In tracing the early progress of Geography it is necessary to remember that, like all other sciences, it arose from “small beginnings.” When men began to move from place to place they naturally desired to tell the tale of their wanderings, both for their own satisfaction and for the information of others. Such accounts have now perished, but their results remain in the earliest records extant; hence, it is impossible to begin an investigation into the history of Geography at the true fountain-head, though it is in some instances possible to guess the nature of the source from the character of the resultant stream.

Another point that may be worthy of note is one of general application. As has been said, the mind advances in “serpentine lines,” and therefore every advance in time is not always an advance towards the truth; on the contrary, some thinkers seem, with singular perversity, to delight in reviving and defending opinions long routed by the victories of truth. One in-stance of this attitude of mind may be mentioned. The school of Philosophy, known as the Epicurean, wilfully denied the spherical form of the earth several centuries after it had become the common property of the Greek world. In a full history such retrogressions would have place, not so much from their intrinsic importance as from the influence they exercised over the minds of those who were brought face to face with them, and who were thus forced to reconsider carefully the main pillars upon which their scientific structure was based; but in the present Introductory Chapter, the aim of which is to show the progress of Geography in outline up to a certain time, these backward steps must be necessarily omitted.
§ 2. — Pre-Scientific Geography or Cosmography.

It is probable that Geography, like many other sciences, had its birth in the far East. Besides the analogy several other facts seem to point to the same conclusion, such as the ratio of a cubit to a mean degree of a great circle; while Greek and Roman writers explicitly affirm that a measurement of the earth was made by the Chaldeans. [1] Be this as it may, it is at least moderately certain that if there were any such geographical knowledge it was only known to the Greeks by tradition, and was rather assimilated unconsciously than classed as the basis of a science. In fact, if we can believe the testimony of Herodotus, [2] the astronomical theorems which the Greeks applied to the measurement of the earth were derived from the Babylonians, and yet so far were they from being aware of this indebtedness that they assigned a mythical origin to their measures, which were due to the same source; for instance, their foot was supposed to be the foot of Hercules. Therefore, when we come to the first written records—those of the Greeks—we find that whatever knowledge there may have been of the earth had already become inextricably involved with the myths of the popular religion, and as a result, the early information of the Greeks, and therefore the earliest information obtainable, must be treated as mythical from which true knowledge of the earth gradually grew.

This earliest discoverable information is found in the Greek poets where the knowledge of the time is clothed under the form of the wanderings of certain popular heroes—for instance, the wanderings of Ulysses. Thus the natural errors in the accounts of the early travellers were enormously multiplied by the vehicle by which they are known to us; for who would bind an epic down to mere stadia? Further, when men began really to investigate the different positions of different countries, and desired to ascertain the exact truth, they found it impossible to free themselves from mythic errors which they had assimilated almost with the air they breathed. Thus the early accounts of the world (or Cosmography) can all be distinguished by the presence of certain poetic fictions which are accepted as the real basis of knowledge. One instance will be sufficient to illustrate the cosmographical tendency, namely, the theory or fiction of a river Oceanus which flowed round the world, and which was the source of all smaller rivers. Accordingly, Æschylus makes Prometheus trace out the wanderings of Io to the Indus, following which she is to reach the delta of the Nile. Euthymenes, a voyager of the same age, sailing through the Pillars of Hercules and down the coast of Africa, found the Nile flowing out of the Outer Sea, giving as his reason for believing the ocean to be the source of the Nile that the water was sweet, and the animals were the same as those of the Nile. A somewhat similar instance of the influence of cosmographical ideas will be found in Herodotus’ tale of the five adventurous youths (Book II. 31-34),

In fact, the influence of this myth of an all-embracing ocean may be traced through all antiquity from Homer, Hesiod, and all the poets, through Herodotus, Plato, Aristotle, and the various schools of Philosophy. Even the mathematical astronomers, scientific travellers, and geographers have not altogether shaken it off, as we find Pytheas censured for his freedom from it by the historians of Geography, Polybius and Strabo. Even in the midst of the geographical knowledge under the empire the mythical theories of cosmography manifest themselves not only among the poets such as Ovid, Virgil, and Lucan, but also with the philosophers, Seneca, Pliny, and Plutarch. They hold their ground under the declining Empire, and run through the middle ages—nay, they revive with the revival of learning—witness amid a vast number Munster’s Cosmographia and the Nuremberg Chronicle.

§ 3. — The Germ or true Geography.

The first step towards scientific Geography was made when the information concerning the earth passed from the hands of the poets to men of general culture. Now, at this period, the great centres of culture were the schools of Philosophy, and so the great majority of con-
tributors to the earliest Geography (as distinct from Cosmography) belonged to some of the first philosophic schools. To the Ionic sect Geography stands in special debt. Thales is named as the first to suggest the spherical figure of the earth, which he may have learnt from the Oriental astronomy with which we know he had been brought in contact. To his younger contemporary, Anaximander, we owe the first geographical tablet, or picture, or map. Anaximander’s map acquired great celebrity, probably from the originality of the idea. Herodotus says (v. 49) that when the Ionians were planning their revolt from the Persian yoke, Aristagoras, the tyrant of Miletus, went to Sparta to ask assistance from Cleomenes; during the conference he produced a bronze plate on which was engraved a map of the whole world. This may have been either the original map or a copy.

