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*H. Green*  
*with Mr. Winslow's respects*

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# Reception of Dr. Gould,

JUNE 22, 1874.

*Handwritten initials*  
AV



RECEPTION

OF

DR. BENJAMIN A. GOULD

BY

HIS FELLOW-CITIZENS OF BOSTON AND VICINITY

*June 22, 1874.*

BOSTON :

PRINTED BY RAND, AVERY, AND COMPANY.

1874.





BOSTON, June 16, 1874.

*Dr. Benjamin Apthorp Gould.*

SIR.—Desirous of testifying to the honor in which your native country and city hold those great services to science, as observer and investigator, which peculiarly propitious circumstances have led you to offer to our sister republic in South America, under the administration of the distinguished President Sarmiento, as director of the Argentine National Observatory and Meteorological Office; and wishing to meet you on your return home with the friendly sympathy of fellow-citizens, and to hear from your own lips something of the results of your labors, we ask you to meet with us at Wesleyan Hall, on Monday, June 22, at three o'clock, P. M., for this purpose.

We are your obedient servants,

CHARLES F. ADAMS,	T. W. PARSONS,
JAMES WALKER,	THEODORE LYMAN,
GEORGE T. BIGELOW,	HENRY A. WHITNEY,
HENRY W. LONGFELLOW,	JAMES M. BABNARD,
RICHARD H. DANA, JR.,	GEORGE S. HALE,
CHARLES W. ELLIOT,	MARTIN BRIMMER,
GEORGE M. LANE,	WILLIAM GRAY,
WOLCOTT GIBBS,	W. G. WILD,
H. L. EUSTIS,	J. H. DIX,
O. W. HOLMES,	ALEXANDER AGASSIZ,
ERVING WINSLOW, and others.	

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*Hon. Charles Francis Adams, and others.*

GENTLEMEN.—Your kind invitation could meet with but one response on my part. Among the incentives to exertion or sacrifice, few can compare with the approbation and sympathy of those whom we love or honor. And your expression of interest in the work in which I have been engaged is peculiarly gratifying to me.

It will give me much pleasure to accept your invitation, and I am sure that my shortcomings in any attempt at a connected narrative, under the circumstances, will meet with a lenient judgement.

I am, gentlemen,

Very respectfully and gratefully yours,

B. A. GOULD.

BOSTON, June 17, 1874.



## RECEPTION OF DR. GOULD

BY HIS FELLOW CITIZENS OF BOSTON AND VICINITY.

JUNE 22, 1874.

Hon. Richard H. Dana, Jr., on taking the chair, spoke as follows :

### ADDRESS OF HON. R. H. DANA, JR.

LADIES AND GENTLEMEN :

We all regret that the public duties cast upon Mr. Adams to-morrow, prevent his taking the chair of this meeting. It will be a consolation to you, as it is a satisfaction to me, to remember that the occasion belongs not to the chairman, but to our guest, and that he is one who needs no introduction.

We have met to express our respect to him for his learning and abilities, and the courageous manner in which he has devoted them to this new field of investigation,—banished from home, and from every association which his childhood and manhood had made most dear to him.

How little do we know of the southern part of our own hemisphere! Our intercourse with China and India is more rapid and complete: and of South America, we know more of the Pacific than of the Atlantic coast, more of Chile and Valparaiso, more of Peru and Lima than of Buenos Aires and the valley of the Rio de La Plata. It is to us

an almost unknown region: but we feel now that there exists a bond between that great republic of the South and our own, — that she has shown the same spirit of enterprise that has caused our own advance, — and we rejoice that through their honored president, Sarmiento, the man of science was invited from this country, who should open some of those great fields of exploration for which her wide territory and cloudless skies present such facilities. Our sympathy and our admiration should be expressed towards the people of the Argentine Republic, and we trust that Dr. Gould will give them to understand that the citizens of his native State have a strong feeling of respect and gratitude to them for the paths they have opened and the progress they have made.

It is in these regions, so little known, that Dr. Gould has been laboring for four years, a missionary of science, under strange skies, as well as on foreign soil, among a new people; and on his return to his native town we are met to give him a cordial welcome, to express our pride that he has secured this opportunity to the honor of American science, of New England and of Boston; to assure him of our best hopes and wishes for his future, and I may add, I trust without indelicacy, our sympathy in his recent past. Nor should we forget that in his exile he has been accompanied and cheered, as was Agassiz, by the tenderest of the human relations, and not the least heroic. But I must say no more.

To you, Dr. Gould, I tender in behalf of this assembly our sympathy, our congratulations, and our best wishes; and beg to say that it would be a great gratification to us if you will give us some account of those things which have most interested you, and which were thought most worthy of your studies in this new and strange region of scientific labor.

## ADDRESS OF DR. GOULD.

LADIES AND GENTLEMEN :

The kindly interest and sympathy manifested by your invitation to meet you here, and tell of the work accomplished since I left home to labor in the other hemisphere, have been most grateful to me. There is no earthly reward for effort, nor comfort in weariness, like the consciousness that those whose esteem and confidence we prize are supporting us by their good wishes, grieving with us in our failures, or rejoicing with us in our success. Gratitude for this brings me here now, to respond as well as I can by giving some little narrative of my undertaking and its results, and speaking in public in my native city for the first time within the lifetime of many who have already arrived at man's estate.

