THE PRIME MERIDIAN

by W. G. Perrin

(The greater part of this article appeared in the "Mariners Mirror" April 1927)

Why have the nations of the world taken Greenwich as the datum point for the measurement of longitude, when was the Greewich meridian first used, and what were the meridians in use before Greenwich Observatory existed? Having had occasion to attempt to answer these questions I found this by no means so easy a task as it at first sight appeared. There were many authorities for the early history of the meridian, but none complete and hardly one that did not contain some inaccuracy; one of the most valuable of these was buried in obscurity and only found through a lucky accident. Moreover, so far as I could discover, no one had investigated the early history of the Greenwich meridian in other than its purely astronomical aspect. In these circumstances it seems possible that such facts as I have collected and sifted may be of use to other enquirers.

I suppose most of those sufficiently interested to read these notes will know more than I do about latitude and longitude, but for the benefit of the few who do not it may be explained that while latitude is measured from the equator, which is fixed by the nature of things, longitude must be measured from an arbitrary point, or rather from a line drawn through such a point and passing through the natural fixed points of the two poles at the ends of the earth's axis. We may ignore the fact that this axis is not quite stable in position.

The latitude can be ascertained by measuring the height of the pole above the horizon. This is now a simple method in the northern hemisphere, for a prominent star indicates the position of the north pole fairly closely, but 2000 years ago this star was a considerable distance away*; no bright star occupied its place, and it seems doubtful whether the ancients made much use of polar observations. Instead of this they appear to have measured the co-latitude (the difference between the latitude and 90°). By erecting a vertical pillar or gnomon and measuring the lengths of the shadows at the summer and winter solstices they calculated the height of the celestial equator above the horizon, which gives the co-latitude of the place at which the observations were made. But the measurements of the longitude was a difficult problem that the ancients could not solve.

In order to ascertain the longitude it is necessary to compare the local time with the time of a standard meridian.** Before the invention of the electric telegraph there were four possible means of doing this:—

(1) By the observation of eclipses; for which the eclipses of Jupiter's satellites were preferred on account of their frequency.

(2) By observing the position of the moon in relation to the stars (especially occultations of them, when available).

(*) *Polaris is now about* 1°15' *from the Terrestrial Pole. In the time of Eratosthenes it was* 10° *distant.*

(**) *This is the only accurate method at sea, but an approximation may often be arrived at by observing magnetic phenomena, such as the variation of the compass. Direct measurement by triangulation from a carefully measured base is possible on land, but so laborious that it was impracticable in ancient times.*

(3) By observing the passage of the moon across the local meridian.

(4) By carrying the time of the standard meridian in a clock that never varied, or varied only at a known rate.

The first three methods required delicate observations and numerous and lengthy calculations. At sea, (1) and (3) were quite impracticable, and (2) difficult and lacking in precision. The fourth method was practicable at sea as soon as somebody could invent a clock that kept time when it was moved about. Until this was actually done many scientists believed that it was a mechanical impossibility, and urged the need of closer study of the irregularities of the lunar motion, the compilation of more accurate tables, and improvements in methods and instruments of observation.

With the growth of sea communication, the necessity of finding readily the longitude at sea became so pressing that in 1713 the British Government offered a reward of £ 20,000 to anyone who could produce a practical solution of the problem.* This reward was finally won by the genius of a Yorkshire carpenter, John HARRISON, who in 1735 and the following years produced a series of timekeepers that surpassed in accuracy anything hitherto dreamt of. Those who seek further information on this subject will find all they can want in Lieut-Commander R. T. GOULD'S *The Marine Chronometer*, and I need say no more than that Harrison and his successors provided a solution of the great problem that had troubled the seafaring world for thousands of years. This solution is not likely to be superseded, though the invention of wireless telegraphy (which enables a standard time to be communicated broadcast) has provided a method that requires the chronometer only as an auxiliary and not as a principal; one practical result of this improvement being that ships do not carry so many chronometers as they used to, because there is not so much risk of error in position if one stops or goes wrong.

The fact that the Earth is a globe and not a plane surface was surmised by some of the early Greek philosophers and it is possible that this had been realised by Pythagoras about 525 B.C. Even before that time there had been attempts to map the known surface, commencing perhaps with Anaximander c. 575 B.C., but the first to attempt to map the known surface in a scientific manner appears to have been Eratosthenes who was born in 276 B.C. and became the librarian of the great library in Alexandria in 240 B.C., continuing there until his death in 196 B.C.

