

THREE YEARS OF ARCTIC SERVICE

AN ACCOUNT OF THE

LADY FRANKLIN BAY EXPEDITION

OF 1881-84

AND THE ATTAINMENT OF THE

FARTHEST NORTH

BY

ADOLPHUS W. GREELY

LIEUTENANT U. S. ARMY, COMMANDING THE EXPEDITION

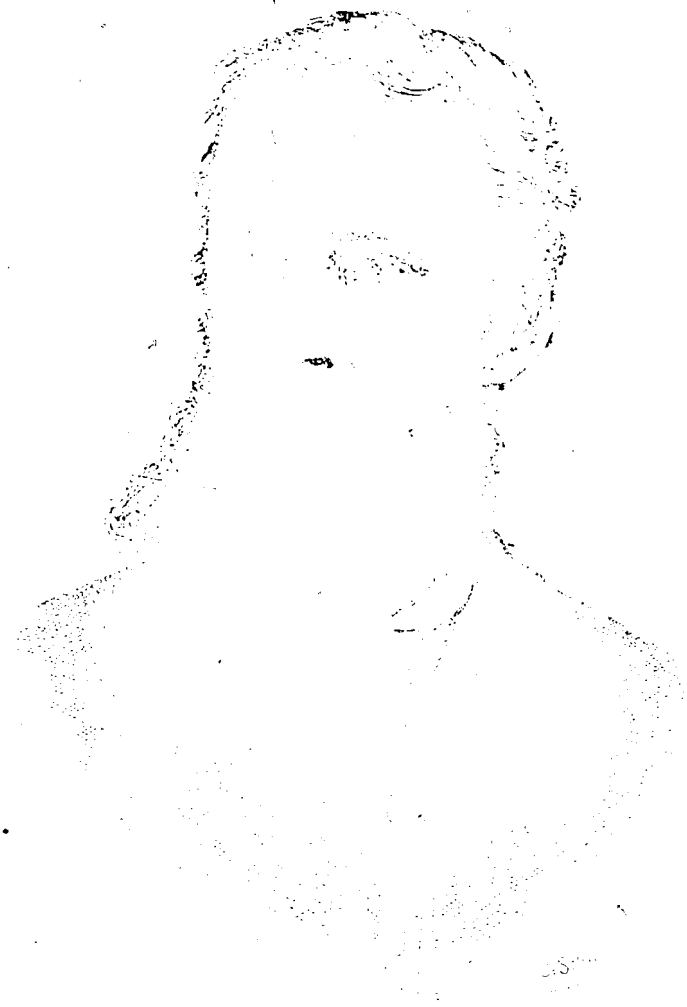
WITH NEARLY ONE HUNDRED ILLUSTRATIONS MADE FROM PHOTOGRAPHS
TAKEN BY THE PARTY, AND WITH THE OFFICIAL
MAPS AND CHARTS

VOL. I.

NEW YORK

CHARLES SCRIBNER'S SONS

1886



Ad. Greely

PREFACE.

THESE volumes appear in response to the demands of the general public for a popular account of the Lady Franklin Bay Expedition; and in their preparation I have spared neither health nor strength since the rendition of my official narrative to the War Department has left me free. The Secretary of War kindly granted me authority to incorporate in this work such official journals, maps, etc., as I might desire.

This narrative, however, is based on my diary, though I have drawn freely, always with credit, from the official field reports, and also from the very complete journals of Lieutenant Lockwood and Sergeant Brainard, the only regular diaries, with my own, kept during the retreat and our subsequent life at Camp Clay.

Fearing exaggeration, I have occasionally modified statements and opinions entered in my original journal, believing it better to underrate than enlarge the wonders of the Arctic regions, which have been too often questioned.

I have profited largely by the acute criticism of my

wife, who, stimulated into intense activity by the critical situation of the expedition during its last year of service, acquired a more than cursory knowledge of Arctic work. During the doubtful time she noted with keen perception the vital importance of the rejected bounty scheme and urged it through sympathizing friends to final passage.

The engravings are faithful reproductions of an unequalled series of Arctic views, the work of Sergeant Rice, the photographer, except field sketches—always noted—and original drawings made under my supervision, for the correctness of which I personally vouch.

No pen could ever convey to the world an adequate idea of the abject misery and extreme wretchedness to which we were reduced at Cape Sabine. Insufficiently clothed, for months without drinking water, destitute of warmth, our sleeping-bags frozen to the ground, our walls, roof, and floor covered with frost and ice, subsisting on *one-fifth* of an Arctic ration—almost without clothing, light, heat, or food, yet we were never without courage, faith, and hope. The extraordinary spirit of loyalty, patience, charity, and self-denial,—daily and almost universally exhibited by our famished and nearly maddened party,—must be read between the lines in the account of our daily life, penned under such desperate and untoward circumstances. Such words, written at such a time, I have not the heart to enlarge on.

The tragic experiences of the party excited such a

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public interest, further intensified by exaggerated and unfounded statements on many points, that I have felt obliged to touch briefly upon all disagreeable questions. In so doing I have adhered to the stern facts; while I have modified the acerbity of my judgments, remembering always that I speak of the dead, and being able in comfort and plenty to judge more leniently than when slowly perishing from cold, disease, and starvation.

