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ON THE EARLY HISTORY OF CARTOGRAPHY, OR WHAT WE KNOW OF MAPS AND MAP-MAKING, BEFORE THE TIME OF MERCATOR.

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The pressure of my judicial duties this year have made it impossible for me to examine the numerous sources of information which are requisite to give in an annual address, as I have done for many years, an account of the geographical work of the world. I have therefore substituted for it an account of what we know about maps and map-making before the time of Mercator—a subject I have previously investigated, and which, I trust, will prove interesting, as very little is to be found respecting it in any book in our own tongue; and, with the exception of the learned Portuguese, Viscount Santarem's Essay on the Cosmography and Cartography of the Middle Ages, the Polish geographer Lelewel's work upon the geography of the same period, and a brief paper by the late M. D'Avezac upon the history of the projection of geographical maps, there is nothing specially devoted to such an inquiry—at least, so far as I know—in any language.

It is now more than three centuries since Gerard Krehmer, better known to the world by the Latinizing of his name as Mercator, produced his large map of the world. The field of my inquiry is before this, and as it extends over a period of more than 2000 years, in respect to which our knowledge is very imperfect, it is not to be expected that I could, within the limits of an address like this, go very fully into details or enter upon a critical investigation of the subject, which is an obscure and difficult one. All, therefore, that I propose to do is to give, in a general way, some

account of what we know, with such conjectures as may be reasonably indulged in.

The origin of maps is involved in as much obscurity as the invention of letters. The cartographic art is probably as old, or older than the invention of the alphabet. We know that the art of writing began with pictorial representations of objects, which is still distinguishable in the Egyptian hieroglyphics, the earliest form of writing with which we are acquainted; and we may fairly assume that long before letters were invented to represent the articulate sounds in human speech, by an arrangement of which any spoken word can be put in writing, that man had sufficiently advanced in the knowledge of the arts of design, to be able to represent the position of countries, cities and towns, the course of rivers, the situation of seas, the locality of mountains, or other distinguishing features of the earth's surface, by some form of delineation, or map, so far as he had occasion for it; for this art has been found in use amongst races who had had no previous contact with civilized man—races that had never advanced so far as to invent a written language. Parry and Ross were astonished to find that the Esquimaux understood their charts; that they were able to recognize upon them not only the outlines of coasts and the positions of places, but to continue the drawing of the coast lines in the delineation of portions of the Arctic unknown to the explorers. Parry published several of these Esquimaux charts, or maps, which, when further explorations were made, were found to be remarkable for their accuracy. Nor is this art confined to the Esquimaux, for the North American Indians have, and have always had, maps which, however rude they may appear to us, are intelligible and serviceable to them.

One of the earliest things known in the nature of a map is the ground plan of a town, now in the Koyunjik gallery of the British Museum, which has been identified by Mr. Loftus as representing with minute accuracy the ground plan of Susa, the Shushan of the Bible, a city of remote antiquity, situated on one of the streams that flow into the lower Euphrates, a little to the north of the head of the Persian Gulf, the country from whence the people or race came that built Babylon, and founded the Chaldean civilization. The age of this topographical work is unknown, but it is assumed to be as old, at least, as the seventh century before Christ. It represents,

in a rude form of design, the plan of the town, its walls, the citadel, the king's palace, and a central square, surrounded on three sides by what is either a wall or a colonnade of buildings of uniform character. On the remaining side of the square is a large gateway, and the suburbs surrounding the town are represented as planted with date trees, and interspersed with buildings to the banks of the river.

The Egyptians had maps of some kind. One of their sacred books was wholly devoted to the subject of geography ; but what it contained we do not know. They had also a learned official class at Memphis, called the "Hir-seshta of all the countries," who are supposed to have been geographers. In the earlier period of their civilization they kept, like the Chinese, closely within their own limits, trading only with the people upon their immediate borders—although it is known that even then, in one or two instances, they sent out intelligent men to gather information respecting certain parts of Asia. As they increased in civilization and power, they acquired, at a comparatively early period, a considerable knowledge of the geography of the world as then known. The military expeditions and conquests of Thutmes III, 1600 B. C., and Rameses II, the Sesostris of the Greeks, 1333 B. C., extended over Asia to Nineveh on the Euphrates, and to the confines of India. They extended also over a large part of Northern Africa, to the north of Greece and almost to Central Europe, embracing nearly the whole world, as known to the ancients. These conquests, however, were but transitory, it being easier to make them than to maintain them; but they were so extensive as to give to the Egyptians, necessarily, a large amount of geographical information ; and as they were a highly civilized people, when Greece was yet in the heroic age, they probably retained this knowledge through a long course of centuries.

As they had, like the Chaldeans, made great progress in the science of astronomy, they doubtless had some general idea of the true form of the earth, and possibly both of its revolution upon its axis, and of its annual revolution around the sun, of which there are some indications. That they had maps, we know to be a fact, from recent information. There is a papyrus preserved in the museum at Boolak containing a map of Lake Moeris on the Nile. It shows the plan of the basin, with its canal and the position of towns and of

certain sanctuaries upon the borders of the basin, with explanatory texts giving information respecting these places. There is also an old Egyptian map preserved at Turin, of what is now Wady Alaiki, where the Nubian gold mines were situated, in the land anciently called Aki-ta. It is a mountainous country, of dreary, sterile, waterless valleys, where men and beasts died upon the roads to these mines. The map shows the mountain tracts, the rocks, and the places where gold was found; the ore-bearing mountains being marked in red color. It also shows the wells, a temple erected to Amon on the mountain, and the appurtenances and buildings in the gold districts. The roads, which had been abandoned, leading to the sea are also given. "Nothing," says Brugsch Bey, "is forgotten calculated to give the spectator an idea of the state of the region, even to the stones and the scattered trees along the roads."* This description is sufficient to show that the Egyptians knew the value of maps, and that they made and used them. These gold mines were worked in the reign of Rameses II, and if this map was made at that period, as from the description given of it would seem to be the fact, then it is the oldest map known. There is a passage in Apollonius of Rhodes, which is supposed to refer to the maps used by Rameses II, but it is too uncertain to predicate anything positive upon it. This information, which, as far as I have been able to ascertain, is all that has come down to us, is too limited to enable us to judge what progress the Egyptians had made in the cartographical art, but the probability is that they did comparatively little for its advancement, as they were at no time a migratory, colonizing or navigating race.

It was very different, however, with their neighbors, the Phœnicians. They were the great maritime nation of antiquity, making constant voyages along the coasts of the Mediterranean on either side, and along the western coast of Europe, as far as Great Britain, and possibly farther. The outlines of a coast once seen would, it is true, be sufficiently preserved in the memory for the practical purposes of navigation ; but a people who had extended their voyages so far, who had established so many colonies, and to whom is attributed the invention of the alphabet, would naturally be led to the

* Brugsch Bey, Egypt Under the Pharoahs, vol. 2, p. 79 ; *id.* vol. 1, p. 169, Lond., 1879.

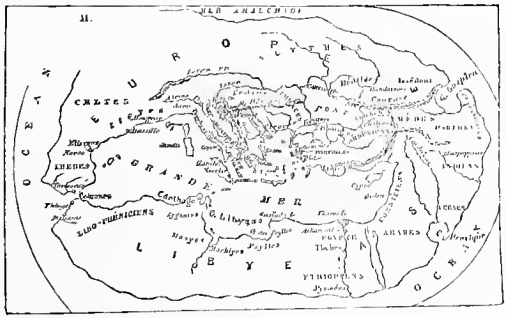
construction of charts, from their utility, as well as maps to give some general idea of the world, of which they knew more than any other people. A jealous commercial policy kept them from imparting their knowledge to others, so that we do not know whether they had maps or charts, which is not remarkable, as we know, in fact, so little respecting them.

It is from the Greeks that we get our earliest knowledge of geographical maps. The first information we have upon the subject is from passages in Herodotus and in Strabo. Strabo says that Anaximander, who was born B. C. 612, was the first who represented the world upon a map. Diogenes Laertes ascribed to him the invention of geographical maps, and also of the gnomen, the simple instrument very much like our own sun dial, with which the ancients, in connection with the clepsydia or water-glass, made their astronomical observations; but the gnomen is known to have been in use among the Chaldeans long before the time of Anaximander. He may have introduced it into Greece, which was enough to have the invention of it attributed to him, for the Greeks were very like our English brethren—if any one of their countrymen was connected with the introduction among them of a new art or discovery, he was frequently declared to be the inventor. The passage in Herodotus is more definite and more interesting than the one in Strabo. He says that, according to the report of the Lacedemonians, Aristagoras, when he went (504 B. C.) to Cleomenes, the King of Sparta, to induce him to invade Persia, he produced before the Spartan King "a bronze tablet, upon which the whole circuit of the earth was engraved, with all its seas and rivers."

It has, until recently, been fashionable amongst historical critics to repudiate many of the statements of Herodotus, and this passage has not escaped. It has been pronounced impossible, or exaggerated. I see nothing impossible or exaggerated about it. If Anaximander had, about half a century before, constructed a geographical map, there is nothing remarkable in the statement that Aristagoras should bring with him an engraved representation of the circuit of the earth as then known, to show the Spartan King where the country was situated he was solicited to invade.

It has been said that Anaximander knew that the earth was a sphere, and so constructed his map, but I apprehend that there is

Homer's World.



Map of Hecataeus, B. C. 500.

corresponding to it, above the plain, was the heaven, or abode of the Gods. The unknown region beyond the Pillars of Hercules was filled up with creations of the fertile imagination of the Greeks. To the northwest and north were the Cimmerians, a people living in perpetual darkness; and the hyperboreans, a race supposed to be exempt from toil, disease or wars, who enjoyed life for a thousand years in a state of undisturbed serenity. To the west of Sicily were the enchanted islands of Circe and Calypso, and the floating island of Eolus. A little to the north of the Pillars of Hercules was the entrance to the infernal regions, and far out in the Western Ocean, beyond the limits of the known earth, was the happy region called Elysium, a land of perpetual summer, where a gentle zephyr constantly blew; where tempests were unknown; and where the spirits of those whose lives had been approved by the gods dwelt in perpetual felicity. Here also were the gardens of the Hesperides, with their golden apples guarded by the singing nymphs, who dwelt on the river Oceanus, which was in the extreme west, and the position of which was constantly shifted, as geographical knowledge increased. No doubt, the unknown and fabulous was mingled with what was known, in the map of Hecataeus. Herodotus, who wrote a century later, had evidently a poor opinion of it, or at least of the maps existing when he wrote. He says, "For my part, I cannot but laugh when I see numbers of persons drawing maps of the world without having any reason to guide them; making the ocean stream to run all round the earth, and the earth itself to be an exact circle, as if described by a pair of compasses." The last remark may possibly have been applied to some attempt to construct a map with reference to the globular form of the earth, for Parmenides, a contemporary of Herodotus, is said by Diogenes Laertes to have been the first person who asserted that the earth was of a spherical form, and that it was situated in the centre of the universe; and the same idea was entertained by Socrates, who was in the enjoyment of a wide-spread reputation more than twenty years before the death of Herodotus. Strabo credits Parmenides also with having been the first to divide the globe into five zones, or, as they were then called, climates. The statement of so late a writer as Laertius, that Parmenides was the first to propound the true theory of the form of the earth, would not of itself be entitled to much weight, but the statement is

probably true, from what is known from contemporaneous sources. We know very little respecting the man who appears to have been the first, at least in Greece, to express a belief in the rotundity of the earth. Plato, who calls him the great Parmenides, says that he was a native of Elea, on the west coast of Italy, and that he came to Athens when rather an old man, with hoary locks and a handsome, noble aspect, and that Socrates then became acquainted with him, so that it is not impossible that it was from him that Socrates received his impression of the spherical form of the earth. Socrates says, as recorded by Plato, "the earth is neither of such a kind or of such a magnitude as is supposed by those who speak of it, as I have been persuaded by a certain person," who may have been Parmenides. Afterwards, in the same dialogue, he refers to the supposition that the earth is of a spherical form, and is in the middle of the universe, and argues that it has no need of anything to prevent it from falling; that it is a thing in a state of equilibrium, placed in the middle of something which presses it equally on all sides, and therefore remains immovable. Although he evidently believed the earth to be of a globular form, his ideas respecting it, and especially as to the character of its surface, were not very clear or definite. It was not so, however, with Aristotle, who, half a century afterwards, was thoroughly convinced that the earth was a globe, and drew that conclusion from the shadow which it casts upon the sun in eclipses; from the fact that the polar distances diminish as we go to the north or the south, and from the tendency of all bodies to fall towards the earth; and after Aristotle's time, the fact that it was not a plain, but a round ball or globe, was generally accepted by the learned. They were, however, few in number; and as it was opposed to the evidence of the senses, it being hard to believe that the sea, which appeared to the eye to be level, was in fact convex, there is no reason to suppose that, at any time, it was a matter of popular belief, especially when we find that, four hundred years afterwards, so accomplished a man as Tacitus disputed it.