Of the nature of the map itself we know little; but it must have been very crude, as there were no sufficient means of determining positions by observation or exact measurement, nor was there any definite datum line, much less anything corresponding to longitudes and latitudes to which to refer them. Greece was placed in the centre of the world, the lands round the Mediterranean were vaguely added, while distances were reckoned from travels and voyages, and the directions were guessed from the position of the sun and course of the winds.

Shortly after Anaximander’s map appeared the treatise of Hecataeus, concerning which the most noticeable feature is the fact that it appeared after the first map—thereby exemplifying the general course of Greek Geography. [3]

Socrates appears to have had a map of the earth amongst the diagrams of his school, [4] while in the time of Plato and Aristotle maps had become an essential part of educational appliances, as may be seen from the will of Theophrastus. [5]

Plato and Aristotle began to apply general laws to the study of geographical phenomena. Their names are associated in Geography with the maintenance of the spherical figure of the earth. They do not however teach it as a new discovery, but rather as an accepted fact—indeed it began to be held some two centuries before their time. Aristotle held also the theory of celestial gravitation. He supports his view by two main arguments:—When matter gravitates to a centre it must assume the spherical form, and all bodies on the earth gravitate to its centre, therefore it is a sphere. Secondly, the fact that the shadow of the earth upon the moon is always circular can only be explained by believing the earth to be itself a sphere. This sphere is at rest in the centre of the Universe, and round it the celestial bodies revolve. In size he made the earth about double its true diameter, but in reference to the enormous distance of the fixed stars it is “as nothing.” After dividing the earth into zones the conception of Antipodes was reached—and was easily accepted if not explained—by reducing it under the already accepted fact of gravitation.

Archytas of Tarentum, the Pythagorean, a contemporary of Plato, and about a generation prior to Aristotle, is said to have had no small influence upon the geography of both. He was celebrated as a mathematician, and still more as the inventor of mechanical instruments. Horace (Odes, I., 28) describes him as the “measurer of sea and earth and the countless sands.” It may seem absurd to collect his influence as a geographer from the verses of Horace were it not that the description corresponds almost literally with that of Aristotle, and the reference to the measuring of the countless sands seems to suggest the problem afterwards attempted by Archimedes of estimating the solid contents of the earth’s sphere by the number of grains of sand which it would contain.
§ 4. — Pytheas,

(a) His position and date.—In Pytheas we meet Geography first treated as a special science and not as a branch of general education. He devoted alike the knowledge of an original mathematician and the bravery of a hardy traveller to the advancement of his chosen study. It is probably to this innovation that we may attribute the scorn with which his discoveries were greeted by the Greek historians of Geography. Besides his personal characteristics, the place of his birth pre-eminently fitted him to be the pioneer both of geographical discovery and its scientific systematization. Born in the flourishing colony of Massalia, which had defeated the fleets of Carthage, subdued the savage Celtic population, and formed alliances with Rome, he was placed in the centre of a circle of active commercial enterprise. How far the first extensive voyages of the Massalians were due to a desire to extend an already existing tin trade or else to compete with that already established by the Carthaginians it would be difficult to determine. Further, Alexander’s expedition in the East would stimulate the Greeks in the West to efforts in maritime discovery. It has also been suggested that the second commercial treaty between Rome and Carthage would make the inhabitants of Massalia desire to strengthen the position of their city by the foundation of sister towns.

It was at this time that Pytheas lived. Unfortunately, his exact date is uncertain. It is probable that he lived between Eudoxus and Dicæarchus, as Hipparchus corrects the former from data supplied by Pytheas [6] while the latter criticizes him unfavourably. [7] Moreover, his contributions to Astronomy and Geography would have been noticed by Aristotle had they been made before his time. Therefore, on the whole, the date of Pytheas may be fixed in the last quarter of the fourth century B.C., while his voyage may be associated with the date of the death of Aristotle, b.c. 322.

(b) His astronomical and mathematical knowledge.—The practical knowledge which Pytheas possessed of both these subjects enabled him to be of the greatest possible service in developing true Geography. Even his arch-accuser, Strabo, bears witness to his celebrity in this respect. [8] His observation respecting the stars round the pole, which Hipparchus adopted, has been confirmed by modern astronomy—the three stars mentioned being fixed as β Ursae Minoris and α and κ Draconis. [9] But there is another instance of his geographical and astronomical accuracy. He was the originator of the first observation by means of the gnomon on record, by means of which he fixed the position of his native city with the least possible amount of error. [10]

(c) His Voyage.—Besides observation and the comparison of records, Pytheas himself undertook an extensive voyage, which even to the present day forms the subject of much controversy. The reason is that none of his writings have been preserved, and such extracts as reach us or such accounts of his work as have been perpetuated come to us only after having passed through the distorting media of several other minds which were not always unprejudiced. Strabo, supported by Polybius, was especially hostile, since he held views which were contradicted by the reports of Pytheas, whom he considered led Eratosthenes astray.

