HISTORY OF GEOGRAPHY

J. SCOTT KELTIE
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O. J. R. HOWARTH

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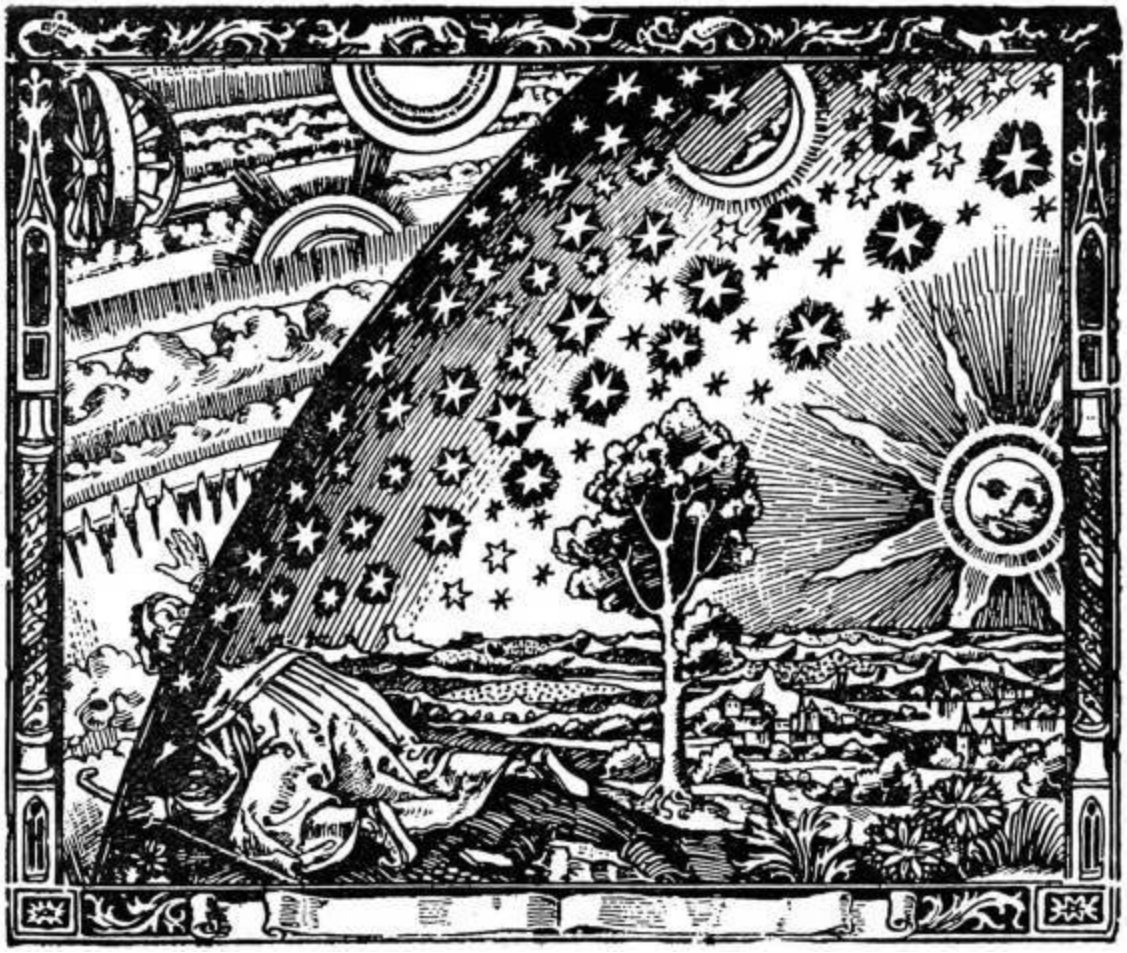

"A Missionary looking over the edge of the world at the point where Heaven and Earth meet."

(*From an old print.*)

HISTORY OF

GEOGRAPHY

BY

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PREFACE

THIS is not a history of geographical exploration, though the leading episodes in the advance of our knowledge of the face of the Earth are necessarily referred to in tracing the evolution of geography as a department of science. That is the object of this volume as one of a series dealing succinctly with the history of the various sciences. We are not concerned to discuss whether Geography is entitled to be considered as a science or not. It is hoped that in the attempt to tell the story of its evolution up to the present day it will be evident that it is as amenable to scientific methods as any other department of human knowledge, and that it performs important functions which are untouched by any other lines of research. I use the first person plural because I am greatly indebted to Mr. O. J. R. Howarth in coming to my help after I had accumulated much of the material, but was seriously delayed owing to a great increase in my official duties. The greater share of whatever merits the book may possess ought to be awarded to Mr. Howarth.

I am indebted to Mr. E. A. Reeves's interesting little book on *Maps and Map-making* for many of the illustrations.

J. SCOTT KELTIE.

July 2, 1913.

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CHAPTER I.

BEGINNINGS

WE need not attempt any elaborate definition of Geography at this stage; it is hoped that a fairly clear idea of its field and functions may arise during the following brief summary of its history and evolution. The old-fashioned definition, "A description of the earth," is serviceable enough if accepted in its widest sense. Geography may be regarded as the mother of the sciences. Whatever was the origin of man, whether single or multiple, and wherever he emerged into manhood, he was a wanderer, an explorer, from the first. Necessity compelled him to make himself familiar with his environment and its resources, and as the race multiplied emigration became compulsory. The more that relics of primitive humanity are brought to light, the further back must man's earliest wanderings be dated. The five thousand years of the old Biblical chronology must be multiplied a hundred times, and still we find that half a million years ago our primitive forefathers must have travelled far from the cradle of the race. They were unconscious geographers. Their conceptions of the earth and of its place in the universe are unknown to us; it is not impossible to infer something of them by analogy of ideas existing to-day among more or less primitive peoples, though to do so is beyond our present scope. Yet it may be said that certain root-ideas of geographical theory and practice must surely date from the earliest period of man's capacity for observation. Thus the necessity for describing or following a particular direction presupposes the establishment of a definite standard—the face would be turned towards the position of some familiar object; then in that direction and the opposite, and to the right hand and the left, four such standards would be found, and would become the "cardinal points." The value, for this purpose, of so patent a phenomenon as the rising and setting of the sun must have been impressed upon human intelligence at an elementary stage. Again, map-making is not

very far removed from a primitive instinct. Modern travellers have described attempts at cartography by the North American Indians, the Eskimo, and the Maori and other less advanced inhabitants of the Pacific Islands.

Fig. 1.—Tahitian map.

It is again beyond the scope of the present summary of the development of geographical knowledge among European peoples to attempt to give any detailed history of exploration; it is only possible to deal with the salient episodes, and these mainly in so far as they have influenced man's general conception of the earth. Nevertheless, ages before the existence of any documentary evidence of its development geographical knowledge must have advanced far in other lands. America was "discovered" probably thousands of years before Columbus stumbled against the New World, or even the Norsemen had set foot in "Vineland"; it had time, before the Spaniards swarmed over it, to become the seat of civilizations whose origin is far beyond knowledge. It is worth noticing for our particular purpose that the European conquerors found evidence of highly developed geographical methods both in Central America and in Peru; the native maps were intelligible to them, and the Peruvian Incas had even evolved the idea of relief maps. China, again, a great power in early ages, possessed knowledge of much of central Asia; India was the seat of powerful States and of a certain civilization; Babylonia and Egypt were working out their destinies, and had their own conceptions of the earth and the universe, long before the starting-point of the detailed investigation within our present view.

But the names of Babylonia and Egypt bring us nearer to that starting-point. The history of Europe dawns in the eastern Mediterranean, and so does the history of geography. It has, however, to be premised that

connection existed, in very early times, between the eastern Mediterranean circle and the lands far beyond. When princes of Iranian stock (to cite a single illustration) are found established on the confines of the Levant as early as the fifteenth century B.C., it may be realized that the known radius from the Mediterranean centre was no short one. Much earlier than this—even in the fourth millennium B.C.—astronomy, a science of the closest affinity to geography, was well organized in Babylonia, and there is evidence for a cadastral survey there. Clay tablets dating from more than two thousand years B.C. show the work of the Babylonian surveyors.

The Egyptians worked along similar lines. Examples of their map-work include a plan, in the museum at Cairo, showing the basin of the lake Mœris, with its canal and the position of towns on its borders, together with notes giving information about these places; and, in Turin, a map of the Wadi Alaiki, where the Nubian goldmines were situated; and this map may date from the earlier half of the fourteenth century B.C.

Meanwhile, in the Ægean lands and from Sicily to Cyprus, at points principally but not invariably insular or coastal, and especially in Crete, communities grew up that developed a high standard of civilization, to which the general name of Ægean is given. It appears that a central power became established in Crete about the middle of the third millennium B.C., and that an active oversea trade was developed in the Ægean and the eastern Mediterranean during the ensuing thousand years. As for the knowledge of the mainland which came to be called Europe, it is suggested that the Ægean civilization was assailed, about the fifteenth century B.C., by invaders from the north, and was practically submerged, probably by a similar movement, five hundred years later; and invasion presupposes intercourse.

The Phœnicians, next taking the lead in Mediterranean maritime trade, must have extended knowledge of the inhabited world, even though they left the reputation of secretiveness in respect of their excursions (a natural and not uncommon characteristic of pioneer traders). A Semitic people, they seem to have emigrated from the Persian Gulf in detachments, and established independent settlements on the Levantine littoral. Tyre was their chief trading city. They provided the commercial link between east and west. Their penetration of the western Mediterranean and even of the Straits of Gibraltar is assigned to the earliest period of their activities. They

established relations not only with the Greeks and other Mediterranean peoples, but also with central European traders; they are said, for example, to have dealt in amber brought from the Baltic overland to the Adriatic and to the mouth of the Rhone. They founded colonies in Cyprus, Sicily, and elsewhere as far as the west of Spain, where Gades (Cadiz) was established perhaps about 1100 B.C. Thence they carried their enterprises far to the north. If they did not actually exploit the tin of Cornwall, they probably knew of Britain. One of the greatest enterprises of antiquity, if we may trust Herodotus, who was, however, sceptical, was conducted by Phœnician navigators under the auspices of Necho, king of Egypt, about 600 B.C. Even before this they brought from distant lands, it may be the Malay peninsula or it may be what is now Rhodesia, gold and other presents for King Solomon. If the Phœnicians had really found their way as far as the Zambezi and the country on the south, they may well have conjectured that it would be possible to sail round Africa. At any rate, if the story as told by Herodotus is true, Necho was convinced that Africa could be circumnavigated. The Phœnician navigators sailed down the Red Sea, and in autumn landed on the coast and sowed a crop of wheat; when this was reaped, they started again and made their way south round the Cape of Good Hope, and so northward, entering the Mediterranean in the third year. At one part of their course they had the sun on their right, which would be natural, though Herodotus regarded this as evidence of the incredibility of the narrative. There is no inherent impossibility in such an expedition, but it led to no direct results; no further effort was made to round the continent for twenty centuries.

The Phœnicians founded Carthage about 850 B.C. (though an earlier trading post occupied the site), and the Carthaginians carried out trading enterprises on their own account from their central point of vantage on the North African coast. Some time after Necho's expedition (probably about 500 B.C.) they sent out two distant expeditions. One of these, under Hanno, appears to have consisted of a very large fleet, and to have been intended to establish trading posts along the west coast of Africa, which was already known to the Carthaginians. Certain details are furnished which serve to identify points at which he touched, and it is generally agreed that he got as far south as the neighbourhood of the Bight of Benin. Almost simultaneously Himilco made a voyage north along the west coast of

Europe. He appears to have visited Britain, and mentions the foggy and limitless sea to the west.

Information obtained by such means as this cannot have become in any sense the common property of the period. But there would be no mean supply of geographical data at the disposal of traders on the one hand, and at least of a few philosophers and generally well-informed persons on the other, at a period long anterior to that at which it is possible to begin our detailed history. Whatever tendency there may have been on the part of the Phœnicians, and no doubt their predecessors, to preserve their commercial secrets, there is no necessity to suppose that traders in distant lands did not describe these lands to those with whom they immediately dealt. The links in the commercial chain would then become links in a chain of geographical knowledge. This supposition granted, geographers may be prepared to risk the charge of temerity if they recognize and enjoy, as an exquisite description of the unbroken summer daylight on some northern fjord-coast, the picture of the Læstrygons' land in *Odyssey*, X.: "Where herdsman hails herdsman as he drives in his flock, and the other who drives forth answers the call. There might a sleepless man have earned a double wage, the one as neatherd, the other shepherding white flocks: so near are the outgoings of the night and of the day." And again, "the fair haven, whereabout on both sides goes one steep cliff unbroken, and jutting headlands over against each other stretch forth at the mouth of the harbour, and strait is the entrance ... no wave ever swelled within it, great or small, but there was a bright calm all around."[1] Here are words which on their face indicate hearsay in the Mediterranean concerning Scandinavia in the Homeric age. Again, the gloomy home of the Cimmerians, at the uttermost limit of the earth, suggests hearsay of the arctic night. As to Homeric geography generally, it may be said briefly that the lands immediately neighbouring to the Ægean are well known, though there is little evidence of knowledge of the inhospitable interior of Asia Minor; something is understood of the tribes of the interior of Europe to the north; the riches of Egypt and Sidon are known; mention is made of black men, and even of pygmies, in the further parts of Africa; the western limit of anything approaching exact knowledge is Sicily. The earth is flat and circular, girt about by the river of Ocean, whose stream sweeps all round it.

[1] *Trans.* S. H. Butcher and A. Lang.

Thus we have found geographical knowledge, so far as it is possible to trace its acquisition at all, to have been acquired for purely commercial purposes, and it remained for the Greeks to seek for such knowledge for its own sake. It has been well said that the science of geography was the invention of the Greeks.

Chapter II.

THE GEOGRAPHY OF THE GREEKS AND ROMANS

The birthplace of Greek geographical theory is to be found, not in Greece proper, but in Asia Minor. Miletus, a seaport of Ionia, near the mouth of the Mæander, became the leading Greek city during the seventh to the sixth centuries B.C., trading as far as Egypt and throwing off colonies especially towards the north, on the shores of the Hellespont and the Euxine. It was thus an obvious repository for geographical knowledge, besides being a famous centre of learning in a wider sense. Thales of Miletus (640–546 B.C.), father of Greek philosophers, geometers, and astronomers, may have learnt astronomy from a Babylonian master in Cos, and became acquainted with Egyptian geometry by visiting that country; he applied geometrical theory to the practical measurement of height and distance. He has been wrongly credited with the conception of the earth as a sphere. That conception is actually credited to Pythagoras, who, born in Samos probably in 582 B.C., settled in the Dorian colony of Crotona in Southern Italy about 529 and founded the Pythagorean school of philosophy. He (or his school), however, evolved the correct conception of the form of the earth rather by accident (so far as concerns any scientific consideration) than by design, for the Pythagorean reasoning was abstract in nature, in distinction from that of the Ionian school, which sought material explanations for the phenomena of the universe. The Pythagoreans (whose view does not greatly affect the later history of geographical theory) conceived the earth as a globe revolving in space, with other planets, round an unseen central fire whose light was reflected by the sun, just as the moon reflects the sun's light. Later the philosopher Parmenides, of Elea in Italy (*c.* 500 B.C.), considered the universe to be composed of concentric spheres or zones consisting of the

primary elements of fire and darkness or night. Anaximander (611-*c.* 547 B.C.), a disciple of the more practical Ionian school, and a pupil or companion of Thales, conceived an earth of the form of a cylinder. He is said to have introduced into Greece the gnomon, a primitive instrument for determining time and latitude, and to have made a map. The first actual record of a Greek or Miletan map, however, occurs half a century after his time, when in 499 B.C. Aristagoras, tyrant of Miletus, asked aid of Cleomenes of Sparta against Persia, and showed him a map, engraved on bronze, of the route of his proposed expedition. Anaximenes, of Anaximander's school, gave the earth an oblong rectangular form.

The physical division of land into continents, though obvious, presupposes the existence of a certain measure of geographical theory. Still more obvious as a primitive division would be a division simply between "my land" and "yours." But there was a clear necessity at a very early period for names to distinguish, generally, the lands which lay on one side and the other of the Ægean-Mediterranean waters. It may well be that the names of Europe and Asia did not possess precisely this application in their original forms. Their derivation has been assigned to an Asiatic source; they signify on this view the lands respectively of darkness or sunset and of sunrise or light—that is to say, the lands towards west and towards east. The earliest known Greek reference to Europe, moreover, does not indicate on the face of it a distinction from Asia, though it does indicate a distinction from lands separated from it partly or wholly by water. The Homeric hymn to Apollo, which may be dated in the eighth or seventh century B.C., refers to dwellers in the rich Peloponnese and in Europe and in the sea-girt islands —albeit in place of "Europe" some scholars would read a word signifying simply "mainland." The name of Europe, if admitted here, is taken to mean no more than northern Greece, and would thus lend some colour to an early tradition that it was derived from a Macedonian city called Europus. However this may be, it is easy to conceive that the name of Europe, being at no time given to a territory with defined frontiers, was capable of an elastic application, which would be gradually extended, or (as is more probable under primitive conditions of geographical knowledge) would remain so vague as to permit of no clear definition.

But when the names of continents emerge in Greek usage they afford the necessary distinction between the lands on either side of the Ægean-

Mediterranean. They so emerge in the 6th–5th centuries B.C., and the distinction appears by that time to have been perfectly familiar, though the precise application, as will be seen, was a matter of controversy. The poet Æschylus (525–456 B.C.), who, by the way, was also a traveller, possibly to Thrace, certainly to Sicily, was acquainted with the distinction, as appears, for example, from passages in the historical drama of the *Persæ*, which deals with the failure of Xerxes's invasion of Europe from Asia, and his retreat across the Hellespont. The distinction would hardly have been introduced into a stage-play if it had not been commonly recognized. In *Prometheus Unbound*, again, Æschylus refers to the river Phasis (Aras) as the boundary between Europe and Asia. Finally, Herodotus states in an early chapter of his work that the Persians appropriate to themselves Asia and the barbarian races inhabiting it, while they consider as separate Europe and the Greek race, and he does not find it necessary to offer any explanation of the names here. At a later stage the continental distinction appears to have been based on or associated with a distinction between temperate and hot lands.

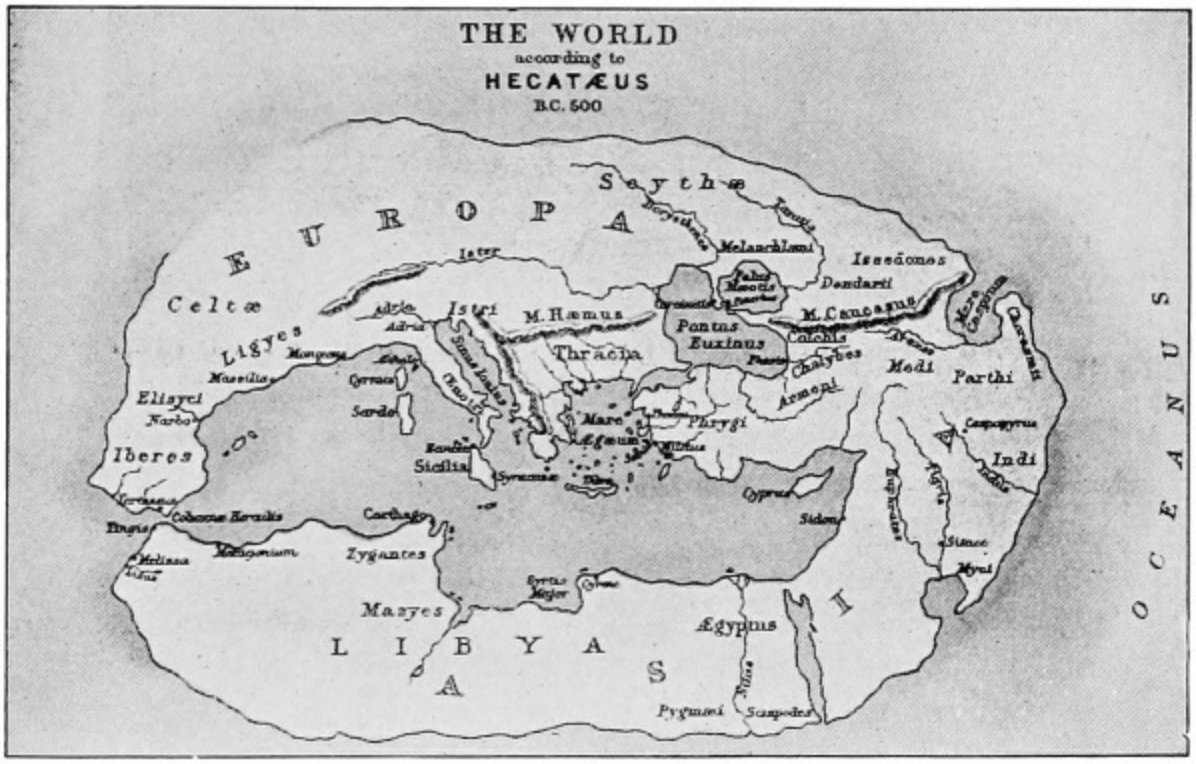

Fig. 2.—The World as supposed to have been conceived by Hecatæus.

Hecatæus of Miletus (*c.* 500 B.C.) has been hailed as the father of geography on the ground of his authorship of a Periodos, or circuit of the earth, the first attempt at a systematic description of the known world and its inhabitants. But even if he wrote such a work, evidence has been adduced that the extant fragments of it belong to a later forgery. However, he was a Miletan and a traveller, besides a statesman. The map which is supposed to have accompanied his work maintained the old popular idea of the earth as a circular disc, encircled by the ocean. Greece was the centre of the world, and the great sanctuary of Delphi was the centre of Greece. If this Periodos is taken as a forgery, there is a parallel case in the Periplus of the Mediterranean attributed to Scylax of Caryanda, a contemporary of Hecatæus. If Scylax wrote any such work, in its extant form it is a century and a half later than his time. He is said to have explored the Indus at the command of Darius Hystaspis, and to have returned by the Indian Ocean to the Red Sea.

Herodotus of Halicarnassus (*c.* 484–425 B.C.) was a historian, but was widely travelled, and understood the importance of a knowledge of the geography of a country, and its bearings on the history of its people. He only introduces geographical information in so far as it throws light on the history with which he is dealing, or because it seemed to him of special interest, or as a report of curious information obtained from the countries which he visited; but he has certainly some more exact information about the restricted world of which Greece was the centre than any of his predecessors. He visited Egypt and the Greek colony of Cyrene, on the coast of what is now Tripoli. There is reason to believe that in Asia he got as far as Babylon on the Euphrates, and perhaps as far as Susa beyond the Tigris. He crossed the Euxine to the northern shore as far as Olbia on the Borysthenes, and probably went round to the south-east coast to the country of the Colchians, whose characteristics he describes as if from personal knowledge. He does not seem to have got very far west in the Mediterranean, though he spent the latter part of his life in southern Italy. There is little doubt that he visited several of the Grecian islands. But apart from the information about the countries round the Mediterranean which he collected personally, his history contains material from various sources concerning the countries and peoples in Europe, Asia, and Africa. This information, on the whole, is of the vaguest kind, and shows that the Greeks whom Herodotus may be taken to represent were only groping their way

with regard to a knowledge of the world outside the limits of their own restricted sphere. This vague knowledge included a considerable section of western Asia as far as the Caspian Sea and the river Araxes. Herodotus had also heard of India and of the Indus river, and had a fair knowledge of the Persians, the Medes, and the Colchians, as also of part at least of Arabia. Eastwards, in what might be called Central Asia, he had heard of the Bactrians and Sogdians to the south of the Jaxartes (Syr-darya, the northern of the two great affluents of the Sea of Aral), and of the Massagetæ, Issedones, Arimaspians, and other races or peoples; those to the north of the Jaxartes being included, according to Herodotus, in Europe, which he took to extend from the Pillars of Hercules (Strait of Gibraltar) to the Hellespont and up the Phasis (Rion) river, from its mouth in the Black Sea, to the Caspian. He also divided Asia from Libya (Africa) along the axis of the Red Sea, and was thus in conflict with others who had divided Europe from Asia at the Tanais, and Asia from Libya at the Nile. He would not permit a theoretical boundary-line to "bisect a nationality," as the Nile does.

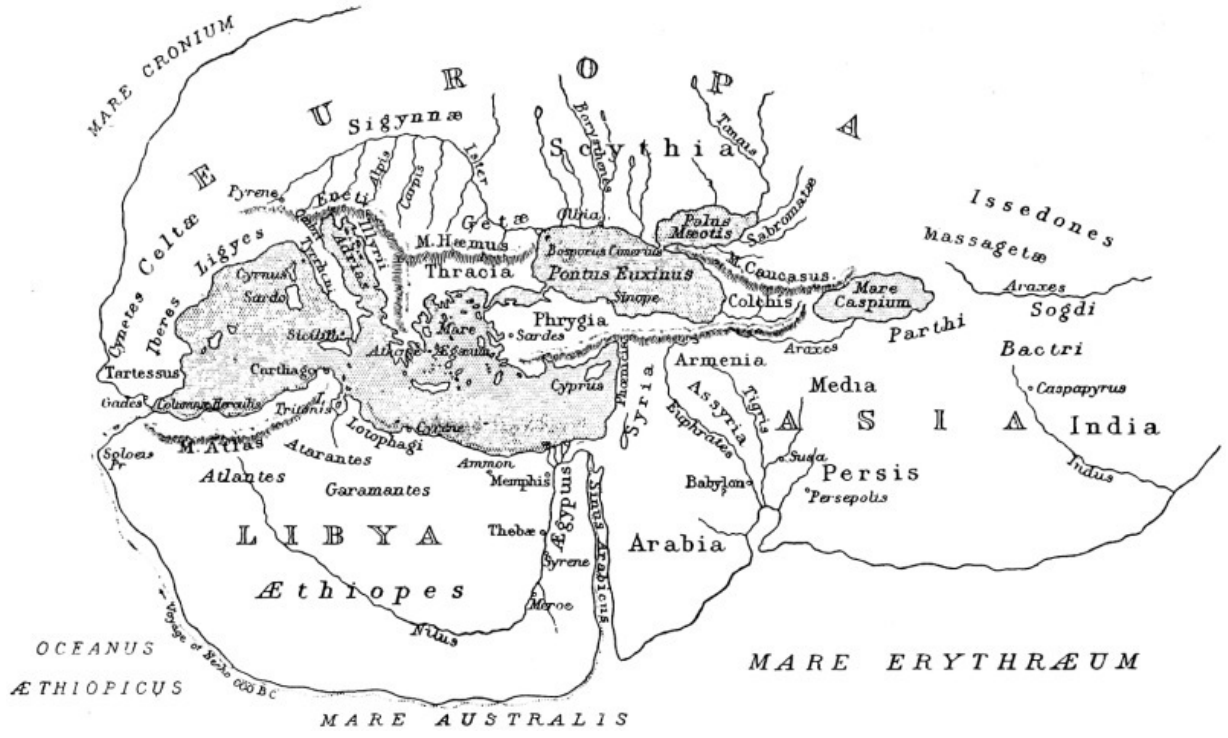

Fig. 3.—The World according to Herodotus B.C. 450.