For a quarter of a century a public servant, in war and in peace, my faults are known. Cruelty and injustice, however, are foreign to my nature; and I rejoice that during the nine months I commanded a party of suffering, starving, and dying comrades, I never treated any man other than he justly merited.

In this spirit I submit these unvarnished records of Arctic service to the public.

A. W. GREELY.

WASHINGTON, January 5, 1886.

ORDERS AND INSTRUCTIONS GOVERNING THE ORGANIZATION AND MANAGEMENT OF THE LADY FRANKLIN BAY EXPEDITION.

SPECIAL ORDERS, }
No. 57. }

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
WASHINGTON, March 11, 1881.

(Extract.)

2. By direction of the President, First Lieutenant *A. W. Greely*, Fifth Cavalry, acting signal officer, is hereby assigned to the command of the expeditionary force now organizing under the provisions of the acts of Congress approved May 1, 1880, and March 3, 1881, to establish a station north of the eighty-first degree of north latitude, at or near Lady Franklin Bay, for the purposes of scientific observation, etc., as set forth in said acts.

During his absence on this duty Lieutenant *Greely* will retain station at Washington, District of Columbia.

BY COMMAND OF GENERAL SHERMAN:

R. C. DRUM,
Adjutant-General.

GENERAL ORDERS, }
No. 35. }

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
WASHINGTON, April 12, 1881.

The following order, received from the War Department, is published for the information of the Army:

In order to carry into execution the act approved May 1, 1880, and so much of the act approved March 3, 1881, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1882, and for other purposes," as provides

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for "observation and exploration in the Arctic seas; for continuing the work of scientific observation and exploration on or near the shores of Lady Franklin Bay, and for transportation of men and supplies to said location and return, twenty-five thousand dollars," it is ordered:

1. First Lieutenant A. W. Greely, Fifth U. S. Cavalry, acting signal officer, having volunteered for the expedition, shall take command of the expeditionary force now organizing under said act to establish a station north of the eighty-first degree of north latitude, at or near Lady Franklin Bay, for the purpose of scientific observation.

2. Lieutenant Greely shall have authority to contract for and purchase, within the limits of the appropriation, the supplies and transportation deemed needful for the expedition; and the appropriation for this purpose, made by the act approved March 3, 1881, shall be drawn from the Treasury and disbursed, upon proper vouchers, by the regular disbursing officer of the Signal Service, under the direction of the Chief Signal Officer.

3. The force to be employed in the expedition shall consist of two other officers, who may volunteer their services; twenty-one enlisted men, who may volunteer from the Army or be specially enlisted for the purpose; and one contract surgeon. The latter to be contracted with at such time as he may be able to join the party.

4. The commander of the expedition is authorized to hire a steam sealer, or whaler, to transport the party from St. John to Lady Franklin Bay, for a fixed sum per month, under a formal contract that shall release the United States from any and all responsibility, or claim for damages, in case the steamer is injured, lost, or destroyed. The said contract shall include the services and subsistence of the crew of the vessel, and shall require that the said crew shall consist of one captain, two mates, one steward, two engineers, two firemen, and seven seamen—not less than fifteen in all. Such steam sealer, or whaler, shall not be hired until it has been inspected by an officer to be detailed by the Secretary of the Navy for that purpose, and found by him fit for the intended service.

5. The expeditionary force shall be assembled at Washington, District of Columbia, not later than May 15, and at St. John not later than June 15, 1881.

6. During their absence on this duty Lieutenant Greely, and the other officers of the Army accompanying the expedition, will retain station at Washington, District of Columbia. The enlisted men, who may volunteer or be specially enlisted for this duty, shall receive the pay and commutation allowances (except commutation for quarters and fuel) that accrue to men detached for duty in Washington, District of Columbia.

X ORDERS AND INSTRUCTIONS.

7. The several bureaus of the War Department will furnish, on requisitions approved by the Secretary of War, the necessary subsistence, clothing, camp and garrison equipage, transportation to St. John, Newfoundland, and return, medicines, books, instruments, hospital stores, arms, and ammunition. The subsistence stores to be furnished as above directed are for sale, not for issue, to the officers and men of the expeditionary force.

BY COMMAND OF GENERAL SHEEMAN:

R. C. DRUM,
Adjutant-General.

WAR DEPARTMENT,
SPECIAL ORDERS, } OFFICE OF THE CHIEF SIGNAL OFFICER,
No. 9. } WASHINGTON, D. C., June 17, 1881.