More than half a century ago, the great astronomer Bessel undertook the formation of a catalogue which should contain the positions and magnitudes of as many stars as possible between the parallels of  $45^{\circ}$  north declination, and  $15^{\circ}$  south, down to the ninth magnitude: thus including all stars one-fifteenth part as bright as the faintest which he could discern with the naked eye. This great work he carried to a successful conclusion; commencing the observations in 1821 and completing them in 1833, and securing more than 72 000 observations of 62 380 different stars. These have since been carefully computed, and the resultant catalogues published by the Imperial Observatory of Russia at the public expense, affording a priceless aid to astronomers. In France, an analogous attempt had been made near the close of the last century, by Lalande, who undertook a scrutiny of all the stars between the north pole and the southern tropic, and his 47 000 observations have been computed and published at the

expense of the British government; but the superiority of modern instruments and methods rendered Bessel's undertaking essentially a new one.

Later, his pupil and assistant, Argelander, upon whom his mantle had fallen, extended this scrutiny by two more series of zone-observations, — one on the north, reaching from  $45^{\circ}$  to  $80^{\circ}$ , the other on the south from  $15^{\circ}$  to  $31^{\circ}$ , — the two jointly containing about 50 000 observations. The vicinity to the pole upon the one side, and to the horizon on the other, presented peculiar difficulties: yet the continued improvement of astronomical instruments and methods, and the rare skill of Argelander, enabled him to attain both a somewhat higher degree of accuracy and a relatively greater number of observations. Thus, in 1852, the heavens had been well studied from  $80^{\circ}$  north of the equator to  $31^{\circ}$  south: and when in that year, our lamented countryman, Gilliss, returned from his expedition to Chile, he brought with him the manuscript results of an extensive series of zones, which he had observed around the south pole. Soon afterwards, the English astronomer, Carrington, explored the ten degrees around the north pole: so that, for the last eighteen years, the only region of the heavens which has not been carefully investigated is that which lies between the parallel of  $31^{\circ}$  south and the northern limit of Gilliss's yet unpublished observations. To fill this hiatus, and complete the survey of the heavens on some plan analogous to that of Bessel and Argelander was naturally an alluring problem.

The singularity and strange beauty of some portions of the southern sky has from the first attracted the attention of navigators. At the very beginning of the sixteenth century, the luminous patches now called the "Magellanic clouds," as well as the "Coal-sacks," those dark blots upon the brilliant milky-way, had been vividly portrayed: and even Amerigo Vespucci boasted that he had looked upon the four stars which, according to Dante, had been

"Ne'er seen before save by the punal people,"

but which have been now, for more than three centuries and a half, renowned in song and story under the name of the "Southern Cross." Nor need we wonder at the poet's fervor, when he adds, —

"Rejoicing in their flamelets seemed the heaven,  
O thou septentrional and widowed site,  
Is that thou art deprived of seeing these!"

The glory of the southern sky in the region near the Cross is indescribable. There, where the Milky Way is crossed by the thick stream of bright stars which skirts this river of light, its brilliancy is wondrously increased, and it exhibits a magnificence unequalled in any other portion of the heavens. There glitter a multitude of bright stars, more thickly scattered than in any region within our northern view, while the background is gorgeous in its splendor. Often, on some clear night, when this region has suddenly been brought to my view in passing some edifice, or turning some street corner, I have stood amazed at the flood of light which it diffused; and often, too, when leaving the observatory in the early morning hours after a night of wearying labor, I have felt reluctant to abandon the magnificent spectacle, for the sake of much-needed repose. In close proximity are the rich constellations of the Centaur, the Keel and Sails of the ship Argo, and the Wolf; and the glory reaches through the Altar even to the southern portion of the Scorpion. There extend large tracts which rival the Pleiades in the profusion of their stars, gleaming upon a background of nebula. Elsewhere the southern heavens are not so brilliant as the northern, nor do they contain so many stars as bright as the faintest which we can discern; but there is nothing between the two poles comparable in beauty with the tract to which I refer.

Yet the earliest accurate observations of southern stars were those of Halley, afterwards Astronomer Royal of England, who visited St. Helena for the purpose between the years 1676 and 1678, under the patronage of King Charles II. and the East India Company, and there determined the

positions of 311 stars. Seventy-five years later, in 1751, the French astronomer Lacaille undertook a similar expedition to the Cape of Good Hope, then a Dutch colony, at the expense of the French government, and with the official support of the French Academy of Sciences, the States-General of Holland and the Prince of Orange. With but one assistant, and only employing a little telescope half an inch in aperture and 28 inches in focal length, strapped to the tube of a mural quadrant, he succeeded in determining the positions of 9766 stars, between the tropic and the pole, in the short period of less than eleven months; but his observations were not published until eleven years later, and then in so crude a form that they were with difficulty available until about a quarter-century ago, when they were computed and published, like those of LaLaunde, at the expense of the British government. These have till now been a principal reliance of astronomers for their knowledge of the southern heavens. I may not dilate on what has been done elsewhere: at Paramatta, where the observations, though laboriously made, have rendered comparatively little service to science; at Madras, thirteen degrees north of the equator, where Taylor made excellent observations of some 6000 southern stars; at the Cape of Good Hope, where observations of great precision and value have been made by various eminent men, and where Sir John Herschel devoted seven years to forming a catalogue of nebulas and double stars; at St. Helena, where Johnson, one of the most skilful and delicate observers of our times, fixed the position of 606 southern stars; or of the observatory established at Melbourne twenty years ago, from which have emanated observations of the highest quality, and where the director, Mr. Ellery, has commenced a grand study of the southern heavens, upon a different plan from mine in Cordoba and for a different purpose. To Gilliss's labors in Chile I have already alluded, and at the observatory of Santiago, in that republic, the places of a considera-



ble number of stars have been determined by him and his successors.