It may be well to examine Herodotus's geographical knowledge in some detail, as representing the general knowledge possessed by a student (increased by his own travels) as distinct from that possessed by traders and colonists in different particular directions. His knowledge of Europe proper was contained within rather narrow limits. He knew, from personal knowledge, or from information obtained from merchants and colonists familiar with the shores of the Euxine (Black Sea), of the country lying to the north of that sea for some distance, of the rivers which flowed into it from the north and from the west, and of various peoples either settled in or wandering over the land that is now mainly included in Russia. His notions of the comparative dimensions of the Euxine and of the Mæotis Palus (Sea of Azov) are altogether erroneous, as might have been expected; but he knew (though in the main vaguely) of the Tanais (Don), the Borysthenes (Dnieper), and other rivers which flow into those seas. The Ister (Danube) he knew as a river of considerable importance, but he made it rise in Spain and flow north-east and east through the greater part of Europe. He conceived it as corresponding to some extent in the direction of its course with that of the Nile on the other side of the Mediterranean. He had some vague notion of the Iberians and of the Celts, as inhabiting the country to the north of the Pillars of Hercules. He knew something of the country lying to the north of Greece, Illyria, Thessaly, and Thrace, and the Rhodope mountains. He has much to tell of the Scythians inhabiting the country north of the Black Sea, but it is difficult to make out exactly to what race they belonged and whither they had wandered; they may have been the forerunners of the Slav peoples. Of Europe to the north of the Danube, and of the Scythian country, he had no information of any importance. He did not believe in the Hyperboreans, nor did he credit the statement that there was any sea north of Europe. He has a good deal to say about Africa. He had been up the Nile as far as the first cataract to the old city of Elephantine, but above that his information is vague and largely erroneous. He knew of the great bend which the Nile takes to the west above Elephantine, and had heard of Meroe on the other side of that bend; but his notion of the length of Africa was so erroneous that, instead of carrying the Nile south into the interior of the continent, he made it rise far to the west and run eastwards before it turned north at Meroe. But he at least controverted the view that it rose in the ocean itself to the south—a belief based possibly on some rumour, transmitted through many lips, of the

existence of great lakes towards its headwaters. As for a river flowing west-and-east, in the west of the continent, he had heard of such a river in a story of five Nasamonian youths who travelled south from the shore of the Syrtis, crossed the desert for many days, and were at last taken captive by black men of small stature, who carried them to a city on the banks of this river, whence they were subsequently allowed to return. It has been eagerly discussed what truth underlies this story, and whether the river was the Niger in its upper course; but at best the account added little to the knowledge of distant Africa. The idea of a pygmy people dwelling towards the southern shore of the ocean is older than the Iliad in which it is found (III, 3). Herodotus's conception of the shape of Africa did not carry its southward extension much beyond the latitude of Cape Guardafui. He discarded the popular conception of the round earth, regarding it as longer from east to west than from north to south. The philosopher Democritus of Abdera (born *c.* 470–450) exhibited the same conception in a map which he constructed.

An important episode in the progress of a more accurate knowledge of the world of the Greeks was the Retreat of the Ten Thousand under Xenophon in 401–400 B.C. The younger Cyrus had made a great expedition from Sardis, in western Asia Minor, eastwards through the Cilician Gates to the Euphrates, and along the course of that river to the neighbourhood of Babylon. He was accompanied by a band of Greek mercenaries, who, after his defeat at Cunaxa, began the retreat of which Xenophon left a graphic account, containing what must have been to the Greeks much new information concerning the region from the junction of the Tigris and Euphrates northwards past Lake Van and through the mountains of Armenia, north and west to the shores of the Black Sea at Trapezus (Trebizond), and along the south coast of the Black Sea, partly by sea and partly by water, to Byzantium. Xenophon's story is an illustration of the well-known fact that war is one of the chief means of promoting geographical knowledge. This will appear more clearly in the next important episode in the story of exploration—the campaign of Alexander the Great.

In the interval there were one or two writers from whose work something is to be gathered of Greek geographical knowledge and theory about the middle of the fourth century. The philosopher Plato (427–347 B.C.)

may be referred to here in connection with his story, based on an Egyptian tradition, of the great island of Atlantis, that land which plays so important a part in later mythical geography. In the Egyptian story it lay just beyond the Pillars of Hercules, and adjacent to it was an archipelago. This would aid its later identification with the Canaries, though it came also to be connected with America and other known lands besides, as well as giving name to an island in the Atlantic Ocean, the disproof of whose existence may almost be called modern. From Plato's account of Atlantis as the home of a powerful people who in early times invaded the Mediterranean lands, it has also been sought to associate the tradition with Crete at the period of the Ægean civilization mentioned in the first chapter.

Some fragments exist of the writings of the historian Ephorus of Cyme in Æolis (*c.* 400–330 B.C.). He seems to have endeavoured to cover the whole field of the world as known to the Greeks, and conceived the four most distant regions of the earth to be occupied on the east by Indians, on the south by Ethiopians, on the north by Scythians, and on the west by Celts. The last he considered as occupying all Spain, as well as Gaul. Strabo (p. 24) commended his geographical work and his skill in separating myth from history. A document of this period is the Periplus, already referred to as known under the name of Scylax. This class of work became more and more common as navigation developed, and corresponded in some measure to the modern Admiralty guide or pilot. The Periplus is confined mostly to the regions known to the Greeks bordering the Mediterranean. From the Pillars of Hercules the writer follows the north coast eastwards, including the Adriatic and the Euxine as far as the mouth of the Tanais, which he regards as the continental boundary. He then follows the Levantine coast, the north African coast westward, and the west African coast as far as the island of Cerne. He incidentally makes what is regarded as the earliest extant mention of Rome; but his notions of rivers and other features away from the coast are generally erroneous.

Aristotle (384–322 B.C.), in two of his extant works, the *Meteorologica* and the treatise on the Heavens, revealed something of his ideas on physical geography and the figure of the earth and its relations to the heavenly bodies. He believed the earth to be a sphere in the centre of the universe, because that was a form which matter gravitating towards a centre would necessarily assume, also because the shadow cast by the earth on the moon

during an eclipse is circular. He accepted the conclusion that the circumference of the earth was 400,000 stadia (nearly 46,000 miles). His views with reference to the cosmical relations of the earth were the same as those adopted by Eudoxus of Cnidus (*fl.* middle fourth century), but he did his best to prove them. He adopted, however, the prevalent view that the habitable world was confined to the temperate zone between the tropics and the arctic regions. He believed there must be a temperate zone in the southern hemisphere, though he did not suggest that it must be inhabited. In the *Meteorologica* he treats of such subjects as weather, rain, hail, earthquakes, etc., and their causes. He recognized that changes took place in the relations of land and sea. His knowledge of the origin and course of rivers and their relation to mountain systems was confused, and mainly erroneous; and it would seem that little progress had been made in geographical knowledge since the time of Herodotus. In the work of Aristotle's successor, Theophrastus of Lesbos (*c.* 372–287), an important department of geographical study—that of distribution—finds a place in its particular application to plants.

Alexander the Great (356–323 B.C.), King of Macedon, however, during the last few years of his life, made possible by his campaigns a greater extension of Greek geographical knowledge than had taken place almost since Homeric times. When he passed eastward through Mesopotamia, by Babylon, Susa, and Persepolis, and through Media to the southern shore of the Caspian Sea, he was in a region which, though an ancient cradle of civilization, had been till then only vaguely known to the Greeks. Beyond that he entered new country, peopled by Herodotus and others with dubious tribal names. He came almost into the heart of Central Asia, founding a city on the upper course of the Jaxartes. Passing southwards through Bactria and across formidable ranges of mountains such as the Hindu Kush, he struck the upper course of the Indus, made his way down to its delta, and would have proceeded right into the heart of India and followed the Ganges to its mouth but for his mutinous troops. He returned through the north of Baluchistan and Persia to Ecbatana, and so homeward. He also sent a member of his staff, Nearchus, by sea along the coast of Baluchistan and Persia, in order to define it and to ascertain the extent of the Persian Gulf. Dicæarchus of Messana, a pupil of Aristotle, who died early in the third century B.C., used the geographical results of Alexander's expeditions, including the distances obtained by his bematists, or measurers by pacing.

Dicæarchus wrote a topography of Greece, and also drew on a map a parallel or equator, for the first time, so far as is known, along the length of the Mediterranean and, with a distorted idea of their relative directions, along the Taurus and Himalayan ranges. Before his time, and probably contemporaneously with Alexander's campaigns, Pytheas of Massilia (Marseilles) visited (practically discovered) Britain, and made mention of Thule, six days' voyage north of it, having perhaps heard of the Orkneys and Shetlands. As these islands, however, are at no such great distance as is here suggested from the nearest point of Britain, the name of Thule has been variously taken to represent some part of Norway, the Faeröe, or Iceland: it certainly seems by some later writers to be applied to Scandinavia, and in literary usage came to signify the uttermost north. Pytheas also obtained an idea of the Baltic Sea, and is considered by some to have entered it; he is stated to have reached the River Tanais; but if that is to be considered as one of the north European rivers, and not the known Tanais of the Black Sea basin, its identity is doubtful. Pytheas was a trained astronomer; he was one of the first to calculate latitudes, and had that of Massilia nearly correct; he heard of the unbroken summer daylight and winter darkness of the far north, and he noted various features of geographical interest, such as the decrease in the number of different grain crops observed as he travelled northward. He appears, in fact, from the references in other authors, which alone furnish us with knowledge of his work, in the light of a scientific traveller of a type rare in his time.

Mathematical geography was carried a long step forward by Eratosthenes (*c.* 276–194 B.C.), a native of Cyrene, who became chief librarian at Alexandria under Ptolemy III Euergetes. He calculated the circumference of the earth. He considered Syene to be situated on the tropic (which it was not, precisely), because at noon on the day of the summer solstice the sun appeared to shine directly down a deep well there. He therefore observed the zenith distance of the sun at Alexandria at the same time, and obtained his result from this and the measured distance between Alexandria and Syene. His result was to make the earth's circumference only about one-seventh greater than it actually is. He also estimated the size of the habitable earth (œcumene), and considered it, as a result, to be about double as long from west to east as it was broad from north to south. But his estimate of the distance from what is now the extremity of Brittany to the known eastern limit of India was about one-third too great. On a map of the

world he drew seven parallels, using the few points of which the latitudes had been worked out, and also seven meridians at irregular distances apart. Hipparchus (middle and second half of the second century), an astronomer, native of Nicæa in Bithynia, who worked in Rhodes, drew an elaborate series of parallels, and made the division into 360 degrees; the spaces between the lines he called climata, or zones. The problem presented by meridians was more difficult, for there was no instrument for the calculation of longitude like the gnomon for that of latitude. A well-recognised line was that taken to lie from the mouth of the Danube to that of the Nile—Herodotus had used this—and southward up the latter river; but not only the line itself, but also the ideas of intermediate points lying on it, were rather far from the truth.

Eratosthenes in his writings also dealt with the history of geography and with physical geography. This last branch attracted a number of students about this period and later, as, for example, Agartharchides or Agatharchus of Cnidus (middle of the second century B.C.). Crates of Mallus, in the first half of the same century, expressed the view of the Stoic philosophers that the spherical earth was divided into four inhabited quarters—the Œcumene (the known world), the Antipodes, the Periœci, and the Antœci. Posidonius the Stoic (*c.* 130–50 B.C.), among his studies in various departments of knowledge, included such subjects as the ocean, volcanoes, and earthquakes; he observed the interaction of the sun and moon in their influence on tides. He recalculated the circumference of the earth, but obtained an underestimate considerably further from the truth than Eratosthenes's overestimate; and, owing to his high scientific reputation, his error persisted in much later work. Posidonius, before settling at Rhodes, had travelled widely in Africa, Spain, and western Europe generally; and both he and Agartharchides, like other writers of this period, and Aristotle before them, recognized the importance of the human side of geography, and the influence of physical environment on the political and social *régime*. Polybius (*c.* 204–122 B.C.) of Megalopolis in Arcadia, historian, statesman, and military commander, was inspired by extensive travel to introduce the results of topographical and geographical studies throughout his history. Among travellers who rank more nearly among explorers there may be mentioned at this period Eudoxus of Cyzicus (fl. *c.* 130 B.C.), who went on a trading expedition to India, in command of a fleet which was despatched by Ptolemy Euergetes of Egypt with the

specific object of exploring the Arabian Sea. Eudoxus subsequently tried without success to circumnavigate Africa, making at least two voyages along the east coast. Finally, it must be remembered that at this period the extension of the knowledge of the world was mainly due no longer to Greek, but to Roman, activities, and Roman conquests were pushed beyond the confines of accurate Greek knowledge in various directions. Much geographical material was made available by writers on Roman military expeditions. Thus Pompey was accompanied in the Caucasian region by Theophanes of Mytilene, as historian of his campaigns; Julius Cæsar wrote his own account of lands into which he carried his arms (Gaul, etc.).

From all this it appears that, according to the lights of knowledge at the time, a fair conception existed of geographical study along the main lines which it follows to-day. There was therefore occasion for a general review of the whole subject; and this occasion was seized by Strabo, a native of Amasia in Pontus, who was born *c.* 63 B.C., and died in the second or third decade of the following century. He was educated partly at Rome, but his language and outlook were Greek. He travelled much, as far as Etruria, the Black Sea, and the borders of Ethiopia, as well as in Asia Minor, though he knew comparatively little of Greece. His geography, which was not finally completed till towards the close of his life, was the first attempt at covering the whole geographical field—mathematical, physical, and human—and his range was thus wider than that of Eratosthenes. Strabo used the recent Roman authorities to some extent, such as Cæsar's Commentaries (in part) and a map of the Roman Empire by M. Vipsanius Agrippa, son-in-law of Augustus, which was set up in Rome; and he also preferred the authority of Polybius to that of Pytheas, but his sources were mostly Greek. His appreciation of them was not always wise. He ranked the Homeric poems highly, but discredited Herodotus, who on some points had better information than he. He added nothing to the mathematical branch, in which Eratosthenes was his master. He thus accepted the spherical form of the earth, its dimensions as laid down by his predecessors, and its division into five zones. He recognized Hipparchus's view that further astronomical observations were essential to precision in earth-measurement and the position of points on the surface; but it was outside his province to add to those existing. His work in the physical field, however, improved upon that of his predecessors, and his surveys of the features and products of the various lands must have been singularly valuable for reference. The

apportionment of the seventeen books of his geography is not without interest as a rough guide to the distribution of available material and to the author's outlook. He devoted two books to introductory matter, to Spain and France two, to Italy two, to northern and eastern Europe one, to Greece and adjacent lands three, to the main divisions and remoter parts of Asia one, to Asia Minor three, to India and Persia one, to Syria and Arabia one, to Egypt and the rest of Africa one.

Rome did not carry on the Greek tradition of the study of geographical theory. H. F. Tozer, quoting J. Partsch, writes: "It has been aptly remarked that the task which Eratosthenes set himself of measuring the earth by means of the heavenly bodies, and that of Agrippa, who measured the Roman provinces by milestones, may be taken as typical of the genius of the two nationalities respectively." Thus Pomponius Mela, purporting to survey the world in his *De Chorographia* (written *c.* 50 A.D.), followed the coast and described various countries in passing, but by no means all, and added very little to geographical knowledge at large. Pliny the Elder (*c.* 23–79) devoted three books and part of another of his *Historia Naturalis* to geography; but his geography may (at least in considerable part) be compared with the arid text-book of a generation ago, though in some instances his descriptions (as of features in Palestine, Syria, and Armenia) are valuable. As bearing on the quotation made above, it may be said here that the famous Roman system of road building gave rise to two classes of road-books (as they may be termed), one consisting of lists of stations and distances, such as the Antonine Itinerary (probably, in its original form, of the late third or fourth century), the other diagrammatic, such as the Peutinger Table (probably of the first half of the third century, though named after a scholar of the sixteenth), on which roads, stations, and other details were presented in a map-like form, but independently of true scale or direction. The Roman agrimensores were skilled surveyors.

It is not, then, surprising that the two great theoretical geographers next to be considered are not associated with the capital of the Roman Empire. Of the work of Marinus of Tyre nothing is known beyond what is recorded by his immediate successor, Ptolemy, who used and acknowledged his results—as far as concerned the Mediterranean fully, and in respect of other countries to a modified extent. Ptolemy, mathematician, astronomer, and geographer, was a native of Egypt, who worked at or in the neighbourhood

of Alexandria in the second century. His geographical book was called *Geographike Syntaxis*. He carried mathematical geography far beyond the standard of his predecessors. He used the theoretical division of the globe into five zones by the equator and the tropics, adopted Hipparchus's division of the equator into 360 degrees, and worked out a network of parallels of latitude and meridians of longitude, first thus applying these terms in their technical sense. In mapping the habitable world he used the Fortunate Isles, beyond the western confines of Europe and Africa, as the location of his prime meridian. The errors which resulted from the vague idea as to the position of these islands (the Canaries and Madeira), and from the fact that Ptolemy followed Posidonius's underestimate of the circumference of the globe and made his degree at the equator equal to 500 instead of 600 stadia,[2] have been very fully analysed, but cannot be even summarized here.

[2] Fifty instead of sixty geographical miles.

PTOLEMÆUS ROMÆ 1490.

Fig. 4.—The World according to Ptolemy.

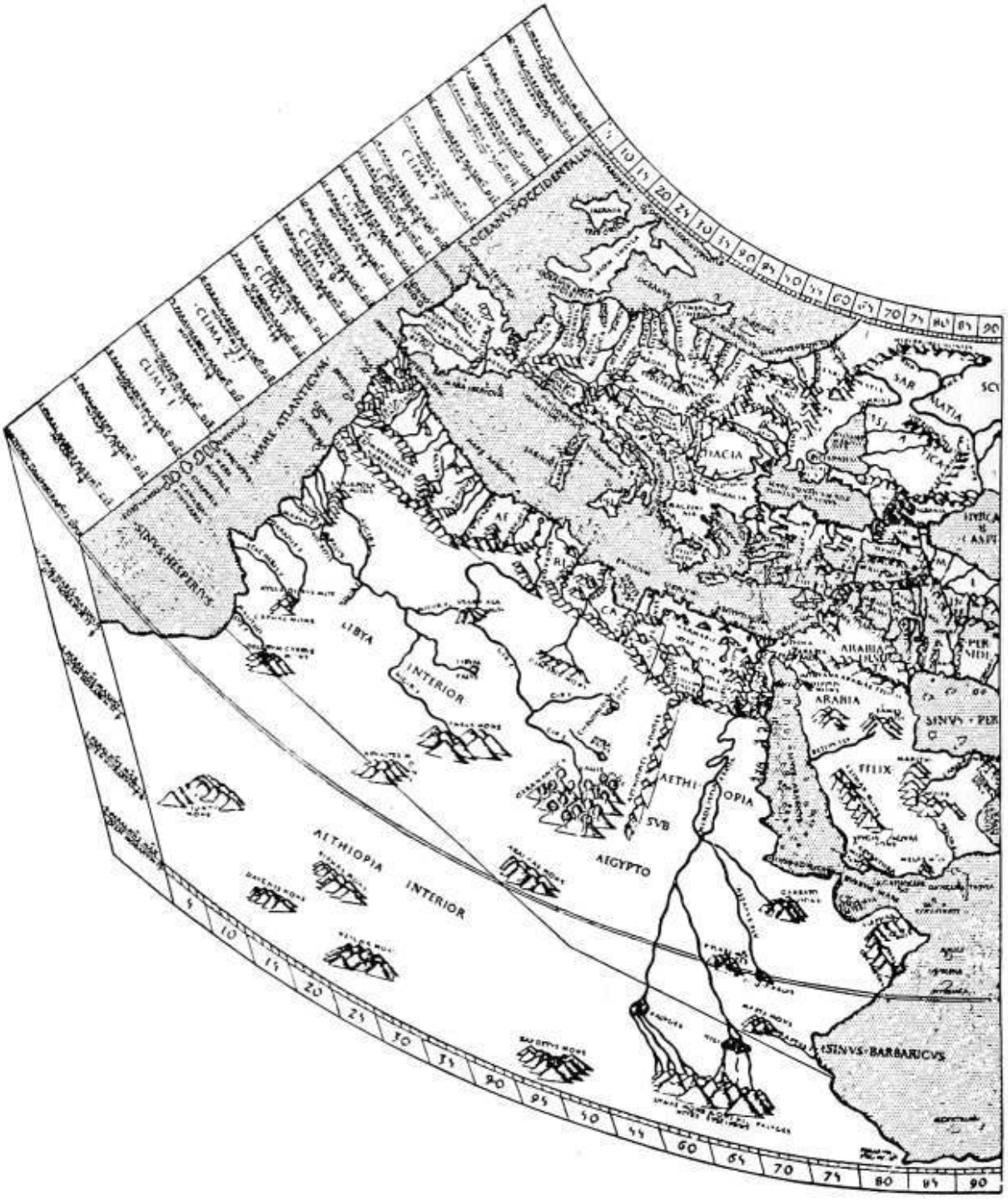

Fig. 4. (left side)

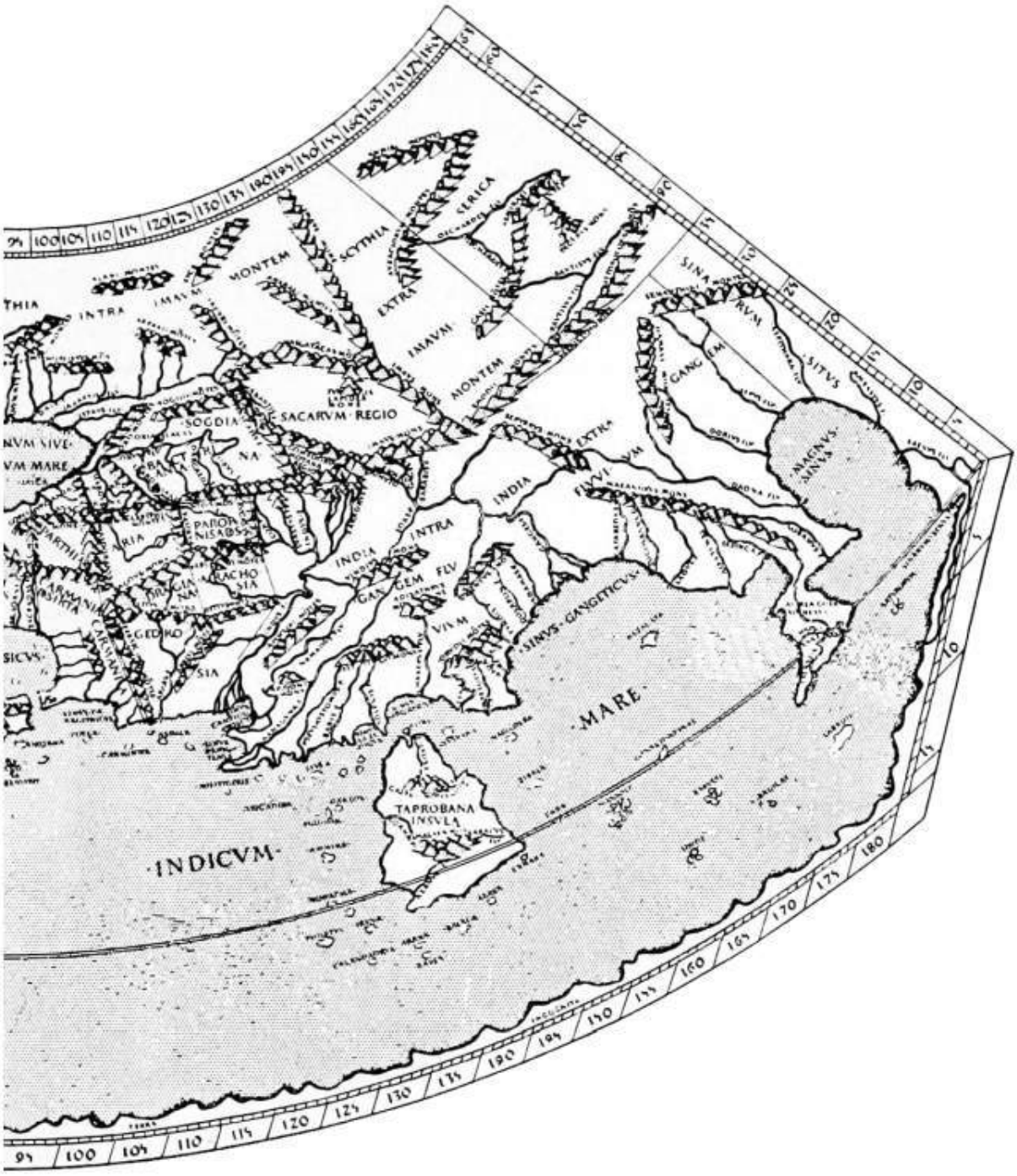

Fig. 4. (right side)

Ptolemy had a strong tendency to exaggerate the size of the great land-masses—his Europe extended too far west (and the Mediterranean was made too long in consequence); his Africa was too wide, especially towards

the south; his Asia was vastly exaggerated in its eastern extension, and many details, even in the Mediterranean area, were made too large. Ptolemy followed his predecessors in using the parallel of 36° N. as the axial line of the Mediterranean. It passes through the Straits of Gibraltar, the island of Rhodes, and the Gulf of Alexandria, and was theoretically prolonged eastward along the supposed line of the Taurus mountains and the range known to lie north of India. In respect to this line there were remarkable inaccuracies in laying down the coasts of the Mediterranean and in fixing the position of the points upon them. The sea itself was made not only too long, but too broad; Byzantium and the Black Sea were carried too far north, and the size of the sea of Azov was immensely exaggerated. On the other hand, Ptolemy restored the correct view, held by Herodotus, of the Caspian as an inland sea, and knew that the great river Volga entered it. Yet again, he knew nothing of Scandinavia, or of the land-locked Baltic Sea, marking only a small island of Scandia, possibly by confusion between the Scandinavian mainland and some Baltic island. But his idea of the British Isles may be taken as fairly correct, if allowance be made for their remoteness. He laid down some parts of the coast very fairly, but oriented the major axis of Scotland more nearly from east to west than from north to south; he also placed Ireland wholly more northerly than Wales. There is plenty of evidence in Ptolemy's work of a growth of knowledge of remote lands, though much of it is vague, if not actually unintelligible to us. Thus in Asia he had an idea of the great central mountain ranges (Pamir, Tian-shan, etc.), for silk-traders had by now established trans-continental routes to China. Ptolemy had also some conception of the south-eastern coasts, which had probably been seen by Greek mariners as far as southern China. But he wholly misunderstood the form of the east of the continent, for beyond the Golden Chersonese (Malay Peninsula) there lies a vast gulf, the eastern shore of which represents his view of China, extending southward far beyond the equator, and facing west. Again, he had no conception of peninsular India—unless, indeed, his huge island of Ceylon (Taprobane) was drawn so by some confusion with the peninsula, as it was certainly also confused with Sumatra. Yet it would seem that he might have gathered a more accurate idea of India from the Periplus of the Erythræan Sea, a guide to navigators dated about the year 80. This work furnished sailing directions from the Red Sea to the mouth of the Indus and the coast of Malabar, following the Arabian coast, although the possibility of crossing the open

sea with the assistance of the monsoon was realized at a still earlier date. And the Periplus distinctly indicates the southward trend of the Indian coast-line.