The works of Eratosthenes have perished, except for a few fragments, but an idea of their importance can be gained from Strabo's discussions of them in the introductory chapters of his Geography. Strabo says that Eratosthenes " enters into a long discussion concerning the figure of the globe, proving that the form of the Earth together with the water is spheroidal ", and he certainly was convinced of this for he attempted to measure the length of the Earth's circumference by estimating the length of an arc of meridian between Alexandria and Syene. In this he appears to have arrived at a result surpassing in accuracy anything achieved until comparatively recent times. **.

In order to divide the known world into equal portions on his map he drew a parallel of latitude through Rhodes. He supposed this to pass through the Straits of Messina, which lie over 2° to the North of it; through the Strait of the Columns (*i.e.* Strait of Gibraltar) which in fact it nearly does; and through the Sacred Promontory (now called Cape St. Vincent), which actually lies 1° to the North. Other parallels were drawn through Alexandria, Syene (which he supposed to lie on the Tropic of Cancer) and Meroe. Eratosthenes naturally chose as his prime meridian that passing through Alexandria, which he supposed also passed through Rhodes, which lies really a degree and a half to the West, and Syene, which is about 3° to the East. He chose seven other meridians passing through important points such as Carthage, the Pillars of Hercules, *etc.* He supposed Rome to lie on the meridian of Carthage though it is really 2° to the East. Despite the difficulties he had to contend with, Eratosthenes' estimate of the length of the Mediterranean (which was about one-fourth too great) was more accurate than that in use by us (for example, in Sanson's maps) in the middle of the seventeenth century.

(*) *Philip of Spain had offered such a reward in* 1598, *but no one could win the prize.*

(**) " *If Pliny is right in saying that Eratosthenes made* 40 *stades equal to the Egyptian "schoinos", says* Sir Thomas HEATH *in his History of Greek Mathematics, Eratosthenes made " a surprisingly close approximation, however much it owes to happy accidents in the calculation* ".

Hipparchus, an eminent astronomer, who flourished at Rhodes some fifty years later, criticised Eratosthenes and conceived the idea of mapping the Earth's known surface by first ascertaining from astronomical observations the latitude and longitude of every important point. This however was impracticable and Strabo say that his map was less accurate than that of his predecessor (*). He adhered to that of Rhodes as the prime meridian, and made some important rectifications to the Mediterranean, especially by drawing the Gibraltar-Rhodes parallel south of Syracuse.

The efforts of both Eratosthenes and Hipparchus to construct accurate maps were defeated because few reliable observations of the latitude had been made, most of the positions having been arrived at from a consideration of the lengths of the longest day at the places in question, and there was no practical means of ascertaining longitude. In order to estimate the longitude all they could do was to guess the distance from the time occupied in travelling between any two points east and west of each other, and they placed localities on the same meridian if the traveller appeared to go due north or south in journeying from one to the other. Hipparchus was the first to point out that eclipses of the moon or sun would serve to give a standard time that could be compared with the local times at various places, whereby the longitudes of those places could be derived; but with no reliable clocks and no means of organizing a system of observers no use could be made of this method.

No further progress was made for 300 years until the time of Marinus of Tyre and his successor Claudius PTOLEMAEUS (c.A.D. 150). Ptolemy's great work on geography has survived, but we do not know how much he is indebted to Marinus. In order to construct his map, he drew up tables of positions by latitude and longitude. It is clear that he really based his longitudes on the meridian of Alexandria, but in order, apparently, to avoid longitudes of different signs he (or more probably Marinus) imagined a prime meridian passing through the most westerly land then known — the Fortunate Islands (Canary Islands). He certainly did not know exactly where they were, for he makes the meridian of the Sacred Promontory (Cape St. Vincent) 2°30', although the nearest of the islands is about 40°3' to the west of it. He complains of the fewness of the observations made for latitude and says there had been none since the days of Hipparchus, but as he speaks of these as " elevations of the north pole " it is clear that this method of deriving latitude was then well known, if not practised. Ptolemy gives the longitude of Alexandria as 60°30', or 58° from Cape St Vincent, whereas in fact the difference is only about 39°. Unfortunately he had abandoned the more accurate estimate of Eratosthenes for a much less accurate one based on the works of Posidonius, and for fifteen hundred years the western world suffered this error. Ptolemy was quite alive to the need for accurate observations, and he points out in his first book that only by such means can an accurate map be constructed ; the real difficulty was that hardly any observations had been made for latitude and none at all for longitude.