Such, my friends, were the circumstances as they presented themselves a few years ago. Argelander's explorations reached only to  $31^{\circ}$  south, which is but eight degrees above his horizon, and where his observations were not only difficult, but subject to serious embarrassments from the excessive influence of refraction. Beyond this, no systematic series, aiming at both accuracy in the positions and tolerable completeness, had been attempted since Lacaille's, with poor instruments, a century and a quarter ago; unless we except Gilliss's unpublished observations around the south pole, which future astronomers may or may not see. The only other observations available were the scattered ones already mentioned, in which the aim had been not to fix the places of many stars, so much as, by repeated observations of some principal ones, to obtain for these the highest accuracy. In all, I scarcely think they included more than about 12 000 different stars.

Information from various sources having led me to believe that the climate of Cordoba, midway between the Atlantic and Pacific, and exempt alike from the frequent tornadoes of the one coast, and the earthquakes of the other, was especially favorable for astronomical research, I addressed a letter, in October, 1865, to Mr. Sarmiento, then Argentine minister to this country, telling him of my desire to make an astronomical expedition thither, and of my hopes of being able to secure the necessary pecuniary means from lovers of science. In this letter I asked him whether such an expedition would be cordially received by the national government and by the people of Cordoba; whether protection would be afforded in case of need; and whether I could reasonably hope that on my own departure the establishment would be adopted by the government and continued as a national institution. His reply was most cordial, answering all my questions

favorably, and promising even more than I had ventured to ask; and in due time a full official indorsement was received from the Argentine government, and Dr. Costa, Minister of Public Instruction, in a note dated January, 1866, expressed his regret that the heavy sacrifices which the nation was making, in its mortal struggle with the tyrant Lopez of Paraguay, deprived him of the power of offering yet more effective support to the undertaking. My plan failed at that time, owing to my want of success in obtaining the necessary pecuniary means, yet Mr. Sarmiento's interest in it never flagged; nor did he, when nominated for president eighteen months later, forget the astronomical project amid official cares, educational labors, or political excitement. One of his earliest acts after assuming the presidency in 1868 was to recommend a national observatory. This was voted by the Argentine congress at its first subsequent session; and in the latter half of 1869 I received from Dr. Avellaneda, then minister of public instruction, an invitation to organize a permanent National Observatory and provide the needful instruments and buildings; and money-credits were furnished for doing this in an adequate, though unpretending, way. I took the necessary steps as speedily as possible, and a happy combination of circumstances aided the prompt acquisition of instruments, which would else have required a long time for their construction. Happily, as it proved, although it had cost me some regrets in the interval, I had more than three years previously ordered, upon my own responsibility, from the celebrated artist Repsold, of Hamburg, a meridian-circle of dimensions and character especially adapted to the proposed work; and this had been completed but a few months when the opportunity for its employment arrived.

The ready assistance and encouragement which the undertaking received from every side, as soon as it became publicly known, will always afford me delightful remembrances. Not only in its private and personal, but also in

its scientific relations,—not only by words that meant something, but, likewise, by the most practical actions,—aid came to it from all directions. The superintendent of the Coast Survey hastened to offer the loan of such portable instruments as might be serviceable: an offer which I accepted as freely as it was made. The secretary of the Smithsonian Institution did the same: and both these institutions, as well as the Naval Observatory and the Nautical Almanac, contributed full series of all their publications. By some grievous mischance the boxes containing these invaluable books never reached their destination, but the loss has been repaired to a considerable extent by new gifts. The American Academy of this city lent money from its Rumford fund, to purchase apparatus for studying the light of the stars, and gave me permission to return either the instruments or the money, and at the most convenient time. Four of the scientific societies of England, the observatories of Greenwich, Pulkowa, and Leipzig, astronomers in England, France, Germany, Russia, and Italy, sent such generous gifts of valuable books, maps, charts, &c., that the faintest heart could not have failed to gather courage. Not to mention my own countrymen and all I owe them, Profs. Bruns and Zöllner in Leipzig undertook to superintend the construction of instruments for the new institution: and, during the whole period of my absence, the former has attended to all the apparatus and books which I desired from Germany. So, too, Prof. Anwers in Berlin took charge of extensive computations which I needed to have made in some place where professional computers could be found. And, from the beginning of my labors to the present time, I have been encouraged and aided by the sympathy and counsel of my revered friend Prof. Argelander.

The means available for procuring the necessary assistance were insufficient to permit the engagement of trained astronomers, and it was an especial disappointment that I

was unable to secure the companionship of any of my own former pupils or assistants, whose aid in such an enterprise would have been doubly valuable. But I did secure the aid of four very capable and well educated young men, recently graduated, three from Pennsylvania and one from New England. These gentlemen sailed for Buenos Aires direct, while I went by way of Europe, and we reached our destinations at about the same time.

It was the 25th August, 1870, when I arrived in Buenos Aires with my family, and from that day until that on which I left the same pleasant capital, just two months ago, our history is a record of private kindness and public generosity.

Thence we ascended the La Plata, threading an exquisite maze of beautiful and closely crowded islands, decked with the dark green foliage and glowing fruit of the orange; through narrow channels guarded by luxuriant willows, whose trailing branches swept our decks; amid jungles sheltering unnumbered alligators and countless tigers; and then, entering the vast delta of the Parana, moved up that stately river for about twenty hours: now desecring on its western bank the buildings of some large pastoral estate, and now touching at some one of the embryo cities which are, at no distant day, to become flourishing seaports and centers of an active commerce.

