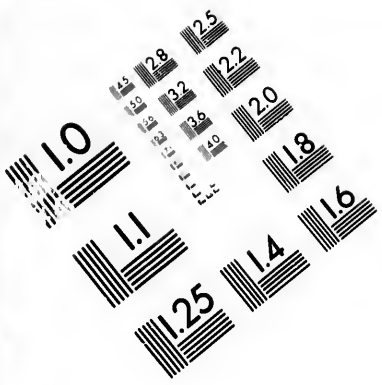

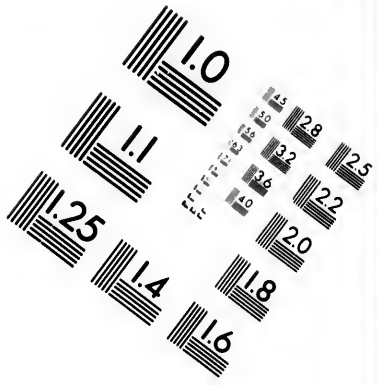

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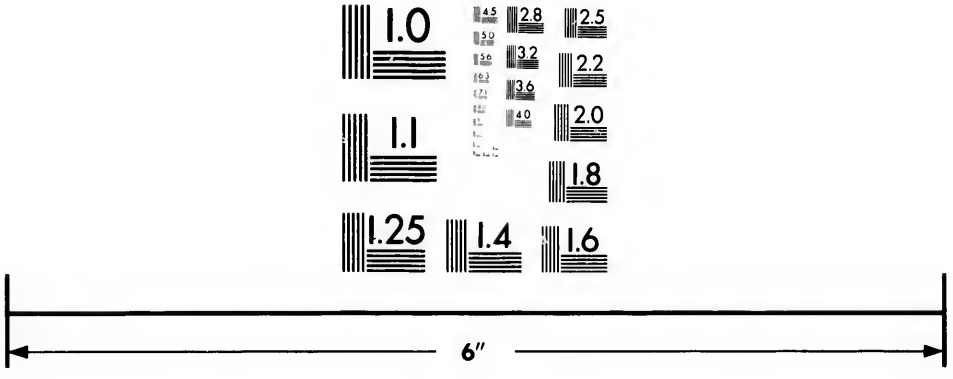

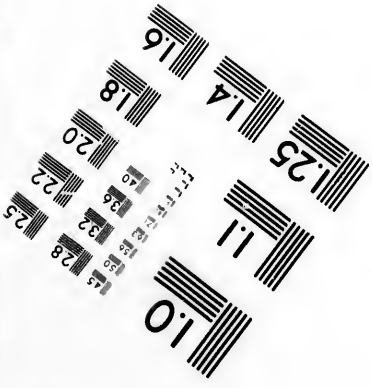

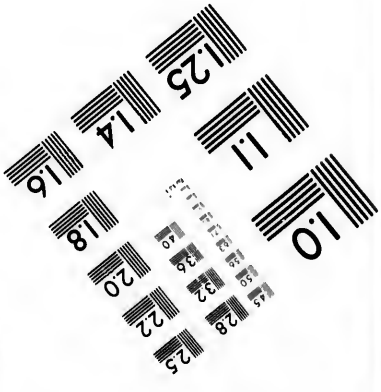

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HISTORY AND CAUSES

OF THE

INCORRECT LATITUDES

AS RECORDED IN THE

JOURNALS OF THE EARLY WRITERS, NAVIGATORS AND EXPLORERS

RELATING TO THE ATLANTIC COAST OF NORTH AMERICA.

1535—1740.

BY THE REV. EDMUND F. SLAFTER, A.M.,

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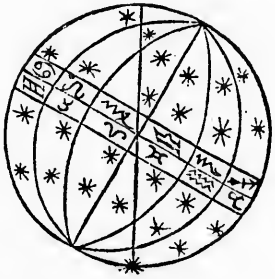
MEMBER OF THE MASSACHUSETTS HISTORICAL SOCIETY; HONORARY MEMBER
OF THE ROYAL HISTORICAL SOCIETY OF GREAT BRITAIN, ETC. ETC.