The result of this voyage was the discovery of Britain to the Greeks, but regarding the details there is considerable doubt. Strabo traces Pytheas as the authority of Eratosthenes, whom he is criticizing, [11] from the Pillars of Hercules round the coast of Iberia and Gaul as far as the Promontory of the Osismii (Brittany) and the Island of Uxisama (Ushant). After “some days’ sail” from Celtica he reached Cantium, giving the length of the whole island of Britain as 20,000 stadia. The difficulty affecting Pytheas in this account lies in the expression “some days’ sail.” For how could the distance across the Straits of Dover occupy “some days”? The explanation lies in a fact which should be borne in mind in considering the similar difficulty in the case of Thule. The coast of Britain was quite new to Pytheas, and so it
was but natural he should coast along it, and the time of the voyage might be spoken of (especially after filtering through several hands) as occupying some days!

From Cantium [12] he sailed up the east coast till he reached Thule, where “there was no longer either solid land nor sea nor air, but a sort of mixture of these . . . which could neither be travelled over nor sailed through. Returning he visited the whole ocean coast of Europe, from Gades to the Tanais.” The perimeter of the island he gives as 40,000 stadia. [13]

As a possible confirmation of the voyage, the account given by Diodorus Siculus, of Britain, may be mentioned, which may have been in the main taken from Timæus, who again is connected with Pytheas. [14] Here, the form of the island is given as triangular, with three headlands, representing the three corners named respectively, Bolerium (Land’s End), Cantium, and Orcas (Duncansby Head) “Of these sides the least is 7500 stadia long extending beside Europe, the second from the strait to the vertex is 15,000 stadia long, the remaining side 20,000, so that the whole circuit of the island is 42,500 stadia.” Here, the near agreement of one of the sides with Strabo’s account of the length of the island given by Pytheas, and also the similarity of the totals, are worthy of note.

(d) The Thule of Pytheas.—The last point of interest in connexion with Pytheas is his Thule, not only in vindication of his consistency, but still more from an independent ground of interest, because the Thule of Pytheas was the most northern point in all later maps, with the exception of Strabo’s. The latter says [15]: “It is true that Pytheas the Massalian says that the furthest parts (of the habitable world) are those about Thule, the northernmost of the British Isles, at which parts the summer tropical circle is the same as the Arctic (Circle). But from the other writers I find no information, either that there is such an island as Thule nor whether the parts (of the world) are habitable up to the point where the summer tropic becomes the Arctic Circle. But I think the northern limit of the inhabited world is much further to the south.”

Strabo also quotes a statement from Pytheas locating Thule “at six days’ sail from Britain.” Remembering the previous uncertainty connected with distance reckoned by “days’ sail,” this latter passage cannot be accepted as decisive, while in the former there are two statements which at least partially contradict each other. Thule is “the northernmost of the British Isles,” and lies upon the Arctic Circle. But there is no island which was accessible to Pytheas that would answer this description; so the difficulty is which to accept? Certainly the acceptance of the latter view would be a serious blow to the accuracy of Pytheas as a geographer, and still more were we to take Pliny’s explanation—that at Thule there is six months’ day and six months’ night.

But Pytheas was better informed. To take first the account of Pliny, one edition reads in the margin, “some copies have six days,” and an Anglo-Saxon Manual of Astronomy actually reads six days—“Thule is the name of an island to the north of Britain, six days’ voyage by sea, in which there is no night for six days at the summer solstice.” [16]

But we can get even nearer the truth: it happens that the exact words of Pytheas have been recorded. “The barbarians showed us where the sun goes to his rest, for it happened about these parts that the night was only a little interval after the setting of the sun before it rose again.” [17] The description Pytheas has given of the harvest, seen probably as he returned, would seem to tally with the time of the summer solstice, and therefore, upon the whole evidence, his Thule may be fixed as one of the Shetland Islands. Ptolemy, with much fuller evidence before him, and Marinus, place Thule in the position of the Shetlands.
§ 5.—Dicæarchus.

Dicæarchus was a native of Messana in Sicily, and survived in the year 296 B. c. He wrote a work entitled *Periodos ges*. He was one of the later pupils of Aristotle. His geographical work marks a new period in the history of Geography—on the one side he is connected with the philosophic, while the specialising tendency of the teaching of Aristotle led him to devote his attention more especially to the study of the earth. By his discovery of a base line he may be named the father of ancient geodesy. From this basal line he measured the length of the habitable world, and to it he referred all positions. The discovery lay in the application to scientific purposes an already existing provision of nature. The known world was divided by the long and comparatively narrow basin of the Mediterranean, lying west and east between shores, roughly speaking, parallel. From its eastern point—the Gulf of Issus—the division was continued by the mountain chains which prolonged that of Taurus. This irregular natural line Dicæarchus reduced to a mathematical line, thereby discovering the longitudinal measurement of the habitable world, which may be named as the first step towards scientific Geography.

Though there is no direct evidence that Dicæarchus used his base line in remodelling the map of the world, there seems to be no other reason to account for his discovery, while it is known that he did actually construct maps of Greece. Therefore it may not be too much to conclude that he gave its final form to the “Ancient map” before it passed into the hands of Eratosthenes in the following century.

§ 6.—Eratosthenes.