In the thriving town of Rosario, 250 miles above Buenos Aires, we found a hospitable welcome at the house of our distinguished countryman, Mr. Wheelwright, whose energy and enterprise had given to South America her first steamboat, first railroad, first telegraph, first waterworks, and first gas-illumination; and on the day following we traversed the pampa westward for yet another 250 miles, over the railway which he had just completed, and which had been inaugurated a few weeks before. For the second time within two years, we raced with the antelopes, and saw the prairie dogs and owls amicably seated at the

threshold of their common dwelling. Ostriches were running at speed across the boundless and level expanse: herds with thousands of cattle, and flocks with tens of thousands of sheep, roamed at will, ignorant of all restraint. The sparse settlements could be seen for a dozen or more miles away, their whitewashed walls and their few trees arresting the attention on the horizon of this terrestrial ocean, just as a distant sail fixes the gaze of a seaman. At intervals the ground was scarlet or white or purple with great patches of verbena or portulacca: the taller shrubs served as trellises for the passion-flower or the white bignonia: and many of our most favorite exotics studied the prairie with brilliant colors.

Sixteen hours brought us to the western limit of the pampa, and to the city of Cordoba, the goal of 10000 miles of journeying, where still another cordial welcome awaited us. Here the provincial, or as we call it the state, government empowered me to select for the observatory whatever site might appear to me most desirable, and I chose one upon the high pampa level, at the brink of the precipitous declivity bordering the valley in which the city lies, 120 feet below. The floor of the observatory is on a level with the crosses upon the high church-towers, three-quarters of a mile away.

Such portions of the building as could be constructed of wood or metal had been made at home, and forwarded by vessel, and it was my expectation that all the work of construction would be completed in three months, so that the observations could begin early in 1871. But the Cordobese workmen had enjoyed no Yankee apprenticeship, and it was not until July that the first dome was completed. We celebrated the Fourth by mounting the equatorial, — an instrument of American construction, the joint work of the optician Fitz and of our neighbor Alvan Clark. Meantime the instruments and books from Europe had suffered unprecedented delays. Some were on a

French ship, and some on German vessels, and all were blockaded for many months by the war, which had been declared a day or two before we sailed from Liverpool, and the first tidings of which were received after our arrival in Cordoba. The war over, the ship with the meridian circle was frozen up for the winter in the Elbe. When at last it reached Buenos Aires, the port was practically closed and the city laid waste by the yellow fever, and many more months elapsed before the quarantine was removed which closed the interior against the capital in conformity with the yet prevalent traditionary prejudices inherited from Spain, and which are so interwoven with all the popular ideas that more than one generation will probably pass before they disappear. Thus season after season passed away, and it was not till May, 1872, that the meridian-circle was mounted ready for use, nor until the 9th of September, 1872, that the regular observations were commenced for the celestial survey which I had planned seven years before.

But this long delay proved in the end not to have been a misfortune, irksome as it was. Within the first month it became evident that the construction of the building would demand a disproportionate amount of time and attention, and that although the large telescope might be employed to some extent, a long time must elapse before the work with the meridian-circle could begin. Although I little dreamed how great would be the delay, I determined to use this opportunity for the construction of a nomenclature, or catalogue of all the visible stars of the southern sky, with an exact determination of the brilliancy of each. The labor of these first eighteen months was certainly as assiduous and fruitful, and I believe it was as serviceable to science, as the later work. Thirty years before, Argelander had made such a nomenclature, giving the brightness of each star to the nearest third of a unit of magnitude. In Albany, in 1858, we had done the same

work, for a portion of the heavens, to tenths of a magnitude, while awaiting the mounting of the instruments. These observations, although stereotyped at the time, have never been published: but they had given me a good deal of experience, which now became very useful.

Thus the scientific labors of the first year went to the construction of star-lists and charts of the visible heavens, as they appeared on the clearest nights to the sharpest unassisted eyes, the magnitudes being estimated to tenths of a unit. No instruments were used other than common opera-glasses: but the purity of the air at Cordoba, and an elevation of about 1300 feet above the sea level, give a remarkable transparency to the atmosphere on favorable nights. My own near-sightedness precluded me from taking part in the actual observations, but I found more than enough to do in identifying those stars whose places had been determined by previous astronomers, in providing for our own future observation of those not to be found in the catalogues, in maintaining a uniform system of estimates by the four observers, and in the general management of the work. Every test in my power was brought to bear upon the accuracy of the work as it progressed, and each scrutiny served to confirm my confidence in the carefulness of all engaged in the observations. After the completion of this undertaking, the results were subjected to careful revision by repeating the whole process in a somewhat different form, assigning to each of the observers a region which in the first scrutiny had been given to some other one. The definite results are now available for publication, and the Argentine government has authorized me to make the necessary arrangements. The published work will consist of an atlas of the heavens, from ten degrees north of the equator to the south pole, showing every star to the seventh magnitude inclusive, and no others, and accompanied by the corresponding catalogues. As a matter of simple justice and propriety, I have given it the name of *Uranometria Argen-*

*tina.* The magnitude of each star has been determined on the average by more than four observations, and by as many as three different observers. At present, Mr. Thome, whom I have left in charge of the observatory, and who is the only one of the original corps now remaining in Cordoba, is engaged in a last systematic scrutiny of the finished work, to insure that no star is either omitted or wrongly placed. Much more than a quarter part of the actual observation has been done by him: and from his constant and assiduous devotion to the undertaking for nearly four years, I am sure that he now possesses a greater personal familiarity with the southern sky than any man ever attained before. Nor does this comparison in the least diminish the honor due to his late colleagues, to whom a large portion of the excellence of the work must justly be attributed. Of another assistant, not on the observatory's books, but without whose untiring and devoted aid my work could scarcely have been accomplished, I may not speak.