Roman penetration of Africa gave Ptolemy some new details; he also conceived the Nile as formed by two headstreams arising in two lakes, possibly on the strength of some hearsay of the facts, and he marked the Mountains of the Moon in remoter Africa, which again suggests hearsay of the heights of Ruwenzori, Kenya, and others. The Romans had penetrated Ethiopia, and possibly the region of Lake Chad, and Ptolemy also used other sources of information about North Africa which are unknown from previous writers, but are completely vague and impossible to follow. Of the shape of the continent he was almost completely ignorant; he just realized that an indentation occurs in the Gulf of Guinea, but gave it nothing like its proper value, and carried the coast thence south-westward till the continent is broader at the southern limit of his knowledge than it is at the north.

Ptolemy's work on physical features was on the whole poor, and he neglected the human side of geography. Discarding the idea of the circumfluent ocean, he supposed the extension of unknown lands northward in Europe, eastward in Asia, and southward in Africa, beyond the limits in which he attempted to portray their outlines; and he even suggested a land connection between south-eastern Asia and southern Africa. Before his time the precision of mathematical method had far surpassed that of the topographical material to which it was applied.

Pausanias, a Greek probably of Lydia and about contemporary with Ptolemy, wrote a description (*Periegesis*) of Greece, which, apart from the archæological value which is its chief interest, contains references to various phenomena of physical geography, while as a detailed topographical work it stands alone in the literature of which an outline has thus far been given.

Chapter III.

THE DARK AGE

From this point it becomes necessary to vary the treatment of our subject hitherto followed. With the breakup of the Roman Empire and the establishment of Christianity the old learning was obliterated. Religion became the central fact of intellectual exercise, and, except in so far as Christian doctrine and Holy Scripture involved reference to natural phenomena, every branch of natural science was withered by the breath of theology. The first serious assaults of the barbarian invader were made on the frontiers of the Roman Empire in the fourth century A.D.; in 330 the seat of government was transferred from Rome to Byzantium, and at the close of the century the empire was divided into eastern and western parts. It has often been pointed out that these events did more than mark the beginning of the disruption of the Roman Empire; they also mark the parting of the ways of eastern and western European religion and culture. In the west it became the function of Christianity to teach and civilize peoples untaught and uncivilized; but, limited and intolerant as was its outlook upon natural science generally, it discarded the learning of the pre-Christian era. We have now to inquire how geography was affected by this attitude towards secular learning.

It is true that the habit of travel, so far from being forgotten, was even fostered by missionary work and the practice of pilgrimage. Again, opportunities for the extension of geographical knowledge were provided by various episodes in the history of the centuries with which we are now concerned; thus Procopius, the historian of the Persian, Vandal, and Gothic wars of the epoch of the Roman (Byzantine) emperor Justinian in the sixth century, had ample opportunities for geographical description and used them well. Justinian even despatched an expedition to China (which

returned thence). But the geographical theorists of the period now under review had little if any concern with contemporary travellers' results.

The Christian cosmographers, having found in a spiritual sense a new heaven and a new earth, were at pains to create them in a scientific sense also. It was their aim to reconcile geographical theory with the literal sense of Holy Scripture, and they were not only unable to explain, but were (for the most part) willing to disprove, pre-Christian theory by that light. Thus Lactantius Firmianus (*c.* 260–340), becoming converted, denied the possibility of the sphericity of the earth or the existence of antipodes. On the other hand, this conception died hard, for it was maintained by pagan writers at this time—as, for instance, Martianus Capella, who, writing in the third or fourth century, followed such authorities as Ptolemy and Pythagoras. And these pre-Christian views must have caused some of the Christian authors to doubt, for they left unsettled such questions as that of the earth's shape, on the plea that they formed no part of the Christian doctrine; an instance of this attitude is provided by St. Basil the Great of Cæsarea (*c.* 330–379) in his treatise on the Hexaemeron (Six Days of the Creation).

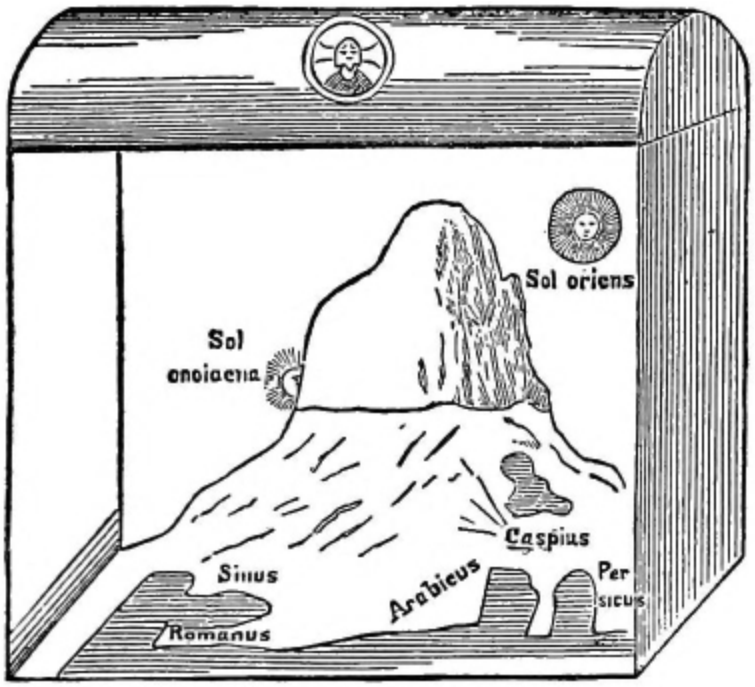

Fig. 5.—The World according to Cosmas Indicopleustes.

One of the principal popular attractions of geography has always been its function of describing the wonders of distant lands, and in Julius Solinus Polyhistor (probably of the third century) we have a typical geographer of the marvellous, who in his *Collectanea Rerum Memorabilium* drew upon Pliny, Pomponius Mela, and many earlier authors for a description of the wonders of the world, and became himself regarded as a high authority. With such influences at work on the study of geography, the genesis of the theories of Cosmas Indicopleustes becomes perhaps less surprising than the theories themselves. He was a merchant of Alexandria, and a traveller (as his surname is inaccurately intended to record) in the Red Sea and the ocean beyond, who, thus fortified in geographical study, became a monk and wrote his *Christian Topography* about the middle of the sixth century, in opposition to the pre-Christian theories. Under his pen the inhabited earth became a flat, rectangular oblong surrounded by oceans. At the north is a conical mountain round which the sun (which is some forty miles in diameter and at no great distance from the earth) revolves, passing about the summit in summer, so that it is hidden from the earth for a shorter time daily than in the winter, when it passes about the base. Again, in such conditions as have been indicated, it is at least intelligible that a responsible writer should accept a mountain 250 miles high, as is stated of Mount Pelion by Dicuil, an Irish monastic scholar who completed his *De Mensura Orbis Terræ* in 825. He, however, was little else than a compiler, and in the manner of his kind made an ill choice of sources. Among them, however, he refers to surveys made by Julius Cæsar, Augustus, and one of the emperors Theodosius; the originals thus referred to are unknown. To mention the various Churchmen and others who, though in no sense geographers, were expected to deal with the theories of the earth and the universe in connection with their religious doctrines, would make but a tedious list.

The view of the sphericity of the earth was not wholly lost. Certain expressions of the Venerable Bede (*c.* 672–735), even if he did not specifically formulate the theory, were capable of that construction, although in 741 we find Virgilius, the Irish bishop of Salzburg, attacked by the Pope for his assertion of the existence of antipodes (or at least an assertion that may bear that construction). Nevertheless, these theories made headway, and from the eleventh century they became more and more acceptable to leaders of learning. Adam of Bremen accepted them; he is also an important figure in other departments of geography. He flourished

in the second half of the eleventh century; his history is a specially valuable authority for the Baltic lands and other parts of Scandinavia and Russia. Its fourth book is a *Descriptio Insularum Aquilonis*, for which there was no little material, for not only had holy men from Ireland visited the Orkneys, Shetlands, Faeröe, and Iceland in the sixth and seventh centuries, but the Norsemen had entered upon their period of colonizing activity; besides Great Britain and Ireland they had reached Iceland in 874, Greenland a century later, and Vinland in 1000; and this last, that much-debated[3] landfall situated somewhere on the North American coast south-west of Greenland, is first mentioned by Adam of Bremen. A similar appreciation of north European geography had been shown by King Alfred the Great, who in translating (and freely editing) earlier works had introduced much of the knowledge acquired down to his own time.

[3] Not only so in modern times; at least one Scandinavian geographer, of the end of the thirteenth century, was prepared to recognize it as belonging to Africa.

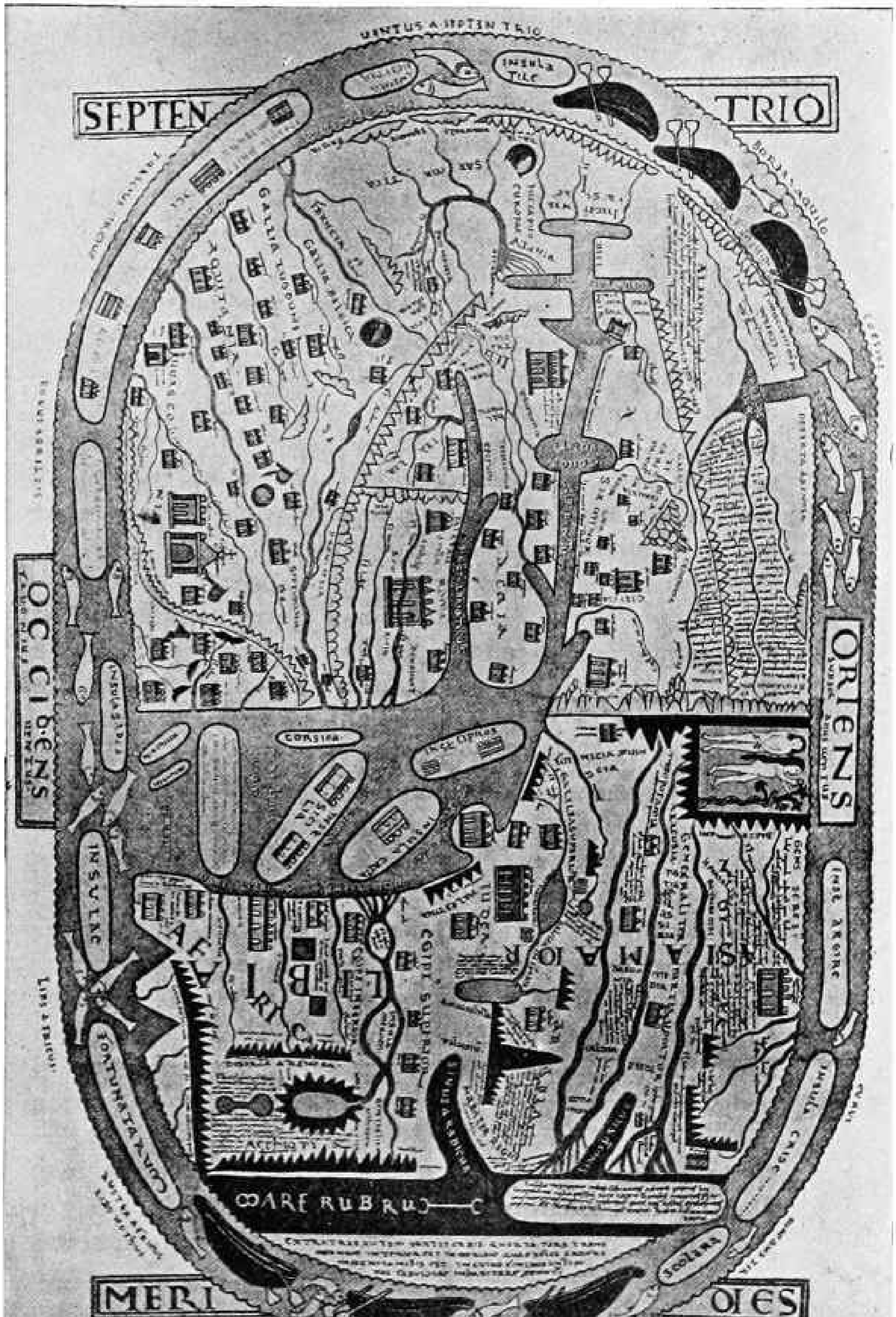
VENTUS A SEPTEN TRIO
SEPTEN
TRIO
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Fig. 6.—Beatus's Map.

Monastic cartography did not keep pace with theory. The disputed habitable land beyond the confines of the known world, and separated from it by the impassable torrid zone (a classical conception), appeared in maps of the seventh and eighth centuries. Apart from this (and it came to be generally admitted) we have rectangular oblong maps like that of Cosmas, and circular maps, out of which was evolved the diagrammatic form of a **T** within an **O**, where the **T** represented the Mediterranean, the Tanais, and the Nile, its upright showing the westward extension of the sea, and the cross-stroke the two rivers, to left and right respectively, so that the west was at the bottom of the map. Europe lay within the left-hand angle of the **T**, Africa in the right-hand angle; Asia was the half circle above it. The holy city of Jerusalem lay "in the midst of the nations." Some maps, again, gave the earth an oval form. In all, the habitable earth was still surrounded by ocean. In the far east sometimes appeared Paradise. This feature and the unknown habitable world above mentioned were both shown in the map of Beatus, a Spanish priest (*c.* 730–798), who illustrated his *Commentaria in Apocalypsin* with one of the earliest known Christian maps of the world, several copies of which, dating from the tenth to the thirteenth centuries, are preserved. In this map the "known" habitable world appears as a dome-shaped mass with its flat base to the south, forming the northern shore of a strait separating it from the unknown southern land. The known world is broken for more than half its breadth by the vast gulf of the Mediterranean, which has two great arms reaching far northward; the Caspian Sea is a gulf opening into the north-east part of the circumfluent ocean, in which are set islands in an orderly ring all round the world; all sense of direction in the flow of rivers is awry, and topographical accuracy is, of course, entirely wanting.

What early Christianity lost by looking askance at classical theory the Arabs, after the establishment of Muhammadan power in the seventh century, in great measure gained, for they were free of scruple as regarded the earlier learning, and eager for knowledge. Early in the ninth century the Caliph Al-Mamun of Bagdad gave a strong impulse to geographical and kindred studies. He caused translations to be made of Ptolemy's

astronomical and geographical works, and of those of other ancient authorities, among whom was Marinus of Tyre. Muhammad ben Musa, librarian of Bagdad, compiled a *Description of the World*, or gazetteer of place-names with their positions, on the Ptolemaic model. Degrees were measured in Syria and Mesopotamia. Among Arab descriptive works the first which survives is that of Suleiman, a merchant, who made voyages to India and China in the middle of the ninth century. In the first half of the following century Masudi travelled widely—to India and Ceylon, probably to China, to Madagascar, to the Caspian, and in Syria and Egypt. His work, the *Meadows of Gold and Mines of Precious Stones*, is an example of the application of the results of travel and personal observation to history; he was commonly compared with Pliny. The Muhammadan demand for geographical works at this period appears to have been great, from the fact that Abu Zaid's work, written about 921, was revised thirty years later by Istakhri, who travelled all through the Muhammadan lands, in his *Book of Climates* (or Zones); and this was again revised and extended by Ibn Haukal in 977 in his *Book of Roads and Kingdoms*.

A more important figure is Idrisi (*c.* 1099–1154), an Arab of Spanish birth, who was probably educated at the great centre of learning, Cordova. He travelled in North Africa and Asia Minor, and, settling in Sicily, made a celestial sphere and a map of the world in silver for King Roger II. Idrisi conceived a substitute for a projection by dividing the inhabited world into seven climates or zones between the equatorial line and the arctic region; each of these was divided into eleven equal parts by perpendicular lines. The squares thus formed were used (to the disregard of natural or political divisions) in a description of the earth carried out by Idrisi for the king, which is noteworthy as having been put together, at least in part, from the reports of an organized system of observers, who were despatched at Roger's order to various countries. Arabian cartography, however, so far as is known, was primitive. Yet the Arab astronomers made some close meridianal determinations—an error of only three degrees between Toledo and Bagdad, for example, and a calculation of the major axis of the Mediterranean which was very near the truth.

Before leaving this period it is worth remarking how commercial activity had not only developed within, but had circumscribed the European area. The Arabs, penetrating eastward into Asia, came in contact with

traders from north and western Europe using a route which, from the eighth century, passed “from India through Novgorod to the Baltic; and Arab coins found in Sweden prove how closely the enterprise of the Arabs and the Northmen intertwined” (H. R. Mill). Thus ways were prepared for the advancement of geographical knowledge when the science should emerge from its stagnation.

Chapter IV.

THE MEDIÆVAL RENASCENCE

It was, in fact, a desire to extend both commerce and Christian religion into the far eastern lands which led to the rescue of geographical study from the evil state into which it had fallen. The Crusades form a group of incidents of no less geographical than of historical importance. Apart from their religious significance, they were undertaken with the object of discovering new routes by which the wealth of the east could be brought into commercial exchange with that of the west; and in connection with their religious significance they gave rise to a period of Christian missionary endeavour in the east. Both movements worked together to bring about the result of a discovery of Asia, so far as Europe was concerned, only less novel and important than the discovery of the New World by Columbus and his successors. Of the many travellers whose records assisted in this discovery a few may be mentioned as examples. The first whose journeys resulted in a noteworthy addition to knowledge of the Mongol Empire was Joannes de Plano Carpini, an Italian of Umbria, who led a catholic mission sent in 1245 by Pope Innocent IV to the Mongols shortly after their great invasion of eastern Europe. He was followed in 1253–55 by William of Rubruquis, a Franciscan, who was sent to Tartary by King Louis IX, and whose account is in many respects more valuable than that of Carpini. We may turn aside here to remark that the great philosopher, Roger Bacon (*c.* 1214–94), freely quoted Rubruquis in the geographical section of his *Opus Majus*. This work, and that of Albertus Magnus of Swabia (*c.* 1206–80), the student of Aristotle, exemplify the revival of interest in geographical theory along lines not dictated by Christian in opposition to pagan doctrines. Bacon revived Aristotle's opinions as to the spherical form of the earth. He held that the sea did not cover three quarters of the globe, and that there

must needs be lands unknown, to the south, east, and west of the known world, from which they must be separated only by narrow waters.

A traveller who followed new lines on the return of his expedition to the east was Hayton, King of Lesser Armenia, in 1224–69, whose journey was described by a member of his retinue. It led him (returning) through the Urumtsi region and the Ili valley, the neighbourhood of the modern Kulja and Aulie-ata, the Syr-darya valley, Samarkand, Bokhara, Merv, and northern Persia. Next follows the greatest name among the eastern travellers of this period, and one of the greatest among all; that of the Venetian Marco Polo (*c.* 1254–1324). His father Nicolo and his uncle Maffeo had travelled, before his birth, to China and established friendly relations with Kublai Khan. That ruler sent them back to Europe to ask the Pope to despatch a large embassy to his court, for he was anxious to extend his relations with the western world and his knowledge of western life. There was a long delay owing to an interregnum in the papacy, nor were the brothers able to obtain the large following the Khan had desired; but they started back to China themselves in 1271, and Marco accompanied them. They proceeded by way of Badakshan, the Pamirs, Kashgar, Yarkand, Khotan, Lop-nor (where they covered ground not again travelled by a European for five centuries), and the desert of Gobi. Marco Polo rose in favour at the court of the Khan. Among many activities he was employed on a mission to the Indies, and no opportunity arose for him to return home until 1292. He was then sent to accompany a Persian embassy on its return journey by sea, by way of Sumatra and India. The journey entailed long delays, and Marco only reached Venice in 1295. He subsequently dictated his experiences while a captive in Genoa, having been taken prisoner in a naval encounter between Genoa and Venice at Curzola in 1298. They were taken down by a fellow-captive of literary ability, Rusticiano of Pisa. His geographical achievements have been thus summarized[4]:—

[4] Yule and Beazley's article on "Polo" in *Ency. Brit.* (11th ed.), vol. xxii.

> Polo was the first traveller to trace a route across the whole longitude of Asia, naming and describing kingdom after kingdom which he had seen; the first to speak of the new and brilliant court which had been established at Peking; the first to reveal China in all its wealth and vastness, and to tell of the nations on its borders; the first to tell more of Tibet than its name, to speak of Burma, of Laos, of Siam, of Cochin-China, of Japan, of Java, of Sumatra and other islands of the archipelago, of the Nicobar and Andaman Islands, of Ceylon and its sacred peak, of India but as a country seen and partially explored; the first in mediæval times to give any distinct account of the secluded Christian empire of Abyssinia, and of the semi-Christian island of Sokotra, and to speak, however dimly, of Zanzibar, and of the vast and distant Madagascar; while he carries us also to the remotely opposite region of Siberia and the Arctic shores, to speak of dog-sledges, white bears, and reindeer-riding Tunguses.

Among Polo's successors were John of Montecorvino (*c.* 1247–1328), a Franciscan, who became Archbishop of Peking, and wrote the first valuable account of the Coromandel coast of India about 1291; and Jordanus, a French Dominican, who, having carried Catholicism into India about 1320, improved even upon Polo's account of the general geography, climate, and products of the peninsula. Another Franciscan who was also a skilled observer both in China and India was Odoric of Pordenone (*c.* 1236–81).

It may be worth recalling the difficulties which stood in the way of immediately making use of the work of travellers and students at this period. Printing was not to come into use in Europe for a century yet. Scribes, no doubt, tended to pay most attention to works of the most popular sort, and it is, therefore, no matter for wonder if the works of conscientious travellers, such as we have been describing, did not obtain anything like a wide circulation within a short period of their production. On the other hand, a work which did obtain very wide favour, judged by the standard of the time, was that much-discussed account of wholly, or very largely, imaginary experiences and wonders which appeared first in French about 1357–71 under the name of Jean de Mandeville, or, in the more familiar English form, Sir John Mandeville. This is an account in the nature

of a parody of the work of Odoric and other eastern travellers, in the sense that the writer took their facts and substituted or superimposed his own fictions. It is a matter for discussion how far his work was based, if it were based at all, on independent travel and research; yet it contains something of interest to students of the history of geography, if only as an opportunity for the exercise of their imagination—as, for example, when the writer tells a story of a man who started forth from his home and travelled always eastward, until at last he reached it again, thus encircling the globe. The difficulties in the way of disseminating knowledge will similarly account for the fact that, although the great Arab traveller Ibn Batuta has his place in this period, he in no way affected European geographical study. He was a native of Tangier (1304–78), who occupied thirty years of his life in travel, covering extraordinary distances in west, south, and east Asia, and in Africa, and wrote valuable accounts. Egypt, Arabia, and Palestine, Syria, Asia Minor, and Persia, the territories north of the Black Sea and the Caspian, were all well known to this wanderer, who also sailed through the Red Sea and along the East African coast, visited many parts of India, the Maldive Islands, Ceylon, Sumatra, and China, and closed his career as a traveller with journeys through Spain and across the Sahara to Timbuktu. His journeys are estimated to have amounted to more than 75,000 miles. Modern criticism has proved the remarkable accuracy of his descriptions of many lands and places; but they were unknown to contemporary Europe, and, indeed, until the last century.

Fig. 7.—The Hereford Map.

It may be said that if a traveller's results did immediately come to be quoted as authoritative, it was in a measure accidental. We have already mentioned the use of the results of Rubruquis by his brother Franciscan,

Roger Bacon; but Marco Polo's results, for example, do not appear to have had any influence on cartography for about half-a-century. An excellent example of mediæval cartography, before these results and others like them began to show their influence on maps, is provided by the celebrated map preserved in Hereford Cathedral, made about 1280 by Richard of Haldingham. Here is the world still shown as a round disk, with little conception of the form of the Mediterranean and its branch seas; while even the British Isles and north-west Europe are strangely distorted to fit the circle. Such is an illustration of the conception of the world still existing in western Europe. Few maps of special areas survive from this period, but that of Great Britain accompanying the work of the famous historical writer Matthew Paris (1259) is an example. It reveals, on the whole, a better idea of the internal features of the land than of its coasts and its shape, which somewhat resembles a fool's-cap. There are also local maps of Palestine; and that country, it may be added here, is the subject of the earliest extant Christian map, in the form of a mosaic on the floor of a church in Madaba, in Syria: it dates from the sixth century. The Crusades would naturally give rise to a demand for maps of Palestine, and they also gave rise to a class of work which may be compared to the modern guide-book.