(a) His Life.—Eratosthenes is closely connected with Dicæarchus; he supplemented, most materially, the “base line” of the latter, while further, we owe to him the first recorded scientific measurement of the circumference of the earth. Born in the year 276 b. c, he received his education at Athens, and was invited by Ptolemy III. (Euergetes) to preside over the great library of Alexandria. Here he was able still further to increase his remarkable acquaintance with the whole mass of literature extant, besides his observatory enabled him to pursue his researches in astronomy. He died at the age of eighty.

(b) Measurement of the Earth.—Before the time of Eratosthenes measurements of the earth had been hazarded by several of his predecessors. There is one due to Aristotle of 400,000 stadia, and another to Archimedes of 300,000 stadia; another, practically correct, has been attributed to Pytheas by calculation (by Lelewel), but without positive authority. The round numbers in which the measures already named have been expressed, show that they were the result of guesswork rather than any scientific process.

Eratosthenes starts from strictly astronomical data. The distance of the northern tropic from the Equator, determined by the vertical reflection of the sun in a well at Syene at the solstice, was the shrewd and simple method of this determination. He reckoned the distance from Syene to Alexandria as 5000 stadia, from which he estimated the circumference of the earth as 250,000 stadia; to this number he afterwards added 2000 stadia, probably to make it a multiple of the 1/60 th part of a great circle which he used instead of the modern division into 360ths or degrees. Thus the world of Eratosthenes was 1/6th larger than the true earth.

(c) His Map.—It is easy to see how much this discovery enabled him to add to the bare base line of Dicæarchus. He was at once able to establish a fundamental meridian at right angles to the parallel which he owed to his predecessor. These two circles cut each other in the Island of Rhodes, which was considered due north of Alexandria. From this time forward the parallel of Rhodes occupied the same position in ancient Geography as the equator does.
in ours; in fact, the terrestrial Equator was an unknown quantity, only to be determined from other known parallels by calculation. Eratosthenes proceeded to supplement the two measuring lines of his world by other parallels or meridians drawn through places whose position was supposed to be known. What we now call Latitude was recorded in *Climates*, of which there were originally seven, determined by the length of the longest and shortest days. The original number of seven was gradually increased as more exact knowledge was obtained. This method was constantly used up to the time of Ptolemy.

So much for the theory of the map—the map itself must have been very imperfect—in fact, Eratosthenes merely grasped the principle of a mathematical basis for Geography without attempting to carry it out in detail, as he did not believe that Geography was susceptible of any great degree of accuracy. For instance, though well knowing there was a difference of 400 stadia between the parallels of Rhodes and Athens, yet he drew his main parallel through both. Not only so, but he sometimes, when it suited his purpose, substituted for this dividing line a dividing belt of 3000 stadia in width! which shows how little he had grasped the true scope of his great discovery.

In connexion with Eratosthenes, it is perhaps worth while noticing his speculation concerning the possibility of circumnavigating the globe, where he comes curiously close to the actual distance to be traversed; but as being a mere speculation, it has less place in the history of Geography than the tales of M. Jules Verne in modern science.

§ 7. — Hipparchus.

(a) His Position and Date.—Hipparchus was one of the pioneers of discovery, without being himself a geographical discoverer. In his astronomical investigations he had solved the whole problem of Geography, but his solution was implicit, not explicit; consequently, it needed one of equal, if not greater genius, to grasp the true fertility of his principles. Therefore, it is not so astonishing as it might appear at first sight, that for three hundred years the discoveries of Hipparchus lay hidden till Ptolemy had the genius to rediscover them after Strabo, Marinus, and others had passed them by. This being so, the genial and open manner in which Ptolemy acknowledges the long-forgotten claims of Hipparchus, gives us a transient glimpse of the frankness of his character, especially as he could so easily have appropriated the work of his predecessor without fear of detection—and yet we know but little of Hipparchus except through Ptolemy.

(b) The surface of the Globe mathematically divided.—Hipparchus as a mathematician at once made an important advance upon Eratosthenes’ division of circles into sixtieths by substituting three hundred and sixtieths. He then took a meridian so divided, and imagined circles drawn through each of these divisions parallel to the Equator, which thus correspond to our parallels of latitude. Upon these parallel circles he took stations from which might be determined the celestial phenomena dependent upon the latitude. Hipparchus desired to calculate the variations of these phenomena for all positions or stations at intervals of one degree—that is at intervals of 700 stadia, as Hipparchus accepted Eratosthenes’ measurement of the earth which would be sufficiently accurate for his purpose. The use of the word calculate gives the essential point of distinction, as this work was purely astronomical and theoretical. If any proof of this were wanting beyond that which will be found in the mere nature of the case, it will be quite sufficient to mention that his system embraced the whole quadrant from the Equator to the Pole, much of which was outside the range of Geography.