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THE progress of geography, as a science, has been dependent, in all its stages, upon that of astronomy. The latter, the purest and most exact of all the sciences, advanced at first but slowly, and was many weary centuries in coming to its present state of perfection. Climates, their peculiar products both in the animal and vegetable kingdoms, the shadows cast by objects in the sun noted at different hours of the day and at different seasons of the year, the length of the longest and the length of the shortest days, their advance, culmination and recession, were the chief elements at first for determining the relations of the earth to the heavenly bodies. About six hundred years before the coming of Christ, Thales described the earth by dividing it into zones. Parallels of latitude were introduced by Eratosthenes, but the graduation into degrees of latitude and fractions of a degree was invented by Hipparchus, a century and a half before the Christian era. The principles, on which these lines or divisions were determined, were thus understood at an early period, but practical difficulties were encountered which it was not easy to overcome. Extraordinary errors in that rude stage of the science were introduced, and sometimes perpetuated for many cen-

turies. An error of more than two degrees in the latitude of Constantinople, the ancient Byzantium, crept into the geography of Ptolemy, composed about a hundred and fifty years after Christ, and remained uncorrected for more than fourteen centuries. In 1594 the latitude of London was found to be fifteen minutes less than it had been computed to be and laid down on the maps; and the city was consequently fifteen geographical miles further south on the terrestrial globe than had hitherto been supposed. Anterior to 1664, the most distinguished astronomers differed as to the latitude of Paris, the widest variation being not less than sixteen minutes. In the reign of Louis XIV. the map of France was revised under the direction of the government, and was so much abridged at many points, that the king facetiously upbraided the royal surveyors for depriving him of an important part of his kingdom.

While the discovery and correction of such errors as these in the East, on the continent of Europe, and in Great Britain, were going forward, the voyagers, explorers, and the chroniclers of our early history, were placing upon record the latitude, according to their best means of ascertaining it, at numberless points, from the Grand Banks, the capes and bays of Newfoundland, the Gulf of St. Lawrence, the borders of Nova Scotia and New Brunswick, the Bay of Fundy, the coast of New England, and along the Atlantic shores stretching down to the inlets and estuaries of our Southern States. To the student of our earliest history it is a question of great interest, and likewise of some importance, to know whether these records are trustworthy, whether they can be implicitly relied upon, or, on the other hand, whether they are erroneous, and, if they are erroneous, to what extent. Fortunately we have to-day the means at our command of determining this question with absolute precision. Until within the last few years, certainly until within the memory of the present generation, it has been impossible for any scholar of our early

history to test the accuracy of these recorded latitudes. But this difficulty no longer exists.[1] Charts emanating from the office of the United States Coast Survey at Washington, and from the Admiralty Office in England, have been constructed after the most careful and scientific surveys, made by authority of government, under favorable circumstances and by the most skilful and experienced engineers. By collating the early recorded latitudes with these charts, or others carefully copied from them, it will not be difficult to determine with exactness where and to what degree errors exist.

We propose therefore to exhibit on the following pages a collation of these latitudes with the modern charts just referred to, in cases sufficiently numerous, taken at different points and at different times, and by different hydrographers and surveyors, to show not only whether errors exist, but if so, whether they are uniform or vary by any fixed and determinate laws.

We proceed therefore to give, in the following references, first, the name of the place whose latitudes we have collated; second, the early latitude with its source; third, the true latitude and the authority on which it rests; and, lastly, the amount of the error, if any be found.

Anticosti, a large island in the Gulf of St. Lawrence, north-west end, Lat. 50°, as given by *John Alphonse*, 1542, Hakluyt's Voyages, Vol. iii. p. 292. True Latitude 49° 53′, according to the *Admiralty Charts*, *Captain H. W. Bayfield* of the Royal Navy. Error, 7 *minutes*.

Advocate's Harbor, Bay of Fundy, Lat. 45° 40′, *Champlain's Voyages*, 1613, Otis's Trans. Prince Society ed., Vol. ii.

[1] Instruments and methods are at the present time so perfect, that, if one skilled in the science were blindfolded and carried to any point on the globe, he would be able, in the space of a few hours, to determine his position within a hundred yards.

p. 25. True Latitude 45° 20′, *Admiralty Charts*, *Captain P. F. Shortland*, Royal Navy. Error, 20 *minutes*.

Bangor, Maine, Lat. 45° 25′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 46. True Latitude 44° 45′, *Charts of United States Coast Survey*. Error, 40 *minutes*.

Boston, Mass., Lat. 42° 10′, *John Dunton's Letters*, 1686, Prince Soc. ed., p. 66. Lat. 42° 30′, *John Josselyn's New Eng. Rarities*, 1672, Tuckerman's ed., p. 33. Lat. 42° 30′, "Almanack of cœlestial motions for the Year of the Christian Epocha, 1681, by *John Foster*, Astrophile. Calculated for the Meridian of Boston in New-England, where the Arctick Pole is elevated 42 Degrees & 30 Minutes."[2] True Latitude 42° 21′, *Charts of United States Coast Survey*. Error for the first, 11 *minutes;* for the second and third, 9 *minutes*.