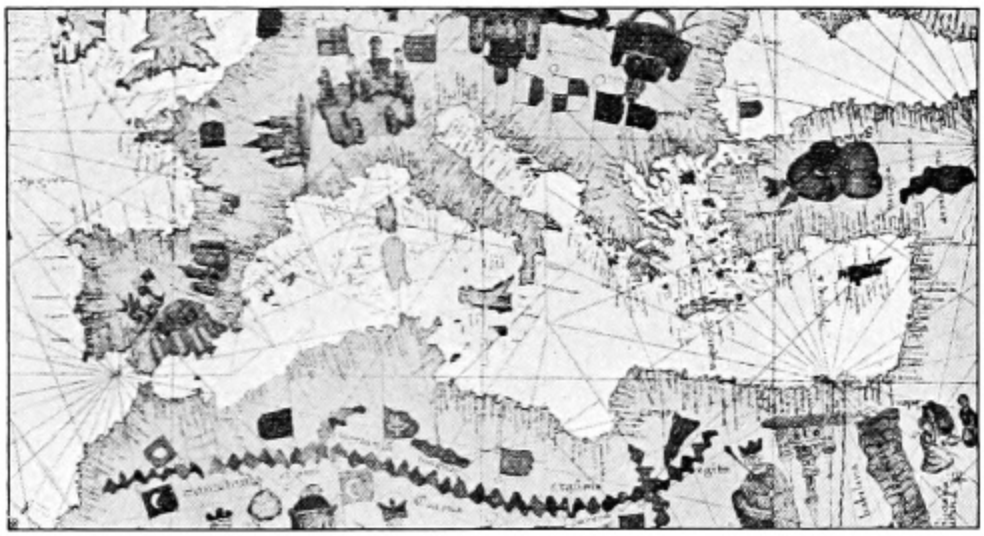

Fig. 8.—Chart of the Mediterranean, 1500, by Juan de la Cosa.

But among maps of special regions the most notable are those known as Portolano maps, which were sailing charts accompanying the Portolani, or sailing directions for the Mediterranean Sea. These, no doubt, existed long before the Crusades, in connection with which they first come to our knowledge. They are in most respects remarkably accurate. They are distinguished by groups of rhumb-lines radiating from a series of centres, and marked usually with the initials of the names of the principal winds. As the accuracy of these maps was probably improved largely as the mariners' compass came into use, it may be mentioned that the first European notice of the use of that instrument is provided by the English scientist Alexander Neckam (1157–1217) of St. Albans, foster brother to King Richard I. From his mention it appears by this time to have been a familiar object. The chief centres for the production of Portolano maps were naturally those identified in an important degree with over-sea commerce; such were Genoa, Venice, Ancona, and Majorca, while the seamen of Catalonia were also prominent at this period. These maps were in some cases extended to cover lands and seas beyond the immediate Mediterranean area, and even the whole world. World maps were usually circular with Jerusalem as a centre, and, in contrast to their accuracy in respect of the Mediterranean, they were not distinguished as a rule for much regard to the best sources of information, though for that we have already adduced some measure of excuse. The map of the world by Petrus Vesconte of Genoa (*c.* 1320) shows the Mediterranean and the Black Seas well, the Nile fairly, the Caspian indifferently, Scandinavia badly. A mountain range extends west and east across almost the whole of northern Europe and central Asia; rivers drain southward to the Black Sea from this; the Indian Ocean appears as a gulf; the south-eastward extension of the African coast is retained, and the peninsular form of India is not realized. Subsequent cartographers disagreed on such points as this last. Thus in a Florentine map of about 1350, called the Laurentian or Medicean Portolano, the west coast of India is well shown, and the influence of Marco Polo's travels is to some degree apparent. This map, moreover, has other details of interest, such as the first appearance in any known map of the Azores and the islands of Madeira with their modern names. The Catalan map of 1375 recognizes the peninsular form of India for the first time, and Marco Polo's results are shown to be thoroughly appreciated; and yet a century later the old errors as

to the form of India and Ceylon persist even in a map so excellent in many directions as that of Fra Mauro (1457).

CHAPTER V.

PORTUGUESE EXPANSION AND THE REVIVAL OF PTOLEMY

THERE were obvious geographical and historical reasons why the kingdom of Portugal should furnish the important series of incidents in the expansion of geographical knowledge which now claims attention. The Arab power in the Iberian peninsula had been broken, and the Portuguese monarchy had established itself during the twelfth century. The Arab mantle of the explorer descended upon Portuguese shoulders. The small kingdom has a large extent of coastline; and not only is communication with Europe by land through the passes at either end of the Pyrenees comparatively difficult, but between those passes and Portugal were Spanish states, with which Portuguese relations were by no means amicable. Thus there was little opportunity for the commercial expansion of Portugal except overseas.

The first important figure in the history of this expansion is that of Prince Henry, surnamed the Navigator (1394–1460), fifth son of King John I. His objects were to extend Portuguese commercial interests mainly in West Africa, and also, it would appear, to discover new lands, if they were to be discovered, to the west of those Atlantic islands which formed the limit of knowledge to the west from very early times. Even the knowledge of the islands themselves was indefinite enough; so that when, in or about 1415, Henry began sending his seamen to the Canaries and later to the Madeira and the Azores, he was inspiring, if not actual discovery, at any rate the acquisition of largely new information. Between 1415 and 1431 colonization and trade had already begun to be established in some of the islands; and, though the Portuguese navigators did not forestall Columbus,

it is likely that they conceived the possibility of a westward route to the Far East. Prince Henry's residence from 1438 to 1460 was Sagres, which consequently became a centre for geographical research, for he gathered about him expert cartographers and instructors for his navigators, whom he supplied with the best obtainable instruments, maps, and information: he used not only European but also Arab sources. With regard to the West African coast, he experienced some years of comparative failure; but from 1444 explorations here were rapidly extended, and a few of the leading navigators and explorers who worked under Prince Henry's direction and after his death may be mentioned. In 1443 John Fernandez travelled inland in the district of Rio de Oro, and collected valuable information about the resources, physical conditions, and people of the south-west part of the Sahara. He made further journeys in 1446–47. Diogo Gomez, in 1448, made his way up the Gambia river. Alvise Cadamosto, a Venetian in Prince Henry's service, was working in 1455 south of the Senegal; and in 1456 he visited, and probably actually discovered, the Cape Verde Islands. His accounts of his voyages were full and valuable, and he also dealt with the explorations of Pedro de Cintra, in 1461 or 1462, to Sierra Leone and the Gold Coast. Gomez made a voyage to the Cape Verde Islands in 1462; but he is most notable as chronicler of the life-work of Prince Henry.

King John II built on the prince's foundations. In 1482 he sent out Diogo Cão, who discovered the Congo and ascended it for a short distance, and subsequently saw the coast of Angola as far as 13° 26′ S. at Cape Santa Maria. On a second voyage (1485–1486) he penetrated still further south, to Cape Cross. He erected pillars at various points on the coast—a practice followed by some of his successors; and some of these monuments have been found and preserved. In a voyage in 1486 or 1487–88 Bartolomeu Diaz extended the knowledge of the west coast nearly five degrees beyond Cão's furthest, reaching 26° 38′ S. He was then driven south by high winds and storms, turned east, and found no land; he therefore steered north again, and struck the coast of what is now the Cape Province at Mossel Bay. Continuing eastward, he reached the Great Fish River, and was able to realize that the coast was now trending north-easterly, and that the southernmost point of the continent had been turned; but his crew were surfeited with their dangers, and insisted on returning. The important cape which he had discovered he is generally stated to have named Cabo Tormentoso, the Cape of Storms; and the story goes that King John,

recognizing the importance of the discovery to the future object of a sea-route to the East, changed the name to the Cape of Good Hope. But there is good reason to believe that the happier name was given by Diaz himself. It had been one of the wishes of Prince Henry, and was one of the objects of the voyage of Diaz, to establish communication with a Christian king of whose powers rumours reached the west coast of Africa from the interior, and who was known under the name of Prester John. In 1487 Pedro or Pero de Covilhão and Alphonso Payva were sent, partly with the same object, by way of the Mediterranean. They visited Egypt, and after many wanderings came to Aden, whence Covilhão proceeded to Calicut and Goa in India, and, returning thence, travelled south along the East African coast as far as Sofala. He then journeyed in the coast lands of Arabia, and visited Mecca and Medina, and finally, entering Africa, proceeded to the court of Prester John in Abyssinia, where he was well treated, but from which he was never allowed to return home. Payva, meanwhile, had travelled into Ethiopia, and had died there.

The journey to India by way of the Cape of Good Hope was completed in due course in the last decade of the century; but earlier in that same decade the New World had been discovered by Columbus, and the era opened by these two tremendous incidents may be more fittingly considered in the following chapter; while for the moment some consideration may be given to the state of cartography and theory at the time when Columbus was planning his voyage.

The works of Ptolemy can have been known to few in the original Greek at this time, and for many centuries before. When, therefore, the translation of his Geography into Latin, originally undertaken by Emanuel Chrysoloras, a Byzantine scholar who settled in Italy, was completed in 1410 by his pupil Jacobus Angelus, these two students lit a beacon in the course of geographical study. The translation, which is usually identified with the name of Angelus alone, was issued under the title of Cosmography instead of Geography. It would appear that Angelus, of whose life apart from this work little is known, not only dealt with the text, but also did the maps into Latin. In a short time there was no lack of copies of the work, and it was soon found necessary to add to the maps at certain points where they failed to represent knowledge which was by this time in possession of the translators. Already about 1424 Claudius Clavus Swartha had constructed in

Italy a map which showed the north-westward extension of knowledge as far as Greenland; the curious orderly curves by which the coastlines are represented frankly acknowledge the draughtsman's lack of detail. About 1470 Nicolaus Germanus, often known erroneously as Donis, produced a manuscript edition of Ptolemy, with maps magnificently illuminated and on improved projections. He also added new maps, and it has been said of the collection that, as far as concerns methods of drawing, it is the prototype of all subsequent atlases (Nordenskjöld). An edition, probably of 1472, if not later, though it is dated earlier, reveals the use of a conical projection with meridians and parallels drawn across the maps; and, as points of some interest in comparison with modern maps, it may be added that the seas are green, the mountains blue, and other parts of the land red and yellow. The Florentine edition in verse, of about 1480, by Francesco Berlinghieri, contained an important series of new printed maps, including Italy, France, Spain, and Palestine.

Although the extension of knowledge to the north-west, as has been mentioned, attracted considerable attention on the part of the editors of Ptolemy, the recent Portuguese discoveries in West Africa did not, apparently, do the same. In an edition, for instance, of 1486, made at Ulm, a geographical description of the north-west lands, including Greenland, was furnished, and there were quoted the latitude and longitude of 183 places in northern Europe and Greenland; but there was no evidence that the conception of the southern limit of the habitable world by Ptolemy was understood to be now proved wholly erroneous by the Portuguese discoveries.

On the other hand, the appreciation of Portuguese labours appeared earlier, as was natural, in Portolano maps. That of Andrea Bianco (1448) drew probably on a Portuguese original, showing the West African coast as far as Cape Verde. On the world map of Fra Mauro, already referred to, the Portuguese discoveries are mentioned in an inscription of considerable length.

In connection with prevailing ideas as to what lands lay in the Atlantic beyond the certain knowledge of men, it may be observed that the conception of a continent or island of Atlantis was very old, and there were other mythical lands which were also given places in distant parts of the ocean. Portolano maps of the fourteenth and fifteenth centuries show the

island of Brazil lying to the west of Ireland, an island named Mam to the south of Brazil, and, still further away in the ocean, and to the south again, a large island in the form of a parallelogram, which bore the name of Antillia, and appears as early as 1426.

The sphericity of the earth, as has been seen, was revived as a theory by Bacon and Albertus; and to these inquirers may now be added the name of Cardinal d'Ailly (d. 1422), whose work, entitled *Imago Mundi*, may be mentioned because it is known to have been in the possession of Columbus. His copy still exists.

A name closely identified with Columbus's preconceived ideas as to the voyage to the Indies by way of the western ocean, and his efforts to obtain recognition for them, is that of Paolo del Pozzo Toscanelli (1397–1482), a Florentine mathematician, astronomer, and cosmographer, whose advice was asked by King Alphonso V. of Portugal as to the probability of this western route. He sent the king a statement and a chart in support of Columbus's ideas. The chart is lost; but the author describes it as showing the Indies opposite and to the west of Ireland and Africa, together with the islands which were known to lie off the coast of the Asiatic mainland, and certain known landing places. A globe made in 1492 by Martin Behaim, of Nuremberg, is usually cited as giving the best existing representation of the views as to the extent of the Atlantic, and the route across it, at the moment when Columbus began his first voyage. Behaim had lived in Portugal, and had a high scientific reputation at court. He had probably visited the more northerly parts of the west coast of Africa and also the Azores, though he claimed to have a much more extensive first-hand knowledge, as having accompanied Diogo Cão. It is doubtful if he did so; but if he did, he made but little use of his opportunity. His representation of the west coast of Africa is not accurate; and for the rest, although he had the chance, and apparently an unusually favourable one, of carrying the results of Portuguese research into Europe, he made poor use of it. He was obsessed by Ptolemaic ideas; he showed in a modified form the old south-eastward extension of Africa, with Madagascar and Zanzibar as two great islands lying off it, Zanzibar being south of Madagascar. He also modified, but still retained, the Ptolemaic idea of the non-peninsular form of India and the exaggerated size of Ceylon. He gave a gross representation of the Malay Peninsula, and in general ignored Marco Polo's results, and those of other

Asiatic travellers. His representation of Scandinavia was indifferent, and even that of the Mediterranean was below the level of the Portolano maps. As regards the width of the Atlantic Ocean between Europe and Asia, he appears to have followed Toscanelli; and he showed the mythical island of Antillia and also that of St. Brandon (the existence of which on maps was an outcome of the fabled wanderings of a holy man of Ireland in the sixth century) in mid-ocean between the Euro-African and the Asiatic coasts.

Such was the view of the ocean barrier which lay between Columbus and the attainment of his ideal. It serves as a reminder, which, in view of the results he obtained, is sometimes necessary, that that ideal was the discovery, not of new lands, but of a new route to lands already known.

Chapter VI.

THE NEW WORLD

The period which witnessed, among other great achievements, the discovery of a new hemisphere, and included the voyages of Columbus, Gama, and Magellan, besides many of an importance only secondary to these, has been called the most brilliant in human history. The exaggeration, if such it be, is excusable; certainly in the department of geographical history no other period shares the peculiar lustre of this. Christopher Columbus (1446–1506) was born of humble parentage at Genoa. He went early to sea, and was attracted to Lisbon no doubt by the reputation of the Portuguese as navigators. He had voyaged to the eastern Mediterranean, to the Guinea Coast, and in the north as far, perhaps, as Iceland. It is not until 1484 that we find his great scheme of the crossing of the Atlantic to Asia matured and laid before the King of Portugal. It was refused by him; it was rejected also in Genoa, Venice, England, and France. Then he presented it at Madrid, and it was examined by a quasi-expert committee, which pronounced against it; but at last it came under the notice of Queen Isabella, and by her was taken up. Columbus obtained three ships, and sailed on August 3, 1492, from Palos, himself in command of one vessel, the others under Martin Alonzo and Vicente Yañez Pinzon. The expedition touched at the Canaries in September, and the story of its subsequent progress is well known—how difficulties were encountered in the Sargasso Sea, how the hearts of the crew failed them, how Columbus was driven to give them false reckonings of the position of the ships, but was at last enabled to point out to them signs of neighbouring land in the flotsam of the waters, and how at length land was actually sighted on October 11, and on the following day a landing in state was effected on an island to which the name of San Salvador was given, and which is now usually identified with Watling Island of the Bahamas. Columbus did not then, or at any time afterwards,

suppose that he had done otherwise than reach some part of the archipelago off Asia. On the present voyage he observed a number of the West Indian islands, and he returned to Spain in March, 1493, to meet with a magnificent reception.

Among the effects of Columbus's discoveries was the necessity which was immediately found for delimiting the spheres in which Portuguese and Spanish explorations respectively should be prosecuted. In the existing state of geographical theory it may be supposed that a satisfactory delimitation was no easy matter to obtain, and, indeed, the line which was chosen was found, in fact, impossible to demarcate. It was determined under the treaty of Tordesillas (June 7, 1494), which followed upon a pronouncement contained in two papal bulls of the previous year, that to Spain should belong islands discovered west of a north-and-south line drawn 370 leagues west of the Cape Verde Islands, and that Portugal might claim all lands lying east of this line. The rule gave rise to such difficulties that Portugal is found later making a claim upon Brazil, while Spain did the same upon the Moluccas.

In 1493 Columbus led a new and much larger expedition to the scene of his triumph. There was now no lack of enthusiasm to be of his company. On November 3 Dominica was reached; the Antilles were subsequently surveyed, and Hispaniola or Haiti, which had been discovered on the first expedition, was again visited. Jamaica was found, the south coast of Cuba was traced—though this island was taken for a peninsula—and it is possible that the mainland of Central America was seen. Columbus returned in 1496 to Spain, and set out on his third voyage in 1498. Holding a more southerly course than before, he came to Trinidad, and subsequently recognized the neighbourhood of continental land by observing a current of fresh water of considerable strength in the open sea; this was from the mouth of the Orinoco. The settlers in the new colonies met with many difficulties, and created more. There was much hostility towards Columbus, and he was doubtless restrained from accomplishing much which might have been accomplished if his followers had been wholly loyal. On his last voyage, in 1502–4, his aim was to penetrate right through the archipelago and to complete the circumnavigation of the world. After coasting along Cuba he turned south, and came upon the coast of Honduras, which he followed for nearly four months before he was compelled to return to Spain. Within a

few days of his arrival there, he lost his great patroness by the death of Isabella, and he himself passed the remaining months of his life in comparative neglect.

Voyagers hastened to follow him across the Atlantic. The work of those who, like Cabot and Cortereal, added a knowledge of the north-eastern coasts of the new continent to the discoveries of the time, will be considered more appropriately in connection with the exploration of the arctic region, and the attempt to solve the long-lived problem of the north-west passage (Chapter VIII). The year 1500 and the first few years of the new century were only less notable than that of Columbus's discovery.

Vicente Yañez Pinzon came of a wealthy Andalusian family, of which several members were well-known navigators—Vicente himself and two brothers, Martin and Francisco, had assisted Columbus. He, in command of an expedition in 1499–1500, was the first Spaniard to cross the Equator, discovered the Brazilian coast at Cape San Agostinho, added 300 miles to the known coast of South America, and found the mouth of the Amazon. The Portuguese Cabral, who has been commonly hailed as the discoverer of Brazil, actually reached its coast some three months after Pinzon, having been driven far from his course round the Cape of Good Hope to the Indian seas in the wake of Vasco da Gama (Chapter VII). In the following years many expeditions crossed the Atlantic for discovery and conquest. Pinzon continued his travels in 1507–09, and in the course of them, in company with Juan Diaz de Solis, sailed south along the Brazilian coast, and is said to have passed without recognizing the great estuary of the Rio de la Plata.

Into this period fall the much-discussed voyages of Amerigo Vespucci, who, if he were indeed a geographical charlatan, as the greater weight of opinion (though it is rather delicately balanced) appears to stigmatize him, is one of the most remarkable examples of a type which, at periods of keen public interest in exploration, has been not uncommon; even modern instances may come into the memory. Vespucci, a native of Florence (1451–1512), came into Spanish service as a naval contractor, and claimed to have himself made a voyage in 1497, which, if the distances and positions quoted by him were accurate, would have extended into the Pacific and as far as the coast now belonging to British Columbia, and would moreover have brought him within sight of the American mainland before any other navigator of this period. He also gave accounts of three later voyages (two

in Portuguese service), abundant in equally or more improbable statements, as that he approached within thirteen degrees of the south pole. If he lied, he was rewarded with something more than the transient fame which others of his kind have usually had to exchange for notoriety. Martin Waldseemüller, professor of cosmography at St. Dié, is credited with the first suggestion that the new continent should take its name from Amerigo, while the hero himself died in the enjoyment of the Spanish office of chief pilot. It must be remembered that at this period of constant fresh discoveries it was almost impossible to form any true conception of the relative importance of the work of different men; and as it was not then the habitual practice of explorers to address themselves immediately on their return to the task of writing down their experiences, Vespucci's narratives were eagerly seized upon as furnishing a trustworthy account of the new world.

It was not until after the first decade of the sixteenth century that the Spaniards, who were to play so large a part in the history of America, began to interest themselves in the penetration of the continent itself, as distinct from the islands in the Caribbean Sea. The voyage of Juan Ponce de Leon, who was obsessed with one of the romantic stories of the period, telling of an island to the north which held the secret of eternal youth, resulted in the acquisition of Florida in 1512—the first Spanish possession in North America. In the next year, 1513, Vasco Nuñez de Balboa, a Spanish adventurer who had conquered an American kingdom with his sword, almost accidentally made the great discovery of the Pacific Ocean from the elevation of "a peak in Darien." After Nuñez had triumphantly taken possession of the whole sea in the name of Spain, and had returned with his news, others hastened to follow him, the most successful being Gil Gonçalez de Avila, who arrived at Nicaragua in 1523. The discovery of the Gulf of Mexico and of Yucatan was delayed even longer than that of the Pacific shore: it was not until 1517 that Hernandez de Cordova touched at the peninsula. But in the next year it and the gulf were explored with some thoroughness by Juan de Grisalva, who brought back to the governor of Cuba the first news of a civilized race living in Mexico, building great cities and rich in gold, to awaken the cupidity of the Spanish adventurers.

One great question, however, remained unsolved: the western route to Asia was still to seek. To the voyagers of the early sixteenth century it must have seemed as though the oceans of the world were divided in two by a

mighty land barrier, stretching from pole to pole. Apart from the unexpected glimpse of the seas on the other side obtained at the isthmus, nothing was known of the length or width of the new continent, until the problem was solved by Fernao de Magalhães (Magellan) in one of the most remarkable voyages recorded. He set sail from Spain in 1519, and after arriving at the mouth of the Rio de la Plata, which was already known, he began a careful search of the unknown coast to the south, always looking for the opening which might lead him to the west. In November of the same year Magellan rounded the southern extremity of the mainland, and sailed joyfully through the straits which bear his name, between the continent and the Fuegian archipelago. He and his men believed that now their journey lay behind them; a few days more with a favouring wind, and they expected to see again lands known to men, some point of the islands of eastern Asia. The wind favoured them indeed, and the name "Pacific," given by Magellan[5] to the ocean, records his gratitude; but the land was far to seek, and it was not until ninety-nine days had passed, and his crew were come to the last stages of starvation, that he reached the Mariannes, and from thence came in ten days to the Philippines. Not only had he sailed half round the globe since he left the shores of the New World, but he had passed among the many scattered groups of islands in that part of the ocean without ever sighting land. He was not destined to enjoy his success, for he died in a skirmish on Matan, one of the Philippine Islands, and the news of the first circumnavigation of the globe was brought home by his subordinate, Sebastian del Cano.

[5] Another story attributes this name to Vasco Nuñez' native informant.

Now that the sea-way to the western coasts of America was pointed out, the outline of the continent became fairly known, and the interior was being gradually covered with landmarks, by the end of the sixteenth century. Under the energetic direction of Cortez, the Spaniards had conquered Mexico. By 1533 his emissaries had arrived at the Gulf of California; in 1541 New Mexico was explored, and by 1571 it was possible

to construct the admirable map of Mexico which figures in Ortelius's Atlas (1579). In South America Francisco Pizarro and his three brothers, with Diego Almagro and Hernando de Luque, had worked with such daring good-fortune that the whole of the Empire of the Incas was conquered for Spain, and in 1535 Chile was added to it. After the first conquest, great tracts of country were explored and taken possession of—first the valleys of the Andes and the country which was named New Granada, then the whole coast between the Straits of Magellan and Peru; and in 1541 Francisco de Orellana, who had separated himself from a disastrous expedition led by Gonzalo Pizarro over the Andes from Quito, made a stupendous journey right down the River Amazon. In 1539 Hernandez de Soto, longing for another Peru to conquer, and full of the fables of treasure and precious metals which were rife everywhere in those days of great discoveries, started on a long and courageous battle to win for himself and his followers the land lying between the Gulf of Mexico and the River Ohio. He penetrated Arkansas; but he was eventually killed, and his followers driven from the country.

Other nations were working to conquer territories for themselves in other parts of the continent. The King of France, Francis I, sent Jacques Cartier on four separate voyages between 1533 and 1543, and he sailed up the river of St. Lawrence to the spot where Montreal now stands; but little colonization was done till the beginning of the following century. From France also came several colonies of Huguenots, sent out by Admiral Coligny between 1555 and 1564, one to Brazil and two to Florida, which were all attacked and destroyed. To England belongs the honour of the second circumnavigation of the world. Francis Drake rounded Cape Horn, and proved that Tierra del Fuego did not form part of the southern continent, as suggested by Magellan's discovery. He sailed up and down the whole of the western coast, and across the Pacific to the Philippines, returning to England in 1580. He was followed in 1585 by another Englishman, Sir Thomas Cavendish, who also sailed round the world.

Although there remained vast tracts unknown in America, the main features of the continent had been determined. The French, under the able guidance of Samuel Champlain, were rapidly settling in Canada, and exploring far and wide, from Hudson Bay to Louisiana. England was occupying the country between the Alleghany mountains and the sea. The

Spaniards were multiplying in South America. But the only expedition undertaken in a scientific spirit which resulted in the acquisition of valuable knowledge was the exploration of the Amazon by Pedro Texeira in 1639. The history of America after the end of the sixteenth century is concerned rather with colonization than with discovery. It was rapidly partitioned among English, French, Spaniards, and Portuguese. Occupation of North America was slowly pushed forward, and the continent more or less provisionally mapped. For many years the United States and Canada have had their regular surveys, and in time the northern half of America will be as well mapped as Europe. The States of South America, with the exception of the Argentine and Chile, are much more backward, and there remain, notwithstanding the work of Humboldt (1799–1804) and other scientific explorers in later years, especially around the Upper Amazon, large areas which are still a virgin field for the explorer.

Chapter VII.