1. By direction of the Secretary of War, the following-named officers and enlisted men are assigned to duty as the expeditionary force to Lady Franklin Bay:

First Lieutenant A. W. GREELY, Fifth Cavalry, Acting Signal Officer;
Second Lieutenant FREDERICK F. KISLINGBURY, Eleventh Infantry,
Acting Signal Officer;
Second Lieutenant JAMES B. LOCKWOOD, Twenty-third Infantry, Act-
ing Signal Officer;
Sergeant EDWARD ISRAEL, Signal Corps, U. S. Army;
Sergeant WINFIELD S. JEWELL, Signal Corps, U. S. Army;
Sergeant GEORGE W. RICE, Signal Corps, U. S. Army;
Sergeant DAVID C. RALSTON, Signal Corps, U. S. Army;
Sergeant HAMPDEN S. GARDINER, Signal Corps, U. S. Army;
Sergeant WILLIAM H. CROSS, General Service, U. S. Army;
Sergeant DAVID L. BRAINARD, Company L, Second Cavalry;
Sergeant DAVID LYNN, Company C, Second Cavalry;
Corporal DANIEL C. STARR, Company F, Second Cavalry;
Corporal PAUL GRIMM,* Company H, Eleventh Infantry;
Corporal NICHOLAS SALOR, Company H, Second Cavalry;
Corporal JOSEPH ELISON, Company E, Tenth Infantry;
Private CHARLES B. HENRY, Company E, Fifth Cavalry;
Private MATRICE CONNELL, Company B, Third Cavalry;
Private JACOB BENDER, Company F, Ninth Infantry;

* Grimm having deserted, he was replaced by Private Roderick R. Schneider, First Artillery.

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Private FRANCIS LONG, Company F, Ninth Infantry;
 Private WILLIAM WHISLER, Company F, Ninth Infantry;
 Private HENRY BIERDERBICK, Company G, Seventeenth Infantry;
 Private JULIUS FREDERICK, Company L, Second Cavalry;
 Private JAMES RYAN, Company H, Second Cavalry;
 Private WILLIAM A. ELLIS, Company C, Second Cavalry.

2. First Lieutenant A. W. GREELY, Fifth Cavalry, Acting Signal Officer and Assistant to the Chief Signal Officer, is hereby assigned to the command of the expedition, and is charged with the execution of the orders and instructions given below. He will forward all reports and observations to the Chief Signal Officer, who is charged with the control and supervision of the expedition.

W. B. HAZEN,
Brigadier and Brevet Major General,
Chief Signal Officer, U. S. A.

WAR DEPARTMENT,
 INSTRUCTIONS, } OFFICE OF THE CHIEF SIGNAL OFFICER,
 No. 72. } WASHINGTON, D. C., June 17, 1881.

The following general instructions will govern in the establishment and management of the expedition organized under Special Orders, No. 97, War Department, office of the Chief Signal Officer, Washington, D. C., dated June 17, 1881:

The *permanent* station will be established at the most suitable point north of the eighty-first parallel, and contiguous to the coal seam discovered near Lady Franklin Bay by the English expedition of 1875.

After leaving St. John, Newfoundland, except to obtain Esquimaux hunters, dogs, clothing, etc., at Disco or Upernivik, only such stops will be made as the condition of the ice necessitates, or as are essential in order to determine the exact location and condition of the stores cached on the east coast of Grinnell Land by the English expedition of 1875. During any enforced delays along that coast it would be well to supplement the English depots by such small caches from the steamer's stores of provisions as would be valuable to a party retreating southward by boats from Robeson Channel. At each point where an old depot is examined or a new one established, three brief notices will be left of the visit—one to be deposited in the cairn built or found standing; one to be placed on the north side of it; and one to be buried twenty feet north (magnetic) of the cairn. Notices discovered in cairns will be brought away, replacing them, however, by copies.

The steamer should, on arrival at the *permanent* station, discharge her cargo with the utmost despatch and be ordered to return to St.

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John, Newfoundland. After a careful examination of the seam of coal at that point has been made by the party, to determine whether an ample supply is easily procurable, a report in writing on this subject will be sent by the returning vessel. In case of doubt, an ample supply must be retained from the steamer's stores.

By the returning steamer will be sent a brief report of proceedings, and as full a transcript as possible of all meteorological and other observations made during the voyage.

After the departure of the vessel the energies of the party should first be devoted to the erection of the dwelling-house and observatories, after which a sledge party will be sent, according to the proposal made to the Navy Department, to the high land near Cape Joseph Henry.

The sledging parties will generally work in the interests of exploration and discovery. The work to be done by them should be marked by all possible care and fidelity. The outlines of coasts entered on charts will be such only as have actually been seen by the party. Every favorable opportunity will be improved by the sledging parties to determine accurately the geographical position of all their camps, and to obtain the bearing therefrom of all distant cliffs, mountains, islands, etc.

Careful attention will be given to the collection of specimens of the animal, mineral, and vegetable kingdoms. Such collections will be made as complete as possible, will be considered the property of the Government of the United States, and are to be at its disposal.

Special instructions regarding the meteorological, magnetic, tidal, pendulum, and other observations, as recommended by the Hamburg International Polar Conference, are transmitted herewith.

It is contemplated that the *permanent* station shall be visited in 1882 and in 1883 by a steam, sailing, or other vessel, by which supplies for and such additions to the present party as are deemed needful will be sent.

In case the vessel is unable to reach there in 1882, she will cache a portion of her supplies and all of her letters and despatches at the most northerly point she attains on the *east coast of Grinnell Land*, and establish a small depot at Littleton Island. Notices of the locality of such depots will be left at one or all of the following places, viz., Cape Hawks, Cape Sabine, and Cape Isabella.