Less than two years ago, there was published by Professor Heis, a new uranometry of the northern sky, precisely on the same plan as Argelander's, of which it is in fact an enlargement, with the addition of fainter stars seen with his unassisted eye, which is of exceptional strength. My plan was somewhat different, and we availed ourselves of opera glasses to obtain more accurate estimates: and after I found that stars of the seventh magnitude are distinctly visible at Cordoba to eyes of average power, I fixed this magnitude as the limit for the uranometry. — a large number of fainter stars being excluded, although their magnitudes have been well determined. If we only consider stars as bright as the sixth magnitude, Heis found 3139 of these in the northern half of the sky, while we have only three-quarters as many in the southern half. Yet while he has in all 4909 northern stars, we have 7670 southern ones, so great is the difference between the transparency of the sky at Cordoba and at Münster. The number of



stars in the whole sky visible to the naked eye has usually been estimated at about 5500. Heis estimates that there are about 6800 of a brightness not inferior to the faintest which he can see. But I now find that if the sky was as transparent as that at Cordoba on a good night, even an average eye would probably discern not much less than 15000 in the full circuit of the heavens. The *Uranometria Argentina* contains 8522 stars, of which 7670 are situated in the southern heavens, and 852, or just one-tenth of the whole, are within the first ten degrees of north declination.

In connection with the uranometry, an opportunity presented itself to introduce, or rather to suggest to astronomers for their acceptance, a greatly needed reform in the arrangement and boundaries of the southern constellations, which have from the beginning been in a state of such confusion as to call forth continual complaints from those who have had to deal with them, and which are depicted alike in no two different maps or globes within my knowledge. I have now re-arranged the whole system in such a manner that the boundaries of the constellations shall be formed, so far as possible, by meridians and parallels of declination, and have found it practicable to arrange this with almost insignificant disturbance of the nomenclature of the principal stars. To this portion of the labor, also, I attach considerable value.

The meridian-circle possesses essentially the same optical power as the instruments employed by Bessel and Argelander, the object-glass having an aperture of  $4\frac{1}{2}$  Paris inches. But methods of observation have made considerable advance in twenty years: and this new instrument is supplied with various conveniences which the others did not possess. The principal difference of method, however, is in the employment of the chronographic method of observing transits, the instants of these being registered by telegraphic signals upon a cylinder revolving at

a uniform rate. The fundamental plan of all the zone-observations of which I have spoken, consists in restricting the vertical motion of the telescope to narrow limits previously assigned, and then determining the moment of transit and the declination of every star that traverses the field within these limits, which of course regulate the width of a strip or "zone" of the heavens, whose length is determined by the duration of the process. It is manifest that the width of the zone can be so chosen that only a small portion of the stars of sufficient magnitude can escape detection. Thus, beginning each zone where the adjacent one ends, the whole region in question is gradually explored.

The most essential point in which the plan of my undertaking differed from that of previous observers, is, that it was my aim to make the determinations absolute, instead of relative. The principle adopted more or less completely in former series has been, in fact, to observe an entire zone in such a way as to determine the differences of the several stars among themselves, and then, identifying those whose positions may be found in catalogues already existing, to calculate the places of the new stars from those of the others. Such had been my own original plan; but I soon became convinced that a sufficient number of star-places of the needful precision was not accessible, and that it was desirable to keep the work independent of any previous catalogue, by aiming at what is called an *absolute* determination of the stars observed,—that is to say, an entire independence of the work of all other astronomers, outside of the data in the astronomical almanacs. This implied a great increase of labor, since it would demand nearly an hour of additional observations, before and after every zone, for the sole purpose of ascertaining the needful corrections to the indications of the instrument and the clock, which vary appreciably from hour to hour. It likewise entailed much additional labor

in the computations; and it became necessary to prepare for our use in Cordoba the daily places of fundamental polar stars, which northern observers find calculated to their hands in the "Nautical Almanac." Still, it was manifestly desirable, and thus the work was arranged. Whenever possible, we observed, each night, three zones with their belongings, which consumed about eight hours,—often more. The zones averaged about a hundred minutes in length: more than this strained eye and nerves too much.

It is an exhausting process to lie for this length of time with the eye glued to the telescope; one hand signaling the instants of each star's transit over a group of delicate threads, and the other pointing the telescope by means of a long screw-handle; estimating at the same time the magnitude, and calling out the data to be recorded; the judgment being meanwhile kept in active exercise for deciding upon the best order in which to observe the various stars which are within view at once, and the telescope kept in motion over the whole width of the zone (which is many times wider than the field of view), in order that as few stars as possible shall pass unobserved. In many zones we thus observed more than 260 stars; in one there were 285, an average of one star to every twenty-one seconds. Nor is the labor much less for the assistant at the microscope. He must be on the alert to measure and record the reading of the graduated circle as soon as the telescope is pointed; must record the magnitude and groups for each star, as well as the approximate moment from the clock-face, to prevent danger of confusion when his record comes to be combined with that upon the chronograph. And, what is more, he must watch the various pieces of apparatus to see that nothing goes amiss; for chronographs will run down, pen-points will clog and cease to mark, and telegraphic connections will sometimes give out; and, when they do, it is always at some critical

moment. The quickness and dexterity which the assistants acquired was a source of astonishment and delight to me: and, should our results prove to be what I hope and believe they will, there is no one of the five gentlemen who have at different times taken part in this labor, who may not feel a just pride, not only in the conscientious fidelity with which he performed his part, but also in the skill which he attained in most difficult operations.