THE FAR EAST AND THE DISCOVERY OF AUSTRALIA

In the meantime the Portuguese had at last won the sea route to India by way of the Cape of Good Hope, through the agency of Vasco da Gama (1464–1524), a native of Sines. He started from Lisbon in July, 1497. He was accompanied by a pilot who had been with Diaz, and he had a map on which the Portuguese discoveries on the African coast were shown so far as they extended. On November 22 he sailed round the Cape of Good Hope; by Christmas he reached a point beyond the furthest limit of Diaz, and named it Natal. Continuing northerly along the coast he met with a number of Arab settlements and a hostile reception from some of them; but from one he obtained a pilot across the Indian Ocean, and he reached Calicut on May 20, 1498, after a voyage of ten months and ten days. This is not the place to discuss the commercial and political difficulties which supervened upon the endeavours of the Portuguese to draw to themselves a share of the rich trade of the Indies; but Gama made a second successful voyage with this object in 1502–03, and subsequently became viceroy in India in the year of his death.

In 1511 the important town of Malacca was taken by the Portuguese, and became the starting-point for many journeys in all directions—first to Sumatra, Java, and the Philippines; in 1512 to the Moluccas, and in 1516 to Canton, and by 1520 a Portuguese embassy was established at Peking. After that exploration proceeded apace in the Malay islands and on the coast of China; and Borneo, New Guinea, and Celebes rapidly became important trade centres, though Japan was not reached till the beginning of the following century, when in 1542 a Portuguese sailor, Antonio de Mota, was

driven to its shores. Some years later a mission was sent there by St. Francis Xavier, which brought back the first trustworthy accounts of the new country.

The Portuguese and Spanish ascendancy in the Malay Archipelago lasted until 1595; in the following year a Dutch fleet, under Cornelis Houtman, came to blows with the Portuguese off the coast of Java; in 1602 the Dutch East India Company was incorporated, and during the following decade Dutch influence was strongly established in the Archipelago. With this epoch in far eastern history is connected the discovery of Australia. At what early period the native peoples of the east—Malays, and even Chinese—had acquired knowledge of Australia, and what was the extent of that knowledge, it is impossible to determine; but Marco Polo had happened upon rumours of a southern continent. In the following chapter we shall discuss the early European conception of that continent, which gave rise to a wider problem in which the discovery of Australia is merely incidental.

A landing on Australian soil has been claimed for the French navigator Paulmyer, Sieur de Gonneville, in 1503, and Guillaume le Testu of Provence is asserted to have sighted the coast in 1531. There were certainly, about 1527–39, French pirates in the Malay Archipelago. There are similar early Portuguese claims to the first view of the island-continent. When Torres had passed through the strait which bears his name, south of New Guinea, in 1606, and when, in the same year, the crew of a Dutch vessel, the *Duyfken*, effected a landing in the Gulf of Carpentaria, the first definite steps were taken towards the exploration of Australia. By 1665 the Dutch had worked out and charted a general sketch of most of the western seaboard; in 1696 William de Vlamingh re-charted a large part of it with fair accuracy. In the meantime, in 1642, Abel Janszoon Tasman had sailed from Batavia to Mauritius, thence south-eastward, till he struck the southern and eastern coasts of Tasmania, whence he passed on to obtain the first sight of New Zealand. The exploration of the Australian coasts from the direction of the Pacific belongs to following chapters.

During this period England began to interest herself in the East Indian trade, and the great efforts which were made to reach Eastern Asia by way of the arctic region will be discussed in the following chapter. In 1591 James Lancaster made an adventurous voyage to the Malay Peninsula; the formation of the East India Company followed. In 1600 Lancaster, in its

employ, started again for the East, and laid the foundations of English commerce in the Spice Islands, visiting the Nicobars, Sumatra, and Java. He was accompanied on this voyage by Davis, famous for his work in the Arctic, who was killed on a further voyage in Eastern waters in 1605. The work of the East India Company led to the undertaking of many important voyages of discovery. In 1607 Captain Hawkins travelled to Agra and the court of the great Mogul, and a factory was started in Japan in 1613. The men in the employ of the East India Company were not, however, the first Englishmen to reach Japan: William Adams, a trader, had been forced to anchor off the island of Kiu-shiu in 1600. He had been very kindly received, but had not been allowed to return home. Permission, however, was at length granted to him, and, after helping to found an English settlement in Japan, he spent the rest of his life in the service of the East India Company. On one of the early expeditions sent out by the trading company in 1612, under Captain Best, the first foothold of the British in India was gained by the establishment of factories.

During the sixteenth and seventeenth centuries Englishmen were also playing a prominent part in the gradual lifting of the veil which lay over Central and Western Asia. Between 1558 and 1579 traders in London made great efforts to open up to commerce the countries round the Caspian Sea, of which vague reports had been brought back by travellers, and embassies were sent to Bokhara, Persia, and Russia. Anthony Jenkinson did much to advance the knowledge of Persia by his journey as an accredited representative of Queen Elizabeth in 1579; Christopher Burroughs traded across the Caspian Sea at the end of the century, and Sir Anthony and Robert Shirley stayed at the court of the Shah of Persia. During the seventeenth century Persia, Syria, and Asia Minor were visited by many travellers, who brought back many tales of the new and strange countries, but added little to the store of geographical knowledge.

Up to the end of the seventeenth century, the only people to bring any news of China and Tibet were missionaries, of whom several made adventurous journeys from India. Tibet had been visited by Friar Odoric in 1325; but the next European to enter it was Antonio Andrada, in 1624. Between 1685 and 1687 P. Tachard journeyed to Cochin-China and Tongking, and made a number of astronomical observations, from which he was able to prove the gross errors in the longitudes of Ptolemy, which were

still in use. After permission to enter the empire of China was granted in 1553 to the Jesuits, much valuable geographical work was done by them throughout the seventeenth and eighteenth centuries. During the seventeenth century the Russians were gradually pushing towards China by way of Siberia. In 1581 a Cossack made himself master of the country round the lower course of the River Irtish; early in the next century the Sea of Okhotsk was reached by Russian hunters; in the middle of the century the River Amur was navigated to the sea; and by its end Kamchatka had been explored, and a treaty had been concluded with the rulers of China. In 1768 and the following years an organized exploration of the whole of the Russian Empire was undertaken. Both the coasts and the inland provinces of Siberia were surveyed from Novaya Zemlya as far as the Sea of Okhotsk.

By the end of the seventeenth century the general outlines of the coast of Asia were known, though much of the interior was still unexplored. Such knowledge of central Asia as was acquired during that and the preceding century was mainly due to the travels of European missionaries following Andrada—Fra Desideri and Fra Freyre (1715), and Orazio della Penna (who was in Lhasa from 1735 to 1747), were among those who entered Tibet, while others actually carried out surveys in China in 1708–18 under the direction of the Emperor Kang-hi. The Dutchman Samuel van der Putte passed thirty-seven years of his life in Asia, and travelled widely, but at his death (1745) left no narrative. At the close of the century English missions began to make their way into Tibet from India. George Boyle led one in 1774, and Captain Turner another in 1783. English and French traders were opening up Persia in the eighteenth century, and in Arabia the principal journey was that of Carsten Niebuhr (1762–67), sole survivor of a Danish scientific mission.

CHAPTER VIII.

POLAR EXPLORATION TO THE EIGHTEENTH CENTURY

(a) Arctic: The North-East and North-West Passages.

ALTHOUGH polar exploration is not very directly associated with geographical theory at large, it has been associated with certain individual geographical theories which occupy important positions in our history as having held the minds of men for long periods, and as owing their proof or disproof to some of the most noteworthy exploits in the story of exploration. There is sometimes a tendency to suppose that polar, or at any rate arctic, exploration has always been concerned mainly with the attempt to penetrate as far north as possible along one meridian or another, and that any discoveries made *en route* have been merely incidental. But the mere desire to set a more northerly or southerly limit to human travel, and ultimately to reach the Poles, really belongs to a relatively late period in the history of arctic and antarctic work. Taking arctic exploration first, we find that its object was in its early stages mainly commercial; from that object there naturally developed a desire to extend geographical knowledge, and, lastly, the extension of many branches of scientific knowledge was served by that particular branch of exploratory work.

Some reference has already been made to the early knowledge of arctic lands acquired by Scandinavian seamen, who in the second half of the ninth century had carried not only their commercial explorations but also their actual rule round the North Cape and as far as the White Sea. At this period they also reached Iceland; but they had been preceded there by holy men

from Ireland, as is stated by Dicuil about 825. In the tenth century Greenland became known to the Norwegians, and during its ninth decade Eric the Red visited the western coast of that land, and colonization and more or less regular intercommunication were carried on thereafter until the early part of the fifteenth century. In the year 1000 Leif Ericsson reached that part of the North American coast which he named Vinland. A second expedition under Thorfinn Karlsefne reached the same coast by way of Labrador and Newfoundland, but these discoveries were not followed up. In the northerly direction Spitsbergen was found by the close of the twelfth century, and, in the easterly, Novaya Zemlya a little later.

We have already seen something of the effect which these discoveries had upon European geographical studies and cartography; and it has been pointed out that their effect is still more to be observed when, in that brilliant final decade of the fifteenth century which witnessed the triumphs of Columbus and Gama, John Cabot was despatched by a company of Bristol merchants across the Atlantic, and reached Cape Breton and Nova Scotia as some believe, or at least Newfoundland, for at Bristol many Scandinavian merchants were settled, and doubtless helped to inspire this and succeeding journeys. A second journey was made by Cabot in 1498, and in 1500 to 1501 a Portuguese, Gaspar Cortereal, visited eastern Greenland and Newfoundland, and these voyages had the incidental result of opening up the important Newfoundland fisheries. But the ultimate object of exploration in this direction, which now and for a long succeeding period possessed the minds of men, was to discover a north-west passage which was held to exist and to be feasible for commerce between Europe and the Indies; and we shall presently see that a similar north-east passage along the north coast of Europe itself and Asia to the same goal was no less eagerly sought after. Cortereal may have seen the opening of Hudson's Strait, and, though he was lost on a second voyage (as was his brother who sought him), the possibility of finding a practicable north-west passage attracted the Portuguese as well as others, but only for a little while—their instincts like their interests led them southward, not northward.

We cannot here detail all the work of explorers who, in the sixteenth century and after, extended discovery in one or another of these directions; nor, indeed, in the case of some of the earlier journeys, do the records admit of doing so. It is thus probable that in the second half of the sixteenth

century Portuguese sailors had anticipated Henry Hudson in acquiring considerable knowledge of Hudson Bay, but it is not possible to say how far they had penetrated it. In 1558 Nicolo Zeno of Venice put forth a forged narrative of a fictitious journey which he attributed to an ancestor of his own. He attached a map to it, and showed thereon an imaginary land named Frisland to the south of Greenland, and other equally false details which set many later travellers and geographers astray. Sir Martin Frobisher, holding that the discovery of the North-West passage was the crowning piece of exploratory work remaining to reward the adventurer, secured Queen Elizabeth's and other powerful interests, and led an expedition to the north-west in 1576. Zeno's map put him wrong when he discovered Eastern Greenland and thought it to be Frisland, and he subsequently reached the southern part of Baffin Land; but this was supposed to be Greenland. He made a second voyage in 1578. Frobisher's successor, John Davis, another explorer of high scientific standing, misinterpreted some of Frobisher's results, as other geographers did, thus placing Frobisher Strait not in Baffin Land but in Greenland, where it long appeared in maps. Davis made voyages in 1585, 1586, and 1587. He passed along Davis Strait, and explored both its eastern and its western shores, extending the knowledge of the west coast of Greenland on his third voyage as far north as 72° 41′. Henry Hudson, in his two earlier voyages in 1607 and 1608, was concerned with the seas of the north-east, and we shall consider them later. But in 1610 he sailed west and entered Hudson Bay, where, after many sufferings, he was set adrift by a mutinous crew and was lost. Following him Sir Thomas Button, in 1612, became acquainted with the west coast of the bay, and maintained the belief, which was upheld for more than a generation following, that the North-West passage to the Indies would be found to open from this coast. In 1615 and 1616 William Baffin made a voyage which brought within men's knowledge the channels which ramify northward and westward from the head of Baffin Bay; but this knowledge was not appraised at its true value; indeed, even the authenticity of his work came to be doubted, notable though the voyage was for many important discoveries, including, among others, remarkable magnetic observations, for in Smith's Sound Baffin discovered the greatest known variation of the compass. His explorations carried him more than three hundred miles beyond Davis's northern limit. In spite of these discoveries, which gave no impulse towards theoretical discussion of the North-West passage along

right lines, and in spite of the opportunity for investigation to the west of Hudson Bay by the early servants of the Hudson's Bay Company, which was established in 1670, the theory that the passage lay westward from that bay was still alive in 1722, when the voyage of John Scroggs, in search of two ships previously lost, was held to prove the existence of a strait leading into the Pacific; but in 1742 Christopher Middleton made further acquaintance with the inlets on the west shore of the bay, and later in the century some of the servants of the Company began to arrive at a conception of the north-westward extension of the continent. Thus about 1770 Samuel Hearne reached its arctic shore by way of the Coppermine River, and in 1789 Alexander Mackenzie came to the mouth of the great river which bears his name. The North-West passage had now ceased to be sought as a highway of commerce, though as a matter of scientific interest James Cook, on the third of his great voyages (1776), which will be dealt with in a later chapter, was instructed to find it from the Pacific, but was stopped by the ice in 70° 41′, beyond Bering Strait, having been the first English navigator to observe the western extremity of Alaska, which had, however, been known for a century or more to the Russians.

The exploration for the North-East passage, though of considerably greater importance to commerce, was hardly of equal importance with that of the North-West passage from our present standpoint, for it could scarcely have been preceded by that complete ignorance which the voyages to the North-West just mentioned did so much to dispel. Some general idea of the coasts of northern Europe, based upon early Scandinavian and possibly Russian work, may be supposed to have existed even when, in 1484, the Portuguese are said to have endeavoured to find a route in this direction to the Indies, and when in the first half of the following century the feasibility of such a route came to be seriously discussed in England. From that country an expedition, in the arrangement of which Sebastian, son of John Cabot, took a leading part, started in 1553 under Sir Hugh Willoughby, with Richard Chancellor commanding one of the ships. Willoughby was lost on the Kola peninsula; Chancellor succeeded in entering the White Sea, travelled to Moscow, and made arrangements for the opening of a commercial route between England and northern Russia. The Muscovy Company of merchants was founded; and, after Chancellor had been lost on a second expedition in 1555, the Company sent out one of his companions, Stephen Borough, in 1556, with the river Ob as his goal. From this voyage

information was first disseminated about the Kola region and Novaya Zemlya, though these had been known long previously to Russian fishermen and hunters. The Company also sent out Arthur Pet and Charles Jackman in 1580. They entered the Kara Sea, but only Pet returned. At this period the Dutch entered the field; they were trading in the White Sea towards the end of the century, and in 1582 Olivier Brunel, and in 1594 and 1596 William Barents and others, penetrated far eastward. In 1596 an expedition with Barents as pilot discovered Spitsbergen, and one of the ships proceeded eastward to Novaya Zemlya, where Barents died; but the rest of the party withstood the winter and won their way back to the Lapland coast in boats. It was found that Russian trading vessels were making regular journeys to the Ob and the Yenisei, and in the two following centuries the Russians were chiefly instrumental in extending knowledge of the northern coast of Asia. In 1648 Simon Dezhnev may have passed through the strait which afterwards bore the name of Vitus Bering. In 1735 the northernmost promontory of Siberia was rounded in sledges by Lieutenant T. Chelyuskin, and his name was given to it; and in 1728 and 1740 Bering explored both the strait and the sea which bear his name.

Meanwhile Henry Hudson had done for the Muscovy Company and for England what Barents had done for the Dutch, for in 1607 he reached a point on the east coast of Greenland in 73° N., studied the conditions of the ice between that country and Spitsbergen, and discovered the island afterwards called Jan Mayen. In 1608 he made similar investigations of the ice from Spitsbergen to Novaya Zemlya, and he was again in the same seas before proceeding to the west to discover the Hudson river and the strait and bay which, as we have seen, were also given his name. Upon the work of Hudson and Barents followed the celebrated whale fisheries of Spitsbergen and elsewhere, with which we have little direct concern in this history; but when, in the second half of the seventeenth century, these fisheries, as far as British enterprise was concerned, reached the height of their prosperity, geographical research was encouraged along the lines which this industry gave opportunity to follow, for a reward of £5,000 was offered in 1776 to any ship which should first sail northward of 89° N. Though the prize was not then won, the foundations of scientific research in the arctic were firmly laid by able and intelligent captains of the whaling ships, among whom William Scoresby is pre-eminent through his voyage as far as 81° 12′ 42′′ N., in 1806, his exploration of the east coast of

Greenland from 75° to 69° N. in 1822, and his admirable *Account of the Arctic Regions*.

(b) Antarctic: the Great South Land.

The leading interest of arctic exploration thus far, in connection with our present study, has been seen to be concerned with the opening of sea routes, by north-west and north-east, from Europe to Asia. The story of antarctic discovery, on the other hand, brings into prominence a problem of far different character which we have already had occasion to notice incidentally. It might be labelled as the problem of the Fifth Continent, though its origin dates from a period long before the discovery of the fourth. We have seen how the conception of a spherical earth was supported on grounds of speculative philosophy by the Pythagoreans, and proven by the observations of Aristotle. We have met with the Stoic conception of the four land-masses, one in each of the "four quarters" of the globe, of which but one, the *œcumene*, was known. Here, then, was the material already for an antarctic problem. There can be no doubt that its solution was regarded in ancient times as beyond the limit of human endeavour, because the passage of the torrid zone was held impossible in spite of those rumours of far southerly voyages, to which we have referred, and which might otherwise have pointed the way to further discovery.

We pass over the period when the antipodean theory was maintained only by the freest of Christian thinkers, and resume the antarctic story at the point where Bartolomeu Diaz demonstrated by experience that the torrid climatic belt is not impassable, and entered a temperate belt to the south of it. After this, the discovery of Brazil, the frequent enforced voyages south of the Horn by mariners driven thither by storms, and the exploration of the Pacific, are all intimately associated with the antarctic problem. Spanish and Portuguese voyagers at the beginning of the sixteenth century revealed Brazil as continental land; a Portuguese expedition in 1514 reported the southern extremity of South America to be in 40° S., and asserted that the coast of a southern continent was observed beyond this. Ferdinand Magellan, again, passing in 1521 through the straits which bear his name, between the South American mainland and Tierra del Fuego, proved

nothing as to the continental or insular character of the latter; but the general tendency of geographical theory favoured the idea of a continent. It took various shapes. We find its coastline roughly coincident with the Antarctic Circle according to Leonardo da Vinci's globe constructed in 1515; this was at least a better estimate of its extent than that of Orontius of 1531, wherein the west of Terra Australis ("lately discovered but not yet fully known," as it is ingenuously labelled) approaches close to the southern American promontory about 55° S., runs thence eastward between 50° and 60° S. to the south of Africa, extends northward to the latitude of southern Madagascar in the Indian Ocean, where the "region of Brazil" is found, and to the south-east of Malaysia reveals a vast peninsula (Regio Patalis), which has suggested some obscure conception of the existence of Australia. A little later, in the middle of the century, New Guinea took its place as a northward promontory of the southern continent, after the discovery of part of its coast by Inigo Ortis de Retes, a Spanish navigator.

Pursuing the course of Pacific exploration so far as it affects the Antarctic problem, we find that after Mendaña's researches in that ocean had resulted in the discovery of some of its many islands, his Portuguese pilot on his second voyage, Pedro Fernandez de Quiros, was inspired to petition for the command of a great expedition to the South Land, obtained his desire by promising the Pope and the King of Spain an untold expansion of their realms, respectively spiritual and temporal, and sailed in 1605 from Callão to discover an island of the group afterwards known as the New Hebrides, from which he returned satisfied in the belief of having performed his self-allotted task, and having taken possession of his "Australia del Espiritu Santo" in the name of his masters. Torres, his companion in command, proceeded through Torres Strait, and thus cut off New Guinea from the supposed continent, as afterwards Tasman did Australia itself, crowning the work of the Dutch navigators who had gradually unveiled the western shores of that vast island, working from the direction of the Malay Archipelago (Chapter VII). Tasman proceeded to discover the west coast of New Zealand, which thereupon succeeded to the position formerly occupied in the minds of the theorists by Java, New Guinea, and Australia as the northward extension of the Antarctic continent in these seas. Such ideas died hard: at the end of the previous century the conception of even Java as continental land survived, after a number of voyagers had sailed the seas to the south of it.

During this period a number of vessels, mainly those of English buccaneers, on passing through the Straits of Magellan had suffered the common fate of being caught by northerly storms and driven to the south. Little enough, however, emerges from their exiguous and indefinite records excepting vague pictures of peril from tempest and ice. Thus Sir Francis Drake was carried to about 57° S. in 1578, and afterwards made northward to discover some of the islands of the Fuegian archipelago; but even these took their place on the maps as part of the southern mainland; and it may be added that the same fate befell the remote and tiny Easter Island when it was observed by Edward Davis more than a century later—if Easter Island was indeed his landfall; his observations were not sufficiently definite to enable us now to determine. The Dutchmen Jacob Lemaire and Willem Cornelis Schouten, however, successfully aimed at discovering a passage into the Pacific south of the Straits of Magellan, saw and named Cape Horn, and passed across the ocean through the Paumotu and Tongan archipelagoes by New Pomerania to the East Indies in 1615–17. To an intervening date (1598) is assigned the disputed episode of the voyage of a ship commanded by Dirk Gerrits, one of a Dutch squadron which was said to have been driven south to 64° and there to have fallen in with a mountainous snow-clad coast, identified later with the South Shetland Islands. The story is typical of the uncertainty and misunderstanding associated with all the early southern voyages; it seems probable that Kaspar Barlæus, who in 1622 translated into Latin a history of the "Doings of the Spaniards in America," was misled by the confusion of a later voyage of one of Gerrits's shipmates (in the account of which, however, no mention occurs of a far southern land) with that of Gerrits himself. However this may be, another mythical point was duly established on the mythical coast-line of the Antarctic continent running westward athwart the southern Pacific. And the old theory held its place in spite of the strong proofs adduced by William Dampier, during his voyage round the world in 1699–1701, of the inaccuracy of the continental coast as laid down according to the cartographers' theories. Dampier, after sharing to the full in the adventures of the buccaneers in the Pacific, was under the orders of the admiralty on this voyage, in the course of which he approached Australia directly from the Cape of Good Hope, and made careful explorations in the Shark's Bay area of the west coast. In 1721 Jacob Roggeveen, leading an expedition on behalf of the Dutch East India Company, was satisfied of the

neighbourhood of land about 64° S., south of Tierra del Fuego; and subsequently, after voyaging north-westward into the Pacific and (as is generally supposed) discovering Samoa, believed that he had located promontories of the long-sought continent.

Even the British naval explorers, John Byron in 1765 and Samuel Wallis and Philip Carteret in 1767, had it in command to continue the search. The French were now taking a share in Pacific exploration, and Louis Antoine de Bougainville in 1768 passed across the Pacific by way of the Paumotu, Society, Samoan, and New Hebrides groups to the south coast of New Guinea. But these and other voyages only served to add to the map the archipelagoes of the Western Pacific, when they did not actually cause confusion by imperfect position-finding and by the practice of successive voyagers of renaming islands previously discovered.

The French voyager Lozier Bouvet, supplied with vessels by the French East India Company, sailed in 1738 to discover the continent, and battled long and bravely with the Antarctic ice about 55° S. for no positive reward save the discovery of Bouvet Island (whose insularity, however, he himself did not recognize) and the negative one of abolishing the imaginary coastline from the chart of the South Atlantic. Hope of future great discoveries was revived by the observation of the Marion and Crozet islands during the expedition under Marion-Dufresne in 1772; but the chapter closes with the bitter disappointment of Yves de Kerguelen-Trémarec, who, after a first voyage in 1772, during which a too vivid imagination led him to regard his discovery of the island now called Kerguelen as revealing the “central mass of the Antarctic continent,” and a land of promise, was hopelessly disabused on his second visit (1773) to that inhospitable shred of land, whose name he changed from Southern France to the Land of Desolation.

Chapter IX.

JAMES COOK AND HIS SUCCESSORS

The name of Captain James Cook stands above those of all others who voyaged in the southern half of the globe, for he finally laid to rest the myth of the southern continent, and brought the first definite news to the world of the great island of Australia and of New Zealand. His first voyage was undertaken under the auspices of the Government in 1768 with the object of observing under the most favourable circumstances the transit of Venus, and was thus not primarily one of exploration. An immense amount of work was done, however; the transit was successfully observed at Tahiti, and the Society Islands were discovered. Six months were spent in a thorough exploration of the coast of New Zealand, and of 2,000 miles of the east coast of New Holland, or Australia. Thence he sailed to Batavia, and proved what Torres had stated in 1607, that New Guinea was not, as had been supposed, a part of Australia. In 1772 he started on another journey under Government auspices, designed for the special purpose of finally solving the question of the southern continent. This object was thoroughly accomplished, as Cook sailed from the Cape of Good Hope to New Zealand, passing twice within the Antarctic circle on the way, and thence he sailed three times across the Pacific. He first cruised about to the south-west of New Zealand, reaching as high a latitude as 71°, and finally touching at Easter Island. He then visited for the first time New Caledonia, Norfolk Island, and the Isle of Pines, besides gaining a clearer knowledge of the Marquesas, New Hebrides, and Tonga groups, and again reached New Zealand. Finally he voyaged from New Zealand to Tierra del Fuego and the Cape of Good Hope, exploring and touching at many little-known points. This journey, from which he returned in 1775, was remarkable as much for Cook's splendid success in combating scurvy, the scourge of ocean travellers, as for the great discoveries made. During the long voyage,

equalling three times the circumference of the earth, only one life was lost, and this striking result of his precautions did much to encourage and help explorers who followed after him.

Cook's third voyage, which was undertaken primarily with the idea of forcing a way through the north-west passage, has already been mentioned in the chapter on Polar Exploration. But it must be noticed here that on his way to the Arctic region, besides revisiting many of his previous discoveries and finding the larger islands of the Cook Archipelago, he sighted for the first time since the sixteenth century the Hawaiian group. These important islands are supposed to have been discovered by the Spaniard Gaetano in 1555, but had long been forgotten; it was here that Cook was murdered by the natives in 1779. His work was of extreme importance in several directions: he made known to the world a larger area of the globe than perhaps any other man before or since; he overcame the disease which had previously been one of the greatest obstacles in the way of explorers, and he laid the foundation of the British Australasian Empire. It is said that had he returned from his last voyage he would have received honour from the King; it would have been due, and overdue.