When the idea became firmly fixed in the mind of the learned that the earth was a sphere, it naturally followed amongst an artistic people like the Greeks that some attempt would be made to give a physical representation of it, and accordingly we are told that Crates, B. C. 326, constructed a globe of the inhabited part of the earth, from the arctic to the tropic, in the form of a half circle.

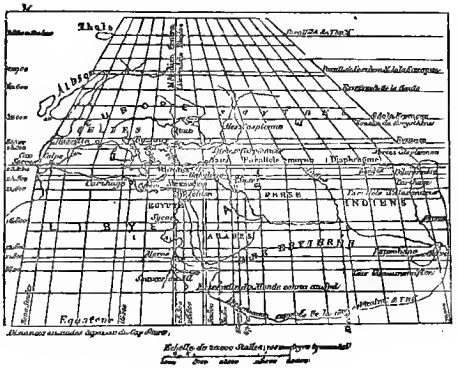
The zone about the tropics he represented as an uninhabitable portion entirely covered by water, a belief which existed for a long time afterwards, and the southern half beyond, as that of an unknown but inhabited region. Strabo refers to the globe of Crates, with which he appears to have been familiar, and describes how such a globe should be constructed, which he says, to present all the regions of the habitable earth accurately, should be at least ten feet in diameter. The diameter of the little globe I now hold in my hand, which took the prize at the Paris Exhibition, and contains more than Strabo ever dreamed of, is less than five inches.

Dicearchus, the Messinian, B. C. 296, a very accomplished man and the writer of several geographical works which are lost, constructed a map of the world in an oval form, which appears to have been highly estimated, and to have been the model upon which subsequent maps were made. We know that maps were in use from the time of Dicearchus to the period of Eratosthenes, but whether they were constructed with reference to the globular form of the earth, or how they were constructed, we have no information. It is inferable, however, from passages in the classic writers, that those at least in popular use conformed in respect to the unknown part of the world to the ideas deeply implanted in the popular mind by the poems of Homer and from other sources.

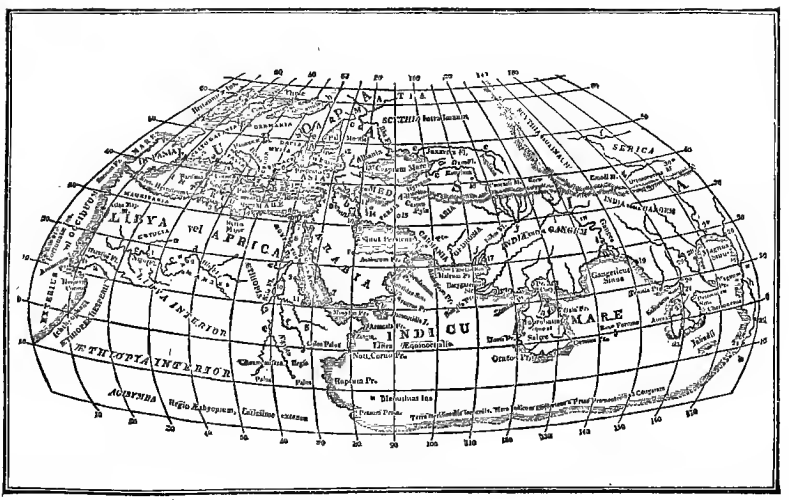
With Eratosthenes, who died about the beginning of the second century before Christ, the science of geography may be said to have begun. He was the first to apply a purely scientific method to ascertain the magnitude of the earth; for when a knowledge of the exact circumference of the globe was once obtained, the different countries and places could be arranged in these ancient maps, in their relative position to each other, far more accurately. The distances between places in what was then known as the inhabited part of the earth, was previously ascertained by the number of days it took to go from one place to another, derived from the information of travelers and mariners. This information, collected in the form of intineraries, was all that the ancient geographers had, which was not a very certain measure of distances even upon the land, and was much more uncertain when the journey was by sea, the vessel being subject to the caprice of the winds, and liable to be delayed by calms, head winds, storms, or other impediments; so that the number of days that a vessel took in sail-

ing from one place to another was a very unreliable means upon which to depend for computing the distances between places.

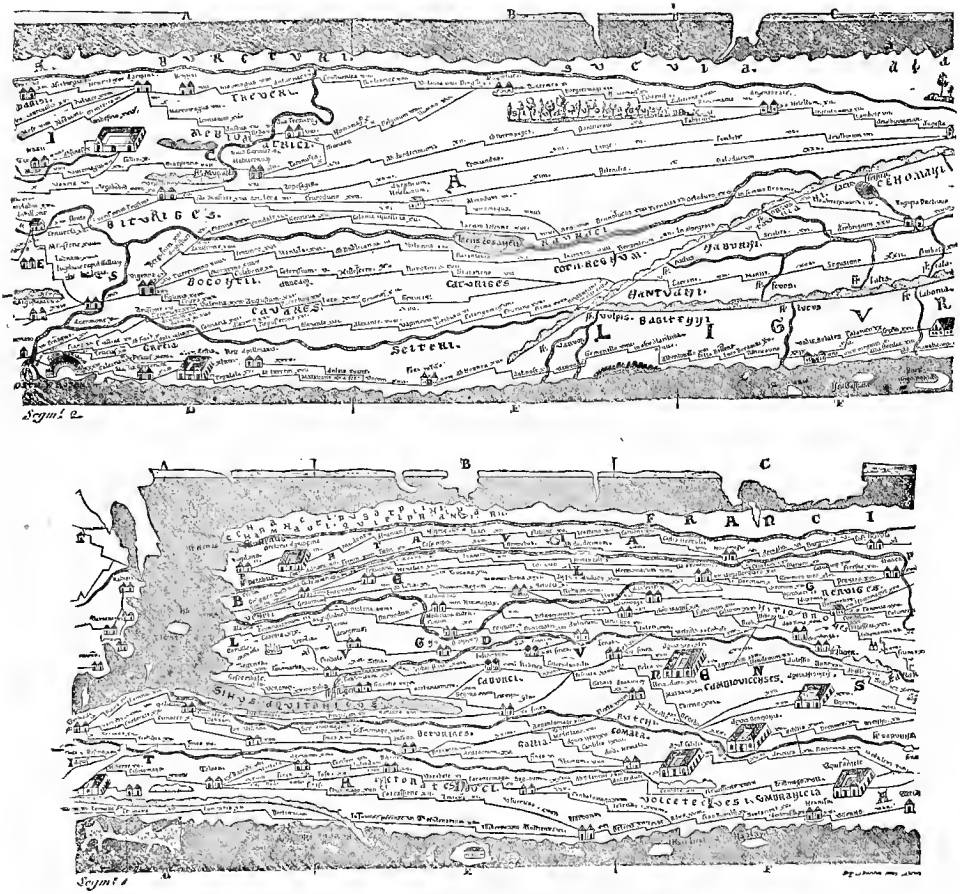
To rectify the errors which became more apparent and confusing as the inhabited part of the world became better known, Eratosthenes devised, what has ever since been employed, as the most accurate means of determining the circumference of the earth, the measurement of an arc of the meridian. He found a confirmation of the globular form of the earth in the fact that at Syene, in Upper Egypt, upon the tropic, the sun at noon on the day of the summer solstice was vertical; that is, that it cast no shadow, a well at the bottom being enlightened by its rays; whilst at Alexandria, upon the same day and time, it was distant from the zenith one-fiftieth of the circumference of the circle. He assumed, in which he was slightly inaccurate, that Syene lay due south from Alexandria, or, as we should now say, in the same longitude, and the distance between the two places having been measured by the royal overseers of the roads, Eratosthenes obtained by this means the length of what is called an arc of the meridian, or a portion of the curved surface of the earth; and from this he was able, by a familiar rule, to determine the circumference of the whole circle. The distance between Syene and Alexandria was found to be 5,000 stadia, which, being the one-fiftieth part of the circle, gave for the whole circumference 250,000 stadia. His measurement was not very precise, but it was a beginning, and a very important one. Having ascertained in this way what he considered to be the circumference of the earth, he, in projecting his map, drew parallel with the equator, a line from the Pillars of Hercules to the farthest known point of Asia, and adjusted the places north and south of this line, in what he supposed to be their true position. We do not know what means he adopted in the division of the globe to indicate the exact position of places for his geographical work, and the map connected with it is lost. Our information respecting what he did is derived from Strabo and others, and from passages quoted in Strabo, it appears that he speaks of parallel lines, lines at right angles, and sections, showing that he had some mode of marking the divisions of the sphere. This was a great advance, but it was not wholly satisfactory; for Hipparchus, the greatest astronomer of antiquity, three quarters of a century afterwards, criticised Eratosthenes' labors rather severely, and declared that, in some respects, the previous maps were preferable.



Hipparchus, 100 B. C.



Ptolemy's Map, A. D. 150.



The Peutingerian Table, illustrating the Roman Maps.

The happy idea occurred to Hipparchus of applying to the earth the same method he had used in fixing the position of the stars in the celestial sphere. Regarding the earth as a great circle, which, like any other circle, is divisable into 360 degrees, he so divided it, by lines of circles drawn perpendicularly from the poles to the equator, and by parallel lines at equal distances from the equator to the poles; which was the beginning of the division of the globe by lines of longitude and latitude, into degrees; or, as the Greeks called them, the divisible parts of a great circle. When this was done a foundation was laid for scientific geography, and the more accurate representation of the relative position of places upon the earth's surface in the construction of maps. But although Hipparchus hit upon the true method to be adopted, he was, as will subsequently appear, very far from accurate when he came to work out his plan in detail.

The Romans, in their representation of the earth, would seem, at first, to have followed Eratosthenes and Hipparchus. All that we know, however, upon the subject, is very limited. About half a century before our era Posidonius, who was a geographer, and had been an extensive traveler, constructed a universal map of the world, in which he did not adopt Eratosthenes' measurement of an arc of the meridian; but, to conform his map to his own astronomical ideas, he greatly reduced the dimensions of the globe, and thereby fell into the grossest errors in respect to the true position of places. The habitable part of the earth he represented somewhat in the shape of a sling, the greater extent being from East to West, and the broader part being at the East. We know also that the Emperor Augustus, about sixty years afterwards, ordered the geographers and designers to prepare for the use of the people a map of the habitable world, which should represent fully the extent of the Roman Empire; and, from some fragments that were preserved, it is known that this map was a cylindrical projection of a great circle. The Romans, however, had a map for practical use which they styled a *descriptive itinerary,* or, as they sometimes called them, "*painted roads.*" This map was in the form of a band about a foot wide, and about 20 feet long, upon which the habitable earth was continuously represented along parallel spaces. These maps, which, it would appear, were derived from the Greeks, represented pictorially and as well as by writing, the great routes or roads of the

empire, the position of places, with the distances between them; the range of the mountains, the direction of rivers, and the situation of seas, with other information, partly in writing, but chiefly by drawing. This kind of map was mainly used for military purposes, and was regarded as a map of the world, for the vast extent of the Roman Empire comprised nearly all that was then known of the habitable world. These maps were very numerous, and being full of topographical information, were of great value. As they served for all practical purposes, there was little motive for the construction of scientific maps of the world; which, moreover, were probably not in very good repute, for the topographical information supplied by the itineraries showed that the scientific maps then in existence were, as to the position of places and the size of countries, full of errors.