After the time of Ptolomy no further progress was made in the western world for over a thousand years. Meanwhile, the Arabs kept the torch of geographical learning alight. Though they do not seem to have done much in actual map construction, they drew up revised tables of positions and reduced Ptolemy's exaggerated estimate of the length of the Mediterranean, which was nearly half as long again as the reality, to something nearly approaching the truth. These results appear to have become known in western languages mainly, if not entirely, in astrological works, but it seems probable that the makers of the Mediterranean charts (known as Portolani) in the fourteenth and fifteenth centuries were indebted to them—as they certainly were to the magnetic compass also derived from the Arabs— for the superior accuracy of those charts.

(*) " *Eratosthenes, as is usual in Geography, speaks of right lines, meridians, and parallels to the equator with considerable latitude, whereas Hipparchus criticises him with geometrical nicety, as if every line had been measured with rule and compass, Hipparchus at the same time himself frequently deciding as to right lines and parallels, not by actual measurement, but mere conjecture. Such is the first error of this writer. A second is, that he never lays down the distances as Eratosthenes has given them, nor yet reasons on the data furnished by that writer, but from mere assumptions of his own coinage*". *Strabo, book II, ch. I,* 39.

Some of the Arabian geographers used as a prime meridian one supposed to be drawn midway between the farthest east and farthest west through a mythical city called Arin situated on the equator. This meridian was subsequently assumed to be 10° East of Bagdad; it appears to have been originally of Hindu origin.

With the renaissance of Greek learning in Europe, Ptolemy's original text (long known only in Arabic translations) was rediscovered. Early in the fifteenth century Latin translation of it appeared in manuscript, and about 1472 appeared the first printed edition, which was accompanied with 26 maps. In a sense this discovery was unfortunate, for his great reputation caused these erroneous maps to be preferred to the more accurate Portolani charts, but it led to Colombus's voyage to America. The globe of Martin Behaim which was constructed in 1492 before the return of Colombus has an equator divided into 360 degrees, but these are not numbered and its only meridian is drawn 80° to the west of Lisbon. The globe discovered at Laon in 1859 which is believed to belong to this period has several meridians, one drawn through the Canary Islands.

The discoveries of Columbus gave a great impetus to map and globe making and I propose to mention in chronological order the most important of those appearing during the next two centuries. Apparently the earliest of the post-Columbus globes with a definite prime meridian is one constructed about 1510 now at Cracow. This meridian is drawn through Ferro, the most westerly of the Canary Islands. In 1515 was constructed the Quirini globe at Paris, in which the prime meridian is placed further west and passes through the Cape Verde Islands.

In 1538 Gerhard Kremer (Mercator) produced his first map, a map of the world on the recently invented " double cordiform " projection. In this he drew his prime meridian vaguely through the position of the Canary Islands as Ptolemy had done, but in 1541 he produced a set of globe gores with this meridian precisely drawn through Fuertaventura, one of the easternmost of those islands. At this time he was still under the influence of Ptolomy, but had begun to reduce the excessive Mediterranean length.

In 1542 Alonzo de Santa Cruz also produced a gore map, on which he drew the meridian west of Fayal in the Azores, and 20° west of this he drew the line of demarcation between the spheres of discovery of Spain and Portugal—which by the Treaty of Tordesillas in 1494 had been fixed as 207 leagues west of Cape Verde—as a Meridianus particionis (*).

In 1554 Mercator produced a map of Europe in which he cut down the Mediterranean length (which Ptolemy made 62°) still further from 58° to 53°. From a letter which he addressed to Charles V in 1553 it is clear that he had abandoned the Ptolemaic meridian and was intending to select a new datum point, that at which the compass showed no variation. The fact that there was a position of zero variation had been discovered by Columbus, but it was long before anyone realised that the variation underwent a slow secular change, or that the isogonic lines were mostly tortuous curves. In this map the prime meridian appears to be based on Ferro, the westernmost of the Canary Islands, but the map does not extend far enough to the S. W. to show this island.