With regard to longitudes Hipparchus had the true conception of their connexion with differences of times, as is shown by his proposal to determine them by means of eclipses—of
which method Ptolemy proves the theoretical soundness, and at the same time shows the practical uncertainty in that age. [20]

(c) The application of these principles by Hipparchus.—The object of Hipparchus being altogether astronomical, it is but natural to expect that his realization of these principles would be very imperfect. As Ptolemy says (Geogr. i. iv. § 1), “Hipparchus alone (among preceding writers) handed down to us the north polar elevation for a few cities among the great number laid down on the map, and that too of places lying on the same parallel.” Further, how far theory prevailed with him over practice is shown by his remarkable error in the latitude of Byzantium. But most important of all he was not in the strict sense of the word a geographer. He did not make a map, neither original, nor did he rectify the ancient map, but rather endeavoured to apply that ancient map to his own astronomical purpose, and in so doing was led to criticize it as left by Eratosthenes. [21] (His real service to geographical science was to suggest the idea of a scientific framework, at least with respect to the system of latitudes, which was carried out in practice by Ptolemy, but which formed no part of the work of Hipparchus to himself.

§ 8.—Recapitulatory.

Geography has now been traced from its origin with the poets through the philosophic schools till passing thence it became a science. The various steps in scientific Geography are sufficiently apparent; the travels of Pytheas astronomically verified; the base line or prime parallel of Dicæarchus, supplemented by the fundamental and other meridians of Eratosthenes; which again gave way to the more accurate determination of the length and breadth of the inhabited earth by Hipparchus, are all stages which pave the way for the man who could understand them, and accurately fit in stations consistently with the theory. Therefore, Ptolemy is the true follower of Hipparchus, and the names which are scattered through the intervening three centuries mark retreat rather than advance. However, a brief notice of these others may be added partly to keep up the connexion of the dates and partly also to show the great difficulties Ptolemy had to contend with, and the many paths which were offered to him—all leading from the truth.

§ 9.—From Hipparchus to Ptolemy.

(a) Posidonius.—Next after Hipparchus occurs the name of Posidonius, who lived in the first century, and resided chiefly at Rhodes. His name is connected with a new measurement of the earth; in fact the later calculation which he made was accepted by Ptolemy. Eratosthenes having calculated from Alexandria to Rhodes, Posidonius likewise started first from his native city, and worked in the reverse direction from Rhodes to Alexandria. From observations such as the altitudes and disappearances of constellations or stars observed at each, he decided the distance to be 5000 stadia; he likewise over-estimated the arcual distance as 1/48 of a great circle. Hence, multiplying the two together, he obtained the result 240,000 stadia as the whole circumference. Now it so happened that the errors in both calculations were upon the same side, namely, in excess, consequently they partly balance, and the result came nearer the truth than any other of the calculations upon record.

Unfortunately, in a second attempt he spoiled the harmony of his errors by correcting the nautical distance while the arcual distance remained the same. He now estimated the former at 3750 stadia, which gave him 180,000 stadia for the whole circumference. It is worth while remarking that he errs just as much in defect as Eratosthenes in excess—the globe of the latter is one-sixth too large, that of Posidonius one-sixth too small. Taking the true measure of a degree as 600 stadia, Eratosthenes took 700 st. and Posidonius 500 st. Perhaps, as coming last, or for some other reason we cannot now trace, this measure prevailed over that of
Eratosthenes; and just as Hipparchus without question accepted the one, so Ptolemy equally without question accepted the other, each believing that, whether accurate or not, it would not make much difference for the observation of heavenly bodies from the several stations.

(b) *Strabo’s Map.*—Strabo quite ignored the fertility of the principles of Hipparchus, and returned back to the older and less developed ideas. Accepting the earth as spherical and divided into zones, he took as the basis of his map the north temperate zone. Believing the frigid and torrid zone alike uninhabitable, he considered it an immediate inference to say that our habitable world lay in the North Temperate zone. Here it lay, like an island in the midst of the sea, occupying about half of the chosen zone in one hemisphere, and resembling in shape a military cloak or chlamys. The length he decides is about 70,000 stadia, and the breadth less than 30,000 stadia.

He next passes to the method of giving an actual visual picture of it which could be done by taking a sphere “like that of Crates,” and dividing it into zones with the cloak-shaped inhabited world in the proper position. But considering how small a portion the inhabited world would cover, it would be necessary, he says, that the globe should be not less than ten feet in diameter. Therefore the student who cannot obtain one of such size had better delineate his map upon a plane tablet not less than seven feet long.

Here we reach the map of the world on a plane projection, and the infantile simplicity of this unscientific process—which indeed can scarce be called a projection—shows how much was left for Ptolemy to do. It is simply a division of the surface into irregular rectangles, determined by climates and distances, abandoning any attempt to preserve their proportionate intervals. For, he reasons, it will make little difference if instead of the circles, namely, both parallels and meridians, we use straight lines—those used instead of the parallels, parallel, and those used instead of the meridians perpendicular, since the imagination can easily transfer the form and magnitude seen on a plane surface to the curved and spherical surface.