Brant Point, Marshfield, Mass., Lat. 42° 45′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 76. True Latitude 42° 5′, *Charts of United States Coast Survey*. Error, 40 *minutes*.

Bryon Island, entrance to Gulf of St. Lawrence, Lat. 47° 30′, *Jacques Cartier*, 1535, Brief Recit, D'Avezac, ed., p. 45, *verso*.

[2] In the last part of Foster's Almanac for 1681, the following note is introduced: "The Reader is desired to take notice that our Latitude here in *Boston*, hitherto reputed to be 42 *gr*. 30 *min*. is by better Observations found not to exceed 42 *gr*. 24 *m*. of which you may expect the certainty by the next opportunity." Mr. Foster was a graduate of Harvard College in the class of 1667, a famous school-master of Dorchester, and the first printer in Boston. He was styled an "Ingenious Mathematician and Printer." *Vide Sibley's Harvard Graduates*, vol. ii. p. 224. Mr. Foster died in 1682, and his Almanac for that year, which he left incomplete, did not give the latitude of Boston: The same latitude, 42° 30′, continued to be given in the Almanacs until 1685, when it was stated to be 42° 21′. After the year 1686, however, it fell back to 42° 30′. But in 1690, in Harvard's Ephemeris or Almanac by H. Newman, the latitude of Cambridge, where it was published, is given as 42° 27′. But the same year, in the Almanac of John Tully, the latitude of Boston is still given as 42° 30′, and so continued till 1701. Mr. Tulley died in 1702. In 1707, Nathaniel Whittemore's Almanac makes the latitude 42° 25′. In 1710 Thomas Robie's Ephemeris gives the latitude of Boston 42° 24′. In 1727 Nathaniel Ames's Almanac has the latitude 42° 25′, and continues to give the same for many subsequent years. In Thomas Salmon's Geographical Grammar, published in 1785, the latitude of Boston is given as 42° 25′.

True Latitude 47° 48′, *Admiralty Charts*, *Capt. Bayfield.* Error, 18 *minutes.*

Cap de La Heve, Nova Scotia, Lat. 44° 5′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 10. True Latitude 44° 11′, *Charts of Hydrographic Office*, United States. Error, 6 *minutes.*

Cap des Monts nostre Dame, Gulf of St. Lawrence, Lat. 49°, *John Alphonse*, 1542, Hakluyt, Vol. iii. p. 292. True Latitude 49° 18′, *Admiralty Charts*, *Captain Bayfield.* Error, 18 *minutes.*

De Mont's Island, St. Croix River, Maine, Lat. 45° 20′, *Champlain's Voyages*, 1613, Prince Soc. ed., pp. 33, 34. True Latitude 45° 7′, *Admiralty Charts*, *Capt. Shortland.* Error, 13 *minutes.*

Elizabeth's Island, Cuttyhunk in Vineyard Sound, Mass., Lat. 41° 10′, *Gabriel Archer*, 1602, Purchas Pilgrims, Vol. iv. p. 1649. *Bartholomew Gosnold's Letter to his father*, Sept. 7, 1602, Lat. 41° 20′, idem, p. 1646. True Latitude 41° 25′. Error, first, 15 *minutes.* Error, second, 5 *minutes.*

Gloucester Harbor, Mass., Lat. 43°, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 115. True Latitude 42° 36′, *Charts of United States Coast Survey.* Error, 24 *minutes.*

Irondiquois Bay, *Karontagouat*, in Lake Ontario, east of the Genesee River, N. Y., Lat. 43° 12′, *Relation de L'Abbe de Gallinée*,[3] 1669, Decouvertes des Français de L'Amérique Septentrionale, par *Pierre Margry*, p. 126. True Latitude 43° 14′, *Charts of United States Survey of Northern Lakes.* Error, 2 *minutes.*

[3] Gallinée says he took the latitude *avec le baston de Jacob.* Jacob's Staff was one of the names given to the Cross-staff. Perhaps the good Father chose this rather than the more usual appellation out of respect to the Patriarch. It was sometimes rendered in Latin, *Radius astronomicus*, and in the French, *Ray nautique.* The close approximation to the true latitude in this instance was doubtless a mere accident, as will appear in the sequel.