Ten years later (1564) Ortelius produced a map of the world on a cordiform projection. In this he has drawn the prime meridian through the centre of Madeira and the eastern part of Teneriffe. These two places are really about half a degree apart in longitude, but the exact positions of the various islands in the Atlantic were not known then nor for very many years afterwards.

In 1569 Mercator produced the work which made his name (or rather the latinised form of it) immortal. This was a map of the world constructed for the use of seamen (Nova et anota orbis terrae descriptio ad usum navigantium emendate accomodata) on the celebrated projection which (as improved by Edward Wright in 1590) we call Mercator's projection. On this he drew the prime meridian through the Cape Verde Islands because, as he explains in a legend upon this map, he had consulted an experienced pilot of Dieppe who told him that the needle did not vary in the islands of Sal, Bonavista and Maio, and others that this also occurred at sea between Terceira and St Michael and in Corvo in the Azores. As a matter of fact he has actually drawn the line through St Michael and St Mary in the Azores, 3° west of Madeira, 1 ½° west of Ferro in the Canary Islands, and then between St Jago and Bonavista in the Cape Verde Islands.

(*) *In the MS. map of* Diego Ribero, 1529, *this line is taken as the prime meridian.*

A glance at a chart will show the considerable differences in longitude of these groups of islands. Evidently Mercator thought that the magnetic meridian was a meridian great circle.

For many years at this period the prime meridian wandered about in search of the isogonic zero line, and it may be as well to explain that the deep-sea navigators of this period found in the variations of the compass the only practical check over dead reckoning of longitude that was available to them. It will be remembered that Columbus's crew in 1492 were so much disturbed by the unwonted variation they began to observe that he had to bemuse them with a statement that it was really due to change in the position of the pole star. Even as late as 1700 it was worth while for Halley to spend two years at sea in order to prepare a general chart of magnetic variation for the use of mariners.

In 1570 Ortelius produced the first printed collection of maps in the form of a modern atlas; to which he gave the name Theatrum Orbis Terrarum. In the world-map which precedes the set the zero meridian passes through the Azores and Cape Verde Islands. Shortly afterwards (1583-84) appeared the first collection of sea charts, the Spieghel der Zeevaerdt of Waghenaer, which was translated into English in 1588 as " The Mariner's Mirrour". This has only one map with the longitude marked upon it; in this the prime meridian passes through the Canary Islands between Gomera and Teneriffe.

In 1601 Hondius produced a terrestrial globe which is of special interest to us because it contains upon it a memorandum on the longitude, which may be translated as follows:—

> It is well known to those skilled in hydrography that hitherto there have been numerous errors in the longitudes of places, because almost all regions have been mapped from the observed directions of seamen proceeding from one place to a second without any reckoning of a third (*), or consideration of the variation of the compass or of the compass cards (directoriti nautici) which they make use of indifferently although the needle lies differently in different places, and varies more or less from the true north and the cards vary accordingly to the place in which they are made, whereby errors arise in the longitude of places. Many have in vain endeavoured to correct these errors by the pole stars, others by lunar observations (per Lunae cursum) others with more certainty by eclipses. But what an immense labour! And who will make the necessary eclipse observations for such a multitude of places? But when through the variation, or deviation of the compass as they call it, the longitude of places has been found I thought it would be of great use if on this globe I gave all places their true degrees of longitude (at least all those yet known) although it were no light labour. We have begun our longitudes not as Ptolemy did from the Fortunate Islands but from those called Azores because there the compass needle points due north.

A globe designed by Plancius in the year 1612 has its prime meridian placed in the Azores because the absence of variation in the islands of Corvo and Flores indicated that these islands were the location of the common magnetic meridian of the world and therefore the logical position from which to measure the longitude.