As information respecting the inhabited part of the earth accumulated, as it did, during the three centuries after the time of Hipparchus, by the voyages of mariners, the journeys of travelers, and in a large degree by the military conquests of the Romans, his representation of the position of places and countries was found to be very inaccurate; and Marinus of Tyre, who lived during the second century of our era, undertook, by a general reconstruction of maps and the preparation of an accurate geographical work, to correct these errors. He studied with great care the works of his predecessors, collected all the information that was procurable from travelers and mariners, and produced a geographical work far beyond anything that had preceded it, illustrated by maps which were covered with a network of parallel and meridian lines, cutting each other at right angles, under which the different places were indicated according to their direction and distance from each other. His object was to put an end to the uncertainty about the position of countries and cities, by assigning to every locality or place its approximate latitude and longitude. He divided the globe into sections, each having an astronomical extent of fifteen degrees, and the places falling within these limits he put together in what he supposed to be their relative position to each other. He drew a line due east from the Fortunate Islands, and arranged countries and places in what he regarded as their proper position north and south of this line, so as to bring them alike under the proper zone or climate, as well as under the astronomical section he had devised;

but the interior towns that lay in the same parallel of latitude he merely placed along that line, one after the other, in their proper order. He undertook to combine the results of astronomical observation with the information supplied by the itineraries of travelers, which was very difficult to do—as it was not easy to reconcile the distances between places as given by travelers and mariners, with their position as indicated by astronomical observation, both modes then being very defective. The only means for astronomical observation at that time was the shadow cast by the gnomen. The ancient astronomer had no compass to determine the course or direction. He had not the delicate instruments we have now for ascertaining the altitude of an object when in or near the meridian, nor a chronometer to mark the intervals of time. The latitudes, as ascertained by the simple means he possessed, were not always correct within a degree, nor could the longitude be ascertained within two degrees. Errors of three or four degrees were not uncommon in the position of places situated in the same country, and when they were in distant countries the errors were much greater. The distances between places, as supplied by travelers, were very defective, for the reasons already stated, and yet it was only from their information that anything could be exactly known respecting the surface of the earth When the geographers, therefore, undertook to harmonize their information with the true form of the earth and the position of places, as fixed by astronomical observations, a multitude of errors was inevitable. Marinus had not only to correct errors which had been ascertained by subsequent and more accurate information, but he had collected a large amount of new material which had to be properly disposed of, and the consequence was that in providing for it and adjusting it in his general delineation of the earth, he greatly exaggerated the distance or length of the inhabited part, from east to west. He revised his work, making many alterations, and would no doubt have greatly improved it thereafter, had not his labors been cut short by a premature death.

The geography of his immediate successor, Ptolemy, which has fortunately come down to us, was written at least within half a century afterwards, and as Ptolemy himself says, was based upon the work of Marinus. Ptolemy's labor was what, in this day, we would call editing a new and revised edition of an existing work. It was written to correct Marinus's exaggeration of the distance

from east to west; so that the map of the world might conform to the true figure of the earth; and to correct mistakes, through Marinus relying too much on the statements of travelers, and to correct parts of the coast line of Africa, and an erroneous representation of the Venetian Gulf. Ptolemy was a much better mathematician and astronomer, but evidently very inferior as a geographer to his predecessor. He undertook to correct Marinus's chief error by reducing his projection of the earth, from east to west, from 225 to 180 degrees. In making this geometrical correction, however, he fell into a multitude of errors which, had he been a better geographer, he would readily have detected. As Marinus's work is lost, we have no means of comparing the one with the other to ascertain to what extent the errors that abound in Ptolemy existed in the work of his predecessor. The impression conveyed is that they were, in a large degree, due to Ptolemy's attempt to make everything conform to his reduced geometrical proportion, by which he distorted the figure of countries and adjusted the position of places in a way that an able geographer would not have done. With respect to the distances given by travelers, he appears not to have taken into account whether the Greek or the Egyptian measures were meant, which was like a geographer at the present day accepting distances in miles, without enquiring whether they were German or English miles. He made the Mediterranean one-third larger than it is; and where Eratosthenes and Strabo had estimated the distance of the known world as about two-sevenths of the whole, he made it about one-half, adding to the length somewhat over 40 degrees, and by the liberties which he took to carry out his geometrical idea, he no doubt effaced a great deal which would have been valuable in tracing the progress of early geographical knowledge.

It would appear, from what is said in Ptolemy's work, that there was a set of maps attached to it. An edition of Ptolemy was printed in Rome in 1478, with ancient maps, twenty-six in number. Whether they are copies of original maps belonging to Ptolemy's work is an unsettled question. All that is known is that these maps were attached to manuscript copies of Ptolemy, as old as the eleventh century, one of which is at Vienna and another at Venice; and that at the end of these manuscripts there is this statement: "Agathodæmon of Alexandria delineated the whole inhabited world, according to the eight books on geography of

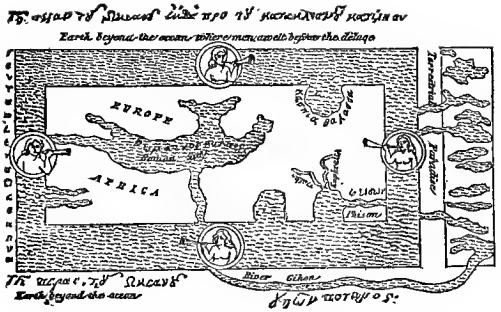
CLAUDIUS PTOLEMY.

(From an Old Map.)

Claudius Ptolemy." As all that is known of Ptolemy, apart from his works, is that he lived at Alexandria about the middle of the second century of our era ; and as the Agathodæmon referred to is described as of Alexandria, it is supposed that they were contemporaries, and that the maps were designed under Ptolemy's direction, and formed a part of his work. There is, I think, a reasonable probability that this may be the fact : that they are Marinus maps, reconstructed under Ptolemy's direction by the Agathodæmon referred to. Marinus's maps were in existence in the tenth century of our era, for in the work of the Arabian geographer, Masudi (Kitab et tenbih), which was written A. D. 955, he says, in referring to the division of the globe into climates or zones : "I have seen these seven climates illuminated in various colors in several books, and the best I have seen of this kind was in the geographical treatise of Marinus of Tyre."

Geographical enquiry was arrested for many centuries after the time of Ptolemy, and the preservation of his work is doubtless due to the fact that, being the last of the eminent geographers of antiquity, it was supposed to embody all that the ancients knew upon the subject. His idea of the earth was that it was an immovable body in the centre of the universe, and he rejected as absurd the theories of the philosophers before his time, who believed in the rotation of the earth upon its axis, and in its annual revolution around the sun.

This belief, which, in one form or other, had existed for more than four centuries before the time of Ptolemy, may have been derived from the Chaldeans or the Egyptians, in both of which countries astronomical observations had been carried on for more than two thousand years before Christ with an assiduity and precision which the Greeks never gave to the investigation of the physical sciences. The idea of the movement of the earth appears to have been first entertained in Greece by the philosophers of the Pythagorean school. Pythagoras, himself, is said to have passed twenty-two years in Egypt in acquiring knowledge, and the philosophers of his school, whose names are connected with the advancement of this theory, spent more or less time in Egypt, so that it may be that it was from that country that they brought away whatever impressions they had upon the subject. What the sect as a body really believed or taught in respect to the motions of the earth, is difficult to say.



Cosmos Map of the World.

Map of the World, 8th Century.

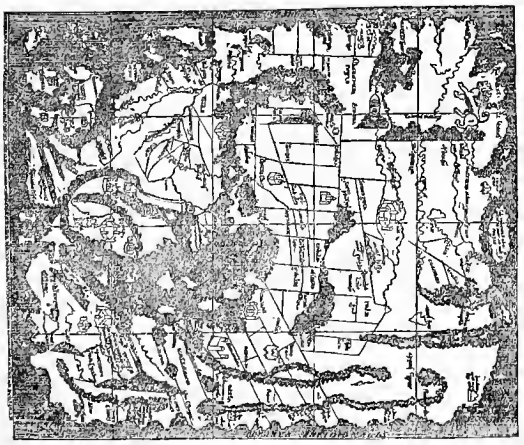
their works were generally rejected as contrary to Holy Writ. In the middle of the sixth century Cosmos, who had been a merchant, an extensive traveler, and who afterwards became a monk, was the writer of several geographical works, one of which has survived, in which he maintained that the idea of the earth being a globe was contrary alike to the Scriptures and to common sense; sustaining his views by ingenious arguments, which, in that age, were very convincing. Cosmos was not an ignorant man; on the contrary, his account of the countries with which he was acquainted was accurate and valuable, and it was his topographical knowledge which made him so formidable an antagonist in disputing the rotundity of the earth. "There are," he says, "false Christians, contemnors of the authority of Scripture, who dare to maintain that the earth is a sphere. I combat this error, derived from the Greeks, by citations from Holy Writ." He then ridicules the idea that the earth revolves in space without axis, or anything to support it, and characterizes the belief of antipodes, or people living on the other side of a round globe, as old women's tales. Having thus disposed of the anterior belief, he proceeds to give his own idea of the earth, which he says no true Christian can doubt. It was, that the earth was an oblong plain, enclosed at its four extremities by huge walls of immense thickness, on which the firmanent or vault of the heavens rested; and that near the North Pole there was a high mountain, around which the sun, the moon and the stars turned, the intervention of which mountain, at certain periods, caused eclipses.

From this point our knowledge is very obscure. It is the period of the dark ages. We know that in the seventh century they had maps in the monasteries of Ireland, for from the sixth to the ninth centuries there was an amount of learning in Ireland that was in striking contrast with the general ignorance that prevailed throughout Europe. In the eighth century Charlemagne brought many learned monks from Ireland and from England for the instruction of his people, and upon organizing his provinces he had constructed, it may be supposed, with the assistance of these monks, a general map of the world, which was engraved upon three large tables of silver. It did not exist, however, very long, for his grandson, Lothair, had the largest of these silver tables cut up into small pieces for distribution among his soldiers. The destruction of the other two probably followed in like manner, which is all that we know of this great map of Charlemagne.

We have now approached a period when Europe sank into the deepest ignorance. Communication between places was broken up through the long continuance of wars; roads were destroyed, there was little or no commerce, for traveling was difficult and dangerous, and people living in close proximity knew comparatively nothing of each other. It was, as I have before said, a period of rest and torpor, during which whatever was known respecting geography or maps was confined to the cloisters, where some interest in the subject was still kept up. In the 10th century an Anglo-Saxon map of the world was constructed in England, which is still preserved in the British Museum, though much injured by the ravages of time. It is a rude work, and very inaccurate; but in its general design and execution, it is in marked contrast with much ruder productions that followed it, and shows a knowledge of Roman geography, but a knowledge that was rapidly decaying.