Isle of Hares, River St. Lawrence, Lat. 48° 3′, *John Alphonse*, Roberval's Expedition, 1542, Hakluyt, Vol. iii. p. 293. True Latitude 47° 54′, *Admiralty Charts, Capt. Bayfield.* Error, 9 *minutes.*

Isle des Coudres, River St. Lawrence, Lat. 47° 45′, *John Alphonse*, in Roberval's Expedition, 1542, Hakluyt, Vol. iii. p. 293. True Latitude 47° 26′, *Admiralty Charts, Capt. Bayfield.* Error, 19 *minutes.*

Isle of Orleans, River St. Lawrence, north-eastern end, Lat. 47° 20′, *John Alphonse*, in Roberval's Expedition, 1542, Hakluyt, Vol. iii. p. 293. True Latitude 47° 2′, *Admiralty Charts, Capt. Bayfield.* Error, 18 *minutes.*

Isle of Monhegan, coast of Maine, Lat. 43° 30′, *Capt. John Smith*, Description of New England, 1616, Veazie's ed., p. 19. True Latitude 43° 46′, *Charts of United States Coast Survey.* Error, 16 *minutes.*

Kennebec, mouth of the River, coast of Maine, Lat. 43° 40′, *Pierre Biard*, Relation des Jésuites, 1616, Quebec ed., p. 36. True Latitude 43° 44′, *Charts of United States Coast Survey.* Error, 4 *minutes.*

Mount Desert, Bar Harbor, Maine, Lat. 44° 30′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 39. True Latitude 44° 23′, *Charts of United States Coast Survey.* Error, 7 *minutes.*

Nauset Harbor, Eastham, Mass., Lat. 42°, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 81. True Latitude 41° 49′, *Charts of United States Coast Survey.* Error, 11 *minutes.*

Plymouth, Mass., Lat. 41° 37′, *Josselyn's Voyages*, 1675, Veazie's ed., p. 122. True Latitude 41° 59′, *Charts of United States Coast Survey.* Error, 22 *minutes.*

Quebec, Canada, Lat. 46° 30′, *Le Grand Voyage dv Pays des Hvrons*, Gabriel Sagard, 1632, p. 57. True Latitude 46° 49′, *Admiralty Charts, Capt. Bayfield.* Error, 19 *minutes.*

Rossignol, Liverpool, Nova Scotia, Lat. 44° 5′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 10. True Latitude 44° 3′, *Charts of Hydrographic Office*, United States. Error, 2 *minutes*.

Richmond's Island, Maine, Lat. 43° 34′, *Josselyn's Voyages*, 1675, Veazie's ed., p. 154. True Latitude 43° 32′, *Charts of United States Coast Survey*. Error, 2 *minutes*.

Salem, Mass., Lat. 42° 35′, *Josselyn's Voyages*, 1675, Veazie's ed., p. 129. True Latitude 42° 31′, *Charts of United States Coast Survey*. Error, 4 *minutes*.

Saguenay, entrance of River, Gulf of St. Lawrence, Lat. 48° 20′, *John Alphonse*, in Roberval's Expedition, 1542, Hakluyt, Vol. iii. p. 293. True Latitude 48° 7′, *Admiralty Charts, Capt. Bayfield*. Error, 13 *minutes*.

Saint John, New Brunswick, Lat. 45° 40′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 30. True Latitude 45° 16′, *Admiralty Charts, Capt. Shortland*. Error, 24 *minutes*.

Saco River, Maine, Lat. 43° 45′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 67. True Latitude 43° 28′, *Charts of United States Coast Survey*. Error, 17 *minutes*.

Seguin Island, coast of Maine, Lat. 44°, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 60. True Latitude 43° 42′, *Charts of the United States Coast Survey*. Error, 18 *minutes*.

Stage Harbor, Chatham, Mass., Lat. 41° 20′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 130. True Latitude 41° 40′, *Charts of United States Coast Survey*. Error, 20 *minutes*.

Strait of Canseau, Nova Scotia, Lat. 45° 45′, *Champlain's Voyages*, 1613, Prince Soc. ed., Vol. ii. p. 155. True Latitude 45° 21′, *Charts of English Hydrographic Office republished by United States*. Error, 24 *minutes*.

Seven Isles, Gulf of St. Lawrence, Lat. 50° 30′, *John Alphonse*, 1642, Roberval's Expedition, Hakluyt, Vol. iii. p. 292. True Latitude, most northerly point, 50° 11′, *Admiralty Charts, Capt. Bayfield.* Error, 19 *minutes.*

Trinity Harbor, Newfoundland, Lat. 49°, *Richard Whitbovrne's Voyages*, in Purchas Pilgrims, 1625, Vol. iv. p. 1884. True Latitude 48° 22′, *Wilson's Charts of the Coast of North America*, London, 1880. Error, 38 *minutes.*

Wiers, New Hampshire, Lat. 43° 40′ 12″, *Survey made under the direction of a Committee appointed by the General Court of Massachusetts*, 1652. Vide New England Historical and Genealogical Register, Vol. i. p. 312. True Latitude 43° 36′, *Survey by Prof. E. T. Quimby.*[4] Error, 4 *minutes.*

In the collation of the latitudes given above, it will be observed that variations have been found in every case examined, and that they follow no uniform rule. The early latitudes sometimes exceed and sometimes fall short of the true latitudes. The average variation as tested by these collations is over fifteen minutes, the smallest being two and the largest forty. The cases here reported have been investigated without reference to any probable error, whether large or small, and we are sure that a wider collation would reveal the same inexactness.