A full night's work consisted of three zones, with four series of observations for instrumental corrections. All the zones, and the last series of determining stars, I observed myself: and, until the last few months, the first series also. Between the zones I gave rest to my eyes. The remainder of the work was distributed, as well as might be, among three assistants, in such a way that each should be able to rest his eyes for about an hour and a half on the nights of greatest labor, and also have each third night free. But there was a period of six or eight weeks when our force was temporarily reduced, so that the aid of Messrs. Thome and Bachmann was needed every night. I need not add that just at this time we had a spell of exceptionally clear weather, with only two cloudy nights in a whole month. But there was not the shadow of a complaint, nor was labor ever more cheerfully or cordially performed than this, which I should hardly have been justified in asking, but was contributed with the readiest good will.

The climate of Cordoba did not correspond with my expectations. Knowing that it was rainless during half the year, and remembering the astonishing continuance of favorable weather which Gilliss had enjoyed in Santiago, I had counted upon an abundance of unclouded sky. But to my sorrow it soon became evident that absence of rain by no means implies absence of clouds; and judging from my memory, I should not estimate the number of good nights in Cordoba as much greater than in Boston: although, to be sure, we should there scarcely be favored with our

present experience of a four days' northeaster at midsummer. The sky has provoking tricks of suddenly clouding over just at nightfall, after a magnificent day, or covering itself in a few minutes with a thick veil of mist without previous warning. Thus the rapidity with which the survey progressed has been by no means proportional to the labor expended. Still the conclusion of the first year of the observations in September last showed the gratifying number of 429 zones, containing more than 56 000 observations, and, so far as I could judge, about two-thirds of the region to be explored were disposed of. And it was manifest that, with no better fortune in the weather than in the year past, all the remaining work could be accomplished, and all the unsatisfactory zones repeated in less than a year more. I have not mentioned that the width of the region to be explored had been increased by one-half from my original plan. Instead of taking  $29^{\circ}$  as the northern limit, and thus lapping two degrees upon Argelauder's work, I had, at the earnest instance of Argelauder himself, commenced at  $23^{\circ}$ , thus overlapping his zones by eight degrees, and beginning at a point  $16^{\circ}$  above the horizon of Bonn; and instead of going only to Gilliss's northern limit at the southern polar circle, the Cordoba zones extend to within  $10^{\circ}$  of the pole itself, thus covering a belt fifty-seven degrees wide, or about one-third of the whole heavens as measured from pole to pole. On the 13th of April, when my last observation was made, the number of zones observed had reached 619, and the number of star-places was nearly 83 000. These were, furthermore, in the full tide of preparation for the press: five persons being engaged in transcribing and preparing them for computation.

Although the object of labor is not to conquer difficulties, — this part of the process being only a means and not an end, and the only proper motive being to secure results, — it is pardonable to look back upon the obstacles and impediments, and I can truly say that these have been neither

few nor small, nor indeed conquerable, except with the aid of such faithful and able co-workers as I have been favored with. I will not weary you with the tale of all the mishaps, large and small, — instruments disturbed, apparatus giving out, tornadoes, dust-storms, and the like; of insects in one's nose and eyes and mouth, when the hands could not be used to fight them nor the head moved from the telescope, — but there is one inhabitant of the pampas whose memory can never fade. This is the *vinchuca*, an elder brother of that unnameable insect whom Birdofredum Sawin found running away with his colonel in Mexico; but it is a dozen times longer and broader and thicker, and far more savage. And it has wings. By night this insect comes flying in from all the open country round, and it seems to have a special predilection for astronomers. But for them the observation of the summer zones would have been easier.

The plan of the zones was based, as I have said, upon the fundamental idea that the determinations should be absolute in their character: still it is by no means certain that one observes under the high nervous tension inseparable from such work, in the same manner in which he would make a leisurely measurement of the position of an isolated star. It has therefore seemed desirable that the positions of not less than six or seven stars in each zone should be determined with all possible accuracy, and by means of repeated observations. With this view I prepared a list of a few thousand stars, whose places were to be measured on not less than four nights, as opportunity should offer: and the intervals between the transits of the fundamental stars, as well as those nights or parts of nights on which flying clouds or mists preclude the zone-work, although the heavens are partially clear, have been devoted to this class of observations. Already a very considerable amount of material of this sort has been collected and computed, and this work is now going on in my absence.

Among my most cherished hopes, when leaving home, was that of supplementing in the southern hemisphere the remarkable and important results obtained here by our gifted countryman, Mr. Rutherford, whose ingenious methods and surpassing skill had enabled him, and him alone, to obtain photographic impressions of star-clusters with a sharpness permitting delicate measurements,—as well as to execute these measurements with such an accuracy as to yield results rivaling, if indeed not surpassing, those afforded by direct observation with the most elaborate and costly instruments, and with a hundredfold greater expenditure of time. It had been my privilege to subject these measurements for the first time to those numerical computations, by which the stellar positions are reduced to the corresponding astronomical form of right-ascensions and declinations, and thus, through the kindness of the valued friend to whom both the new method and its sole results were due, to connect my name in a slight degree with this great step, by determining the relative positions of the principal stars in the Pleiades and the Præsepe from his measures of the photographic plates.