Fortunately, however, this was not the state of things throughout the world. During the period that marks the rise, the maturity and decline of the empire of the Arabs, or from the 9th to the 13th centuries, geography was assiduously cultivated by them as a science-especially in Bagdad, the capital of the Caliphs, and for a part of that period in Spain. It is to the Arabians, and particularly to the geographical scholars of Bagdad, that we owe the preservation of the work of Ptolemy, which they translated into Arabic, and annotated; and they appear to have been well acquainted with what was known respecting geography as a science up to the point where Ptolemy left it. They determined the obliquity of the ecliptic, measured two arcs of the meridian, ascertained more accurately the longitude of places in Asia and about the Mediterranean, and enlarged descriptive geography by an account of the countries in Asia over which they had extended their conquests; for the Caliphs generally instructed their generals to give a geographical description of the countries they subdued. The Arabs had not only a knowledge of those parts of the interior of Asia which they added to their empire; but as early as the 9th century they trafficked in the ports of the Indian Ocean. They had intercourse also at that time with China, and it may he that it was through this intercourse that the mariner's compass was brought to the Mediterranean, for it was in use in China long before it was known in Europe. I may also mention, in this connection, that the Chinese, according to the state-

Map of the World, 10th Century.



Anglo Saxon Map, 10th Century.

ments of their own writers, had maps from a very remote period. It is known that there was, in A. D. 265, a map of the empire on twenty-four pieces of silk; and a Chinese writer of about that period speaks of an atlas of maps representing China and the barbarous countries conquered by it. He describes these maps as representing the mountains, seas, rivers, lakes, plains, and basins; and says that they were compiled by the order of one of the Emperors. It appears, also, that there was a triangulation of the Empire, A. D. 721, and that, in the 9th century, when the Arabs were in communication with the country, a map of the world was constructed, A. D. 820, in which China was represented as in the centre of the earth. But to return to the geographical labors of the Arabs :

In the reign of the Caliph Al Mamoun, A. D. 830, a geographical work, founded upon Ptolemy, was written by the custodian of the library of Bagdad, Abou Djafer Mohammed Ben Mousa, which was the foundation for all the subsequent labors of the Arabian geographers. This great work, for such in that age it seems to have been, is called by the Arabs the Rasm, a word for which there is no equivalent in any other language. This work, unfortunately, is lost; but from the references to it by Arab writers, we know that it gave a description of the habitable earth, and indicated the prominent places in different countries by their latitude and longitude, correcting, in the countries with which the Arabs were well acquainted, the gross errors in longitude of Ptolemy. The work, which, in its form and execution, was a magnificent one, was accompanied by a planisphere, or general map of the world, which Massoudi, an Arabian geographer of the 10th century, who was familiar with the maps of Ptolemy and of Marinus of Tyre, saw, and pronounced superior to theirs.

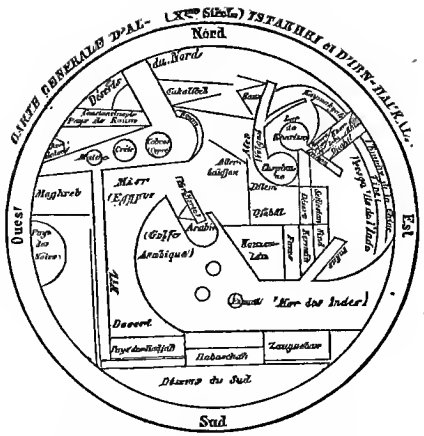
The Arabs, in their geographical works, after the manner of Ptolemy, gave catalogues, or tables of the latitude and longitude of places, wherever they had been ascertained by astronomical observation; and the tables in the Rasm were referred to so often and so fully by subsequent Arabic writers, that Lelewel was able, from these references, to reconstruct the greater part of this map.

It is from these catalogues, or tables of latitudes and longitudes, that we know the wide extent of the geographical knowledge of the Arabs. Their corrections from West to East extended from Cadiz to the Indus, and they restored to their true position the places in

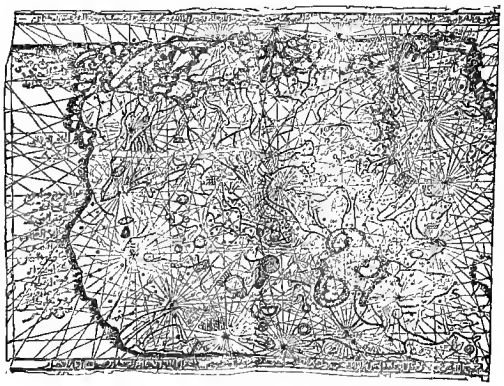
the countries watered by the Euphrates and the Tigris. It is inferable from statements of Arab writers that they had maps constructed upon a mathematical basis. As these maps have not come down to us, it is supposed that they were rare, and were not intended for practical use, but constructed to aid the inquiries of the learned; for the Arabians pursued the study of geography mainly in its connection with astronomy, and were not, as we would understand the term, topographers, or only to a very limited extent. We have one of their maps of the 10th century, and others of the 11th, 13th and 14th centuries, and if they are to be taken as specimens of what they could do in the construction of maps, they were very poor cartographers. Instead of delineating coasts or seas by lines representing the natural curvature of the coast, or shore, in several of them straight lines, or arbitrary curves, are used. Thus the Mediterranean is a long sea, enclosed within four straight lines, and other seas are represented as an exact circle. Everything is mathematicai —lines, curves, and circles—so that, upon first examining these maps, it is difficult to understand them.

It is rather for the preservation of what was previously known, that we are indebted to the Arabs: for, though they studied geography with great assiduity, they cannot be said to have greatly advanced it as a science. In the countries with which they were familiar, they corrected numerous errors, but in the countries unknown to them, they followed Ptolemy aud Ptolemy's system, and putting both together in their general delineation of the world, they produced the greatest confusion, so that their system of geography had, as will hereafter appear, but little effect upon the growth of the art of cartography in Europe, which was developed by methods entirely different from theirs, and owed nothing to their labors except a more accurate knowledge of Asia.

Most of the Arabic geographers accepted the conclusion of Ptolemy that the earth was a sphere, but as a body they do not appear to have come to any positive conclusion upon the subject. Some thought it was like a ball, the half of which was cut. Some thought it was an entire ball, and moved around. Others, that it was hollow in the interior. Edrisi, in the 10th century, thought that it was a globe floating in an ocean, like an egg in a basin of water, and that it was the half that was above the surface that was inhabited; whilst Kasuiny, in the 14th century, entertained



Arab Map of the World, 10th Century.



Arab Map of the World, A. D. 1009.

Homer's idea that it was a flat plain environed by an ocean, which was also the opinion of Ibu Warde.

Leaving the Arabs and their labors for the present, we will now return to the growth of cartography in Europe. We have maps designed to represent the earth as known, or particular parts of it, from the 9th to the 15th century ; and which, from the rude efforts in the 9th century, exhibit the widest diversity in plan and execution. Some consist of straight parallel lines drawn across a circle, with the names of countries or places arranged along the lines. In others, the position of the Mediterranean is indicated simply by the name of the sea, and the names of countries and places are grouped about it in what was supposed to be their true position. In none of these early maps is there any attempt to give in curved lines the form of continents, or to indicate the boundaries of countries. In some, as in the Leipzic map of the 10th century, the circle is divided in the centre, the upper half of the circle being Asia, with Phœnicia, Troy, and Babylon, represented by three castles ; and the lower half is divided in the centre by a line separating Africa from Europe ; three rude curves denoting the Alps, and a few jagged lines the Pyrenees. Others are itineraries, or skeleton road books, arranged in successive parallel spaces, as in the Jerusalem Itinerary, which gave with much detail the route from Bordeaux to the Holy City. These itineraries mark the route from city to city, with the prominent castles or places on the way. Where a river had to be descended, or a gulf, or an arm of the sea crossed, it was pictorially represented, and in these general features they resembled and appear to be a continuation of the descriptive itineraries of the Romans.

About the middle of the 12th century, Roger, King of Sicily, determined to have a map of the world constructed from the best information that could then be obtained. For this purpose he sent intelligent men to various parts of the known world, to take the latitude and longitude of places, to collect itineraries, and gather every kind of information that was desirable. Fifteen years were spent in this preparatory work, and what had thus been obtained was entrusted to Edrisi, an Arabian geographer and traveler, who had been invited to the king's court, and from these materials Edrisi compiled a general map, which was engraved upon a round table, or globe of silver. In a manuscript in the National Library

of Paris, there are 69 maps supposed to have been copied from this silver globe, and there is a general copy of the map attached to a manuscript in the Bodleian Library at Oxford. This work of Edrisi was superior to anything that had preceded it in the Middle Ages. It appears to have given a new impulse to geographical inquiries, as it was compiled chiefly from the new materials that had been obtained; for Edrisi, upon examining the works of his Arabic predecessors and the work of Ptolemy, found that they had involved the general subject of geography in such doubt, uncertainty and confusion, that in constructing his map he rejected them altogether as sources of authority. Edrisi also composed a geographical work which has survived. Wherever in it he had to refer to the fabulous and impossible things asserted by his predecessors, he generally accompanied the statement with the formula, "God only knows how this is."

There is a large map of the world, of the 13th century, preserved in the Hereford Cathedral, in England, which, though compiled a century afterwards, exhibits none of the knowledge found in the map of Edrisi, or even in the previous Anglo-Saxon map of the 10th century. As a cartographical specimen, it is of the grossest kind, exhibiting not only the profoundest ignorance of the world in general, but an ignorance of England and Scotland, with which, it might be supposed, the compiler would be familiar. Whilst this is its character as a map, it is a most elaborate and carefully-executed work, as respects the writing and the embellishments. It is covered with religious conceptions, such as a representation of the Garden of Eden; the Expulsion of Adam and Eve; the Tower of Babel; the Several Apostles; Satan bearing off the Condemned; and with drawings of wild and fabulous animals, savages, castles, noted individuals, &c. Cosmos' conception of the oblong form of the earth with four walls had, since the 9th century, been abandoned, for the reason that the belief, after that time, became general that Jerusalem, the Holy City, was in the exact centre of the earth; and as Cosmos' plan would not harmonize with this idea, the circular form of the earth was restored. Thus the Hereford map is of an oval shape, and has Jerusalem in the centre of it.

The map of Ranulphus Hyggeden, A.D. 1360, may be taken as a specimen of the kind that was produced in Western Europe in the 14th century. The earth is represented as oval in form, and surrounded by water; the principal portion of the upper half of the

Edrisi's Map, A. D. 1154.

Ranulphus Hyggeden's Map, A. D. 1360.

oval represents Asia; the principal part of the lower half, Europe, while Africa occupies nearly the whole of the right of the map. There is some attempt to give the outlines of the Mediterranean and the Black Sea, and islands of the Mediterranean are represented, and the course of rivers, especially the Nile, the Euphrates and the Tigris, but erroneously and very rudely.

The map of the Italian Sanuto, which was constructed forty years before (A. D. 1320), on the contrary, is of a very different character, and shows the influence of the labors of Edrisi, an acquaintance with the Arab geographers, and a familiarity with Ptolemy, and other sources of information. The Mediterranean, the Euxine and the Caspian are for the time very well defined. Some idea is imparted of the mountain chains of Asia, and the source and the course of the Nile are given, as in the map of Edrisi. Some idea, although a rude one, is also imparted of the mountain system of East Africa, and the outline of the southern and eastern part of the continent of Asia shows some general acquaintance with that part of the world.

But it is unnecessary to dwell further upon these general maps, as they had very little to do with the improvement in cartography, which about this time began to make considerable progress. They were intended generally for the learned, and were of no interest to the bulk of the people. What the merchant or traveler required was an itinerary, or road book, which gave the great routes, the position of towns and cities, and their distance from each other, with such other information as was useful to those making journeys, and the voyager or mariner depended upon what was called a portulan, a small oblong book, which had the two-fold qualities of an almanac and a coast chart. On the cover of the portulan was a representation of the points of the compass, and a table of the days of the year, such as we have in our present diaries, and upon the sheets inside was a careful delineation of the outline of the coasts, the positions of seaports, and statements of the distances from one port to another, according to the direction of the compass, which was denoted by straight lines running in all directions; with which was comprised such intelligence as the depth of harbors and other nautical information of a practical character.