In case no vessel reaches the *permanent* station in 1882, the vessel sent in 1883 will remain in Smith Sound until there is danger of its closing by ice, and, on leaving, will land all her supplies and a party at Littleton Island, which party will be prepared for a winter's stay, and will be instructed to send sledge parties up the *east side of Grinnell Land* to meet this party. If not visited in 1882, Lieutenant Greely will abandon his station not later than September 1, 1883, and will retreat

southward by boat, following closely the east coast of Grinnell Land until the relieving vessel is met or Littleton Island is reached.

In view of the familiarity of Lieutenant Greely with the methods pursued by previous expeditions, and of the confidence reposed in his judgment and discretion, it is not thought necessary to furnish him with more definite instructions than those contained in the following pages. While he is left at full liberty to vary the details according to circumstances, yet the main points here given should be held in view as of predominant importance.

W. B. HAZEN,
Brigadier and Brevet Major General,
Chief Signal Officer, U. S. A.

condition. Five thousand pounds of carefully selected coal was screened, bagged, and carried to Dutch Island, where the launch lay.

The wisdom of laying her up at that point was then obvious, as the harbor-floe had never sufficiently opened to permit of her being moved had she been laid up for the winter at the station. Other stores and supplies had also been accumulated near the launch.

For the greater part of the year, with my clerk, I had been engaged in reducing, arranging, and copying the scientific observations, which, by August 8th, were completed to July 31st. These records, weighing about fifty pounds, were packed in three tin boxes, which were soldered and thus made water-tight. Two boxes were to be in my charge. These contained original reports, field journals, my own diaries, original sheets of magnetical and meteorological observations, and other official papers. Lieutenant Lockwood was to take charge of the third box, which contained letter-press copies of all scientific observations, star sheets, and the official collection of ~~the~~ the work of duplicating these records was great, but I hoped thus to save one set in case of any disaster during our retreat. All private property was abandoned, except eight pounds of baggage for each man and sixteen for each officer. My own extra baggage consisted of a seal-skin jumper, two or three towels, one suit of underclothing, three pairs of stockings, a woollen afghan, and my private collection of plants. Selections by the others were of the same character, being almost entirely articles of clothing, tobacco, etc. As commanding officer I took in addition my epaulets, sword, etc., and at Lieutenant Lockwood's request carried for him a favorite revolver, as he wore another which he had invariably carried in the field.

The pendulum, first secured in its box, was afterward soldered

in a tin case, and later secured against harm from rough handling by a wooden covering, which raised its weight to nearly a hundred pounds. The most valuable thermometers were carefully secured in a strong wooden case, and the magnets were transported in the prism. Four rifles, with about a thousand rounds of cartridges, and two shot-guns, with ample ammunition, were also selected.

The greater part of the men turned in their private diaries, sealed and addressed, which, with forty-eight photographic negatives, were carefully packed in a stout water-tight box. Medical stores designated by Dr. Pavy were handily arranged by Hospital Steward Bierderbick, on whom that duty fell. The medical liquors were also taken in as great a quantity as I felt was possible.

In addition to my own baggage, I also carried needles, bodkins, gimlets, thread, yarn, etc., not only for trade with the Etah Eskimos, if we should reach them, but for our own use. A large assortment of tools of various kinds, and material for repairing boats were also selected, and the outfit of the boats was made as complete as our means would permit. Our complete sledging-gear, which had answered so admirably in the field, was adopted for the retreat, and alcohol for fuel was taken in quite large quantities.

All these and other arrangements were perfected, but still the ice would not open. July ended in southerly gales, which did much toward breaking up the last year's floe in Hall Basin and Robeson Channel. Unfortunately Kennedy Channel did not break up until July 24th, one day after the Proteus sank. Discovery Harbor broke up July 30th, so that it was navigable at times in the southern portion. Time pressed, our fresh meat and vegetables were gone, our fuel nearly exhausted, and everything in an unsettled condition.

CHAPTER XI.

OUR SCIENTIFIC OBSERVATIONS.

THE primary object of the ~~Franklin Bay~~ Expedition being to carry out the scientific programme of the Hamburg Polar Conference, the utmost care was given to physical observations. The series commenced on July 1, 1881, at St. John, Newfoundland, and terminated June 21, 1884, forty hours before the rescue of the survivors.

Summaries of these, and such other observations as are of general interest, will be found in the appendices of this work. To avoid tediousness and repetition, allusions are made in the body of the narrative only to such as are of special interest or importance.

The observations as to the pressure of the atmosphere, temperature and dew-point of the air, direction and force of the wind, quantity, kind and movement of clouds, the aurora and the state of the weather, were made hourly after the vicinity of Fort Conger was reached.

On the upward journey by vessel the temperature of the sea-water at the surface and when practicable at ten metres (32.8 feet), was noted first every four hours, and later hourly. On occasion these observations were supplemented by soundings, with serial deep-sea temperatures by means of the Negretti-Zambra thermometer. After our arrival at Conger, serial sea-temperatures were recorded on the 1st, 11th, and 21st of each month, at which time the thickness of the sea-floe was also

noted. Surface sea-temperatures were observed the second year at every high and low water.