But the most interesting decription is that upon the globe made by Blaeu in 1622 and it is worth translating in full:—

> Although the prime meridian (initium longitudinis) is arbitrary, nevertheless it seemed good to the ancients to place it in the west because there a boundary of the world existed, whereas no expedition to the east could ever discover one. And for that reason Ptolemy (to whose zeal and industry all owe the soundness of geographical science though they do not all admit it) started with the furthest known limit of the west, called the Fortunate Islands in the Atlantic Ocean, and placed there his prime meridian, which disputable starting point (theticum principium) almost every one has since kept out of respect for his authority. But in our days a good many think this starting point ought to be based on nature itself, and have taken the direction of the magnetic needle as their guide and placed the prime meridian where that points due north. But that these are under a delusion is proved by that additional property of the magnetic needle through which it is no standard for the meridian, for itself it varies along the same meridian according as it is near one land mass or another. But those who agree that on account of its instability the magnetic needle is of no use, disagree about the prime meridian, Wherefore, in order that, for the greater convenience of Geography, one certain meridian may

(*) *I.e. to form a triangle.*

be kept and observed as the first commencement, we, following in the steps of Ptolemy, have chosen the same islands and in them Juno, commonly called Teneriffe, whose lofty and steep summit covered with perpetual cloud, called by the natives El Pico, shall mark the prime meridian. In that way we have differed barely a quarter of a degree from the longitude of the Arabs who chose the extreme western shore of Africa (*), and I thought it well to point this out.

Here we have what appears to be the first attempt to fix the meridian as passing through a precise geographical spot instead of vaguely through an island or group of islands. Blaeu had abandoned the idea of fixing a " natural " point indicated by the compass variation, but although he saw that the isogonic zero line did not coincide with a terrestrial meridian, he does not appear to have known that the isogonic lines slowly changed their form and position. It was in this year that Hunter made the observation near London that showed that the variation there had decreased over 5° in forty-two years, but the fact does not appear to have been properly appreciated until Gellibrand made further observations in 1634 and published his *Discourse Mathematicall on the Variation of the Magneticall Needle* in 1635.

Hitherto we have been considering the results of the work of the geographers of the Low Countries who were the pioneers of that science during this period, but in 1634 an event occurred in France which is of some importance because the French delegates at the Washington Conference in 1884 used it as one of their main arguments for a neutral international meridian. This was the publication by Louis XIII on July 1st, 1634, of a decree fixing the prime meridian at the westernmost point of the Canary Islands. It was claimed that this was a result of a disinterested settlement of a troublesome question by a congress of scientists assembled by Richelieu, but the real truth seems to be that it was one of the diplomatic moves of the Thirty Years' War. From its term it appears that its only object was to fix a clear line of demarcation for the hostilities going on at sea with Spain, against whom open war had been declared the preceding May. It was a case of "no peace beyond the boundary", similar to the old " no peace beyond the line " with which our Elizabethan seamen were so well acquainted. The abstract devotion to science, of which so much was made in 1884, was an acquired merit.

This interesting decree (**) is to the following effect:—

French ships are not to attack Spanish or Portuguese ships in water lying east of the First Meridian and north of the Tropic of Cancer. In order that this first meridian may be more clearly known than it has for some time been, the Admiral of France has consulted persons of knowledge and experience in navigation. The King in consequence forbids all pilots, hydrographers, designers or engravers of maps or terrestrial globes to innovate or vary from the ancient meridian passing through the most westerly of the Canary Islands,(***) without regard to the novel ideas of those who have recently fixed it in the Azores on the supposition that there the compass does not vary, for it is certain that this happens also in other places that have never been taken for the meridian.

The remaining globes of interest must be briefly mentioned; they are those of Habrecht (1625) with meridian of Corvo, Coronelli (1688), meridian of Ferro, and Moroncelli (1716) who copied Blaeu's legend in part, but substituted Ferro for Teneriffe.

Whatever the real origin of the 1634 decree, it certainly had the effect of encouraging the use of Ferro. A few years later France had the opportunity of putting this " scientific " meridian to a practical test. In 1680 Louis XIV set two members of the Royal Academy of Sciences, the astronomers Picard and de la Hire, to correct the map of France. They appear to have made observations for longitude by the eclipses of Jupiter's satellites, and they took for their meridian Paris Observatory which had been founded in 1667. In their report (****) dated 1682 they say " we thought we had better not mark the longitudes as they are ordinarily shown on maps, commencing from the Isle of Ferro as has been decreed, because we did not know the position of this island in respect to the Observatory." An outline of their map laid upon an outline of the best map then procurable (that of Sanson), which accompanies the report, shows

(*) *I.e. Cape Verde.*

(**) *La Grande Conférence des Ordonnances, vol. I, p.* 307.