This was all that was wanted in that age by the traveler upon land, or the voyager by sea, neither of whom felt any interest in

maps of the world, the construction of which were left to the learned. But to supply what was required for these useful guides, the itineraries and the portulans, a mass of information had to be collected. For the itineraries it was gathered from merchants, pilgrims, ambassadors, and in fact from all who made extensive journeys by land, and was rarely of a scientific nature, as what these travelers brought back was descriptive accounts of the countries they had visited, and their ideas of the relative distances between places, or the number of days it took to go from one place to another. But the information required for the portulan was of a more scientific character, and laid the basis for such an improvement in cartography that the mariner was soon enabled, guided by the compass and his chart, to steer boldly out to sea without relying, as before, upon the stars when out of the sight of the land, which, in a comparatively short period, led to those extensive maritime discoveries that gave Europe a passage by water to the Indies, and revealed the continent of America.

To understand more clearly the rapid progress which was made in cartography in Europe in contrast with the little that was done for its improvement by the Arabs, although they had had the advantage for five centuries previously of the geographical knowledge of the ancients, it will be necessary to draw attention to the difference between the nature of the empire which they established by their conquests, and that era of maritime enterprise and commercial activity which sprung up, and after the 12th century developed so rapidly in the cities of the Mediterranean, such as Amalfi, Genoa, Pisa, Venice, Majorca, Cadiz, Barcelona, Bilboa and Lisbon.

The Arabs had a vast empire, the great bulk of which had no connection with the sea. Their capital, Bagdad, was in the interior of Asia, far up on the banks of the Tigres, and their empire was so great, and so rapidly acquired, that they did not and could not give much attention to the geographical examination of it in detail. A highly imaginative people, they were more attracted by speculative enquiries respecting the earth as a whole, and therefore studied it more in its connection with astronomy than by those careful, patient and practical topographical labors which constitutes such an important part of geography. What could be done by astronomical observation to show the relative position of places they did, and

Italian Itinerary, 13th Century.

Portulan, A. D. 1476.

did somewhat extensively in Asia, but in respect to the sea they did little. They knew nothing of the Atlantic ; their geographers declared that it was navigable only to a certain extent, and that beyond that limit it was a sea of darkness.

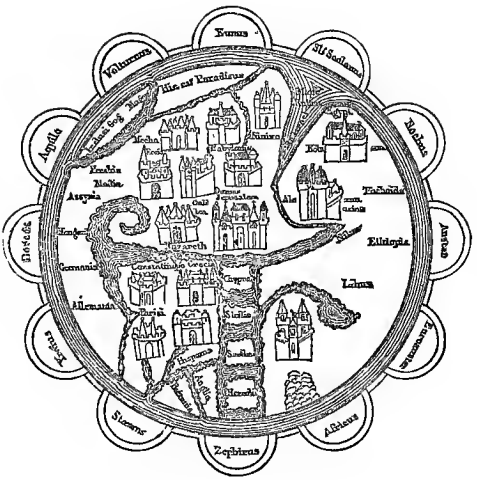
The people of the maritime cities of the Mediterranean, or the Latins, as they are frequently called, to distinguish them from the Arabs, had a field of activity very limited when compared with the great empire of the Arabs. It was the Mediterranean. Their pursuits were maritime. They were the carriers by water of products between Asia and Europe, and therefore became, what the Arabs never were, a nautical people. To them navigation and everything that tended to its improvement was of the highest interest, and they consequently gave great attention to details. They observed closely the outlines of coasts; carefully delineated them, and as they had an eye for form and proportion, their maps, in design and execution, greatly excelled those of the Arabs.

In the thirteenth century the mariner's compass came into general use in the Mediterranean, and as this greatly extended the maritime commerce of these cities, it was impossible to do without nautical maps and charts. A map of the world like Edrisi's was of no use to the pilots or mariners. What they wanted were special maps or charts, giving the outline of the coasts, the position of harbors, the nautical distances by the direction of the compass, with everything as aids to navigation that could be represented upon a map or connected with it, and to supply this want a class of men sprang up in these maritime cities, known by the name of cosmographers, who devoted themselves to the production of all kinds of nautical maps, special as well as general. These cosmographers studied the marine routes, collected from the itineraries of voyages and from other available sources, every kind of information that could he useful, and in this way a vast amount of material was collected, which served as a basis for the construction and improvement of nautical maps. It was not only collected, but carefully preserved, being transmitted by one cosmographer or cosmographical school to his or their successors. These cosmographers cared little for the scientific labors of the Arabs. They did not, in constructing their nautical maps, avail themselves of the longitudes and latitudes collected by the Arabs, or construct their maps upon any mathematical or scientific basis, as they knew from practical ex-

perience that the positions of places obtained in this way were unreliable. Whatever geographical knowledge, therefore, they acquired was practical, and the result was a rapid improvement in cartography, for what they laid down upon their maps was what had been obtained from actual observation. Pilots and mariners also made charts from their own observations, and all information procured in this way was carefully collected and preserved. In preparing the portulan for the mariner, the care of the cosmographer was to give as accurately as possible the outlines of coasts, and to indicate the promontaries, the dangerous points, the shallow places, the reefs, the curvature of gulfs and bays, the sinuosities of the shore, and to fix the distance of one position from another with some exactitude. In addition to this, the portulan was annotated with other information useful to the mariner, and these portulans furnished the material for more general charts and maps of the world, for they gave as a foundation for maps an exactness which did not previously exist.

These cosmographers knew very well the position of places to the pole, or geographical latitude, but in making their maps they drew no parallels of latitude, and paid less attention to longitude; for the mariners for whose use these maps were intended knew nothing about figures representing degrees of latitude and longitude, and they are consequently not found upon these maps. The distances on the land or over the sea were laid down from certain fixed points in the direction of the compass, and hence these maps are covered with a network of lines running in all directions from central points, called wind roses (*Rose de Vent*), which, to persons familiar only with maps of the present day, are unintelligible.

The Catalans, who were extensively engaged in navigation, became especially distinguished in the thirteenth and fourteenth centuries for the fabrication of portulans, as well as for the construction of maps in general; and in 1375, Charles V of France sent to the Catalan cosmographers to have a map of the world executed, which resulted in the transmission to him of an atlas of six maps, executed upon vellum and illuminated in colors, and richly embellished with gold and silver, the whole enclosed in a volume. Four of the maps of this atlas constituted a general map of the world, which is what is known as the celebrated Catalan map. It was extensively copied and reproduced in a cheap form in all the



St. Denis Map, 14th Century.

Andrea Bianco's Map, A. D. 1376.

Fra Mauro's Map, A. D. 1457.

maritime cities of the Mediterranean for the use of mariners. Each master of a vessel, or, as he was then called, pilot, had a copy of it, and for a long time it was the map in use for all practical purposes.

In the 15th century, great acquisitions were made to the knowledge of the world, especially in Asia and Africa, by the journeys of Marco Polo and Cadamosto; and the result of this accumulation of new information was the construction, in 1457, of a large map of the world, by Fra Mauro. It was painted on the wall of a convent in Venice, and was, for its time, an admirable production. It is not only remarkable for the extent of the geographical information it embodies, but for the artistic skill with which it is executed, and the cleverness with which the different parts of the world are brought together and represented as a whole, although, when examined in detail, it is very defective.

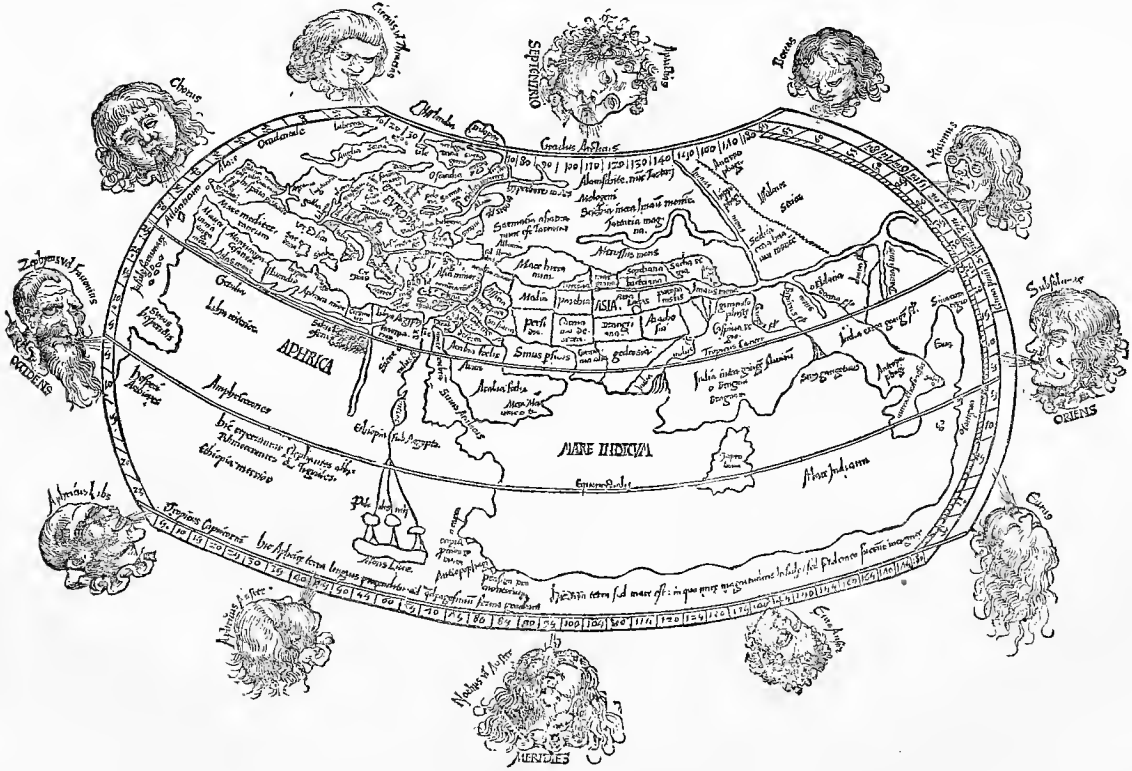
Fra Carmelite was a friar who had established a geographical school in Venice, and whose acquisitions as a geographer were, for the time, so extensive, that he received from his contemporaries the title of "*the incomparable.*" He knew that the earth is a sphere; being well acquainted with Ptolemy, but did not follow Ptolemy's scientific method, of so projecting the world as to give the longitude and latitude of places. He represented the whole earth as embraced within a circle, giving to each part its proper relative position, being of the opinion that that was the most effective way of representing the whole world upon a map; and, considering the peculiarity of his plan, his map was a very successful cartographical achievement.

It should be stated as explanatory of the defective construction of general maps of the world at this time, and before it, that the belief of the ancients in the globular form of the earth was far from being generally accepted. Even amongst cosmographers there was great uncertainty as to its real form. Columbus thought it had the shape of a pear, and in fact, its spherical form was not fully admitted until Magellan's vessel, in 1521, sailed around it. In Italy, however, the belief of the ancients, both as to the form and as to the motions of the earth, was revived as early as the middle of the 15th century. Cardinal Cusa, who was a contemporary of Fra Mauro, maintained that the motion of the heavens was apparent, and that it was the earth that moved. He declared also that the earth was not a perfect sphere, and that in its

movement in its orbit it departed, to some extent, from a circle—a declaration that was very remarkable as suggesting what was afterwards ascertained, the eccentricity of the earth's orbit. Towards the close of that century, in Italy, the doctrine of the earth's rotation became quite general, and was the subject of public discussion in the schools of Bologna, which was more than half a century before the appearance of the great work of Copernicus, who, in all probability, got the idea which he afterwards worked out so successfully during that part of the early period of his life, which he passed in Italy.