Our observations were always made by Washington mean time, and reference to that time is invariably meant when only the hour and minute are given. To reduce to Conger mean time, it is necessary to add forty-nine minutes.

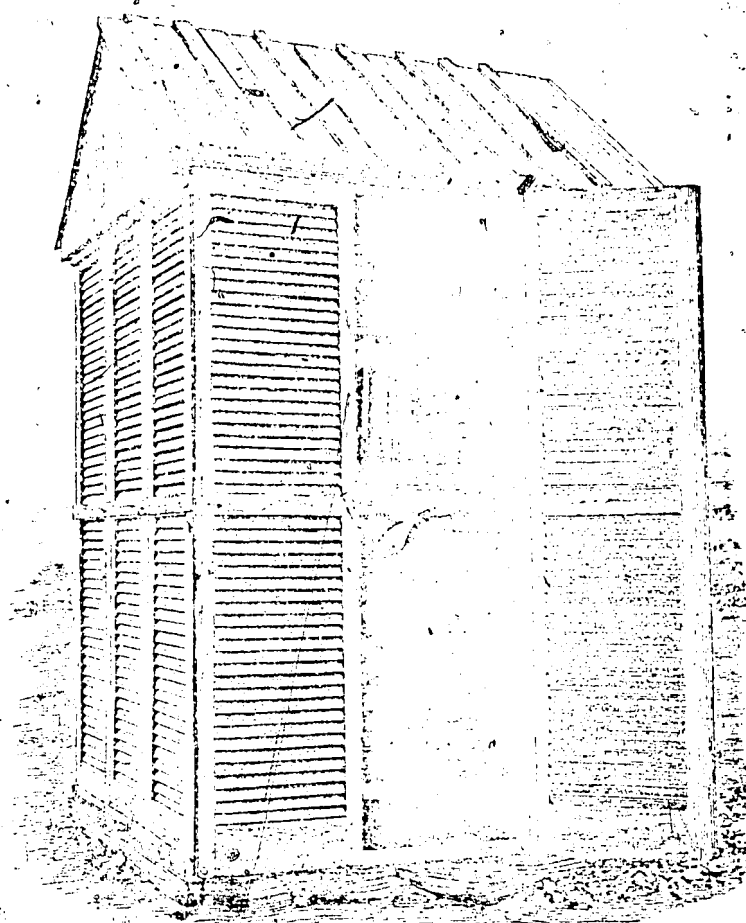
The temperatures given in this narrative are corrected from tests with frozen mercury, that metal being assumed to solidify at a temperature of -37.9° F. (-38.8° C.). Thermometers having but very small errors at high temperatures required large corrections at -40° (-40° C.), reading from two to five degrees too low. Some of our alcohol thermometers were so unreliable that they were never used. I could have sent these costly spirit thermometers into the field, from which actual though erroneous readings of -80° (-62.2° C.) to -90° (-67.8° C.) could have been obtained. Extremely low temperature readings, made in connection with Arctic explorations or otherwise, must be received with caution, unless the history and accuracy of the thermometer can be vouched for. Honest but inexperienced observers, in ignorance of the true facts, have frequently misled themselves and others.

Some excellent standard thermometers, of bisulphide of carbon, pure spirits of wine, and ether, were made for the expedition, under the careful supervision of Professor Waldo of Yale College Observatory. They were graduated in millimetres arbitrarily, and so served as an excellent check on other instruments. Their errors at freezing mercury proved to be inconsiderable, less than a degree Fahrenheit.

Our thermometers were exposed in a large wooden shelter of Louvre pattern, four feet square and seven high, which was situated about forty yards northeast of the house. The instruments were fastened to a sheet-iron drum, so made as to revolve,

which was shielded by another small shelter, made after the Louvre pattern, of galvanized iron.

The anemometer and wind-vane were placed on the ridge-pole of the main building, where the exposure was excellent.



Observer making Temperature Observations at Fort Conger.

In order to secure most reliable barometric readings, the observer, before making the current observation, verified each hour the vernier reading of the preceding hour, and in case a

change greater than .03 inch in the hour had occurred the observer reported it to me, whether day or night.

The solar and terrestrial radiation thermometers furnished the expedition had such limited range to their scales, that the observations were necessarily discontinued at the most important seasons, *i.e.*, from the middle of October to March 1st.

The magnetic observatory was situated about two hundred yards northeast of the main building. It was a wooden structure, about eight by fourteen feet in size, which was secured and fastened by wooden pegs in default of copper nails. A heavy bank of earth and sod to its eaves, supplemented by snow and ice during the winter, somewhat ameliorated its Arctic temperature, but it still remained an uncomfortable building the first year. During the term-days of the second year, when the observers remained in it the entire day, it was made comfortable by the construction of a small fireplace and chimney.

The magnetometer was mounted on a stout tripod, its solidity being ensured by freezing the legs of the stand into the earth. Of this instrument ten readings were made hourly, except on the 1st and 15th of each month, which were known as term-days. On term-day two readings were made every five minutes, except during one hour, when two readings were made every twenty seconds.

For the uninitiated it should be said, that the object of these readings was to note the declination of the magnetic needle.