This brief sketch of Strabo’s map on a plane surface is quite sufficient to show how far he fell short of even the idea of a true projection. As a “descriptive geographer” his mind was possessed by the notion of a map as a picture, not so much for any scientific use in exhibiting true relations of distance, as for a framework on which to lay down the records of itinerary distances with an approximation to accuracy in the resultant positions, y

(c) *Increase of data.*—The interval of about a century which separates the work of Strabo and Marinus is just the period at which the Roman Empire reached its widest extent and most undisputed power. The rule of the Cæsars, from Augustus to the Antonines, over the civilized world from Britain to Africa, and from the Rhine to the Euphrates, further the expeditions beyond these frontiers, and the vast extension of commercial enterprise prompted by the wealth and luxury of the Empire—all aided in the vast and rapid accumulation of information most serviceable to Geography. As examples there may be mentioned the exploration of the Nile to the Lakes by two centurions in the time of Nero, the expedition of Suetonius Paulinus into the heart of the Sahara; the regular voyage down the Red Sea along the coasts of Africa and Arabia, beyond the Straits into the Persian Gulf, and still further to India and the Eastern Archipelago, while simultaneously land travels were undertaken frequently by the merchants through the heart of Asia to the far East. The reign of Antoninus Pius, during which Ptolemy lived, was rendered remarkable in this connexion by the erection of the further wall in Britain and the despatching a Roman embassy to China.

This period is marked by the names of Pomponius Mela and Pliny, as well as certain important contributions to special Geography. These works, however, have little bearing upon the growth of Geography beyond being the literary expression of the rapidly accumulating
mass of information. They, therefore, form a connecting link between the meagre details of earlier writers and the comprehensive knowledge displayed by Marinus.

(d) *Marinus.*—The name of Marinus has been saved to us by the careful manner in which Ptolemy acknowledges every instance in which he stands indebted to him. No one can read Ptolemy’s account of Marinus (Geog., Bk. i., ch. 6) without recognizing the kindly spirit in which the latter geographer enumerates each of the excellencies of the earlier, which spirit is maintained all through the discussion. “Indeed,” he goes on to say, “if we saw nothing wanting in the last edition, it would be enough to construct our map of the inhabited world from his alone of the commentaries.” The defects pointed out are, that “even Marinus” has set down some things unworthy of belief, and secondly, that he did not exercise the required care about the plan of his map.

The meaning of the last assertion can be more fully seen if we consider what exactly Marinus did in connexion with map-making. He accepted Strabo’s map, with its local right lines passing north and south and east and west, and upon this he ticked off new places as discovered—according to Ptolemy’s account frequently changing their positions according to later information. [22] In fact, he (Marinus) says himself, in the last issue of his “Commentaries,” that he had not as yet reached the drawing of a map [23] He does not seem to have been aware that even if all his measurements were most accurately determined there will still have been a large amount of error inherent in the method of projection adopted by Strabo.

The relation of Marinus to Ptolemy may, therefore, be briefly characterized as follows:—Ptolemy, having established the mathematical basis of Geography, [24] chooses out Marinus as the commentator who has collected most data; these data he sifts most carefully, freeing them from internal improbabilities, establishing, where practical, a fixed standard for measuring the distance traversed by a day’s march, or in a day’s sail, correcting the few imperfect observations, and finally collating the accounts of Marinus with information which Ptolemy himself possessed. Then, and not till then, did Ptolemy adopt the corrected records.

*Ptolemy and his geography.*

§ 1. — General Plan of his Work.

Ptolemy was not so much an author as a practical astronomer. The astronomy which he cultivated was not the theoretical science which has become accidentally associated with his name, but rather the practical observation of celestial phenomena. But as these vary according to the different positions of observers upon the earth’s surface, Hipparchus had long before Ptolemy pointed out the necessity of so fixing positions on the earth, that the appearances of the heavens seen from each of them could be approximately recorded. The inquiry, thus indicated by Hipparchus, was actually carried out by Ptolemy, who undertook to construct an improved map of the world, in order that the positions thus determined might be used for astronomical observations. The construction of such a map for such ends was his real object—not the composition of a treatise on Geography—and the Geographia is simply an exposition of the principles upon which his map was made.

In the first book of the Geographia he explains how he made his map of the “habitabilis,” and in the following books he gives us—not, as seems to be generally supposed, the list of stations or places from which he made his maps, but having first plotted, by a process of simple triangulation, the positions on his map—his lists were constructed from it. In other words, the list of places, with their longitudes and latitudes appended to the several maps, form an index to the maps, and not a table of the data from which they were constructed.
§ 2.—Its Astronomical Basis.

Turning to the Geographia itself we find that he refers us back to his mathematical treatise; and in the Almagest there is a cross reference to the Geographia, which was even then planned out.

Having in the first two books of the Almagest explained fully the principles and method of the determination of positions upon the earth’s surface, by means of angular measurements obtained from the celestial sphere, he concludes the second book with the following passage which completely links the Almagest to this contemplated work—the Geographia:

“Now that we have finished the discussion of the angles, before completing the subject, we have still to investigate the principal positions of the notable cities, province by province, according to their longitude and latitude, with reference to the calculations observed at them. Inasmuch as such an exposition is of great importance in itself, and pertains to geographical science, we shall notice it by itself, following the accounts of those who have treated of the subject as far as possible. Further, we shall indicate how many degrees each of the cities is distant from the Equator, reckoned on the meridian drawn through it (i.e., its latitude), and, moreover, how many degrees this meridian is distant from that drawn through Alexandria (i.e., its longitude); for it is to this that we refer the times of the positions.” [25]

We shall find that Ptolemy (Geo. ch, 2) expressly recapitulates the astronomical and mathematical data which he condenses from his larger work.

§ 3.—Its Consequent Limits.