About forty years before the map of Fra Mauro was executed, Prince Henry of Portugal, surnamed the Navigator, began to send out those expeditions along the western coast of Africa, which was the beginning of that brilliant age of maritime exploration that led to the circumnavigation of the Cape of Good Hope, the discovery of the continent of America and the voyage of Magellan's vessel around the world. During this period of active discovery, the limits of Africa were greatly extended to the South, a vast continent was revealed by the discovery of America, and the knowledge of the earth being thus largely augmented, a general map of the world had to be differently arranged and represented by new methods.

The first step in this direction was made by Toscanelli, a learned cosmographer of Florence. He constructed a map, now lost, the object of which appears to have been to represent the eastern portion of Asia, and the islands to the east and south of it, a part of the world unknown to Ptolemy, but with which Toscanelli had become acquainted through the travels of Marco Polo, and others, and also to show that Asia could be reached by sailing westward from Portugal, directly across the then unknown Atlantic; and in 1474 Toscanelli sent this map, accompanied by a letter, to Columbus, to confirm the great discoverer in the design he then entertained of attempting to sail westward across the Atlantic to the Indies. In this map Toscanelli divided the space between the western shores of Portugal and the eastern part of Asia into twenty-six divisions or spaces of 250 miles each, and probably laid down the eastern part of Asia with Marco Polo's outlying islands of Cipanga (Japan), Java, &c., as they are found on the globe of Martin Behaim, supposed to have been constructed in the year that Columbus discovered



Map of the Margarita Philosophica, A. D. 1503.

America (1492), and which geographical information, it has been inferred, Behaim acquired from the map of Toscanelli.*

This map is supposed to have been projected after the manner of Ptolemy, incorporating the information obtained by Marco Polo; but how imperfectly Toscanelli understood the real dimension of the earth is shown by the fact that he represented the distance from Lisbon across the Atlantic to Asia, or the space where the then unknown continent of America is situated, as 6,500 geographical miles across, which is about one-half the actual distance. In 1478 the maps of Agathodaemon, before referred to, were published, and the effect of the continuation of these maps in subsequent editions of Ptolemy was gradually to restore the scientific method of the ancients and of the Arabs, of dividing the globe into degrees of latitude and longitude. In 1503 George Reisch, the prior of a chartreuse at Fribourg, published a kind of manual of general knowledge, *Margarita Philosophica*, that was very popular in the 16th century, and passed through many editions. It was accompanied by a map of the world, to which I refer, because it is the earliest of that period with which I am acquainted in which the method of Ptolemy was followed, of dividing the map of the globe into degrees of latitude and longitude. The projection was spherical, but it was an imperfect representation of a sphere, for the obvious reason that its author, like his contemporaries generally, was uncertain as to the exact form of the earth. It is truncated or cut off at the Arctic circle and at the 25th parallel south of the equator, giving to the map the shape of a curved oblong, the length of which from east to west is twice as great as from north to south. As respects geographical information, it added comparatively little to the map of Ptolemy, there being no indication upon it of what Marco Polo had ascertained respecting Asia, or of the discovery of America, or of the exploration of the Portuguese along the western coast of Africa, although the Portuguese discoveries had then been going on for more than half a century, and the continent of Africa had been circumnavigated seven years before this book of Reysch was published. It is known that the book was in existence some years before it was printed, and the map which accompanied the

* 1 Irving's Columbus, p. 57.

first edition in 1503, was probably constructed many years previously.

The first map upon which the discoveries of Columbus appear is that of John Ruysch, in the edition of Ptolemy printed in Rome in 1508. Ruysch adopted the method of Ptolemy of projecting the earth in the form of a cone, with the Arctic at the summit, but so expanding the cone as to bring in the western hemisphere and show the islands and a part of the main land discovered by Columbus and others. In 1511 Bernard Sylvanus produced in his edition of Ptolemy a general map of the world, upon what has since been called the cordiform, or heart-shaped projection, which, while giving the whole of the geographical features of the earth, was, from the curve and sweep of the parallels of both latitude and longitude, better adapted than anything that had preceded it to convey upon a plane surface a general idea of the earth's globular form. In this map the newly discovered continent of America, under the name of The Land of the Holy Cross (Terra Sanctæ Crucis), was laid down more fully and accurately than in the preceding map of Ruysch. In the following year, 1512, a Polish geographer, John de Stobnicza, in an introduction to Ptolemy, published a map which I regard as of great interest, as it was, as far as I have been able to ascertain, the first attempt to project the spherical surface of the earth upon a plane. If I am right in this supposition, it was the parent of the mode now in use in all atlases of representing in a map of the world both sides of the globe upon a flat surface by two planispheres, or circular maps joined together, one of which includes Europe, Asia and Africa, and the other America, North and South.*

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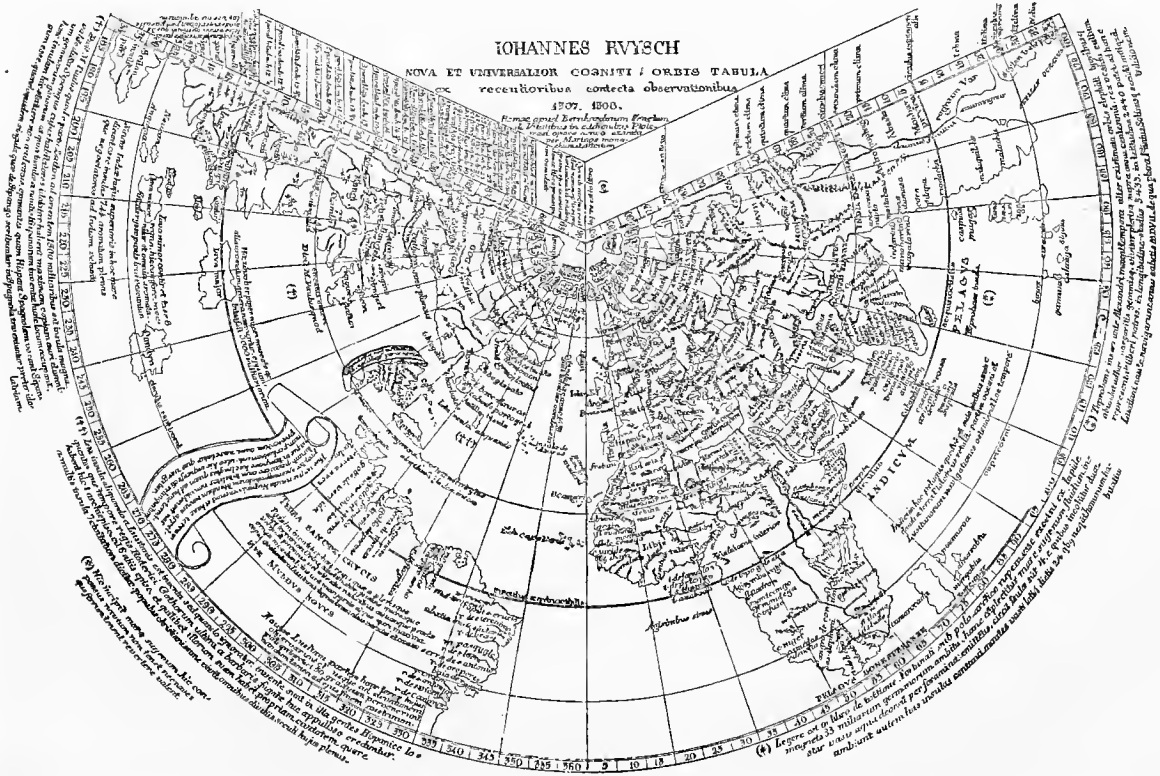
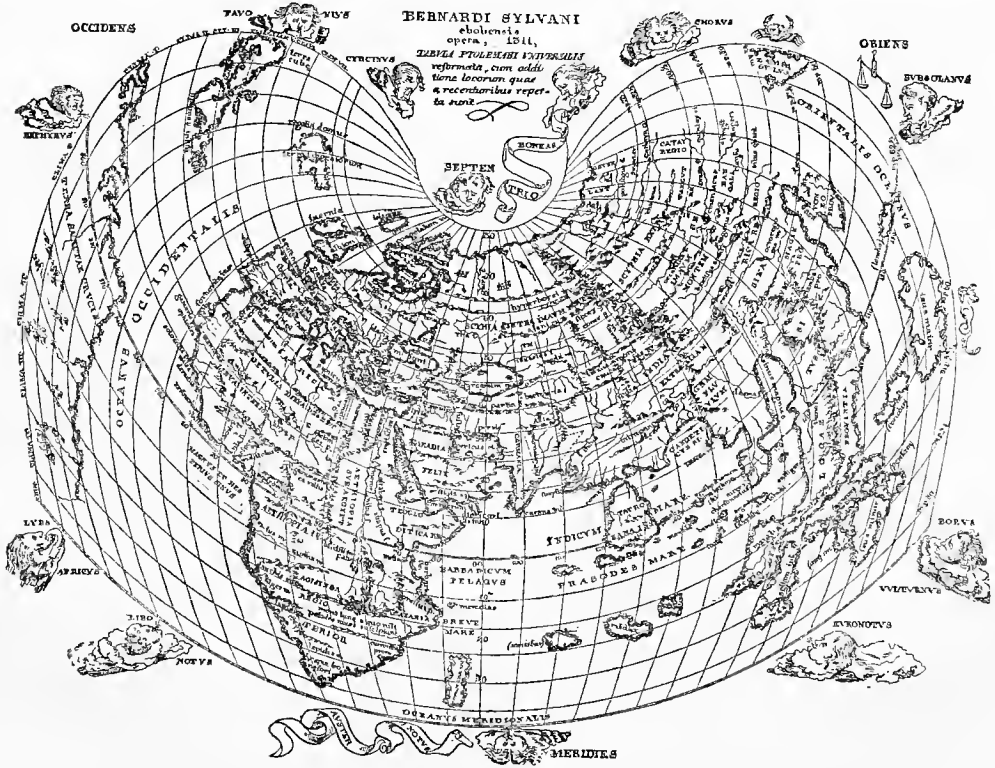
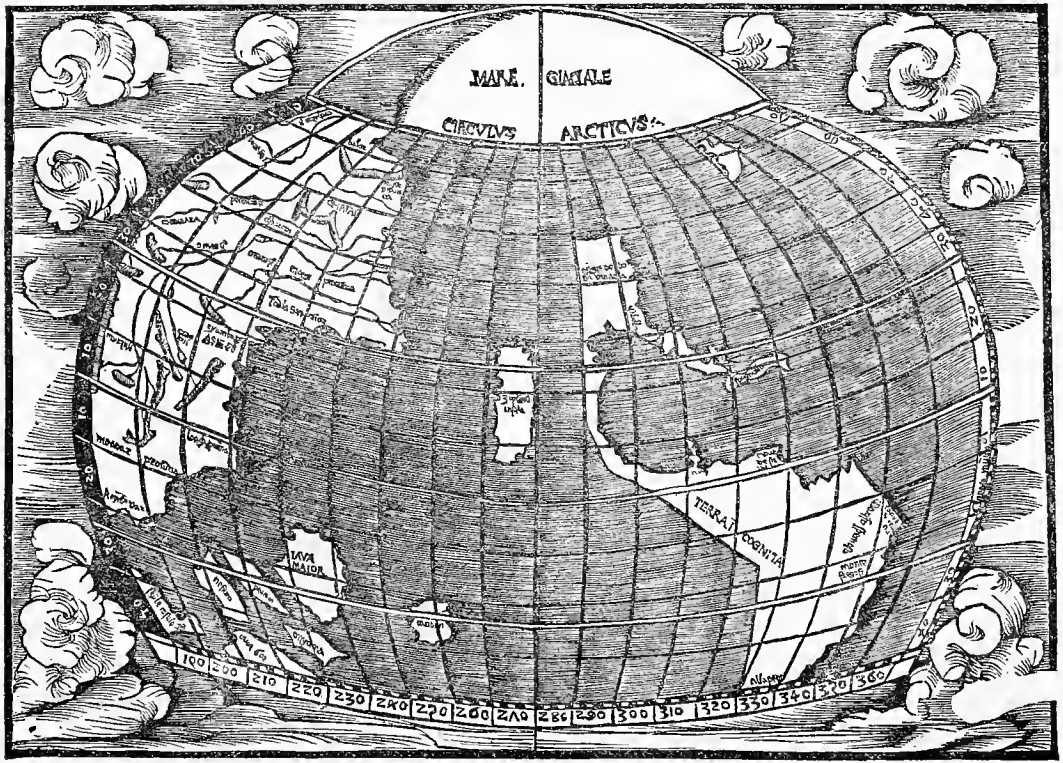
* *Letter of J. Carson Brevoort Esq., February* 20, 1879: * * "I think you were right in assuming that the Mapamundi found in Stobnicza's Introduction to Ptolemy of 1512 was the first attempt to project a spherical surface on a plane in what might be called a *partial* and *subspherical projection truncated at the poles.* D'Avesac had not seen this map nor the *rectiparallel projection* proposed by Apianus in 1524. Oronce Fine, in his Protomathesis, Paris 1532, gives rules and diagrams for the old planispheric. The single heart-shaped projection appears first, as you said, in the mapamundi of Sylvanus. The double cordiform projection or artificial development of a sphere on a plane, by Oronce Fine, in 1531, must have been considered as a mere *tour de force* only, for he does not allude to it in his Protomathesis and Cosmography.