In the greater part of the world the compass does not point to the geographical pole, and the saying, "true as the needle to the pole," is only an inaccurate simile. The magnetic declination of any place is the difference between the geographical pole and the quarter to which the needle actually points, and is measured in degrees to the east or west. For instance, where the needle points to the true west, the declination is said to be

90° W., and when pointing to the southwest, to be 135° W. At Fort Conger, in 1882, the magnetic needle pointed between the west and southwest, the declination being 100° 13' W.

In the magnetometer a small magnet, freely suspended by a single fibre of untwisted silk, swings readily in any horizontal direction. This magnet, at Conger, was never quiet, not even on what are technically known as *calm* days, but swung to and fro in a restless, uneasy way, which at various times impressed me with an uncanny feeling quite foreign to my nature. As it swung to right and left, its movement was clearly outlined on a fixed, illumined, glass scale, which served as a background, and the extreme oscillations, seen through a small telescope by the observer, were recorded.

In the other end of the building was placed, on a stable pier, a dip-circle, from which the inclination or dip of the magnetic needle was hourly determined. A magnetic needle, nicely and delicately balanced, in the middle latitudes assumes a nearly level position. At Conger, however, the needle, adjusted so that it can move freely in a vertical plane, shows a strong tendency to assume an upright position. At a dip of 90° the needle would be erect, while at Conger the inclination was about 85°.

In speaking of this instrument, it is necessary to say that a dip-circle was especially made for the Lady Franklin Bay Expedition, but it was by error shipped to the United States Coast Survey. On calling for it, when the duplicate instrument ordered could not be had in time, the late Mr. Carlisle Patterson, then Superintendent, promptly promised that it should be sent to me at New York. On the day of my sailing, a dip-circle, carefully boxed, was received; but on opening it, at St. John, an old, rusty, unreliable instrument was found in the place of the new circle. This resulted in unsatisfactory and incomplete

observations at Conger, for the old circle having upright standards instead of transverse ones, as in the new, but one end of the needle could be read. It must always be a matter of regret that this unwarrantable and unauthorized substitution by some person was made, which materially impaired, if not effectually destroyed, the value of our two years' dip-observations.

Accurate tidal observations in high latitudes have always been difficult to obtain. As far as I know, the two years' observations obtained by the expedition formed the first unbroken series of any length ever made from a fixed gauge in a very high latitude. For the greater part of the time, the gauges in use were iron rods, forced as far as possible into the stiff clayey bottom. To keep open the tide-hole required the constant labor of two men, and occasionally other assistance was given when the gradual, steady movement off shore of the main-floe required a corresponding extension of the tide-hole. The main floe moved in one winter nearly twenty-five feet off shore. To prevent the rapid formation of ice in the tide-hole, a large snow-house was built over it. Additions were made to the original house from time to time as the floe moved. Despite this protection, the ice in the tide-house formed to a thickness of eight feet, partly from tidal overflows. The tidal observations of Conger were supplemented by observations on fixed gauges at Black Horn Cliffs and Repulse Harbor on the North Greenland coast, at Capes Sumner, Baird, Beechy, Cracroft, and Distant Cape, which, being simultaneous with those at Conger, can readily be reduced. These readings have been submitted to the Superintendent of the United States Coast Survey, and, united to those of the British expedition at Floeberg Beach and Discovery Harbor, in 1875, and by Bessels at Thank God Harbor, in 1871, will probably enable that tidal-expert, Assistant Charles Schott, to determine satisfactorily the

co-tidal curves of Robeson and Kennedy Channels and the entrance to the Polar Sea.

Our time observations were made from a transit kindly loaned the expedition by the superintendent of the Coast Survey, which was in moderately serviceable condition. The chronograph, however, which was furnished for the especial purpose of registering the star observations for time in connection with the pendulum observations, was an incomplete, broken-down affair. It certainly was sent by a careless or incompetent person, whose action came near frustrating the plans of his department for a valuable and unparalleled series of observations. Fortunately, Sergeant Gardiner, of the Signal Corps, was an instrument-maker, and while he with other aid rebuilt the chronograph, I reconstructed the electrical portion of it.

The pendulum observations were due to the intelligent and liberal action of the Superintendent of the United States Coast Survey. Under the instructions and supervision of Assistant Charles S. Pierce, of that bureau, a beautiful pendulum was especially made for this work. In default of a break-circuit chronometer, for use with the chronograph in time observations, Professor Pierce kindly loaned his own chronometer, which was used in the pendulum work. As a recognition of this action, I felt it incumbent on me to see that the instrument was returned, and so, in all the dark days of our retreat, that chronometer was carefully looked after, and has since been delivered to Professor Pierce.

My astronomer, Sergeant Edward Israel, had received from Professor Pierce careful and detailed instructions concerning the pendulum work. Professor Pierce had pointed out to me the importance not only of uniformity of temperature, but of determining accurately the temperature of the pendulum. The

problem was not an easy one, from the stubborn way in which heated air rises and cold air falls. The necessity of piers with great stability was obvious, but the conditions at Conger required the construction of such piers on frozen ground and at temperatures below zero Fahrenheit.