Just before my departure, Mr. Rutherford had supplied himself with a yet larger telescope, adapted to the same purpose; and I improved this fortunate opportunity of securing the identical photographic object-glass which he had employed in all his previous investigations. And when I left home, it was not without some ground for hoping that a sufficient sum would soon be contributed from private sources to enable me to carry out the plan of securing photographic impressions of the chief southern star-clusters without appealing to the Observatory or to any other institution. The telescope is adapted for either photographic or optical use, since the two object-glasses are easily interchangeable, and a camera can readily be substituted for the astronomical eyepiece. Immediately on arriving in Buenos Aires, I explained these plans to the

President and Minister, and received their cordial promise of all needful aid,—promises which, like all others from the same source, were more than fulfilled. Inasmuch as the direct observations proposed would clearly demand all my available time and strength, I naturally desired to secure the photographic impressions from my private resources; not only because all of the Observatory's funds would be required for the regular work, but also that I might be justified in reserving the photographs for measurement and study at my subsequent leisure, and might remove them from the country without impropriety, should I desire. Consequently, I addressed to the government a formal application for leave to use the large telescope for this purpose, at such times as might not interfere with the regular work of the Observatory, and this permission was at once accorded with great cordiality, and a full understanding of the case.

The endeavor to secure the requisite funds by private subscription met with the same fate as the similar one in 1865, in behalf of the expedition then proposed. Promises were secured for a portion of the necessary means, but the difficulty of obtaining the full sum was found too serious to warrant a continuance of the efforts, and the plan was therefore abandoned. But this disappointment was alleviated by an unexpected and delightful encouragement. My parents, by blood and marriage, gave a practical support and token of sympathy by authorizing me to draw on them for the means of carrying out my fondly cherished plan. And although I was fortunately able to go forward without availing myself of this generous permission, it was of essential service in the justification it afforded me in undertaking this work, upon which I might not otherwise have ventured.

That this undertaking has thus far been less successful than the rest of the work, many of you know: and I will not dwell upon the various troubles, mortifications, and



disappointments which have attended my struggles in this direction. A photographer was engaged in New York by the friendly efforts of Mr. Rutherford, who caused him to be instructed in his observatory, and sent him out to me, with all the needful apparatus and chemicals. But when, after his arrival in Cordoba, I unpacked the photographic object-glass, the flint lens was found broken in two, and all efforts to restore it to full usefulness proved fruitless. Nevertheless, a contrivance was carried into effect by a skillful Swiss watchmaker in Cordoba, by means of which each of the broken pieces was supported by three pairs of adjusting screws, thus permitting it to be brought into position with sufficient nicety to yield results which, if not perfect, will be at least very serviceable. Meanwhile, I resolved to avail myself of the opportunities at my disposal for procuring a new object-glass like the former, and sent the order to Mr. Fitz. But here too the Argentine government was ready with its support, and not only volunteered to assume the cost of the new lens, but expressed its desire to provide the services of the photographer. This new lens arrived in Cordoba many months ago, and although the person originally engaged accomplished but little, and proved in the end unworthy, my plan is by no means abandoned. The experience and knowledge already acquired cannot fail to render essential service in the new attempt, and the results of the Uranometry and the Zone-observations have enabled me to complete and correct the list of southern clusters well adapted for photographic determination. Meanwhile, the stellar photographs already secured, although by no means what I had hoped, and very disproportionate in number to the expense and sacrifices which they entailed, certainly possess a high scientific value. Repeated observations of the principal stars of each group have been made with the meridian-circle, for the purposes of fixing the scale of measurement, and of controlling the reductions: and I entertain the confident hope

that the relative positions of more than a dozen important southern clusters have thus been secured in a form which is both very accurate, and as valuable for future generations as for the present.

I have spoken of the liberality of the Argentine government. In both its executive and legislative departments there are continual illustrations of the strong desire of the cultivated men of the nation to foster the intellectual development and the scientific reputation of the country by every means in their power. I have mentioned the readiness of the government to aid an astronomical expedition at the very time when all the nation's energies and resources were taxed to the utmost by the struggle with the Paraguayan despot, Lopez, one of the most sanguinary and ruthless tyrants in all history. At the time of my arrival in Buenos Aires this monster had been overthrown by the allied forces of Brazil and La Plata, but internal rebellion, probably in part a consequence of that struggle, still remained, and pressed heavily upon the almost exhausted nation. Still there was not only ready support for the Observatory, but additional provision was made for its maintenance. Thus it has been from the beginning to the present time, and the fact of such readiness in a young nation to bear its part in scientific investigation speaks for itself. Another illustration is afforded by the recently established Meteorological Office.