Cook's work in the Pacific was ably carried on after his death by several other explorers, of whom the best known was J. F. G. de la Pérouse, who set out in 1785 to fill in the gaps left by Cook on his voyages, and particularly to explore the great sea between North-west America and Japan. He made a successful exploration of Manchuria and the islands to the north of Japan, which were then little known, and he visited Petropavlovsk in Kamchatka, whence he sent home the journals of his voyage. He then voyaged to the east of Australia, touching at Samoa, and reached Botany Bay. Then disaster overtook the expedition, and no one returned to tell how its members perished somewhere to the north of the New Hebrides. In 1791 d'Entrecasteaux set out to search for La Pérouse; and though he was unsuccessful, he advanced to a large extent the knowledge of the islands north-east of Australia. During the following hundred years many explorers and scientists worked in the Pacific, filling in the gaps left by the pioneers in the region. In 1803 the Russians came on the field, with Adam Krusenstern, followed by Otto von Kotzebue (1816), and Fabian von Bellingshausen (1819–21). The French followed in 1818 with L. C. D. de Freycinet, and later with Louis Duperrey and Dumont d'Urville.

In 1839 the first important American expedition sailed under Charles Wilkes. Much scientific work for purposes of research was carried on in Oceania in the nineteenth century; but with the exception of the famous "Challenger" expedition (Chapter XIV) it is beyond the scope of this book.

Chapter X.

MEASUREMENT, CARTOGRAPHY, AND THEORY, 1500–1800

It is characteristic of our history that a gap, almost entirely unbridged, exists between the early period and the sixteenth century in the story of the development of methods of precision in determining geographical position. We have already referred to early efforts to estimate the size of the earth, and in this connection have mentioned that simple instrument of unknown origin, the gnomon. Aristarchus improved upon the mere upright rod whose shadow was measured, by setting one upright in a bowl, the length of the rod and the radius of the bowl being equal; by means of this instrument, which was called the scaph, the angle of altitude could be read on a scale of circles inscribed on the inside of the bowl. Among other early instruments were the astrolabe, an invention attributed to Hipparchus, which served mariners and others down to the seventeenth century; the diopter, which appears to have resembled an alidade mounted on a stand, and may be regarded as a prototype of the theodolite; and Ptolemy's rods, or the triquetum, in which a rod working upon two others, one vertical while the other pointed to the observed object, enabled the angular zenith distance to be read. It is true that some additions to this list of instruments were made by, or for the benefit of, mediæval mariners before the pregnant period about the beginning of the sixteenth century. Thus the less cumbrous quadrant was early brought into use, to the partial displacement of the circle of the astrolabe. The cross-staff, for measuring the angle between the horizon and the sun, is first described, so far as is known, in 1342.

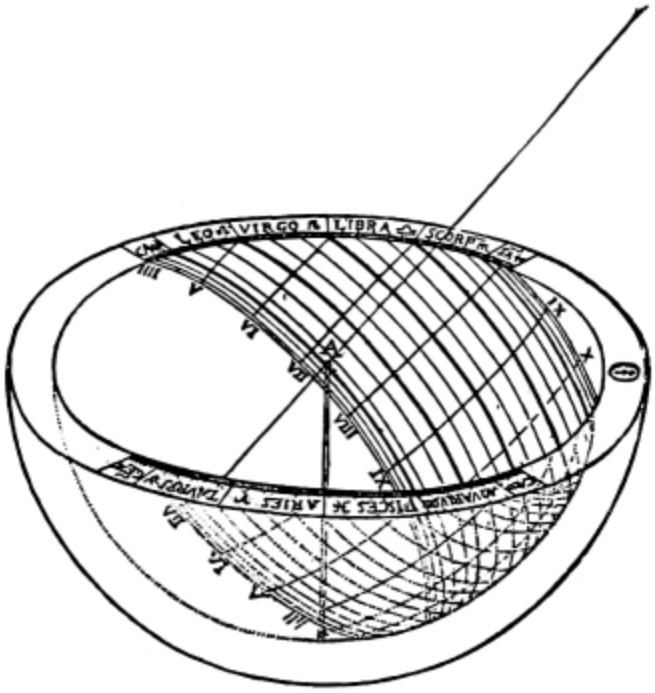

Fig. 9.—Scaph.

(Front.) (Back.)

Fig. 10.—Astrolabe.

Fig. 11.—Quadrant.

But it was not until the sixteenth century that the study of the earth's size and figure began again to attract attention. The fact that it did so, and the interest that was thereafter maintained in this investigation, stand in the first instance to the honour of French science. The Spanish and Portuguese congress which attempted in 1524 to lay down the boundary fixed under the Pope's award as separating the areas of Spanish and Portuguese dominion in the new world—a line lying 370 leagues west of the Cape Verd Islands—failed utterly; the length neither of a degree nor of a league could be agreed upon. Jean Fernel (1497–1558) in France, however, made measurements by calculation from the revolutions of a carriage wheel and by means of quadrant observations, and reached a fair estimate of a degree. A Dutchman, Willibrord Snell, who published his results in 1617, laid the foundation of modern methods of survey by applying to the measurement of an arc between Alkmaar and Bergen-op-Zoom the system of a series of triangles

and the trigonometrical computation of the distance. During the century which intervened between the labours of Fernel and of Snell, it is clear that interest was waking in the development of precise methods of land-surveying, for the compass was probably first applied to this work at the beginning of the period; in 1571 we find Leonard Digges introducing in England an instrument which represented the theodolite at an early stage; and Jean Pretorius at Wittenberg in 1590, and Philip Danfrie in France in 1597, with his graphometer, foreshadowed that most valued equipment for detailed survey work, the plane-table.

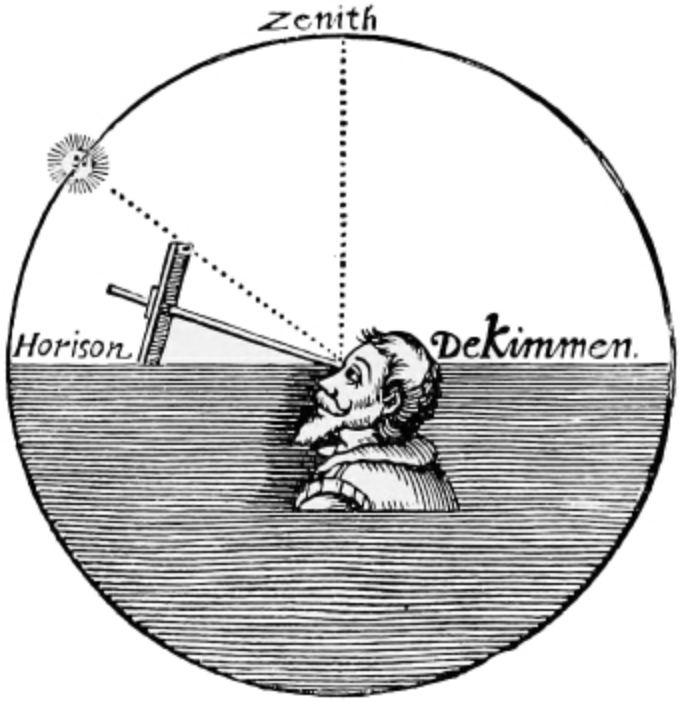

Fig. 12.—Cross-staff.

An arc was measured and the length of the degree calculated in England by Richard Norwood in 1633–37. Important improvements in instruments appear about this time. Thus François Vernier introduced in 1630 the microscopic attachment named after him the vernier, through which close and accurate reading of scales may be made. In 1643 appeared Torricelli's barometer, and in 1648 Pascal, in France, applied the principle of the difference of atmospheric pressure at different elevations to the

measurement of height above sea-level. A little later follows the application of the telescope to surveying instruments. In 1669 Jean Picard, measuring an arc in France, used a quadrant fitted with a telescope in which crossed wires were inserted, providing lines and a point (the intersection of the wires) in the field of observation, for the purpose of ensuring accuracy. Meanwhile, in 1657, Christian Huygens, a Dutch scientist, introduced (if he did not actually invent) the pendulum clock; and Jean Richer, using one in the course of astronomical work undertaken in South America for the French Academy of Sciences, found that the pendulum regulated to beat seconds in Paris failed to do so in Cayenne. This opened up the problem of the deviation of the earth's figure from the true sphere; Sir Isaac Newton had argued such deviation to exist from mathematical theory associated with the rotation of the earth, and Huygens himself also investigated the question. Their conclusions, and that to be drawn from Richer's pendulum observation, represented the earth as an oblate spheroid, or (in simpler expression) as somewhat flattened at the poles, the polar diameter being shorter than the equatorial. On this showing, a degree measured, let us say, in the north should be longer than one measured nearer the equator; but J. and D. Cassini, in the course of an extensive triangulation in France in 1684–1718, obtained an opposite result. Their measurements were subsequently proved inaccurate, but not before much controversy had arisen as to whether the earth is a prolate spheroid (as their results would go to prove), or oblate, as held by Newton and Huygens; and the French Academy had despatched expeditions to Peru and to Lappland, there to measure arcs for comparison. The Peruvian arc was measured by Pierre Bouguer and Charles de la Condamine in 1735–45, in the face of difficulties sufficiently reflected by the length of time occupied and by the fact that they fell out over the work and published separate accounts of it; the Lappland arc was worked out by P. L. M. de Maupertuis and his party in 1736–37.

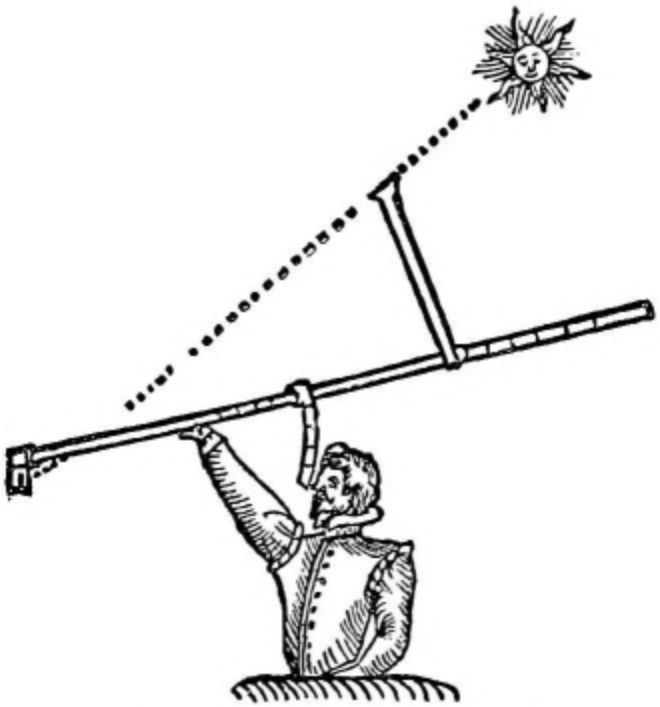

Fig. 13.—Davis’s Back-staff.

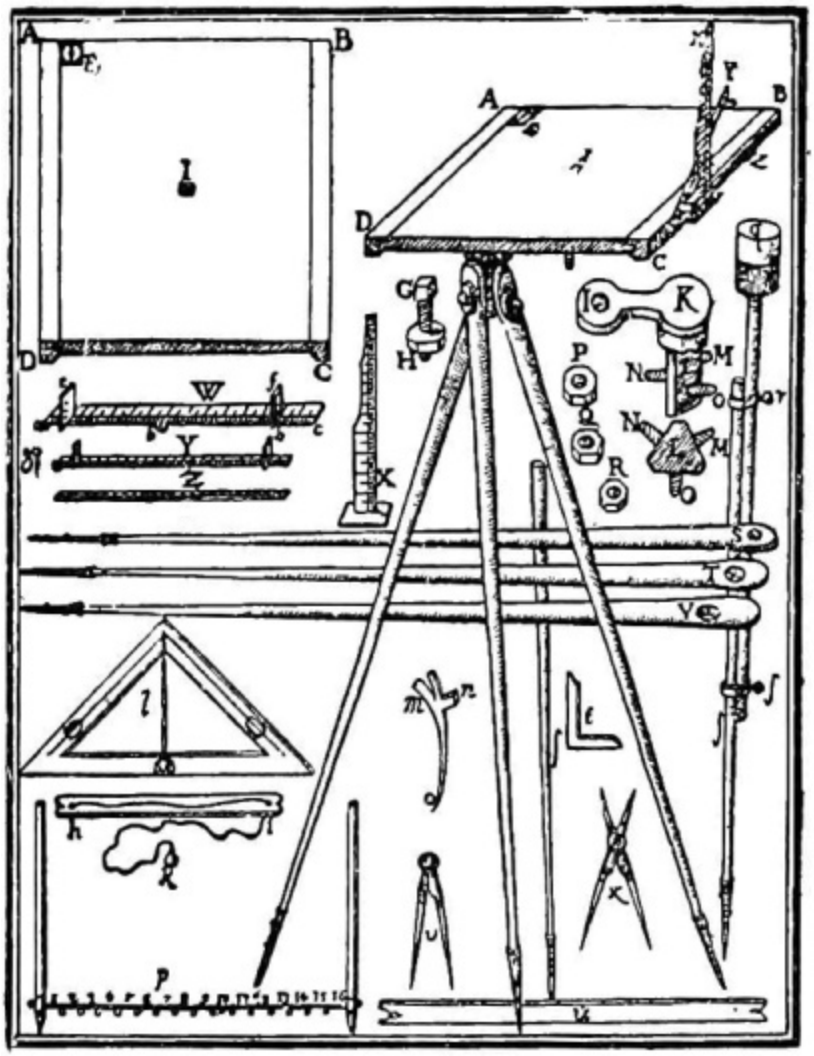

Fig. 14.—Pretonius's Plane-table.

It may be noticed that the difficulties of Bouguer and De la Condamine included troubles with untrustworthy instruments; but during the following half-century, while geodetic work proceeded apace in France, and was also carried on by measurements in South Africa, North America, and Italy, instruments making for greater precision were being designed.

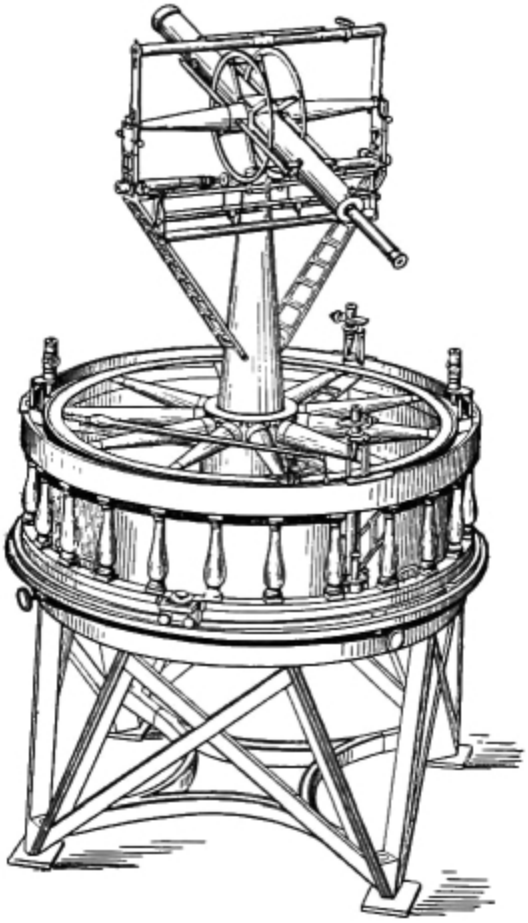

Fig. 15.—Ramsden’s Theodolite.

The instruments and data available during the sixteenth and seventeenth centuries had been fairly effective in skilled hands for the observation of latitude, but observations for longitude remained very difficult. Regiomontanus had prepared ephemerides for 1474–1506, and Columbus used them; Peter Apianus made a series for 1521–70, but the results continued to be far from accurate till the appearance of Kepler’s Rudolphine Tables in 1526. Harrison’s work on the chronometer had been anticipated as early as 1530 by Gemma Frisius, who indicated the possibility of using a clock in determining longitude; but even Huygens’s clock was not found effective for this purpose. In 1735, however, John Harrison’s first chronometer appeared, and afforded the accurate measurement of time under varying conditions which is essential to the calculation of longitude. About 1737 Jonathan Sission produced a

theodolite, and later in the century Ramsden's greatly improved theodolite (actually a pioneer instrument, greatly though its type was afterwards modified in detail) was constructed and brought into use in the trigonometrical survey of England and Wales, which was begun in 1784.

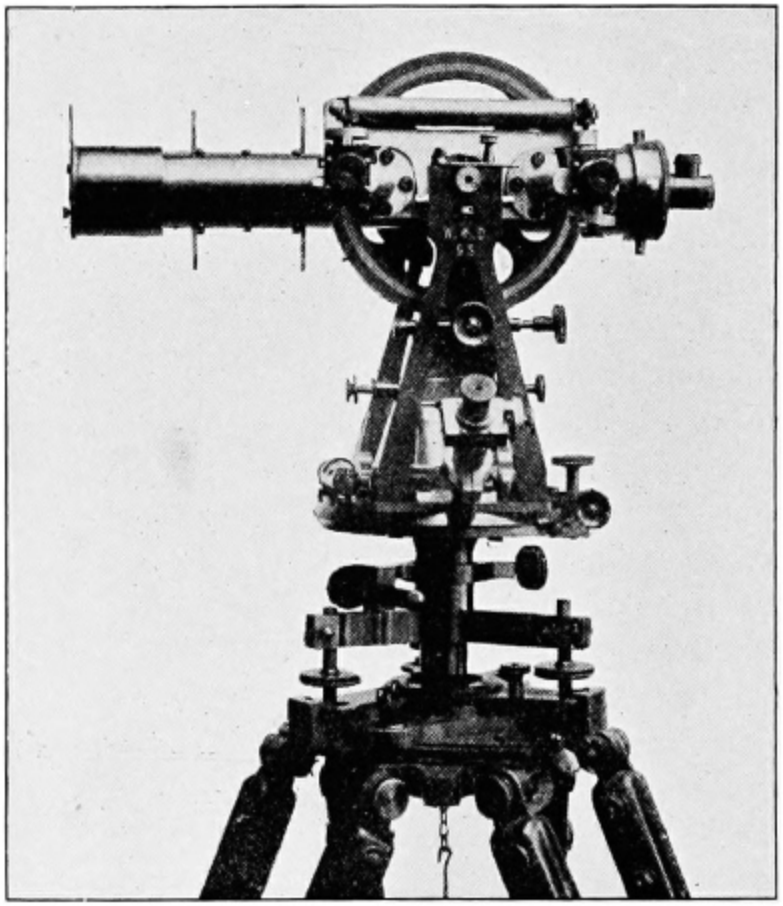

Fig. 16.—Modern five-inch transit Theodolite.

Meanwhile in this period cartography underwent an evolution from ancient to modern methods. It is impossible here to attempt any catalogue of even the principal cartographers, and the work of a few must be taken as typical. In the earlier part of the period (sixteenth century) the marine chart was still the most generally valuable of the cartographer's wares; but he was already extending his stock in other directions. Thus Gerhard Kremer (1512–94), more famous under the name of Mercator, is principally known for his chart of the world on the familiar rectangular projection which bears

his name; but his other activities, besides the production of an atlas, included that of maps of various special areas; and he carried out survey work himself in Flanders as the basis of a map of that territory, which he produced in 1540. Not only the projection named after him, but also the secant conical, are usually attributed to Mercator. Edward Wright, a mathematician of Cambridge, produced the first English map on Mercator's projection, which indeed has been stated to be actually Wright's own invention; on this map we should observe the omission of various imaginary and erroneous details common to maps of the period—notably the southern continent. But the renewal of the study of map-projection was mainly owing to German mathematicians, such as Werner of Nuremberg, and Apianus, in the first two decades of the century. In Mercator's work there are to be observed various tendencies towards modern practice, such as the abolition of the old small sketches or miniatures representing towns and divers other subjects, and the introduction of symbols. On the other hand, the period of the application of criticism by the cartographer to the data before him was not yet come. Mercator was content to supplement data, where imperfect, by imagination; and that tendency is to be observed in other work of the period, as, for example, in the astonishing conception of the hydrography of Africa set forth by F. Pigafetta in 1591. However, the application of criticism and prompt attention to new sources of information soon became recognized as cartographers' duties. Thus, Nicolas Sanson of Abbeville, who founded a famous map-making establishment in 1627, made a common practice of citing his authorities; and again, promptly upon the work of Jean Picard (noticed above) and others, in the determination of positions from 1669 to the end of the century, there followed the production of a map of France corrected according to these observations, which were also used in other French publications. On some of these appears—first about 1674—the earliest rude representation of relief by hachures, though the old practice of the cartographer, of drawing relief in a species of perspective, and thereby making a molehill on his map out of a mountain in nature, was by no means yet superseded. It was more than half-a-century later that the cartographers hit upon the contour-line. M. S. Cruquius adopted this method of showing relief on a chart of the Merwede in 1728; P. Buache similarly showed the depths of the English Channel in 1737; J. G. Lehmann used contours as the proper scientific basis of hachuring in 1783, and a contoured map of France was produced in 1791 by Dupain-Triel. The

atlas of Germany, begun by a famous cartographer of Nuremberg, Homann, and published in 1753, illustrates successive stages in the evolution of hill-shading; for the earliest map in the series, dating from thirty-five years earlier, shows the first endeavour to differentiate the shading according to the steepness of slope. In the meantime the use of maps had already been recognized in some of the many special departments of geographical science from which they are now inseparable. For example, the variation of the compass had been mapped by C. Burrus early in the seventeenth century, and was more effectively worked out by the famous astronomer E. Halley in 1683. A. Kircher, again, took an early step in the department of oceanography by mapping currents and other features of the oceans in 1665.

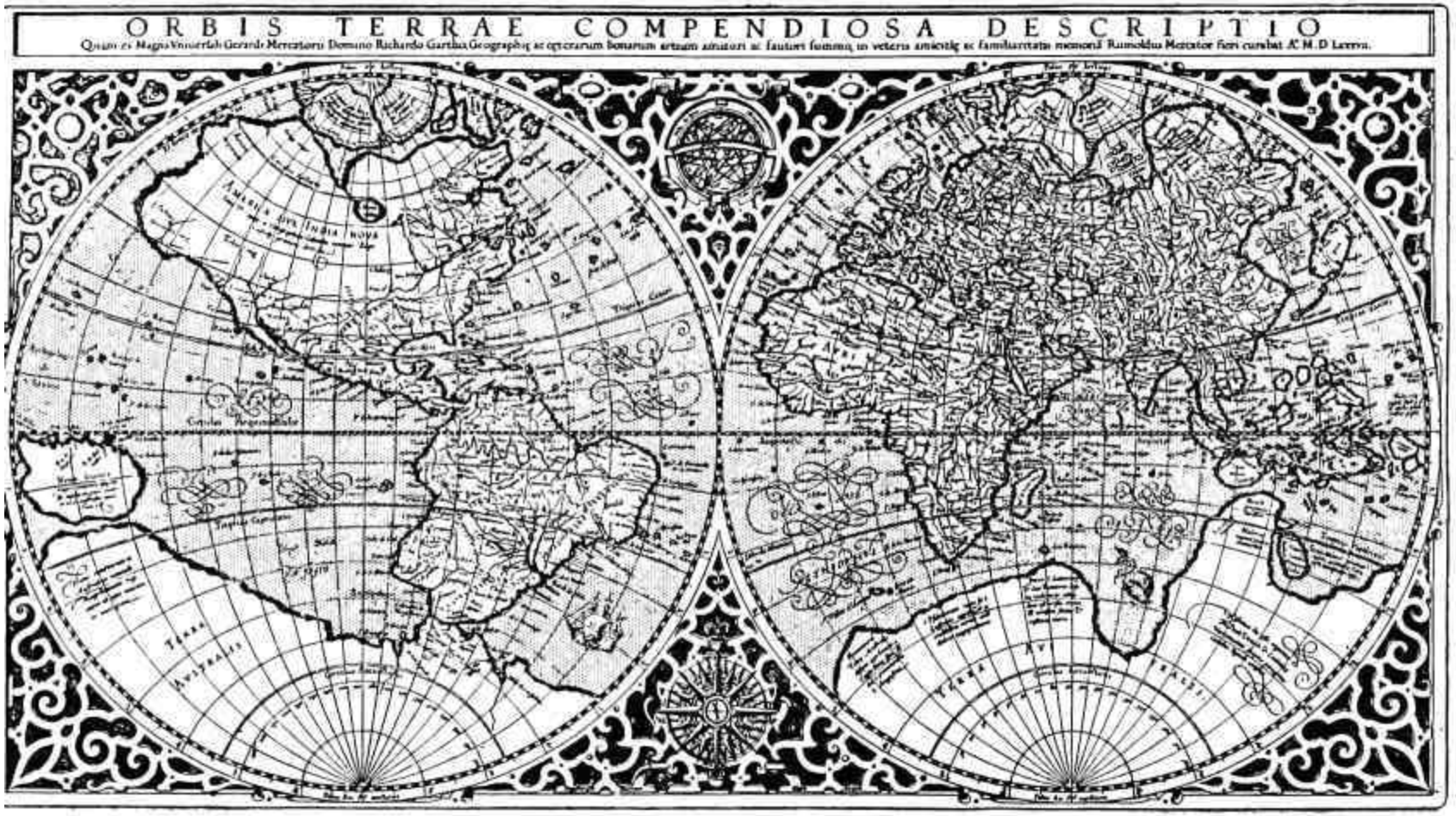
ORBIS TERRAE COMPENDIOSA DESCRIPTIO
Quam ex Magni Ventoselch Gerardi Mercatoris Domino Richardo Gartho Geographiæ ac cæterarum bonarum artium amatori ac fautori summo in veteris amicitiæ ac familiaritatis monumē Rumoldus Mercator fieri curabat A° M.D Lxxvii.

Fig. 17.—The World according to Mercator (1587).