Sergeant Gardiner and Private Connell, under my directions, succeeded in building strong, stable piers. Brick and Portland cement had been purchased for the purpose at St. John's. The site selected was in a lean-to built on the north side of the officers' room. Holes three feet square were dug to a depth of about twenty-seven inches, the ground being found frozen at a depth varying from twenty-two to twenty-four inches. Over these holes a tent was pitched, and alcohol lamps lighted within it to raise the temperature. On the bottom of the holes dry, hot ashes were spread, and then two courses of bricks were laid. As the bricks had been previously heated to a temperature of 150° , the cement formed before the temperature fell to the freezing-point. In this manner the piers were finally built in a solid, substantial manner. Around the piers a house was erected of ice-slabs, which maintained an almost constant and exceedingly uniform temperature. French plate-glass being set in the front of the ice-house, and in the door leading into the officers' room, the observer was able to remain comfortably in the latter room, and by a set of reflectors throwing light on the pendulum to read its oscillations through a telescope.

Several sets of maximum and minimum thermometers were so disposed as to show the ranges of temperature at the head, the centre, and the bottom of the pendulum, and one thermometer was so placed that it could be read at any time by the telescope from the officers' room. These arrangements were so successful that the range of temperature rarely exceeded five degrees Fahrenheit, during an entire set of observations. Forty-eight

swings of the pendulum with corresponding time observations were successfully made, and it is probable that these observations, under Professor Pierce's skilful discussion, will prove of marked value to geodesy.

Near the end of November, 1881, the observers began to obtain samples of the air, according to instructions furnished by Professor Edward Morley. The samples were to have been analyzed by that gentleman in connection with his investigation as to the variations of oxygen in the atmosphere. Unfortunately for his researches, the samples were necessarily abandoned, with other bulky and weighty collections, on the occasion of our retreat.

An excellent series of observations as to the velocity of sound at low temperatures was obtained, which generally confirm the theoretical law as to the effect of temperature on its velocity in air, as deduced from observations at higher temperatures. These experiments are dwelt on elsewhere more in detail.

Experiments were made with a view of comparing the actual with the theoretical dew-point; and also many other special and comparative observations were made which need not be here referred to at length.

The number of observations made and recorded each day were as follows: Meteorological, 234; tidal, 28; magnetical, 264—aggregating 526 daily. On term-days the number of magnetical observations were increased to over twelve hundred, so that the observers were always busy.

Sergeant Israel had all the astronomical work, and the observations of magnetic intensity to attend to, and was also in general charge of the magnetic work. Lieutenant Lockwood and I did duty as observers on term-days. Sergeants Gardiner, Jewell, and Ralston were particularly charged with meteorological and tidal work, being occasionally assisted by Sergeant

Israel and Private Henry. Sergeant Rice, the second year, noted the high and low tides and sea-temperatures, being at times relieved by Private Long. Private Connell likewise assisted at times in making meteorological observations, and during all pendulum, time, and sound, experiments was in charge of the chronograph.



The Frog.

[A Floberg in Robeson Channel, May, 1882.]

Fortunately systematic preparation and wise prevision secured the safe return to this country of the observations made at the cost of so much labor and care, though the bulky original records were necessarily stored at Fort Conger.

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latter shows the effect of hauling the whaleboat even two days. We started at 1 p.m., and, by nine hours' hard work on the road, have succeeded in making about two and a quarter miles in a southwest direction. It is to be remarked that we came into our old camp from the northeast and started out to the southwest, but yet, owing to the rotary movement of the floe, we marched out on the same road over the same ice by which we marched in. The travelling to-day was excellent for the most part, but on the last floe was very heavy from the deep new snow. On reaching the floe I should have camped upon it, but it was separated from the one to the southwest by high, dense rubble, with a slight fringe of new ice; and, although the men were very tired, we cut rubble and hauled the boat to the new floe, in order that there should be no uncertainty about to-morrow's travel. We went to our bags after 10 p.m., worn out with the labors of the day. Land looks very near—some say three or four miles, but it must be nearer twice that distance. In order not to discourage the men, who fortunately look on the bright side, I have directed the astronomer to report our exact location to me alone, and I make it known only at suitable seasons when it confirms the hopeful view. Several bear-tracks seen to-day.

"I abandoned to-day, everything which could be spared and was not of vital importance, about a hundred pounds weight, and yet we are hauling about six thousand pounds, which necessitates only two trips however. We keep a telescope and marine glass, all rifles, a shot-gun, all ammunition, records, instruments, food, fuel, and serviceable clothing. Its outer case has been stripped off, reducing its weight, but we still carry the pendulum. I informed the men that I was unwilling, much as I wanted to save that instrument, to lessen their chances of life by hauling it longer, unless all concurred, and that it would be

dropped whenever they wished. Not only was there no objection to keeping it, but several of the party were outspoken in considering it unmanly to abandon it. Such a spirit is certainly most creditable."

Brainard's journal says: "Turned in at 11 p.m., after ten hours of the severest physical strain. As the sleeping-bags (of those of us in the tepee) are protected from the ice by only one thickness of canvas, our comfort can be imagined."