John Ruysch, A. D. 1508.



Sylvanus' Map, A. D. 1511.



John de Stobnicza's Map of the Western Hemisphere, A. D. 1512.

This map was constructed to represent that half of the globe which was unknown to Ptolemy, or substantially what is now known in maps of the world as the western hemisphere. Stobnicza says in his Introduction that he had been careful to make notes about certain parts of the earth with which Ptolemy and other old writers were unacquainted, which he says had become known through the travels of Americus Vespucius and others; that there were three parts of the earth already known, but that there was a fourth part, which had been discovered by Americus Vespucius—a large part of the earth, to the west, beyond Africa and Europe, and which, it was proposed, should be called *America*, after its discoverer. *

The main object of this interesting map was to show where this newly discovered land was situated, and place it in its true position

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Another letter from same, February 26, 1879: * * "The planispheric projection in present use by the map-makers is only an improvement upon the one proposed by Hipparchus and explained by Ptolemy in a small treatise preserved to us through an Arabian translation. It is entitled '*Claudii Ptolemæi Sphæræ aplanetis in projectio in planum,*' and was first printed, though incomplete, in the Roman edition of Ptolemy, which appeared in 1507. The late French geographer D'Avezac, in his paper on the projection of maps, § 6, note 7, gives a history of this treatise, and expressed his intention to publish it with the full text, which he did not live to do.

This mode of representing the entire surface of the sphere within the compass of two circles, was again proposed as a novelty by the French mathematician Oronce Fine, in 1530, in his Cosmographia, which forms the fourth book of his Protomathesis. At the end of the book he briefly explains the projection, adding a large circular diagram to illustrate its construction. He does not, however, fill it with geographical details, but merely remarks '*that either half of the world may be drawn upon it.*' About the same time Fine was drawing a small map of the world to accompany the Paris edition of the Novus Orbis, in which he uses the double cordiform projection, which strangely deforms the outlines of the land, and is useless to sailors or geographers.

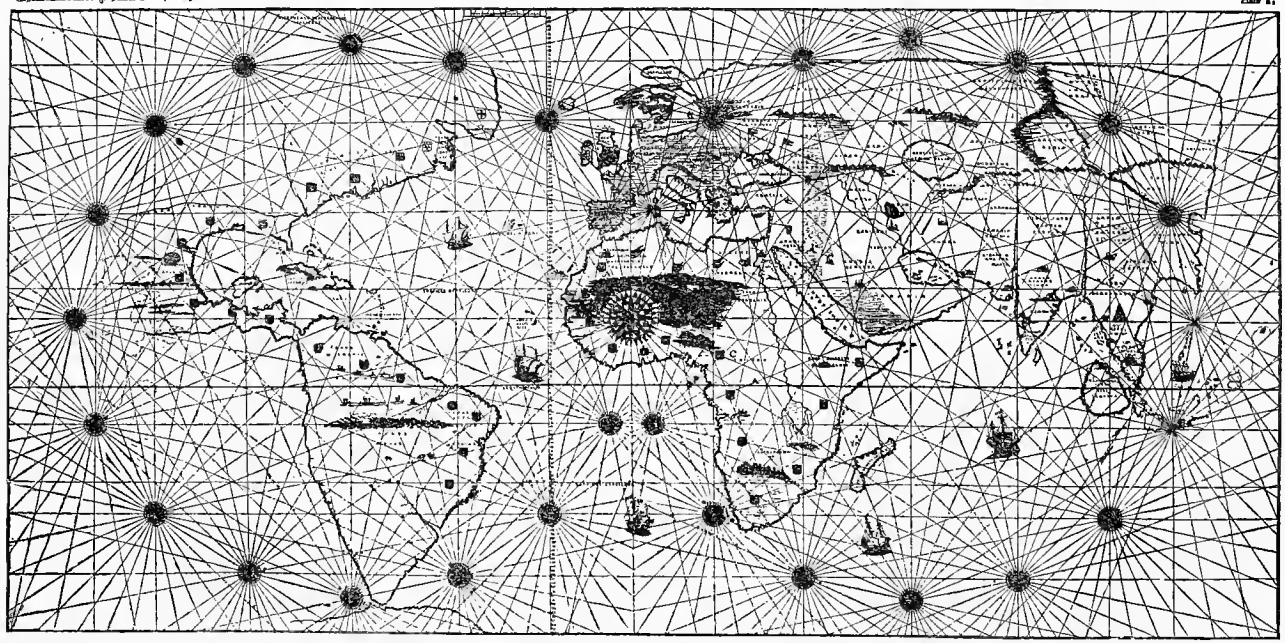
Not until near the close of the seventeenth century was the planispheric projection proposed for the third time, as a new one, by De la Hire, in which he was soon followed by others. Thus, a most valuable method of projection slumbered for nearly fourteen hundred years, unnoticed by geographers, whilst astronomers were using it for charting the heavenly bodies, and every astrolabe bore it in part carried out.

* Bartlett's Bibliotheca Americana, Part I, pp. 53, 54.

with respect to the whole globe. The map is but a partial or subspherical projection, being cut off at the 70th degree N. lat., and at the 40th degree S. lat. Within these limits it represents the half of the globe unknown to Ptolemy, or that half extending about 180 degrees west of the continent of Africa, so as to take in what Stobnicza conceived to be about one-half of the eastern part of Asia, and also some of the large islands lying south of Asia, such as Java, &c. The continent of America, north and south, is represented as running northwesterly to the centre of the map, and as extending from 70° N. lat. to 40° S. lat., the shape of the continent as then understood being evidently derived from a chart, not then published, which, from an inscription upon it, is supposed either to have been drawn by Columbus, or under his direction. The breadth and general shape of South America, though rudely given, is remarkably correct. The isthmus separating South from North America is laid down, but exaggerated in length ; and a small portion of North America is given, its extension to the west being left undefined. The position which the whole continent occupies as a part of the globe is, as would be expected, not correctly laid down, but as a conjectural representation of its exact position, the map was for that time (A. D. 1512) a very remarkable production. It is not only remarkable for the true scientific principles upon which it was projected, but for the geographical insight of its author in other respects. Columbus believed to the end of his life that the land he had discovered was a part of the continent of Asia ; and he had been dead but six years when this map of Stobnicza's was published. Stobnicza, better informed than Toscanelli or Columbus about the eastern part of Asia, and having evidently a correct idea of the true form of the earth, fell into no such error ; and in laying down the newly discovered continent as a part of the earth's surface, he placed it not far from the centre of the previously unknown part of the earth, and, as I have said, as extending in a northwesterly direction between Africa and Asia, with a large ocean separating the western part of it from Asia, or what we now know to be the Pacific Ocean, although the Pacific was not discovered by Vasco Nunes de Balboa until A. D. 1513, a year after the publication of Stobnicza's work.

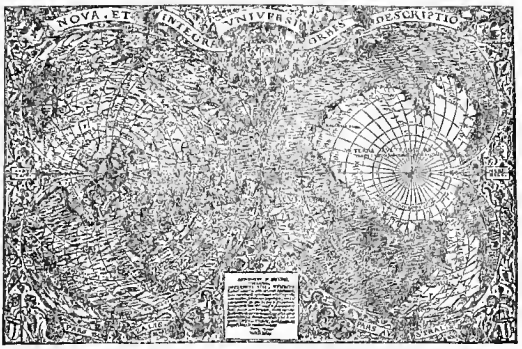
I have dwelt upon this map, because it has not received from geographers the attention it deserves ; and for the further reason

Apianus's Map, A. D. 1520.

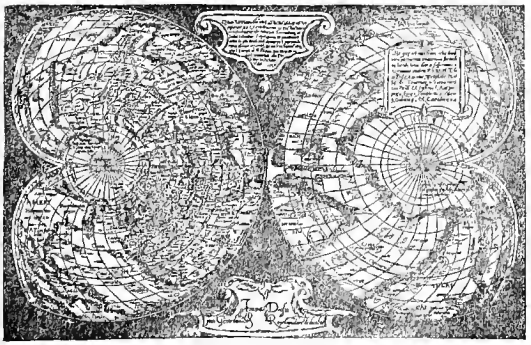


Reduced Copy of the Mapamundi drawn by HIERONIMUS DE VERRÁZANO about the year 1529.

From Photographs of the Original, preserved in the MUSEO BORGIANO at the Collegio Romano de Propaganda Fide in Rome.



Oronce Fine's Map, A. D. 1531.



Mercator's First Map, A. D. 1538.

that it furnishes a striking illustration of the slow progress of geographical knowledge; for the projection of maps of the world, upon the same scientific method, did not come into general use until about the beginning of the last century, or nearly two hundred years afterwards.

In 1520, Peter Benewitz, or as he called himself, Apianus, constructed a map of the world in the form of a heart, after the method of Sylvanus, but with the heart greatly extended from west to east, which has acquired a celebrity as the first map upon which the name of *America* appears.

In 1531 Oronce Fine undertook to improve this by a projection in the form of a double heart, so as to give, by that method, upon a plane or flat surface, both sides of the globe; and in 1538 Mercator, then a young man of twenty-eight, published a map of this double heart projection, making many corrections, especially in respect to the continent of America, of which only one copy is known to exist, attached to an edition of Ptolemy of 1578, that belonged to Mercator, and which has been liberally deposited by a member of our council, J. Carson Brevoort, in the library of our society.

Simon Grynæus, in 1531, constructed a map of the world in the shape of a very broad oval, which will be found in the edition of his "Novus Orbis" of 1537; and this form having been adopted by Sebastian Munster in his Cosmography, 1541–1550, it became for a long time, through the influence of Munster's work, which had a wide popularity, and was in its time a great authority, the favorite mode of representing the earth.