(***) *I.e. Ferro.*

(****) *Published by the Academy in its* Mémoires *in* 1693 (*Vol. VII*).

the value or their work; not only had Sanson exaggerated the width of the Channel, but he had put the Brest peninsula more than a degree too far west.

By this time most nations had given up the pursuit of the elusive prime meridian and made their own on their own country for local purposes, so that real measurements could be taken when necessary. Thus there was London (defined as St Paul's Cathedral in large-scale maps a little later), Paris, Cadiz, Toledo, Freudenberg, Konigsberg, Uranienburg, Copenhagen and Bologna, though the older longitudes still appeared in the world maps. To the seaman who could not measure his longitude even if the maps gave it accurately the " international " longitudes were not of much use, and I do not suppose he troubled much over them.

In 1725 after fruitless attempts to get concordant results in measuring the difference of longitude between Paris Observatory and Ferro it was decided to assume it at 20°. This was really the abandonment of Ferro and transfer of the prime meridian to Paris, but the convention remained for some years (*), the zero line being pushed into the ocean when it was discovered that the real difference was about 20°30'. In a local French chart of 1750, the *Carte réduite du Golfe de Gascogne* (Bay of Biscay) by Bellin, there are no less than six scales, one each for Paris, Madeira, the Lizard, London, Teneriffe and Ferro. A legend upon it explains that this multiplicity of scales is to enable passing ships to communicate their supposed longitude the more readily.

The Royal Observatory was founded at Greenwich in 1675 by Charles II with a view to " the Rectifying of the Tables of the Motions of the Heavens and the Places of the Fixed Stars, in order to find out the so much desired Longitude at Sea ". From that day it has been one of the foremost of the world's observatories, but it was long before even the British took the meridian of Greenwich for their prime meridian.

Greenvile Collins' *Great Britain's Coasting Pilot*, published in 1693, was the first collection of scientifically constructed charts published in England, and was a great advance in accuracy upon its predecessors, but though many of these charts have scales of latitude not one has any scale of longitude. In Morden's *Atlas Terrestris* published at the end of the seventeenth century, the maps have two scales of longitude, one east and west of London, the other east of Teneriffe (from 0° to 360°), London being taken as 18° east of Teneriffe, whereas in fact it is not 17°.

In English charts of the early eighteenth century the zero meridian is usually either that of the Lizard, or London, or sometimes Ferro, but in large-scale local maps a local object was often taken. Thus in the *Map of the County of Middlesex* by John Rocque in 1757 the meridian passes through St Paul's Cathedral; in the *Map of Wiltshire* by Andrews and Drury in 1773 it passes through Salisbury Cathedral; in Avery's *Exact draught of the Sea* Coast from Arundel to St Albans published by Mount and Page c. 1710 the zero meridian is drawn through Southampton. The earliest maps on which, so far, I have found the prime meridian based on Greenwich are the two charts attached to the *Description of Sea Coast*, published by Fearon and Eyes in 1738 and the *Survey of the County of Oxford* by Thos. Jeffreys published in 1769, but the meridian of London was still in use in the *New Hydrographical Survey of the British Channel* published by Sayers and Bennett in 1777. In the *Atlantic Neptune* published by Des Barres, which commenced publication in that year, perhaps the most magnificent collection of sea charts published up to that time, the meridian of Greenwich is used, and thereafter it rapidly superseded all others in English maps and charts. It is probable that the starting of the Nautical Almanac in 1767 had a good deal to do with this.

Practical considerations had caused the abandonment of the idea of an international meridian based on a point in the extreme west of the Old World, and the various nations had each chosen their own datum, usually that of their principal observatory. Thus in 1870 the following meridians were in use; Greenwich, Paris, Cadiz, Naples, Christiana, Ferro, Pulkowa, Stockholm, Lisbon, Copenhagen, Rio de Janeiro, Washington and Amsterdam, and I do not think this exhausts the list.

This multiplicity of prime meridians was a great nuisance to the seamen; who had often to make use of charts of more than one nation. Several conferences talked about it, and suggestions for the adoption of the meridian of Jerusalem, the Great Pyramid, or some other world-renowned spot were put forward.