"September 18th.—Called the cooks at 5 a.m.; got off at 7.45 a.m., and camped at 9 p.m., with a short delay to drink tea, which was cooked as we worked. The labor was of the most arduous character, for we worked with a sense that the situation was desperate, as the ice was moving eastward and threatened to pass Cape Sabine. We crossed five lanes of water by boat where three loads were necessary, which involved constant change from sledge to boat and consequent separation of the party. As the pack was moving, such separations were dangerous, but were absolutely essential to progress. One or two of the men at one time commented on their being left till the last party, and in consequence I reproved them, pointing out that they were last only in their turn, and not always so. I have invariably been the last man to enter the boat under such circumstances. Rice to-day broke through the young ice, completely wetting himself. I was with him, and stripped myself of underclothing for him, which was supplemented by other dry clothing as the party came up. When we drank our tea, at 7 p.m., we were on the northern edge of a palæocrystic floe; but, though the men were thoroughly tired out, we all realized the importance of reaching land, and so pushed on for two hours and camped on the southwest edge of the floe, then being, I estimated, about four miles from shore. Darkness set in at that time (9 p.m.), which, with the open water and moving floes ahead,

The spirit of Lieutenant Lockwood's notes was the same as that which prevailed generally in the party during the entire winter. It was frequently said that those who were near and dear to us at home were more to be pitied than ourselves. We were facing a stern and frightful reality, but they could not fail to be mentally tortured by doubts and fears of every kind.

"October 23d.—Cloudy, with chilling northwest wind and a temperature of -6° (-21.1° C.). As Sergeant Rice reported that ice was forming yesterday along the shore, so that possibly the party might reach Sabine with a sledge, I called the cooks at 4 A.M., and sent Lieutenant Lockwood with eleven others to bring as much of the English cache as possible. In order to insure the safety of the records of the expedition, I sent them and the pendulum, with orders to cache them in a prominent cairn on the south side of Payer Harbor. I know that point will certainly be visited, and that possibly our present camp might be missed by a relief expedition, and all the records lost if left here. I am determined that our work shall not perish with us. Lieutenant Lockwood was directed to leave with the records a notice similar to the one sent by me a few days since to the cairn on Brevoort Island. I ordered that the cache at Payer Harbor be taken up prior to the clothing and tea at Sabine. The days are shortening now so rapidly that it is with difficulty the party can travel from here to Payer Harbor and return, so the cache there must be taken up first. The party was unable, owing to the sledge breaking, to bring in a load to-day farther than Sabine, whence they returned without sledge, having been absent over ten hours. Lieutenant Lockwood and Dr. Pavy each injured a foot while pulling through some pointed rubble ice. Open water and one or two seals were seen in Payer Harbor. Lieutenant Lockwood reports that he has made a very prominent cache, with the pendulum rising from its top, so that no

one visiting Payer Harbor can miss seeing it. It is on Stalknecht Island. The record was left in the sextant-box."

"October 24th.—Sent a party to Sabine, which brought in the load by half past five, after ten hours' work. Elison temporarily repaired the sledge at Cape Sabine this morning, and will put it in good order to-morrow. I have told him that the sledge must not only do our autumn work, but must be so strength-



Our Records and Instruments.
[Cached October, 1883, on Stalknecht Island.]

ened that we can cross to Littleton Island in March, and he has promised that it shall be. Lieutenant Lockwood told me that he had not the heart to refuse the men permission to eat some mouldy bread at Cape Sabine, and I in turn had not the heart to reproach him farther than to say such permission must not be repeated." His journal says: "Allowed the men to eat the mouldy bread out of one of the bags; we ate ravenously."

"October 25th.—The sledge broke again yesterday, and was

(-45.7° C.) on the 9th, and the day following the minimum touched -58.2° (-50.1° C.).

Everything being in readiness, we commenced our pendulum observations on January 6th. During this work regular time observations were necessary twice daily, and the severe cold made the work of the most trying character to our astronomer, Sergeant Israel. He made the observations on the 14th, in temperatures varying from -54° (-47.8° C.) to -56° (-48.8° C.). A few days later, being exposed for a long time to a temperature of -48° (-44.4° C.) in the open observatory, he froze superficially one of his feet. Apart from this the pendulum experiments, though tedious, and involving exposure and suffering, were most fortunately and successfully conducted.

In the meantime the entire quarters had been made as comfortable as was possible. The house had been well banked up with both earth and snow, and all cracks in the men's quarters had been papered over so that no draughts were possible. The men had constructed shelves over their bunks, and had arranged curtains, which insured a certain privacy whenever they sought it. In the officers' room such shelves and conveniences had been erected for each one as were desired. The surgeon had his books, instruments, and such medicines as he wished, on shelves constructed in his corner.

My own domain of eight by eight was in general thrown into the main room, but heavy curtains were so arranged that at night, or whenever I desired privacy, they could be drawn so as to cut off my corner from view. Such little personal trappings as I had taken with me were arranged to the best advantage. On shelves near me were placed my personal books and the excellent Arctic library we were favored with. To save space, my bunk was built on the top of an ammunition-chest, in which the greater part of my clothing was packed.