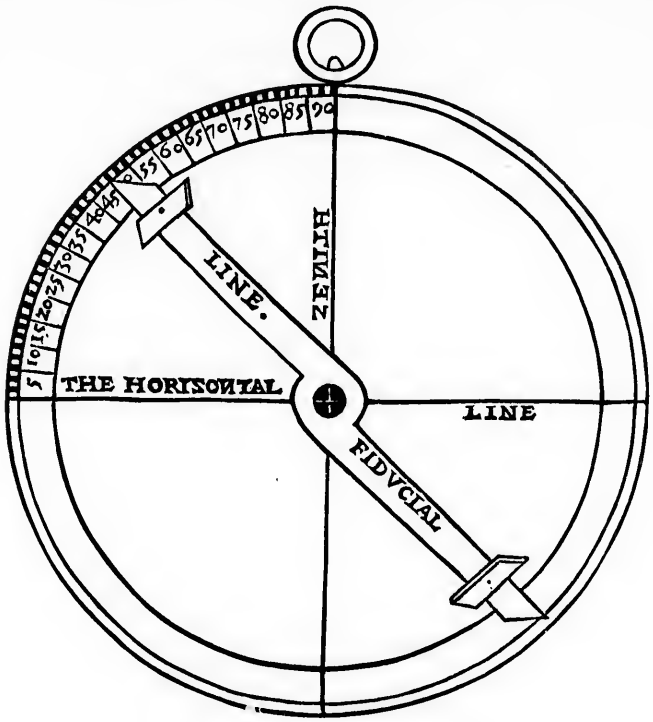
It is obvious, if a cartographer of two hundred years ago, residing in London, or Paris, or Berlin, had proposed to himself to construct a map of our Atlantic coast, and to fix the situation of our principal towns according to the latitudes given by the best au-

[4] The latitude of the Wiers not having been determined by the United States Coast and Geodetic Survey, we are happy to give the latitude on so good authority as that of Professor Quimby, whose name alone would be sufficient, even if he were not at this time connected with the U. S. Coast and Geodetic Survey. He had taken the latitude of a point not far from the Wiers, and by a close estimation he adds, "I do not think it can differ one minute," which is of course sufficiently near for our present purpose. *Ms. letter of Prof. Quimby*, Dec. 28, 1881.

thorities then existing, his work would have presented many extraordinary and surprising features. Our ancient Plymouth would no longer rejoice as the *magnum oppidulum* in Cape Cod Bay, but would have been fixed on the heights of South Boston, and the little Pilgrim colony would have been surprised and perhaps annoyed to find itself in such close proximity to its Puritan neighbor. Gloucester Harbor would no longer have been the jewel and ornament of Cape Anne, but would have exchanged its cool breezes of July and August for the softer and less invigorating atmosphere of Cohasset. Salem would have lost its excellent harbor, and have built its stately mansions on the serrated and picturesque shores of Beverly Farms. Bangor would have retreated to the north at least forty-five miles, and have spread out its lumber yards on the flats of Mattawamkeag. St. John, New Brunswick, would have abandoned its splendid harbor, and have nestled under the frowning cliffs of Campobello, on the chilly little island now occupied by Eastport. Boston, following one authority, would have floated down the bay and moored itself at Scituate Harbor, while by another authority, it would have gone to the north and have made a lodgement on the rocky peninsula of Marblehead.

In the face of such excessive inaccuracies the inquiry naturally arises as to the origin of the errors. They were clearly not accidental. The general principles on which latitudes were determined, if we except some minor disturbing causes, were as well understood at that time as at the present moment. But the instruments employed were inadequate to their purpose, and have long since gone into disuse. In these we shall probably find the chief source of most of the variations. A brief description of the processes necessary for taking latitudes will elucidate the cause of the errors, and at the same time will not be an unimportant, and, perhaps, not an uninteresting page, in our early history.