Looking upon Geography as altogether ancillary to Astronomy, Ptolemy emphasizes this point in the opening chapter of the Geographia. He there defines it “an imitative delineation of that part of the earth comprehended within our knowledge as a whole, with its parts roughly (lit. generally) appended.” It thus differs from Chorography, inasmuch as the latter selects the various regions and exhibits each separately by itself, copying all the details, even to the minutest, contained in that portion—such as harbours, villages, districts (or townships), the tributaries branching off from the main rivers, and other things like these. The proper object of Geography, on the other hand, is to exhibit the known earth in its unity and continuity, showing its actual condition and position, and the features belonging to it only in general outline, such as gulfs, the more important cities, nations, the more important rivers, the more remarkable things, each after its kind.

He goes on to further distinguish the two by saying that “Chorography deals with the part only, Geography with the whole, as the artist who copies an ear only or an eye only is to be distinguished from the artist who paints the whole figure. Further, the former is concerned with the kind (τὸ ποιεῖν), whereas the latter deals with magnitude (τὸ ποιοῦν), and thus aims at representing the proportion of distances, positions, and the general configurations by mere lines and the appended form.” [26]

Lastly, Chorography having to do with depicting, has therefore “no need of mathematical science, but in Geography this plays the leading part.” [27] For the Geographer “ought first to consider the form and magnitude of the whole earth; and, moreover, its position with regard to the surrounding heavens, in order that he may be able to say, with respect also to the part of it comprehended within our knowledge, both how great and of what kind it is, and, moreover, as to the several places in that part, under what parallels of the heavenly sphere they are situated. [28] From all which it will be in our power to determine both the length of the days and nights and which of the fixed stars become vertical and which of them always revolve
above the earth or below it (i.e. those which never rise above the horizon of the place in question); and, in short, whatever is connected with an account of the habitabilis. All which forms the most sublime and beautiful study revealing to human understanding by the aid of mathematical science, on the one hand the nature of the heaven itself (inasmuch as it can be seen revolving round us), and, on the other, as regards the earth, showing by means of a sort of likeness that the real earth, which is very great and does not go round us, cannot be inspected by the same men either as a whole or in its several parts.”

§ 4.—His Data and Pre-suppositions,

Having thus defined his meaning of the word Geography, he next proceeds to mention the data to be used. “I” may now ask the reader to accept what has been said as a rough sketch of the object to be set before anyone who proposes to do the work of a geographer, and the difference between him and a chorographer. Proposing, as we now do, to delineate or map out (καταγραφαίνι) the world as inhabited at our epoch, so that our map may tally as nearly as possible with the actual world, we consider it necessary to state, at the very outset, that our datum is the body of information obtained from travellers. Now this furnishes us with the greater part of our knowledge, which is derived from the accounts of those who traverse the countries in their several parts with most careful scrutiny. But both in such survey and the accounts of it part is ‘geometric’ and part ‘meteoroscopic’ The ‘geometric’ method determines the positions of places by base measurement of their distances; the meteoroscopic, on the other hand, by observations taken by the astrolabe and gnomon. The latter method is more satisfactory and accurate, while the other is more general and dependent upon the ‘meteoroscopic’ For, first, suppose we would set down, according to the first method, to what part of the globe the distance between the required places is to be assigned, we must know not only the interval between them, but further towards what quarter of the Universe this interval points—for instance, whether to the North or the East, or the various directions sub-dividing the space between these. Now, it is impossible to determine anything of the kind accurately without the aid of the two instruments mentioned above; for by means of these at every place and every time, we can easily find the position of the meridian, and by means of the meridian the bearings of the distances already obtained.

“But, secondly, suppose all this were granted, such a measurement by stadia does not make the apprehension of the truth quite definite. For we rarely meet with perfectly straight ways, since many deviations occur both in itinerary distances on land and in a ship’s course on sea, therefore to find the straight line required we must subtract from the whole amount of the account the probable amount of deviation in the case of travels by land, while in sea voyages we must allow for the variable force of the winds. Further, suppose the net distance between places on the line of march were accurately determined, even this does not give the proportion to the whole circumference of the earth nor the position with regard to the Equator and the Poles.

“But the measurement by observation of celestial phenomena determines accurately each of these points. It shows, moreover, the magnitude of the arcs, which the parallel and meridian circles intercept upon each other. By this I mean the parallels cut off the arcs of the meridian between themselves and the Equator, while the meridians cut off those arcs which lie between them, both on the parallels and the Equator. Further, we learn what are the two places intercept from the great circle of the earth drawn through them. Now this method does not require any reference to stadial reckoning for showing the proportion of the parts of the earth or for the whole plan of the delineation (or map). For it is sufficient, if we assume the circumference of the earth as consisting of any number of parts whatsoever, to show the several distances as occupying so many of those parts described upon a great circle of the earth. On the other hand, when we come to reduce the whole circumference or any of its parts
to certain and known intervals we cannot do without the measurement by stadia. And for this one reason alone was it necessary to fit in some one of the straight roads with an equal arc of a great circle; and so, by determining both the pro-portion of this (arc) to the whole circle by observation, as well as the length of the road in stadia by measurement, we can find the number of stadia in the whole circumference.”

§ 5.—Manipulation of the Data.