From what has been written above, it may be inferred, and justly so, that Holland and France led the way in the development of cartography from the sixteenth to the eighteenth century. But by the end of the sixteenth century and throughout the seventeenth the mapping of most of the western European countries was rapidly extended, as in Germany, Austria, Switzerland, and Italy, in Denmark and Scandinavia, and in the British Isles. German local mapping ranked high, as appears from the collection in Ortelius's Theatrum Orbis (1570) and from Mercator's map of Germany (1585), both of which show the superiority of the cartographical material available for Germany. A large number of maps were based on original survey work. As early as 1566 a map of Bavaria by Philip Bienewitz, on a scale approximating (in terms of our survey) to two and a quarter miles to an inch, gave the results of a regular survey of remarkable accuracy for the period. Such was also the case (to select an example at home) with Christopher Saxton's atlas of England and Wales (1574–79), in which the maps are about an inch to three miles in scale. This work marked the beginning of an important period in the history of British maps; Timothy Pont's maps of Scotland appeared about 1608, and John Speed's, of the British Isles on about the same scale as Saxton's, in 1610. Hollar adopted a smaller scale (about five miles to the inch) in his maps of England and Wales dated 1644. These were of service in the Civil War, and the importance of military requirements in furthering the extension of organized survey work—which will appear in its subsequent history—is early exemplified in a survey of Ireland made under an Act of 1653; though this, the first British cadastral survey, was not a preliminary but a result of military operations, for it was made in connection with the parcelling of Irish lands among those who took part in the suppression of Irish rebellion. Again, the Scottish rebellion of 1745 led directly to a survey under Captain (afterwards General) Roy in 1747. It may be added here that in later cadastral work Ireland again took precedence of Great Britain: the six-inch survey begun in the former country in 1825 was nearly finished when that of Great Britain was undertaken in 1840.

France continued to lead the way in cartography in the eighteenth century. The maps of G. Delisle (1675–1726) and of J. B. B. D'Anville (1697–1782) were not merely confined to local work; they also included the presentation of cartographical material for distant lands selected according to truer scientific criteria. Thus D'Anville's map of Africa, though preserving a few old inaccuracies, did away with details which were purely imaginary, and boldly revealed the then practically complete ignorance of the interior by representing it almost wholly as a blank. We may contrast this with earlier maps of the continent. Thus Waldseemüller (1516) showed waterways running parallel with the west coast, from north to south, and showed no conception of the Congo. Gastaldi (1564) marked the Zaire (Congo); but this and an east-flowing river and a branch of the Nile all flowed from a great central lake, Zembere. Mercator established a definite parting of the Nile, the Zaire, and the east-flowing system, though his ideas were still far from the truth.

English cartographers of the eighteenth century were inspired by the over-sea expansion of the empire to much good work beyond the home shores. Thus J. F. W. Desbarres in 1774–79 made use of the nautical surveys of James Cook and others in his Atlantic and North-American work. Thomas Jefferys produced West Indian and American atlases at the same time, and Aaron Arrowsmith founded a famous cartographical establishment, the work of which was carried on for a century. Mention is also due here of the work of Major James Rennell, who became surveyor-general of Bengal in 1763, and covered that territory in his atlas of Bengal (1779) on a scale of five miles to one inch, the work depending mainly upon route surveys and being, of its kind, extraordinarily good. The trigonometrical survey of England and Wales, already referred to as begun in 1784, owed its origin to French inspiration; for Cassini de Thury, who in 1740 had re-measured and found incorrect the work of J. and D. Cassini in France, represented the desirability of establishing a geodetic connection between Paris and Greenwich, and General William Roy was appointed to supervize the English work.

The revival of interest in earth-measurement and survey led directly to the furthering of the study of theoretical geography. We have happened already upon the names of Peter Apianus and Gemma Frisius in the history of the mathematical branch of geography; these two—Apianus by

publishing in 1524 his *Cosmographicus Liber*, and Frisius by editing and expanding that work under the title of *Cosmographia*—re-founded the science on a mathematical basis, though they remained bound to the Ptolemaic view of a sharp distinction between geography, the general description of the world, and chorography, the particular description of a region. There is, perhaps, something characteristic in the insistence on this curiously arbitrary distinction; there has been sometimes a tendency to narrow the view of the field of "pure" geography on the part of workers labouring in one corner of it and turning their backs upon the rest. Indeed, at this very period is found another *Cosmographia*, to which its author added the epithet "universalis," wherein the now familiar view of geography as a human and political field of study appeared, to the no less familiar exclusion of the mathematical aspect; for Sebastian Münster, in his work published in 1544, neglected the mathematical side entirely, modelling his work on that of Strabo. Philip Cluverius, again, in his *Introduction to Universal Geography* (1624), preserves the distinction between geography and chorography, albeit but one out of his six books deals with the earth at large, while in the rest countries are treated in detail, the human aspect being closely studied. Nathanael Carpenter of Oxford, however, threw over the distinction in so far as he recognized that neither geography, as distinguished by earlier writers from chorography, nor chorography itself, nor topography (under which term were classified the closer descriptions of smaller areas than those which belonged to chorography), was anything more than a part of a whole. Therefore, he divided his *Geography* (1625) into "spherical" and "topical" parts, the first dealing with the mathematical side, the second with different divisions of the earth according to physical, not political, considerations; his work is thus notable as indicating his realization of the function of geographical study which follows from those of measurement and description—namely, that of the correlation of phenomena. In 1650 appeared the *Geographia Generalis* of Bernhard Varenius, who died, still a young man, in that year. He laid down a broad division of the subject into general and special parts. His general part was sub-divided so as to include, firstly, the shape, size, and general physical characteristics of the earth, the distribution of land and water, land forms and hydrography; secondly, the astronomical and mathematical aspects, such as zones, latitude and longitude, the investigation of which was carried further in the third sub-division, which

was comparative, dealing in this manner with data previously adduced. Varenius did not himself take up the special part of geography, though he defined it as also falling into three sub-divisions, the first of which should deal with the position, boundaries, physical features, and natural products of a country, the second with celestial and atmospheric conditions, and the third with the human element. This last was (as it still is) a popular branch of the subject which, for his own part, he would not have admitted; he held pure geography to be a matter apart from political and social considerations. But here was a geographical framework which, as H. R. Mill has pointed out, "was capable of accommodating itself to new facts, and was indeed far in advance of the knowledge of the period." Being so, its worth was by no means generally recognized at first, although in 1672 Sir Isaac Newton put forth an annotated English edition for use in connection with lectures of his own. "The method included a recognition of the causes and effects of phenomena, as well as the mere fact of their occurrence, and for the first time the importance of the vertical relief of the land was fairly recognized." The work found its place in time; the French and Dutch geographers, as well as the English, had it in their own tongues, and it became a standard, not only for the century of its original production, but for the next also.

Chapter XI.

THE NINETEENTH CENTURY: AFRICAN RESEARCH

Since the later years of the eighteenth century geographical knowledge has been extended in the manner of a great railway system. The main lines of exploration will provide the subject of this and following chapters; with the ramification of branch lines we can hardly concern ourselves here. Taking one consideration with another, Africa may be termed the most important area of geographical conquest during this latest period of our history. The opening of the interior of that continent was long delayed for geographical reasons which have often been insisted upon. The difficulty of inland communication, the fact that the rivers do not offer uninterrupted highways, the barrier of the tropical forests, the unhealthiness of many parts both of the coast lands and of the interior, which modern science is only now fighting—such are the disabilities against which exploration had to contend, to which must be added the lack of commercial instinct in many of the native peoples, and their unhappy experiences of the early slave-trading, and the labour-recruiting which has in some instances provided its modern counterpart.

During the larger part of the eighteenth century hardly any progress was made with the exploration of Africa. The west coast was still a resort of traders for slaves and gold, but very little attempt was made even to acquire further territory. In the middle of the century, however, the Turkish dislike of intruders was somewhat allayed, owing partly to the growth of the coffee trade, and it became more easy for travellers to enter Egypt. In 1770 James Bruce started on the task, which he had been anxious to undertake for many years, of searching for the Nile sources. He was courteously received by the

ruler of Abyssinia, and after finding and mapping the source of the Blue Nile, he traced it to its junction with the White Nile at Khartum. On his return he was disgusted when it was proved to him by D'Anville (whose map, based on a critical judgment of data, was considerably more correct than Bruce's) that he had been anticipated by the Portuguese Jesuits. He delayed the publication of his results for seventeen years, and when they appeared, though they constitute a remarkable description of Abyssinia and its inhabitants, they were universally disbelieved.

Towards the end of the century two causes operated for the revival of interest in African affairs—firstly, the foundation of the African Association in 1788, and, secondly, the removal by Napoleon's conquest of Egypt of the obstacles placed in the way of travellers by Moslem fanatics. In 1795 Mungo Park, a Scotchman, started under the auspices of the African Association to explore the Niger. He travelled up the Gambia River, and after extraordinary difficulties reached the Niger at Sebu, and traced its course for three hundred miles. He had been so long away that he had been given up for dead, and his exploits, carried through with such success, aroused great enthusiasm. Unhappily, his second journey, undertaken in 1805, ended in disaster; he and all who were with him except one guide perished, after descending the Niger for about one thousand miles towards the coast, and only just failing to solve the problem of its outflow. In 1798 Francisco de Lacerda, a Portuguese explorer, lost his life on the Zambezi, and early in the nineteenth century Africa was actually crossed for the first time (so far as is known), by two Portuguese traders, from Mozambique to the west coast.

During the first half of the nineteenth century, when the European nations had been roused first to protest against and then to abolish the slave trade, a great deal of valuable work was done to increase the knowledge of Africa, especially by Englishmen. In 1823 W. Oudney, who was sent out as consul to Bornu, and H. Clapperton penetrated to Lake Chad, previously unvisited by any white man, and Clapperton afterwards explored the flourishing civilization of Bornu and Hausaland. He died on a second journey undertaken to open up trade with the Sultan of Sokoto; but in 1830 his servant on this last journey, Richard Lander, succeeded in solving one of the many problems which were beginning to present themselves to students of the continent—the question of the outlet of the Niger. He started from the

Guinea coast, and followed the course of the river from Bussa to its mouth in canoes. Much good work was done also by A. G. Laing, who was the first European to visit Timbuktu (in 1826), but was killed there. R. Caillié, who succeeded in reaching the city in 1828, was the first to return from it in safety, which he did by crossing the Sahara to Tangier. H. Barth, who had already travelled all through North Africa, and had ascended the Nile to Wady Halfa, started in 1850 on a trading mission under the auspices of the British Government to the states of Central Africa; both his companions died, but Barth carried through alone a brilliant journey, in the course of which he travelled from Lake Chad to Timbuktu, and studied minutely many of the ancient civilized states of the region. Thus the geography of Senegal and the Niger had been largely cleared up by 1850. The great questions which remained untouched were those of the sources of the Nile and the Congo. By 1850 Abyssinia and the greater tributaries of the Nile were pretty well known, through the work of naturalists and travellers, the efforts of Austrian missionaries, who had established stations down to Gondokoro on the Nile, and the interest taken in exploration by Mahomed Ali, ruler of Egypt under the Turks. But the seventy miles of rapids above Gondokoro, and the fierce people of the Bari tribe who lived there, had prevented the acquisition of any but the most meagre knowledge of the upper reaches of the Nile beyond that point. The problem was now approached from a different direction. For some time missionaries had been working at Zanzibar, finding the natives there more tractable than in Abyssinia, the original field of their labours; and two of their number, L. Krapf and T. Redmann, had seen and sent home accounts of snow-mountains under the Equator—Kilimanjaro and Kenya—and also of the great lakes, which they imagined to be all parts of an enormous inland sea. Since the annexation of Aden by the British Government in 1839, moreover, officers of the English army stationed there had shown an interest in the exploration of the African coast opposite them; and in 1854 R. F. Burton got permission to try to reach the centre of Africa through Somaliland, with T. H. Speke. Burton first made a courageous and successful journey to the walled city of Harar in Abyssinia; but the more important stage of the expedition was unsuccessful owing to the suspicions of the Somalis. For thirty years after this Somaliland remained unexplored, and Burton and Speke, inspired by the accounts of the Zanzibar missionaries, devoted themselves to the discovery of the source of the Nile.

They arrived at Zanzibar in 1856, and penetrated without much difficulty to the great plateau of Unyamwezi, where the Arab traders received them kindly, and thence to Lake Tanganyika. Burton was forced through illness to allow Speke to continue the work without him, and the latter saw, though from a distance, the waters of the Victoria Nyanza. Though he underestimated its size, he was convinced that here was the answer to the question of the Nile source; but Burton, jealous of his success, refused to credit it, and endeavoured to prove that the Victoria Nyanza was nothing but a great swamp. In 1860, however, Speke set out again, with J. A. Grant, and verified and enlarged his previous discoveries. In face of immense difficulties due to mutinous porters and suspicious and warlike chiefs, he succeeded in making a rapid survey of the Victoria Nyanza, in exploring the unknown country of Uganda, and in finding the Ripon Falls, where the Victoria Nile leaves the lake. In spite of the great gaps in Speke's knowledge, his ideas on the relative importance of the Nile tributaries and of the geography of the lakes were very accurate, and the honour of settling the old question of its source must be given to him. Speke and Grant were met on their return at Gondokoro on the Nile by Samuel Baker, who had come with help and reinforcements for them, and he took up the work of definitely locating the Albert Nyanza, of which Speke had heard various accounts. Though he and his wife passed through terrible dangers and difficulties, they completed their task, finding the Albert Nyanza, and journeying along the Victoria Nile as far as the Murchison Falls. The importance of Baker's discovery, however, was somewhat vitiated by his erroneous judgment of the size of the Albert Nyanza, which he made far too large; he, like the other explorers who had gone before him, saw nothing of the great snow-range.

In other parts of Africa valuable work was being done. David Livingstone was always a missionary first, but his explorations form a nobler memorial than those of any other African traveller. He had been working in Africa since 1840; in 1849 he crossed the Kalahari desert, and reached Lake Ngami; and in 1852 he started on a great journey up the Zambezi, discovering the Victoria Falls, and crossing to the west coast; and returning followed the Zambezi to its mouth on the east coast, thus taking the first steps to fill a great blank which had previously existed on the map of Africa. Between 1858 and 1864 he did much good work in the exploration of Lake Nyasa and the lower Zambezi, and incidentally made

splendid efforts to stop the trade in slaves which was still carried on in that region. But it is his last journey, which took the form of an expedition to discover the watershed between Lake Nyasa and Lake Tanganyika, that is of paramount interest from the geographical standpoint. He started from Zanzibar in 1866; and, in spite of continual and serious illness, he travelled from Lake Nyasa to Lake Tanganyika, discovered lakes Mweru, Mofwa, and Bangweulu, and also the river Lualaba, which he took for the upper part of the Nile. He was cheered and encouraged by meeting with H. M. Stanley in 1871, who had been sent out to him with money and servants; but in 1873 he died, worn out by his constant travels, and still searching for the "fountains" which he believed to form the ultimate source of the Nile.

In 1874 Stanley undertook and carried through in the face of terrible difficulties one of the most remarkable and valuable journeys in the history of African exploration. He settled the question as to the relative importance of the Albert Nyanza and the Victoria Nyanza, discovered the Mwuta Nzige (Lake Albert Edward), and crossed Africa from east to west, starting from Zanzibar and travelling down the Lualaba from the point where Livingstone had left it to its mouth, thus proving it to be the upper level of the Congo. This great journey opened up the hitherto unknown country in the centre of Africa, and led directly to the formation of the Congo Free State. Stanley had been preceded at Nyangwe, the point of departure for the voyage down the Congo, by Lovett Cameron, who failed, however, to follow the river throughout its course, and reached the coast to the south of its mouth. In 1884 Joseph Thomson supplemented Stanley's work by his journey to Mounts Kilimanjaro and Kenya through Masailand to Victoria Nyanza. Wissmann and other German explorers (1881–6) did much for a knowledge of the great southern tributaries of the Congo, while Wissmann in 1881–2 crossed the continent from west to east. It has been frequently crossed since. Stanley's expedition up the Congo to rescue Emin Pasha (1887–89) opened up the great Central Africa forest with its pigmies, extended our knowledge of Lake Albert Edward and its outlet the Semliki, which flowed into the Albert Nyanza, and revealed the great snowy range of Ruwenzori, which was ascended and mapped by the Duke of the Abruzzi in 1906.

While the problems of Central Africa were thus being elucidated, the exploration of the nine great rivers which form the Bahr-el-Ghazal, the chief tributary of the Nile, was attracting much attention, the most valuable

work being done by Georg Schweinfürth, who mapped the river with high accuracy. The Nile above Gondokoro was also surveyed by English officers; the Sahara and the Sudan were widely explored by G. Rohlfs and G. Nachtigal between 1860 and 1875, and the connection of the river Welle with the Congo system was established by W. Junker, who also travelled in the Sudan from 1875 to 1886. The British during this period were pushing their way northward from South Africa, and emigrants were flocking to the goldfields and diamond mines. The French have spread their explorations over the Sahara and their territories in the Sudan and West Africa. From the date of Stanley's return African history underwent a rapid change. The period of driving the main lines of exploration through the continent was over, and a new era began in which branch lines could be laid down, and colonial expansion could take place along them. The continent is now partitioned among the European Powers, and has been more or less provisionally mapped; but it will take long years of survey and scientific investigation before its features, its resources, its peoples, and its possibilities are adequately known.

Chapter XII.

THE NINETEENTH CENTURY AND AFTER: ASIA AND AUSTRALIA

The beginning of the nineteenth century was signalized by the initiation of the great trigonometrical survey of India, and the first half-century was a period of much important geographical and anthropological work within that empire, but to no great extent beyond its boundaries, though in 1808 a mission penetrated to the sources of the Ganges, and Baluchistan and Afghanistan were in some part explored by officials of the East India Company. But the physical problems of the heart of the continent were left to a later period—those, for instance, concerned with the trans-Himalayan region (as viewed from India), including Tibet, eastward that region so important in the hydrography of the continent, where the river systems of China and Burma take their rise, northward the deserts of Mongolia and Turkestan, westward the nodal mountain-region of the Pamirs, and the area which long concealed the sources of the Brahmaputra (Tsanpo) and the rivers of Punjab. In spite of the endeavours of the Tibetans to hold inviolate the secrets of their land—in great measure successful so far as their capital, Lhasa, was concerned—the Indian native surveyors, such as Nain Singh, Krishna, and Ugyen Gyatso, were able to penetrate the country, and even Lhasa itself; their work covered the period 1863–82. And the last quarter of the century provides a wonderful record of continuous exploration in Tibet, as will appear from the mere quotation of names and dates—P. Bonvalot and Prince Henry of Orléans, 1886–87; W. W. Rockhill, 1888 and 1891; Hamilton Bower, 1891–92; Dutreuil de Rhins and F. Grenard, 1893–94; St. George Littledale, 1895; Captains W. S. Wellby, 1896, and H. H. P. Deasy, 1896, whose work was afterwards extended by Captain C. G. Rawling and by Sir M. A. Stein; and Sven Hedin, 1896–98, 1899–1902, 1906–08, whose

last journey revealed the existence, long suspected, of the great mountain system north of the upper Tsan-po. This list is by no means exhaustive, nor can be that of the Russians who worked from the opposite direction, from their own territory; their leader was Nicolai Prjevalsky, who in 1871–73 and in 1876 worked in the Tsaidam region and made the first contribution to the mapping of the important hydrographical area above referred to, and in 1879 studied the vast physical changes which have taken place in Central Asia within historic times, and form one of the most remarkable geographical problems in the world. He continued his work in 1883–85, and was followed by Pevtsov and Roborovsky (1889 and 1894), P. K. Kozlov, Potanin, and many others. The names of Russian scientists, such as Baron A. Kaulbars and L. Griesbach, are also associated with the problems of the Aral and Caspian depressions. The former extensions of human settlement over areas now covered by the Central Asian deserts has been brought to light in great measure through the researches of Sven Hedin, and especially of Sir M. A. Stein. The general result of all these investigations has been to modify profoundly, even during the present generation, preexisting ideas of the physical geography of the central region. Nor should we overlook the work of recent travellers in China proper, a broad canvas on which outlines had been sketched earlier; but details remained, and still in great part remain, to be filled in, though Ferdinand Baron von Richthofen, in the course of his seven journeys in 1868–72, left few districts entirely unvisited.

The problem of the former existence of flourishing communities in areas now desert, and of the causes of the change, has a partial counterpart in southern Arabia. The modern period of Arabian exploration began earlier than that of Central Asia. The journeys of J. Halévy (1869), E. Glaser (1889), and J. T. Bent (1893) in the south were primarily archæological in purpose. In other parts of the peninsula the work of J. L. Burckhardt (1815), Sir R. F. Burton, Captain G. F. Sadlier, W. G. Palgrave, Charles Doughty, Wilfrid Blunt, C. Huber, Musil, Leachman, and others, has made it possible to lay down at least the position of the chief towns and settlements, and the main physical outlines, with close accuracy, save in the Dahna or great desert of the southern interior, which remains untrodden.

The detailed exploration of Australia began from Sydney, the earliest settlement, and was directed along the coast rather than towards the interior,

the penetration of which was difficult. George Bass, after a short expedition inland, was accompanied by Matthew Flinders in exploring the coast of New South Wales as far as the George River and Hat Hill towards the end of the eighteenth century; in 1797–98 Bass Strait was found to separate Tasmania from the mainland, and that island was circumnavigated. Bass was subsequently lost in South America; but Flinders extended the work in 1801–03, when, having sailed from England, he worked from King George Sound at the south-west of Australia right round the south, east, and north coasts as far as Arnhem Bay, west of the Gulf of Carpentaria, and would have accomplished more but for the unseaworthiness of his ship. Flinders was not only a competent explorer, but also a man of theories: he took the limestone cliffs of the Great Australian Bight (south coast) for coral reefs, and when he entered Spencer Gulf he thought of a northward strait connecting with the Gulf of Carpentaria, and conceived an Australian archipelago; nor was he wholly disabused until he had definitely located the heads of both gulfs. A number of important inlets, such as Port Phillip, Keppel Bay, and Port Bowen, were thoroughly investigated by him, and he also surveyed the Great Barrier Reef. And the substitution of the name of Australia for New Holland is due to a suggestion of his. His unfinished survey of the western shores was completed by Captain P. P. King in voyages between 1817 and 1822.

The accident of a drought in 1813 drove some of the Sydney settlers to look for new pastures in the hinterland. The divide between the short eastward and the long westward drainage systems was surmounted with difficulty; a road to the point where the town of Bathurst afterwards grew up was promptly made, and an arresting geographical problem confronted the investigators when the westward-flowing rivers Macquarie and Lachlan were found. Lieutenant Oxley, R.N., attempting to follow the Lachlan in 1815, was presently brought to a halt by great swamps. He struck south to avoid them, and narrowly missed discovering the Murrumbidgee river, before he turned back to carry to Sydney the conviction that the westward drainage generally was lost in swamps fringing an inland sea. Cunningham found a route from this coast up to the rich Liverpool Plains, towards the north of New South Wales, in 1823; but for the most part exploration was temporarily directed to the south-west, and Hamilton Hume and Hovell in 1824–25 took an inland route from New South Wales to the south coast on the west side of Port Phillip. This inlet was not recognized by them; they

returned to report that they had seen the coast-land, and found it good, further to the east at Western Port; settlers who visited that district on their recommendation were disappointed, and the development of the Victoria coast-lands received a set-back in consequence of this error. Cunningham in 1828 opened the route from the coast at Brisbane to the downs of the south Queensland hinterland. In the same year a new phase was entered in the solution of the problem of the far interior, when Charles Sturt, carrying with him Oxley's conviction of the existence of an inland sea, journeyed inland at a season of drought to find the Macquarie river losing itself on the dry plains, and the Darling flowing salt. He attributed this fact to an admixture of sea-water, and set down the interior of the continent as a desert. In the following year he settled the problem of the drainage of the Murrumbidgee, Lachlan, and Murray rivers by following them to the mouth of the Murray in Lake Alexandrina (south coast); and although he now held that the waters of the Darling were included (as they are) in this system, it was still doubted whether there was a divide between north and south flowing waters about the central latitude of New South Wales, where, in the interior, high ground was known to exist. Sir Thomas Mitchell settled this question by a great journey in 1836, which, among other results, immediately threw open to settlement the fertile country about Port Phillip, hitherto, as we have seen, neglected through the misunderstanding of Hume and Hovell.

The larger problems of Australian geography were thus early settled, though there was (as even now there is in some parts) a multitude of details to be filled in. But the leading questions awaiting solution by explorers now become economic rather than purely geographical. Thus we find Dr. Leichhardt's first expedition (1844), from Moreton Bay in southern Queensland by the Burdekin, Mitchell, and Roper rivers to Port Essington, inspired by the conception of an overland route between Sydney and a northern seaport. He was lost (and the mystery of his fate was never solved) in 1848 in attempting a crossing of the continent from east to west, and Kennedy's expedition in the same year, in attempting to cross northern Australia, also met with disaster, where A. C. Gregory succeeded in 1855–56. The penetration of the interior from the south and the crossing to the north had attracted travellers before this; Eyre in 1840 had discovered the series of salt lakes and swamps which he lumped together under the name of Lake Torrens, while Sturt in 1845 added little to Eyre's discoveries, and, after failing to penetrate the Stony Desert to the north, put a temporary

period to explorations in that quarter. Babbage in 1856 and Parry in the following year obtained more accurate knowledge of the Lake Torrens region, and Goyder in 1857 reported a great freshwater lake which was found later to have been conceived out of some shallow pools and visions of the mirage. J. M. Stuart's six expeditions from south to north in 1858–61 added much to exact knowledge; that of Robert Burke and William Wills in 1860–61, ill-managed as it was and ending in the death of the leaders, obtained a fame in excess of its scientific value; but other expeditions sent in search of it achieved better results, and incidentally made clear the danger of assessing the worth of some of the inland districts on the report of one traveller who might have come upon them at an unfavourable season. Thus J. McKinlay in 1861 brought word of fertile lands which Sturt had condemned as desert. The many journeys through the interior of Western Australia—such as those of J. S. Roe (1836), the brothers Gregory, H. M. Lefroy (1863), Sir J. Forrest (various expeditions in and after 1869), Warburton (1873), and Ernest Giles (first crossing from Adelaide to Perth by an inland route, 1875)—though often of extreme importance from an economic point of view, whether concerned with the discovery of pastoral lands or of gold or other mineral fields, can only be referred to here as having gradually opened up the detailed knowledge of this part of the continent, and as having redeemed it in part from a reputation for complete inhospitality, until we have now a trans-continental railway planned to connect the systems of south and of western Australia. The exploration of the Kimberley and north-western areas of the state was delayed until the latter half of the last century.