The first step in taking latitudes was to determine the meridian altitude of the sun.[5] The instrument generally used for this purpose, down to nearly the middle of the eighteenth century, was the Mariner's Astrolabe, but another instrument was sometimes em-



Mariner's Astrolabe.

ployed, of which we shall presently speak. The astrolabe consisted of a disk, or circular plate of brass or bronze, from five to seven inches in diameter. It was divided into quarters, and the upper

[5] Observations were sometimes made for this purpose upon well known stars, which were practicable, if the observer had likewise a table of their declination, but in practice this resort was at that period exceptionable.

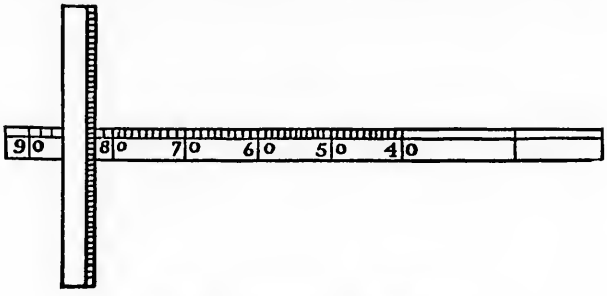
quarter on the left was subdivided into ninety spaces representing degrees, which were duly numbered, as may be seen in the engraved illustration which we here give.[6] Attached to the face of the disk was a moveable index or diopter turning on a pivot in the centre. On each end of the diopter was affixed a small plate, or pinule, piereed with holes or notched with narrow slits to serve as sights. A handle consisting of a simple ring or hinge was attached at the zenith point, by which it was conveniently suspended for use.

In taking the altitude of the sun, the operator, holding the astrolabe in his hand, suspended it so that it should hang plumb or perpendicularly to the horizon. He then directed the index or diopter to the middle of the sun at noon, or to one edge of it allowing for the distance to its centre, so that the same ray of light might shine through the two sights on the pinules of the diopter at the same time. The diopter would then point to the degree of the sun's meridian altitude indicated on the outer rim of the astrolabe.

The other instrument to which we have referred, sometimes used in taking the altitude of the sun, was the Mariner's Cross-staff. It consisted of two square rulers of wood, of very hard and compact fibre. The longest of the two, denominated the staff, was usually about twenty-seven inches in length, and was graduated into ninety degrees. The other piece, called the transom, was about nine inches in length, and had in the centre a square aperture through which the staff could pass freely from end to end. In taking the altitude of the sun with this instrument, the end of the staff, marked with 90, was brought to the eye, while the other end pointed to the hori-

[6] The illustration here given is from an old work on navigation, issued in London in 1622, and represents in a rude engraving the Astrolabe then in common use. Others more elaborate were sometimes made. In some all the quarters of the circle were graduated, but this was probably to give ornament and finish to the instrument. Sometimes a table was attached to the diopter for determining the declination of the sun, but as the table soon became incorrect, this attachment was of little importance.

zon. The transom was then moved until the end of it came into exact range with the middle of the sun, or to one edge allowing for the distance to the centre. The degree on the staff, cut by the edge of the transom at that moment, was the altitude of the sun. Our illustration is from an old drawing issued in London in 1622.

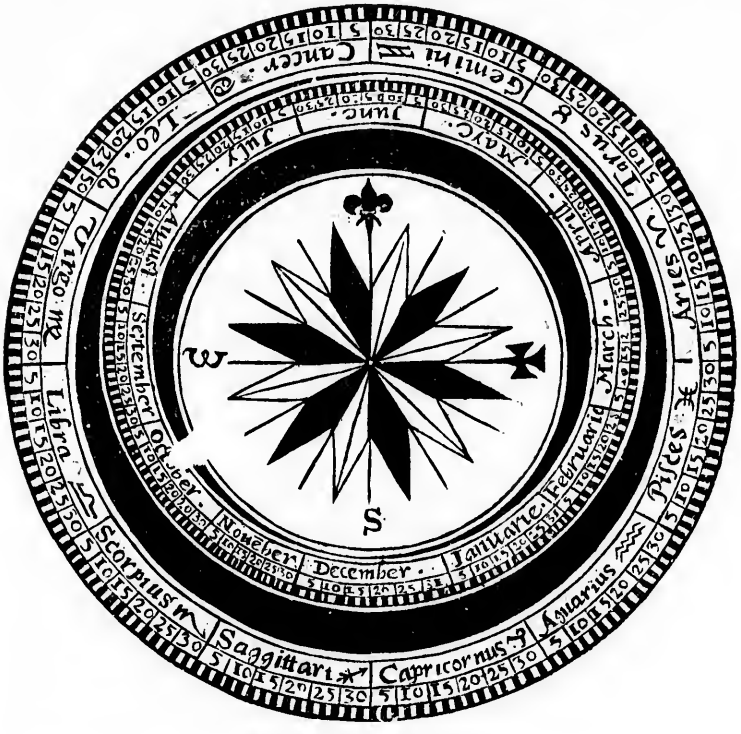


Mariner's Cross-Staff.