Having given a decided preference, theoretically, to the astronomical (“meteoroscopic”) class of data, when Ptolemy comes to deal with them practically he is met by a difficulty. He had too few of them to serve his purpose. As he says (ch. iv.) : “These things then being so, if only travellers in the several countries had happened to have used such observations, we should have had the means of delineating the inhabited world in a form beyond dispute.”

“ But, as a matter of fact,” he continues, “Hipparchus is the only person who has given polar elevation of some few cities, while some of his successors have recorded ‘ the positions lying opposite to one another,’ that is, those approximately under the same meridian. More-over, distances (especially east and west) have been inaccurately reported, owing to the want of sufficient astronomical knowledge, and also to the neglect of the observation of lunar eclipses.” This being so there remained no other course but to set down certain fund-amental points, whose position Ptolemy believed was accurately determined, and starting from these the remaining positions were consecutively put in according to stadal measures or other evidence. He thus himself explains this process : “ It would then be reasonable that a person undertaking to make a map according to such data should first lay down in his delineation, as foundations, the points derived from the more accurate observations ; and next, he should fit into these the information derived from other sources until the relative positions of the latter to one another are found to preserve, with their relative position to the fundamental points, as near an agreement as possible with the more accurate reports of travellers.

§ 6.—Projection.

Having ascertained such fundamental points as he considered necessary, it is obvious that the last step is to project the “ habitabilis” upon a plane surface. At the end of the first book Ptolemy describes two projections, the first of which is of a conical, the second of a globular type. After describing his conical projection, he says (Bk. I., ch. 24, § 9) that the plan of the map might be made “ both truer and more symmetrical” if a second projection be adopted. He then describes a projection of the globular typo, and concludes by saying (§ 22) that the globular is preferable, and he will use it both here and elsewhere, though both are given on account of the difficulty in drawing the latter. It is a curious fact, which should not be omitted, that near the end of Book VII., there will be found instructions for drawing the map of the earth within the armillary sphere. Though this, at first sight, may appear to have been intended as a projection, there is no pretence that Ptolemy ever used it, and it was probably intended for decorative purposes, of which we see so many examples in ancient mural paint-ings. For the present work its most important purpose is the exhibition of the ignorant care-lessness of the editors, of which it is a remarkable example.

It is worth noting that in some MSS. and early editions the conical projection is used, but there is reason to believe that these maps represent the work of Agathodaemon.

Having described the plan of projection adopted, Ptolemy’s work was ended, and the re-maining books of the Geographia are merely a series of indices to his sectional maps ; so it may be said that to Ptolemy we owe the first Atlas, as his work would be named in the present day.
[6] Hipparchus Comm. in Arati Phænom. i. 5.
    named star as a, Ursae Minoris; also Professor Foster of the Berlin University.
[12] Strabo, ii. 4, par. 104.
[13] These dimensions of Pytheas are so excessive that they cannot have been the results of
    his actual work; but the discordance may be explained so as to reconcile the discrepancy.
    In transmission the day’s sails have been reckoned as day-and-night’s sails, and these
    have been given in stadia. We know from Solinus that the technical value of a day’s sail
    was changed, and so far as Thule is concerned the distance is reduced to one-third, and
    the same is equally true of the length of Britain. Further, Lclewel makes the distance from
    Cantium to Orcas 4821 stadia, which is not quite one-fourth of the number attributed to
    Pytheas.
[18] Hipparchus was alive 150 B.C., Ptolemy 150 A.D. Suidas places him from B.C. 160 to 145,
    without mentioning the dates of his birth or death. From Ptolemy’s “Almagest” (v. p.
    299) we learn that Hipparchus made an observation in the 197th year after the death of
    Alexander, that is in 126 B.C.
[20] Indeed the same remark applies to even late mediæval estimates.
[22] Geog., Bk. i., chs. 18, 19, 20, passim.
[23] The passage establishing this important fact in the history of ancient Geography has been
    hitherto entirely ignored. Critics have been misled by Ptolemy’s mention of the “map of
    Marinus,” and have consequently credited him with a mathematically constructed map of
    the greater part of the ancient world, which it was further supposed Ptolomy had appropri-
    ated.
[24] This we shall see hereafter from the “Almagest,” where all the mathematical principles
    necessary for geography are to be found, though Ptolemy, had not at that time dealt with
    the subject, or from the Geography itself, where these principles are briefly recapitulated
    before any mention is made of Marinus.
[26] Ptolemy’s coast-line is always somewhat conventional, as he has but one consistent
    system for depicting promontories, gullfs, and other features. He knew nothing (other than
    by these differences) of the actual peculiarities of each station.
[27] It is possibly worth referring to Werner’s ingenious note upon Chapter I., where he points
    out that Ptolemy has distinguished Geography from Chorography, according to each of
    the Aristotelian “Four Causes.”
[28] It should be noted that in all works prior to Ptolemy the lengths of days and nights deter-
    mined the positions, while with Ptolemy the position is the basis from which to determine
    the lengths of days and nights.
[30] Under the head of observations were classed astronomical observations, especially lunar
eclipses, variations of climate, natural productions. Ptolemy's strong preference for this
class of data is evident from the astronomical purpose of his work.

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