The climatic relations of the vast territory of the Argentine nation were a sealed book. Throughout the immense tract from the tropic to the Straits of Magellan, and from the Atlantic to the Andes, the meteorological characteristics of the country were almost unknown. Only two or three small series of partial observations had ever been published, and these were not easily accessible. And although my powers were already taxed to their utmost by the astronomical work, it seemed to me that it would be disloyal alike to science and to the country to which I owe

so much gratitude and affection, did I not make some effort to remedy this defect. In public communications and private conferences I called the attention of the government to the need of such a national meteorological office, and offered such aid as I could give. The Meteorological Office was thereupon established without opposition: funds being voted for the salary of a secretary, and for the purchase of instruments, to be distributed to such competent persons as might be willing to undertake systematic observations. This is the second year, and means have now been provided for computing and publishing the observations received, and for purchasing yet more instruments. There seem to be persons enough who are able and willing to undertake the necessary labor, troublesome as it is, and with no other stimulus than their desire to serve science and their country. In three cases I have found gentlemen who have carried on observations of the sort during past years, unaided and unencouraged. These have cordially offered all their data, gratified at seeing their labors appreciated at last, and their results put in the way of rendering service to science and the country. The transportation of delicate instruments in the interior is extremely difficult and hazardous. Outside the province of Buenos Aires few railroads are yet completed, and notwithstanding the recent efforts of the government, there are as yet few roads over which a vehicle can safely pass for any considerable distance. But I am gradually succeeding in conveying mercurial barometers, thermometers of various sorts, rain-gauges, vanes, anemometers, &c., into remote regions, and the monthly reports have already begun to flow in from various quarters. The principal objects at first must be to interest and instruct observers, to provide them with facilities, and to collect and reduce all possible data, old and new, and subject them to careful study. Thus far I feel well satisfied with the interest already awakened, and I think that this young nation, so long struggling with

foreign enemies and internal dissensions, has reason to be proud of the number, relatively large, even though intrinsically small, who are ready to work for her welfare and honor, without hope of personal glory or emolument. A few years will afford material for a knowledge of the climatic relations of various points; I shall then hope for simultaneous observations in numerous places, and who knows but the Argentine Republic may yet have an "Old Probabilities" of her own?

I cannot close this cursory but, I fear, tedious sketch of the results of my undertaking, without referring again to the extreme friendliness and kindness of the people. Not to dwell too much upon personal matters, let me say, once for all, that from no Argentine, high or low, have we had other experience than cordial hospitality, fraternal kindness, or respectful consideration. A heartier welcome, a sincerer sympathy in weal or woe, we could hardly have expected in our own country. I am the more anxious to mention this, since I have seen paragraphs circulating in the public press to the effect that some of our instruments have been maliciously broken. If we should say "wantonly," the statement would be true to some extent; yet not because the apparatus was ours, but because its necessary exposure presents a tempting lure for some half-civilized gaucho, fortified with a full complement of alcohol, to try the acenracy of his aim. All races have their weak points, and our apparatus has fared far better than the new street-lanterns of Cordoba; nor would it be fair to expect from the unbreeched and untutored sons of the pampas, what I am assured could not be reasonably expected from the youth of Kentucky or Tennessee.

The fact that the thoughtful men and leaders of opinion in the Argentine Republic are awake to the educational and social needs of the people, furnishes in itself a guarantee that these needs will continue to be supplied. All the tendencies are toward progress. The vast territory of the

nation possesses a population scarcely greater than that of Massachusetts, and three-fourths of this is a mixed progeny of the African negro, the South American Indian, and the Spanish peasant, in which it is difficult to say which element predominates. To a surpassing agility and dexterity in the arts of savage life they join all that sleepy indifference to improvement which the southern sun seems to engender in the lower classes. With not the slightest lack of what is called religion, they have a melancholy want of morality, and discriminate broadly between the two, which indeed they consider to have little to do with each other. Reading and writing are a rare accomplishment among this class, and not even pecuniary stimulus to labor is of much avail. Outside the cities, such elegances as pantaloons are rare, and various accessories which we consider absolute necessities of civilized life are unknown. Yet in constant intercourse with these people are others, their own countrymen, refined, accustomed to opulence, and desirous of contributing to the advancement of their native land. From this class come the legislators; and happy is that land whose lawgivers are taken from among the best educated and most patriotic! All the national energies not requisite for self-defence or self-preservation are now given to the development of the resources of the country, physical and moral. Our four years' observation has exhibited one continuous series of essential improvements. Railroads and telegraphs are springing into being with marvelous rapidity, spanning the before limitless pampas, and traversing the Andes. Roads, bridges, schools, and colleges have been almost doubled within my own experience. Mails are crossing the almost trackless prairies, steamboats are exploring the unnavigated rivers. And, more than all, these advances are not the mere policy of a single administration, enlightened as this policy has been: but they represent the spirit and determination of the ruling classes, which the result of no election can restrict, but in manifes-

tations of which all parties vie. An impulse has been given to trade, new comforts have been introduced, and the habits and usages are growing more similar to those of other countries. In Cordoba, which the residents of other parts of the country love to ridicule as the special abode of bigotry and priestcraft, we have never suffered the smallest discourtesy for our difference of creed, but a frank and cordial treatment from clergy and laity alike. Buenos Aires, like New York, is a cosmopolitan rather than a national city, and can just as little be said to represent the country of which it is the principal seaport. There we find the luxury, the vice, and the strange contrasts which a great capital always presents; but there, too, we find as earnest and enlightened a patriotism as any country can boast or desire. Both cities will be for ever endeared to us by the memory of successful labors, of continual kindness, of cordial aid, and, lastly, of the most tender sympathy.

At the conclusion of Dr. Gould's address, Dr. Geo. B. Emerson rose, and after a few remarks moved that

“The cordial thanks of the audience be given to Dr. Gould for his most interesting address, and for the honor he had conferred upon the country by his labors.”

To which ex-Governor Emory Washburn moved to add

“And a hearty welcome to his home and friends.”

The motion was unanimously adopted amid applause.