If the observations by either of these two instruments were made when the sun was at the equinoctial, the altitude in degrees thus taken, subtracted from 90°, would give the latitude. But if the sun, in its apparent course through the ecliptic, were either north or south of the equinoctial, then the next step was to ascertain the sun's declination. This was taken from a table calculated for every day in the year. As this required a bulky document, it was usually condensed so as to occupy but two pages by employing a Zodiacal Ephemeris, of which we give a drawing on the next page, taken from an old Treatise on Cosmography, dated London, 1594.

It consisted, as may be seen, of numerous concentric circles, on the outer rim of which are displayed the signs of the zodiac, each covering thirty degrees, duly graduated and numbered. On the inner rim, in exact correspondence, are represented the months of the year, divided into spaces representing days, likewise graduated and numbered. By this instrument it was easy to find in what sign and degree the

sun was on every day throughout the year. This was ascertained by holding a slender silken thread at the centre of the instrument, and extending it through the point indicating the day of the month, on the inner rim, for which the declination of the sun was desired,



Zodiacal Ephemeris.

carrying it to the outer rim of the circle, where it would rest upon the degree of the sign of the zodiac which the sun had reached on that day. Opposite to the degree thus found, in a table calculated for the purpose, occupying but a single sheet, was set down the declination of the sun for the day sought, in degrees, minutes and seconds.

Having thus found the declination, if the sun was north of the equinoctial, it was to be subtracted from the sun's altitude, or, if the sun was south of the equinoctial, it was to be added to the sun's altitude, and the remainder or sum, as the case might be, was subtracted from 90°, which gave the latitude sought.

Such were the instruments employed and such the method of taking the latitude two hundred and fifty years ago, and indeed down to 1731, when the invention of Hadley's quadrant introduced a new method, and gradually superseded the old instruments.[7] The reader has undoubtedly observed, not only that the probabilities of error were numerous, but, that with the facilities which then existed, it was impossible for the navigator or explorer to determine the latitude with any degree of exactness. The following sources of error are especially notable.

Both the Astrolabe and the Cross-staff were graduated only to degrees. The disk of the former instrument was usually from five to seven inches in diameter. Long experience proved that a larger disk could not be successfully used by the explorer and navigator, on account of the jostling motion given to it by the wind or the movement of the ship at sea. Owing to the small size of the instrument, the space occupied by each degree would, therefore, be considerably less than one tenth of an inch, and to graduate it to minutes it would be necessary to divide the minute space of less than one tenth of an inch into sixty divisions, which would be practically impossible. While therefore the operator in taking the altitude of

[7] The principle involved in the reflecting quadrant, commonly known as Hadley's Quadrant, was discovered by Sir Isaac Newton, and, after his death, which occurred in 1727, a description of it was found in his hand-writing among his papers. Hadley exhibited his invention at a meeting of the Royal Society in 1731. About the same time Thomas Godfrey, of Philadelphia, invented a similar instrument. The Royal Society decided that both Hadley and Godfrey were independent inventors. The invention of this instrument marks an era in obtaining trustworthy results in astronomical observations. After its introduction it was possible for mariners to take their latitude with nearly absolute exactness.

the sun could get the degrees with some certainty, what he put down as the fraction of a degree, or minutes, was an absolute and sheer guess. To determine to which of the sixty parts the diopter or index pointed, when the whole space was less than a tenth of an inch, was a process too delicate to be undertaken with any hope of success. In the old journals the minutes are usually written in fractions of a degree, as one-fourth, one-third, one-half, two-thirds or three-fourths, but sometimes translated into minutes, and given as fifteen, twenty, thirty, forty or forty-five minutes, but very rarely in any number of minutes not represented by these general fractions. It is highly probable, indeed nearly certain, that the early navigators and explorers did not suppose that their statements of latitude would be interpreted with any degree of exactness as to minutes. They were at best but guesses, as they and doubtless all others at that period knew, with no ground or pretension whatever of certainty.

