the very time he was representing himself as there, busily occupied in administering eau de Cologne and perfumed essences to the gallant but pampered Muscovites. Colonel Shaffner has not—at least, as yet—been caught out. He steps out before the public as an impartial and intelligent traveller, who has spent some months in traversing the Russian empire in all directions, and who feels it a sacred duty to enlighten the minds of his fellow citizens upon the actual condition of that vast territory.

Nothing can be more delightful, nothing more Arcadian, nothing more smiling, than the state of those enormous provinces which court, rather than tolerate, the mild sway of the Russian Czar. The gentle pressure which has been applied by the allies has really effected nothing more than just to bring out the nobler features of the Russian character. The heart of the Czar is melted with a noble enthusiasm—the hearts of the nobles are melted with a still nobler enthusiasm—the hearts of the serfs are melted with an enthusiasm which is the noblest of all. The Imperial family, so far from being troubled with misgivings or torn with dissensions, are only drawn nearer and nearer to the illustrious head of their house. Constantine is without ambition—the Empress is at the summit of human bliss. The simple hearted diplomatists, with Nesselrode at their head, can see nothing in what is passing but a monument of Western violence and Western perfidy, which is sure ultimately to recoil upon the heads of its contrivers, while holy, holy Russia, will be holier than ever—the envy and the admiration of surrounding nations.

Colonel Shaffner deals with his subject as a whole. He leads us from the peaceful drawing room of the Imperial family to the country seats of the nobles, who are resolved to persevere to the last musket and the last rouble—to the huts where the loyal serfs are yearning to be enrolled under the banners of their chivalrous sovereign. Colonel Shaffner has visited Cronstadt. It is impregnable. So many additional fortifications have been constructed—they were scarcely needed—that the Western Powers can expect nothing but disgrace and discomfiture should they be so ill-advised as to attempt any attack. The Russians have taken all the old cannon out and mounted new ones in their places. As for Sweaborg, the bombardment cost the allies $25,000,000, while the loss to the Russians did not exceed $150,000. No harm was done save to a few old Swedish workshops, which the Russians had intended, in any case, to remove. The besieged were so completely at their ease throughout, that they walked about, thoroughly regardless of the bombardment.

Nicholaieff, too is impregnable; the Russians "laugh at the threats of the allies to take it as a foolish, vainglorious boast." We must not, it appears, count upon the financial embarrassments of Russia, for the expenses of the war have been defrayed from the ordinary revenues of the country. The Emperor Alexander has succeeded where Mr. Gladstone failed. There has been but a small loan effected since the beginning of hostilities; but this was not necessary, for at the present moment the public works of Russia, unconnected with the war, are carried on with uninterrupted vigor. The government is actually expending millions upon the erection of ecclesiastical edifices far more stately than any which St. Petersburg or Moscow can yet show. Aladdin, even, would be surprised at the splendor of the Russian churches. "The very domes of some of these are of gold, and the ornaments in the interior are of the same valuable material, and many of them studded with diamonds and other precious stones." Surely, this is a little strong; but never mind, Colonel; jamb down the safety-valves and make creation scream. "The yield of the silver, gold, and platina mines this year has exceeded that of any former year by $3,000,000. In addition to this, the government have forbid the exportation of the precious metals; the Mint is kept in constant operation night and day, and the paper rouble passes as current now as ever." We pause for breath; but the Colonel gives us no respite. He tells us that the effects of the war hitherto are quite imperceptible. Never were the plains of Russia so well tilled, never was so great a breadth of land laid down in grain, never were manufactures, especially that of iron, in so flourishing a condition. To crown all, Col. Tal. P. Shaffner brought away with him from Russia samples of laces and other articles of ladies' dresses, made by serf women during their hours of leisure in their happy homes.

We have been as entirely misinformed as to the effect produced by our operations as we have been with reference to the actual condition of the country. At Sweaborg we assisted the Russians to move some old tumbledown buildings. The evacuation of the south side of Sebastopol was of most trifling moment. The Russians had long contemplated such a movement, and had prepared three bridges—not one, as has been commonly supposed—in order to carry it into effect with perfect comfort and ease. It is quite an error to imagine that they did not carry away their wounded. They passed across over and over again when the town was in the possession of the allies, and carried off their gallant comrades, despite of the French and English. As for the losses at Kertch, they have ever been the standing joke of the best circles at St. Petersburg. Nobody was hurt, save a few rascally Greeks who had attempted to exact an exorbitant price for their corn from the Russian government. That government, however, dealt with them in a spirit of beneficent contempt. The Czar would not undertake to defend them, but he set apart a sum of money, which he handed over to the Greeks to enable them to block up the channel.

Nothing could be more truly ludicrous than the result. In place of sinking vessels filled with stones, these avaricious traders filled the vessels with sand, which was, of course, washed away by the current. When this was known at St. Petersburg the Czar could scarce contain himself for laughing—and the Czarina laughed—and the jarvies of St. Petersburg roared. Nothing, in fact, could exceed the hilarity of the capital.

Space, not material, fails us. Ferdinand Mendes Pinto was a weakling by the side of Colonel Tal. P. Shaffner. It is a pity that his account of the Russian empire has not been accompanied by a full length portrait of the illustrious traveller. We should have liked to see the very figure of that keen and sallow Yankee as he actually crouched in the full filth of a Russian hut, and, while he assiduously whittled away at some convenient piece of timber, resolved with himself the best means of pouring a roseate splendor over that uncomfortable scene. How far he has succeeded, it must be for his readers to decide.

NEW JUDICIAL DISTRICT.—At the General Term of the Supreme Court, held at Ballston Spa last week, the question of remodelling the district, under the new census, was agitated somewhat, and W. A. Beach, Esq., advocated the formation of a district to be composed of Albany, Columbia, Rensselaer, Saratoga and Schenectady, and a petition was drawn up to the Legislature in accordance therewith.

Lieut. Hartsuff, U. S. A., was wounded by the Florida Indians; not killed, as expected.