(*) *It will still be found on charts in use to-day.*

At a Geodetic Conf rence which met in Rome in October 1883 the question of a prime meridian was discussed. A special committee which had examined the question put forward a report in which it stated " that the unification of longitudes and hours is as equally desirable in the interests of science as in those of navigation, commerce and international communication. The scientific and practical utility of this reform considerably outweighs the sacrifices and the trouble some arrangements to which it will put the minority of civilised nations ". The report then went on to propose Greenwich as the initial meridian, and recommended that longitude should be reckoned "in the sole direction of from west to east". In giving reasons for the choice the report pointed out that the meridian of Greenwich was "by far the most extensively used " and asserted that " 90 per cent, of the navigators throughout long voyages calculate their longitudes by the meridian of Greenwich. " After a hot debate the report was accepted by the Conference which added a suggestion that, if the whole world agreed to the proposal, Great Britain should in turn adopt the metrical system.

The Congress requested the Italian Government to communicate their resolutions to the various governments, but it evidently had not sufficient weight to reconcile national susceptibilities and to force the governments into action. A year later the United States Government called together an International Conference at Washington " for the purpose of fixing a Prime Meridian and a Universal Day ". The United States, placing expediency before *amour propre*, had already abandoned Washington for Greenwich in its sea charts, and as soon as the Congress was open one of the U.S. delegates seized the bull by the horns and bluntly proposed the adoption of Greenwich ; another argued that the site of the Greenwich Observatory was better than that of the Paris Observatory and remarked " that the adoption of the meridian of Greenwich as the prime meridian has not been sought after by Great Britain ". The delegates of France, supported by Brazil, were adverse to the proposal and spoke in favour of choosing some " neutral " meridian or returning to the ancient one in the Azores, arguing that a geographical meridian did not require to be fixed with such extreme exactness as an astronomical one. They had already circulated a treatise drawn up by their Chief Inspector of Mines in which he advocated a meridian passing among the Azores but touching none of them, the islands being used only as points to fix it, serving as a " quinconce de bouées d'approche ". One of the British delegates then retorted that what was required was a solution tending to the greatest practical convenience, and it would be impossible to attain to this through merely sentimental considerations.

There was a long and animated debate extending over two sessions on the question whether it was practicably possible to find or fix a really " neutral " meridian, and on the need for having the prime meridian closely connected with an observatory. Finally the resolution was put " that the initial meridian should have a character of absolute neutrality... and especially should cut no great continent — ne ther Europe nor America ", and it was lost by 3 votes against 21. After some further discussion a resolution was put " that the Conference proposes to the Governments here represented the adoption of the meridian passing through the transit instrument at the Observatory of Greenwich as the initial meridian for longitude ". This was passed by 21 votes to 1 with two abstentions, the countries voting as before with the difference that France and Brazil abstained from voting.

I do not suppose the delegates knew as much about the past history of the meridians as we do now, but practical common sense had warned them off the pursuit of an impractical ideal.

With the further discussions and resolutions of this Conference we are not now concerned, except to observe that it was decided that the longitude should be reckoned east and west of Greenwich up to 180°, and that the proposal to count it continuously from 0° to 360° was not agreed to ; and to note that the decision taken regarding time has gradually led to the adoption of " zone time ", by which the times in countries not lying near the prime meridian are made to differ from Greenwich time by an integral number of hours, which is a great practical convenience (*).

(*) *This system was already in use in the United States and Canada. It was adopted by Belgium and Holland in* 1892, *Austria, Germany, and Italy in* 1893, *Denmark, Sweden and Switzerland in* 1894, *Spain* in 1901, *France in* 1911, *Ireland in* 1916, *and by Argentine and Uruguay in* 1920.

For anyone who may be tempted to pursue this subject further I would suggest the following as the first works to be consulted—with a recommendation to verify the facts and check any translations :

Sir E. H. BUNBURY. *A History of Ancient Geography*, 1879.

L. MAHILLON. *Histoire du premier méridien et de l'heure universelle*, in *Ciel et Terre*, Dec. 1884.

Lt.-Gen. WAUWERMANS. *Histoire de l'Ecole Cartographique Belge et Anversoise du XVI^e siècle*, 1895.

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The best general collections of facsimiles of ancient maps are Nordenskiold's *Facsimile-Atlas* (1889) and *Periplus* (1897), but they do not contain all the early maps I have mentioned, especially Mercator's map of 1569, which has however been published in photographic facsimile.