All these maps, in their delineation of the outline of countries, were very defective, and especially in respect to the continent of America. The accessions to geographical knowledge had become so vast, and the details were so enormous, that the work of giving the whole of the surface of the earth, as far as known, with all the details of continents, oceans, gulfs, bays, straits, rivers, mountain ranges, and islands, with any marked approximation to correctness, was not accomplished until Mercator produced his great map of the world in 1569; which, when the fullness of its details is considered in connection with the new and scientific method upon which he projected it, entitles him to the appellation of the father of modern cartography. When it is contrasted with Munster's general map of

the world and his twelve maps of different countries in the edition of his Cosmography published ten years before, A. D. 1559, it shows how rapid at this time must have been the accumulation of geographical information and how great the industry of the man that could collect and arrange this vast amount of new material so successfully, and upon a plan so scientific. In this map he introduced what has ever since been known as Mercator's projection, which not only gave the world in one view, but by an ingenious and simple contrivance showed the most effectual way for a vessel to sail in a straight line over a curved surface, and thereby solved what was before one of the most difficult problems in navigation. That projection constitutes, down to the present day, the basis of every chart that is constructed to guide the mariner in his way over the ocean, and the map of the world on his projection is to be found in nearly every English or American atlas that has been published for a century and more, and yet the inquirer would search in vain in any work in the English language for the particulars of Mercator's life, or for any satisfactory account of what he did. How little is known respecting him, even by nautical men, will be sufficiently indicated when I state that, upon speaking about him not very long ago to a distinguished admiral, he looked at me and exclaimed, "What! was there such a man as Mercator? I always supposed Mercator's projection meant the merchant's projection."

But I do not propose to give an account of what Mercator did. That has been done already in the admirable paper read before this Society last spring by our Corresponding Secretary, Elial F. Hall, Esq., in which justice has at last been done in the English language, to a modest and laborious man of genius, to whom the great commercial and navigating nations of England and America have been indebted to an extent they have never appreciated, or at least never adequately acknowledged.

I have thus sought to bring together and arrange in something like consecutive order the principal facts in the history of cartography down to the time of Mercator. I have attempted to do this because, as far as I know, the facts have never been brought together as a whole. The state of cartography in the middle ages has been treated very fully by Viscount Santarem and by Lelewel, and to the researches of both these learned scholars I am indebted for much that has been stated respecting that period. I have not

brought the enquiry further down than the time of Mercator, because the progress of cartography since consists mainly in technical details, and is therefore not as important nor as interesting as the previous period. It is, moreover, easily ascertained. We have in the library of our society a chain of atlases from the first atlas of Ortelius in 1570 down to the present day, by an examination of which every step in its progress may be traced.

I feel very sensibly that I have undertaken a great deal in attempting to grasp so large a subject within the limits of an address like this—a subject in which the facts have to be drawn from a great variety of sources, and which are to a large extent fragmentary, so as to make it exceedingly difficult, in so limited a space, to group them together as a whole. I have made this attempt, however, in the expectation that some one who has the leisure, which I have not, will hereafter devote it to the production of a volume in which many details can be given that I have been compelled to omit, and which will throw all the light that research and critical investigation can now shed upon this interesting branch in the history of human progress.

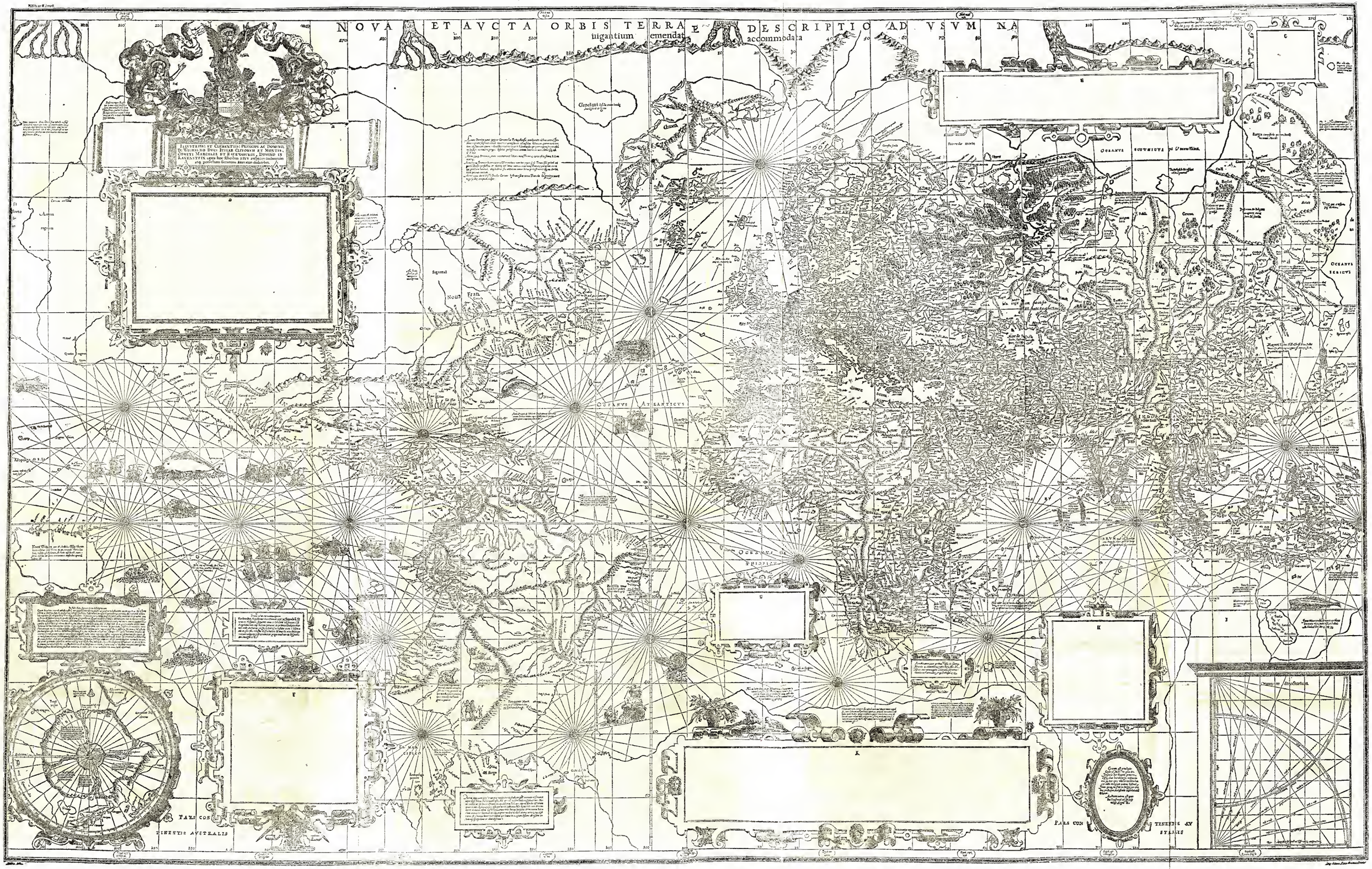
REMARKS OF J. CARSON BREVOORT, Esq.

At the close of the President's address J. Carson Brevoort, Esq., rose and said:

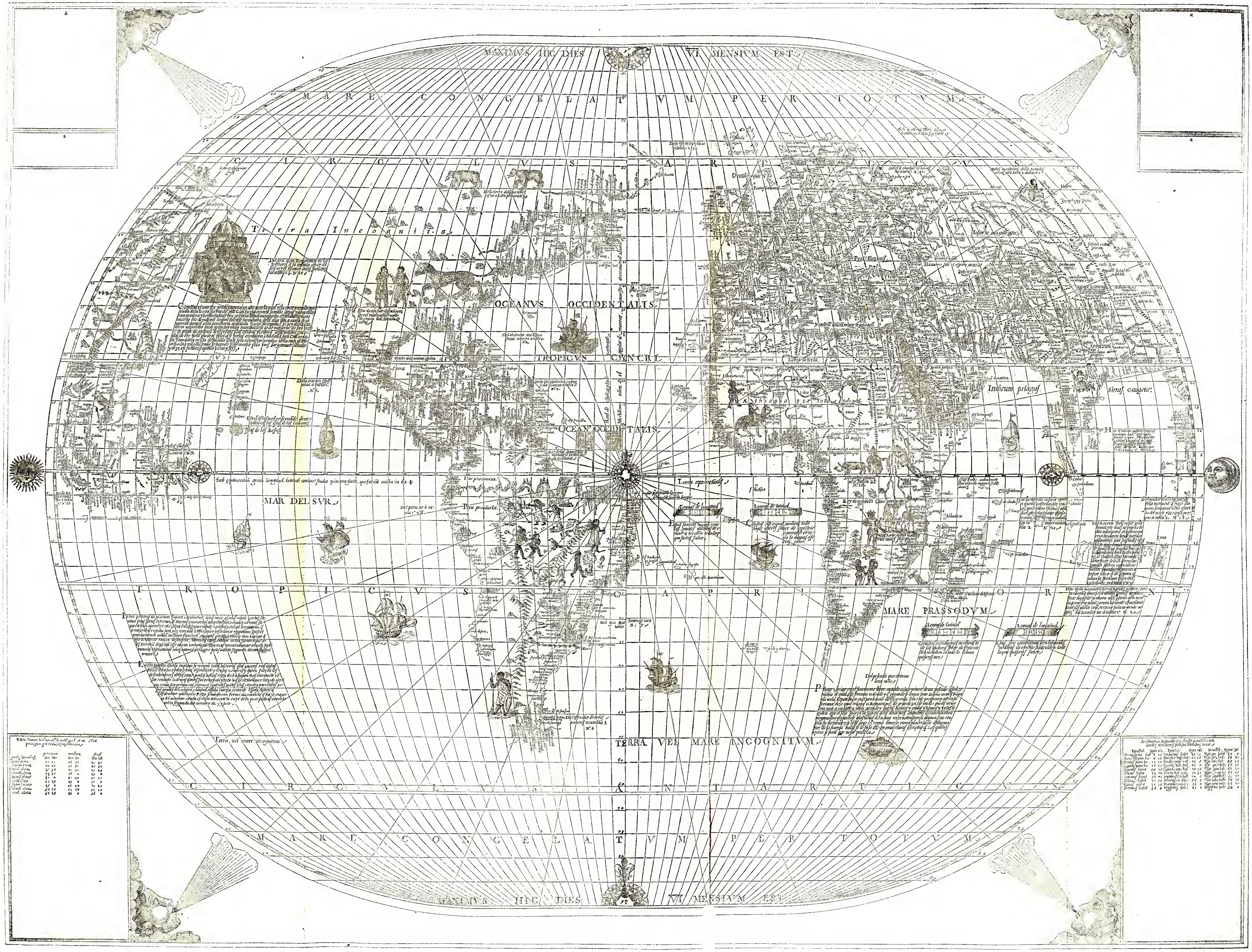
It is hardly necessary, before we disperse, to express the rapt interest with which we have followed our President throughout the essay he has given us, in lieu of his annual address upon the geographical work of the world. But I cannot let the occasion pass without saying that in the whole range of my own studies, which for many years have been directed towards the subject under review this evening, I have nowhere met with such a *resumé* of the History of Cartography. A few detached statements, gleaned mostly at second-hand, is all that is to be found in the so-called encyclopedias, while here the chain of progress has been conscientiously elaborated by original research.

While, therefore, moving that our President be awarded the grateful thanks of the Society for his able essay, I would add the hope, in which I am sure the whole Society will unite, that it may be preserved in a durable form and widely distributed.

The Rev. Dr. Roswell D. Hitchcock seconded the motion, which was passed unanimously.



Mercator's Map of the World. A. D. 1569.


MAXIMVS HIC DIES VI MENSIVM EST
MARE CONGELATVM PER TOTVM
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Terra Incognita
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TROPICVS CANCRI
Indicum pelagus
Sinus gangeticus
OCEANVS OCCIDENTALIS
MAR DEL SVR
Peru prouincia
TROPICVS CAPRICORNI
MARE PRASSODVM
Terra vel mare incognitum
TERRA VEL MARE INCOGNITVM
CIRCVLVS ANTARTICVS
MARE CONGELATVM PER TOTVM
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