But another not unimportant source of error is found in the old method of taking the sun's declination. The zodiacal ephemeris, or diagram then in use, of which we have given a drawing in the preceding pages, was not graduated to minutes, and consequently there was an inaccuracy as to the exact point of the sun in the zodiac at the time of taking the latitude. But a still greater error arose from the tables used in connection with this instrument. These tables were not calculated annually, as is customary at the present time,[8] but were only renewed once in about thirty years. Owing to the precession of the equinoxes, which changes the equinoctial points at the rate of about 50″ each year, these tables were constantly becom-

[8] These tables are now found in the Astronomical Ephemerides, or Nautical Almanacs. They are issued annually, under the authority of government, by Germany, Spain, Portugal, France, Great Britain and the United States. The French began the publication under the title of the *Connaisance des Temps* in 1679, and have continued it to the present time. The British Nautical Almanac was begun in 1767. The American Ephemeris has been published regularly since 1855.

ing inaccurate, and when used several years after the date of their calculation, as they often were, they furnished an important source of error in obtaining the declination of the sun.

No account was taken or correction made, at the early period of which we are treating, for the Dip of the Horizon, for Refraction or for Parallax, sources of error of minor importance compared with the larger ones to which we have referred,[9] but nevertheless of considerable gravity in working results, and carefully corrected by all navigators and surveyors of the present day.

The method of taking the early latitudes which we have described, and the instruments employed, were in universal use. No better method or better instruments were known in any part of the world. The latitudes recorded by the explorers of that day in whatever quarter of the globe, if collated and tested, would be found subject to the same inexactness. It is undoubtedly true that in cities, where structures could be erected for the accommodation and use of larger instruments, somewhat greater exactness might be secured.[10] But these were exceedingly rare, and of course never practicable for the use of the roving navigator or the itinerant explorer.

The result of these investigations leads us to three important conclusions, which we may state as follows:

I. The early latitudes are generally trustworthy to within a single degree.

II. The *minutes* or fractions of degrees, as set down by writers anterior to the middle of the eighteenth century, are never to be relied upon, and are never correct except by accident.

[9] These and some other minor sources of error were known to exist at an early period, but their relations were so complicated and subtle that a correct knowledge of their quantitative value in astronomical calculations has only been approximately determined at a comparatively modern date.

[10] Edward Wright, in 1594, took the latitude of London by observations of the "Pole Star," with a brass quadrant of six feet radius. It was found to be 51° 32′, which is very nearly correct. As no allowance was at that time made for refraction, the accuracy of the result must have been in part accidental.

III. The annotations of the learned commentators upon the latitudes recorded in the journals of our early navigators and explorers, in all cases in which they attempt to identify places, within the limit of one degree, by the latitude alone, cannot properly be cited as authority.

It is to be remarked that some of the more recent writers, by collating with government surveys, have become aware of the discrepancy, at least in the cases which they have examined, but none of those, whose works have come under our own observation, seem to have been clearly aware of the extent of the errors or of their true causes.

If the latitudes of the early navigators had been determined with as much accuracy as is attained by the observations of the present day, some interesting historical questions might be definitely settled, and some not very decisive controversies might have been avoided. In such an event the Pye Bay of De Laet would probably not have been made identical with waters about Marblehead.[11] If the latitude of the little French colony on Mount Desert, swept off by Sir Samuel Argal in 1613, were surely at 44° 20′, controversy would be cut short as to its exact location.[12] If Weymouth's *watering place* were clearly fixed in latitude 43° 20′, several literary skirmishes would not have occurred,[13] and if Whitson Bay were really in latitude 41° 25′, we should no longer doubt whether Martin Pring passed the summer of 1603 in Plymouth Harbor in Cape Cod Bay, or in the little haven of Edgartown on the eastern borders of the island of Martha's Vineyard.[14] But more than this, if the triumphs of

[11] Cf. *Collections New York Historical Society*, ii. s. vol. i. p. 292.

[12] Cf. *Pierre Biard*, Relations des Jésuites, Quebec ed., vol. i. p. 45.

[13] Cf. *Collections Maine Historical Society*, vol. v. pp. 309, 344; vol. vi. pp. 293, 309, *Memorial of Popham Celebration*, p. 301.

[14] Cf. *New England Historical and Genealogical Register*, vol. xxxii. p. 76. *American Biography*, by Jeremy Belknap, D.D., vol. ii. p. 128.

science had been earlier, if the old latitudes had been taken with exactness, we should have been able to trace the course, on sea and on shore, of the intrepid and immortal explorers, who first penetrated our northern waters, Davis, Frobisher, Barents, Hudson, Hore, Gilbert, Roberval, Cartier, and the rest, with the enthusiastic satisfaction which certainty always imparts to historical investigations.

It would have been far more gratifying, we confess, if this investigation had led us to the conclusion, that the old latitudes were always correct. The haziness and doubt, however, which have so long brooded over the subject, have, we think, been cleared away. And it will doubtless be admitted, that the certainty that the old latitudes were always wrong is next in importance to the certainty that they were always right.