CHAPTER XIII.

THE NINETEENTH CENTURY AND AFTER: THE POLES

(a) Arctic

FOLLOWING the new enthusiasm for Arctic exploration undertaken for purely scientific purposes, the British Government despatched three expeditions between 1773 and 1779. The first, under Captain Phipps, was stopped by ice off the north-west of Spitsbergen; the second, that of James Cook with the vessels *Discovery* and *Resolution*, sent to search for either a north-west or a north-east passage by the Bering Sea route, met, as has been seen (Chapter VIII.), with a measure of the success characteristic of his work, but his death at Hawaii put an end to the hope that further research in the Arctic lay before him, and the voyage continued under the command of Captain Clarke was carried only a little north of the 70th parallel in the ice-bound Bering Strait, where Clarke also died. Till 1815 little was done to elucidate the still unsolved question of the north-west passage, owing to the disturbed state of Europe and America, but the offer of a reward (the result of the exertions of Sir John Barrow in 1818) of £20,000 for the discovery of the passage and £5,000 for reaching 89° N., led to the sailing of expeditious to the American Arctic region under Lieut. J. Franklin, Captain Ross, and Lieut. E. Parry. Ross on his first voyage took Baffin Bay and Lancaster Sound to be land-locked on the north, and thus missed his chance of forcing the passage.

Parry in two voyages, on the results of which he gained the £5,000 reward, succeeded in passing through Lancaster Sound, and reaching and

naming Melville Island, thus proving Baffin's discoveries. Meanwhile Franklin attempted to reach the north shores of America by land; he explored 550 miles of the coast and discovered and named Cape Turnagain, though he and his party suffered great privations on the return journey. Then the energies of explorers were directed towards combining the results obtained by Parry and Franklin; further stretches of the north coast of America were explored, and Point Barrow was reached in Bering Strait. In 1829 an expedition was undertaken by Captain John Ross and his nephew James Clark Ross; the opening of the passage was again missed (though the most northerly part of America was passed), and it was not discovered till 1851 by Kennedy on his search for Franklin. J. C. Ross, however, fixed the position of the north magnetic pole on this voyage of five years' duration, and other valuable observations were made. The work of tracing the northern shores of America was nearly finished by 1847, chiefly by travellers in the Hudson Bay Company's service. During this period the north coast of Siberia had also been traced almost in its entirety by the Russians, though they had not succeeded in rounding the most northerly point.

In 1845 Sir John Franklin started on the voyage from which neither he nor any of his companions returned. It is not known exactly what he achieved before he was lost, but he came nearer to accomplishing the north-west passage than anyone before him. The expeditions of Sir John Richardson, Dr. John Rae, and others, sent by land in search of his party, filled in the last gap in the northern coast-line of America. The different expeditions, under McClintock and others, sent by sea in the fifties for the same purpose not only decided the fate of Franklin's party and extended knowledge over a vast area, but also at last rounded the north of America. The passage found by Kennedy in 1851 was traversed in 1853 by McClure, though part of the journey was made by travelling over the ice. An expedition under Captain Inglefield determined the northern point of Smith Sound. Elisha Kent Kane extended the knowledge of Grinnell Land and Greenland towards the north, and opened the way to others who followed the waterways he discovered. In 1871 Charles Hall sailed 250 miles up Smith Sound and reached the hitherto inaccessible polar sea; he touched a more northerly point than had previously been reached by any ship (82° 11′ N.).

Stirred to action by these fine achievements of the Americans, England sent out the important expedition under Captain George Nares in 1875 which obtained very valuable scientific observations, taken on the frozen polar sea, and under Albert Markham reached the furthest point north yet attained—83° 20′ N.—after battling with immense difficulties caused by bad conditions of the ice and scurvy. Meanwhile much good work had been done in the Arctic from the old world. A purely scientific expedition had been sent to the Spitsbergen seas as early as 1827 from Norway; but from then till 1858 the work of exploration was chiefly carried on by the men engaged in the seal-hunting and fishing, in the interests of their trade. Before 1872, however, several Scandinavian expeditions which visited Spitsbergen and Greenland brought back valuable scientific results. The most noteworthy expedition of this period, however, was Austrian; it was captained by Lieutenant Julius Payer, who had previously been on an expedition in Greenland. He and Lieutenant Weyprecht sailed in 1871 to search for the north-east passage. They were beset by ice off Novaya Zemlya, and drifted till they came to a mountainous country which they called Franz Josef Land. They believed it to consist of two large masses of land, instead of perceiving it to be an archipelago, and much of the country they thought they saw has been since proved not to exist. Franz Josef Land was not visited again till 1880, when a large part of it was surveyed by the Englishman Leigh Smith. The north-east passage was made in 1879 by A. E. Nordenskiöld, who accomplished the journey which led so many before him to failure without loss of life or vessel, and almost in one season. He had made several previous voyages in Greenland and Spitsbergen; he had also twice successfully reached the Yenisei through the Kara Sea. Captain Joseph Wiggins, an Englishman, also made several voyages through the Siberian seas, which, together with Nordenskiöld's accomplishment of the north-east passage (1878–9), proved the route to the mouth of the Yenisei to be practicable from a commercial standpoint. Fired by Nordenskiöld's example, the Danes made several remarkable journeys to the interior of Greenland.

A new interest was given to polar research by the establishment of the international circumpolar stations in 1883. The idea was mooted first by Weyprecht, and eventually twelve expeditions of various nationalities were sent out to erect observatories at different points within the polar circle, so that simultaneous and continuous observations might be taken. A great deal

of valuable work was done. An American expedition, led by Lieutenant A. W. Greely (1881–4), to Grinnell Land almost perished from starvation.

Greenland was crossed for the first time by Fridtjof Nansen in 1888. In 1886, and again from 1892 to 1895, Robert E. Peary, an American civil engineer, made several brilliant journeys in Greenland, and extended the knowledge of the country more than two degrees to the north. It was Nansen and Peary who were destined to draw the veil from the great polar area itself, towards which so many fruitless journeys were made. From 1817 onwards many voyages were undertaken with the object of reaching the pole—as by Parry, Scoresby, Markham, and Jackson from England, Nordenskiöld from Sweden, and Koldewey from Germany. These explorers mostly started from Spitsbergen; but Nansen worked on an original plan—that of utilizing the drift of ice, which had been proved to take place right across the polar sea, to carry his ship with it. The plan was so far successful that the *Fram* passed from the New Siberian islands right over to Spitsbergen in three years, without, however, reaching a higher latitude than 85° 55′ N. Nansen, with Lieutenant Johansen, made a dash northwards from this point, reaching 86° 5′ N., the "farthest north" attained up to that date; he met with Frederick Jackson's expedition in Franz Josef Land, and returned safely to Norway. This brilliant journey led to no discovery of land in the polar basin, which proved to consist of a sea of great depth, increasing towards the pole. The Duke of Abruzzi's expedition in 1899 reached 86° 34′ N.

Meanwhile much good work was being done in other directions in extending Arctic research. Franz Josef Land was explored, chiefly by Austrian, British, and American expeditions. Nathorst, a Swede, circumnavigated the Spitsbergen archipelago in 1898, and discovered and mapped King Oscar Fjord in Greenland in the following year. Sverdrup, Nansen's friend and companion, sailed up Jones Sound and charted many previously unknown parts in 1899 and the following years. The story of a continent existing to the north of Bering Strait and extending right across the pole to Greenland, which was believed by many explorers, was disproved by De Long in his ill-fated voyage in the *Jeannette* in 1879, during which the whole party perished, though the ship's books were afterwards found. This voyage and the journeys of the ships sent in search of De Long proved that north of Siberia lay an ocean dotted with islands.

Much work was done in exploring the New Siberian Islands by the Russian, Toll, who lost his life in an effort to reach the most northerly and unknown portion of the group. In 1903–4 Amundsen in the *Gjöa* undertook an expedition to the North Magnetic Pole, where he carried out a continuous series of observations for two years with important scientific results. He returned by Bering Strait, thus for the first time completing the navigation of the North-west Passage. The Danes worked hard at charting the east coast of Greenland, and the outline of the north-eastern extremity of the country was accurately delineated for the first time by the expedition of L. Mylius Erichsen (1905–07), on which he and his companions perished, though their splendid records and observations were found by a relief expedition. The crowning achievement of reaching the pole itself was accomplished in 1909 by Peary, after several previous journeys. He had spent four consecutive winters in the Arctic regions exploring Smith Sound and the north of Greenland, from 1899 to 1902; and in 1905 he had again attempted to reach the pole by Smith Sound and Grant Land, touching 87° 6 ′ N. At or near the pole there was no land to be seen, and the sea was 1,500 fathoms deep. Thus there remains no Arctic problem of the first magnitude to-day. The main outline of the Arctic region as a great and deep sea surrounded by the northern shores of Europe, Asia, America, and Greenland, is known, though there is still a large portion of the polar basin north of Alaska as yet untouched by explorers. Here, however, some high authorities believe that a considerable extent of land remains to be discovered beyond the Beaufort Sea. Even now maps show a doubtful coast-line some fifty miles due north of Point Barrow, and in 1913 an expedition left Canada under Stefansson with the solution of this problem as its main object.

(b) Antarctic.

In the Antarctic an important voyage, which supplemented Cook’s work, was undertaken in 1819 by Fabian von Bellingshausen. He succeeded in sailing half round the Antarctic circle, keeping to high southern latitudes all the way, and voyaging within the circle for considerable distances. He found the first land seen within the Antarctic circle, Peter Island, and, later,

Alexander Island; he discovered the Traverse Islands, and on his return in 1821 touched at the South Shetland Islands, and met there sealers, by one of whom, William Smith, the islands had been discovered in 1819. In the next year, 1822, the South Orkney Islands were found and named by another sealer. The next voyager was James Weddell, who reached the highest latitude yet attained, 74° 15’ S., in 1823. At his highest latitude he had clear sea before him, but was forced to turn back by the approach of winter, and returned with many interesting observations and collections. A courageous journey was also made in 1831 by John Biscoe, a sealer, who started out to search for land from the Sandwich Islands, and succeeded in sailing for some months within the Antarctic circle in a higher latitude than Bellingshausen, and sighted land which he named Enderby Land. In spite of the sufferings he had endured and the death of the greater number of his crew, he started again in the following year from New Zealand, discovered Biscoe Islands, and took possession for England of the land which he could see lying behind them; this was subsequently named Graham Land. Biscoe was in the employ of an enterprising London firm, the Enderby Brothers, and after the remarkable results which he had achieved, they were encouraged to pursue their policy of directing their captains to embrace every opportunity of exploration. In 1833 one of them, John Kemp, found land to the east of Enderby Land, and in 1839 John Balleny discovered the islands named after him.

About 1835 general interest was aroused in Antarctic problems, and three expeditions were prepared in England, France, and America to make magnetic observations, and to explore as far as possible the southern continent, now at length defined within reasonable limits. The French expedition, under Dumont d’Urville, was the first to start in 1838, but achieved little beyond the exploration of some land south of the South Shetland Islands, which was called Louis Philippe Land. After wintering in Tasmania, however, d’Urville decided on making a great effort to reach the south magnetic pole, and though he failed in this, he found a mountainous land which he named Adélie Land. The American expedition under Charles Wilkes did not meet with any great success, hampered as it was by quarrels among the officers and by unseaworthy ships; but land was several times sighted at a distance, and on Wilkes’s return controversy arose as to whether the honour of the discovery of this southern continent belonged to the French or the American expedition.

The British expedition under Sir James Ross was the last to arrive on the scene (in 1841); but it had the advantage of the others, in that it had been specially equipped for Antarctic exploration; Ross's ships could brave dangers from which Wilkes and d'Urville had been compelled to turn aside. He forced his way through the pack, and found a range of high mountains trending southwards, which he called Victoria Land. Following the land he came to the twin volcanoes, named Erebus and Terror after his two ships, and was stopped at length by the great ice barrier, running eastwards. During this remarkable journey Ross reached latitude 78° 4′ S., the highest yet attained. He made two further journeys, neither so successful as the first, though in 1842 he sighted the land which was rediscovered, and named King Edward Land, in the following century. After this no attempt worthy of mention was made on the south polar region for thirty years. The *Challenger* expedition in 1874 was not concerned with the attempt to penetrate very far south (Chapter XIV.). The voyage in Antarctic waters, however, was important from the information obtained as to the depth of the southern ocean and other results which helped to prove the existence of a considerable mass of land in the Antarctic region. This information was supplemented by the observations of two of the international circumpolar stations (to which reference has been made), which were established in Tierra del Fuego and South Georgia in 1882; but it was not until many years later that scientific interest was widely aroused in the problem of the Antarctic continent, and from 1874 to 1898 the only people to cross the Antarctic circle were sealers and whalers; but in 1895 C. E. Borchgrevink landed from one of these vessels for the first time on southern continental land near Cape Adare.

In 1898 three expeditions started south. The first, a Belgian undertaking on board the *Belgica*, explored the coast to the north of Graham Land, and brought back valuable collections; the second, from Germany on the *Valdivia*, re-discovered Bouvet Island, whose position had long been lost; the third, from England, under Borchgrevink on the *Southern Cross*, landed the first party to winter in the Antarctic, reached Mount Terror, and sailed along the Great Ice Barrier, reaching latitude 78° S. In 1901 the problem was attacked for the first time by means of land-exploration; a well-equipped expedition leaving England in that year under Captain R. F. Scott voyaged along the ice-barrier, and found and named King Edward Land, first seen by Ross. Scott then proved Mount Erebus and Mount Terror to be

on an island, and wintered on shore. In the following southern summer Scott, with Wilson and Shackleton, pushed southward and reached the latitude of 82° 17′, where the Great Ice Barrier reaches the foot of the lofty plateau on which the south pole is placed. Other parties traversed the ice-barrier in various directions, and much valuable scientific work was done in geology, biology, meteorology, magnetism, and glaciation. While Scott was in the Antarctic to the south of New Zealand, a German expedition, under E. von Drygalski, on board the *Gauss*, was working to the west of him, and had discovered and named Kaiser Wilhelm II. Land. Two private expeditions were also in the Antarctic at the same time, and the large number of synchronous meteorological and magnetic observations thus taken formed a valuable contribution to the knowledge of the southern continent. In 1903 a voyage was made by W. S. Bruce on the *Scotia*, which is important for the exploration of an entirely unknown sea lying between the tracks of Weddell and of Ross; the latitude of 74° 1′ was reached. Though the land could not be attained, its existence was proved by occasional glimpses and by the dredging up of continental rocks, and the name of Coats Land was given to it. In 1904 J. B. Charcot, a French scientist, cruised along Graham Land and found a new line of coast, which he named Loubet Land. Thus between 1902 and 1904 new land had been discovered in all the four quarters of the Antarctic circle—King Edward Land by Scott, Kaiser Wilhelm Land by Drygalski, Coats Land by Bruce, and Loubet Land by Charcot.

Lieutenant (afterwards Sir) E. H. Shackleton, who had accompanied Scott, led an expedition to the south in 1908–9, which landed at the foot of Mount Erebus. That mountain was ascended by Professor T. W. E. David, who also, with Dr. D. Mawson, reached the south magnetic pole in 72° 25′ S., 155° 16′ E. Shackleton himself led the famous march which brought him to 88° 23′ S., 162° E., a great advance towards the south pole itself, which might actually have been attained but for the lack of food. The scientific results of the expedition were of high value, and revealed the desirability of prosecuting researches in the same field; and in 1910 Scott led a second expedition, with a larger scientific staff than had ever been taken before, the main party of which was landed at Cape Evans, McMurdo Sound. Of two other parties, one was landed on the west side of the sound; another, which worked at first from Cape Adare, was subsequently transferred to Terra Nova Bay, Victoria Land. A considerable area was thus

covered on this part of the Antarctic coast, while Scott's march upon the pole was designed to follow Shackleton's route. The splendour of success was outshone by the splendour of disaster: Scott and four companions, having reached the pole, died bravely on the return journey, overcome by adverse conditions. The work of the expedition as a whole, taking that of the other parties into account, was a brilliant scientific triumph.

The honour of first reaching the pole, however, fell to a Norwegian explorer, Captain Roald Amundsen, who, leading a small but admirably equipped expedition, succeeded in his endeavour at the end of 1911, and he and Scott thus left the way open to research on the Antarctic land-mass unhampered for the future by the natural desire to reach a certain point upon it. In the same year expeditions (not specifically concerned with the attainment of that point) were led south by the German Lieutenant Filchner, whose immediate goal was Coats Land, in the "Weddell" (or South American) quadrant, and by Dr. Mawson, whose objective was Adélie Land, on the opposite flank of the continent, while various projects are also under the consideration of other voyagers, British and American. There is room for the work of all these and more—the Antarctic region is now known as a vast land-area fringed by deep seas separating it from the other continental masses. Amundsen's observations would seem to prove it a single homogeneous mass, and not to be divided into two, or to consist in part of an archipelago. It still remains to investigate the nature of any geological relation between it and the other continents, to study the extension and physiography of the great mountain ranges which are known, and their relation to the polar plateau, and to deal with the many other problems such as are suggested by observations already made on the climate, the ice conditions, and the distribution of flora and fauna—notably, in the last connection, the problem of the resemblances which have been observed between Antarctic and Arctic forms of life.

Chapter XIV.

THE NINETEENTH CENTURY AND AFTER; EVOLUTION AND PROGRESS OF GEOGRAPHICAL SCIENCE

As during a long period in the history of geography it was usual to limit the connotation of the term, so, when a wider connotation came to be recognized, there naturally followed the creation of certain clearly-defined departments of study under distinguishing titles. The whole structure of geography rests upon two great pillars—upon exploration and upon measurement. With the main lines of exploration we have dealt in preceding chapters, and we have carried that part of our history which deals with precise measurement down to the close of the eighteenth century and the institution of the ordnance survey of Great Britain (Chapter X.). The early part of the sixteenth century witnessed the birth of accurate land-measurement; the early part of the nineteenth its re-birth as a function of organized state-administration. The Indian trigonometrical survey, with which the names of Col. W. Lambton and afterwards Sir George Everest are associated, was begun in 1800; a famous survey of Switzerland, coupled with the name of Gen. H. Dufour, was undertaken in 1809, one of Austria-Hungary in 1816, one of France in 1817; what is now the territory of the German Empire was already fairly represented on local maps when a general survey was undertaken in 1878. Indeed, all European countries may be said to be completely surveyed except certain of the Balkan States, though Russia is much behind in this respect. It must not be forgotten that the processes of close survey are slow: the primary triangulation of Great Britain was only completed in 1858, though the filling-in of details of

course proceeded concurrently. And the survey never stands still; there is always revisional work to do.

As concerns the British Empire, it has been an unrealized ideal that a territory should be surveyed as soon as possible after occupation, and it was not until 1905 that the defects and lack of system in the mapping of British territories generally were sufficiently widely realized to cause the creation of a Colonial Survey Committee as a central advisory and supervisory body.

Geodetic survey steadily advanced during the nineteenth century, from the work of Friedrich Wilhelm Bessel in East Prussia in 1838—of the highest importance owing to the systematic accuracy of the observations and their calculation (on the principle of "least squares")—down to the institution of the International Geodetic Association (Erdmessung), which had its origin in a proposal of the Prussian General, J. J. Baeyer, in 1862, and has headquarters near Potsdam, over twenty European, American, and Asiatic countries being represented in it. The accuracy of instruments has been carried far above the standard of those referred to in an earlier chapter. As an illustration we have only to trace the mechanical methods of measuring a baseline or other distance on the surface, from that of counting the revolutions of a wheel, up to that of employing rods of metal or other substance, or chains—methods associated with the endeavour to compensate for or overcome even the slight contraction or expansion of a rod, due to variation of temperature, which might vitiate the results, culminating in the discovery (in France in 1896) of invar, an alloy for practical purposes invariable, when applied to the measurement of baselines by means of such apparatus as that of E. Jäderin of Stockholm.

The work of the cartographer, as exemplified in atlases and small-scale maps of general utility, has by no means in all cases followed the high standard of the surveyor. Commercial considerations are not to be overlooked; cheap and rapid methods of reproduction bring their temptations as well as their advantages to bear upon cartography. Their advantages are manifest; the map, whether as an adjunct to travel or as a graphic illustration of a great variety of subjects, has become a commodity of almost daily use. But in some countries, such as the United States, the standard of cartography generally is as low as that of the maps of the survey is high. The reduction and selection of details from a large-scale survey for use on a small general map, the methods of representing such details, the

permissible limit of generalizing them, the choice of colours—these and other aspects of cartography really demand a scientific standard as exalted in its way as that of the surveyor. That standard has been most firmly upheld in Germany, in such geographical establishments as that founded by Justus Perthes at Gotha in 1785, which publishes the famous general atlas originally formed by A. Stieler in 1817–32, the physical atlas of H. Berghaus (1838–42), and many other such works. Other names of individual workers in the same field come readily to the mind—H. Kiepert, A. Petermann, K. von Spruner, Behm, Supan, Langhans, Andree, Debes, A. Ravenstein. The British and French lists are shorter, though the names of John Bartholomew, W. and A. K. Johnston, Edward Stanford and George Philip, Vivien de St. Martin, F. Schrader and Vidal de la Blache must be remembered.

After many years of effort on the part of the International Geographical Congress, a conference consisting of official delegates from most civilized states met in 1909 to deliberate on the methods to be adopted in the construction of an international map of the world. After much discussion a series of regulations was drawn up to be followed by each country in producing a map of its territories on the scale of 1/1,000,000, or about sixteen miles to the inch. The projection will, of course, be uniform, and altitudes are shown by layers of different tints from sea-level upwards. Actual experience may no doubt demand certain modifications, but it will be a great advantage to have an authoritative map of the world on a strictly uniform plan.

As to the progress of geodesy in recent years, in 1899–1902 an arc was measured in the extreme north in Spitsbergen, by Swedish and Russian workers (P. G. Rosen, O. Bäcklund, and others), while Sir David Gill, as director of the Royal Observatory in Cape Town, subsequently initiated the measurement of a great arc in Africa along the meridian of 30° E. These arcs are capable of connection through Asia Minor and Europe, by which means a continuous measured arc of 105° would be obtained. The arc of Quito (Peru) was re-measured in 1901–06 under the direction of the French Academy of Sciences; a great arc in 98° in the United States of America has been undertaken by the Coast and Geodetic Survey, and these again are capable of ultimate connection. Other arcs of special importance have been measured in Europe and India.

Geomorphology, though not accepted without demur as a definite branch of science in itself, has at last come to be generally recognized as a convenient term to connote the study of terrestrial relief. Elie de Beaumont in 1852 enunciated with too great precision the theory that similarity of orientation was a standard test of similarity in the age and origin of the great mountain chains. Lowthian Green in 1875 proposed his tetrahedral theory of the disposition of the continents and the ocean basins, on the ground that a sphere undergoing contraction tends to assume the form of a tetrahedron, or body enclosed by four equal equilateral triangles. He applied this theory to the form of the spherical earth at its present stage of contraction, indicated how far it accounted for the present distribution of land and sea, and attempted to give reasons for its failure to do so in certain respects. Professor C. Lapworth in 1892 stated his theory of folding, according to which the continents are the arches of vast folds in the crust of the earth, and the ocean basins the troughs between them. E. Suess has modified this view in his treatise *Das Antlitz der Erde* (The Face of the Earth), 1885–1901. Sir George Darwin invoked the effects of tidal strain upon the crust, associating this with the form of the continents. The subject, which has also been dealt with by Professors J. W. Gregory and A. E. H. Love, M. Bertrand, A. de Lapparent, and A. Supan, among others, has thus been approached from both the purely physical and the mathematical standpoint, but the problem has not reached its solution.

We have already given sufficient indication that the exact scope of geography has not been found easy to define by common consent; that fact does not lighten the task of tracing its development in the nineteenth century. It is not inconceivable that on one view of the subject this volume should have concluded with the preceding paragraph. On the other hand, the new value attaching to the geographical studies of distribution and environment makes it imperative to carry the story further. These studies have not only been systematized in themselves, but have become complementary of other sciences, and thus we find the term “geography” incorporated in certain scientific compounds—zoogeography or zoological distribution; anthropogeography, the distribution of mankind; biogeography, the distribution of living things generally—or perhaps more mercifully treated in such phrases as “plant geography.” Zoogeography and plant geography are concerned with the division of the earth’s surface into regions possessing individual characteristics in regard to their fauna or

flora. The principle of regional division, indeed, has become a leading principle of geographical research, in regard not only to fauna and flora, but to man as well; to the physical characters of the land, and to climatic conditions.

The general tendency towards scientific specialization has resulted in the erection, as it were, of separate laboratories for the study of certain specific features of the physical earth, each with its name-plate upon the door. From some of these—as from meteorology and geology—the geographer, in the course of the studies we have just outlined, borrows such data as are necessary to his purpose, and puts them to his special uses. It is no part of a history of geography to deal with that of meteorology or of geology, though both these sciences are fundamentally geographical, owe an obvious debt to exploration and travel, and make ample use of cartography. On the other hand, there are some departments of research which, though standing under their own names, are grouped perhaps more closely as offspring of physical geography. Such are oceanography (the study of the sea), limnology (the study of lakes), potamology (that of rivers). The last term might be justified on the ground that it helps to lighten the burden of different meanings which rests upon the term "hydrography"; it at any rate defines a clear field of study which, in view of its practical importance, has attracted much recent attention. The study of lakes—the depth, movement, and composition of their waters, the life in them, the physical nature of their basins—which was practically initiated by Professor F. A. Forel's investigations of Lake Geneva published in 1892–94, has already a notable monument in the bathymetrical survey of the Scottish fresh-water lochs, completed under Sir John Murray's direction in 1908.

The line between these various branches of science is for our present purpose difficult to draw; but at the risk of a charge of arbitrary treatment it appears pertinent to refer to certain facts in the history of oceanography. As an organized department this is no less a creation of the nineteenth century than others we have named. Among ancient geographers there was certainly some speculation as to the physical character of the seas, known and unknown. From a very early period sounding in shallow waters has been recognized as a method of navigation, and Strabo, for example, displays some knowledge of the greater depths of the Mediterranean. But to mere navigation a close study of the sea was not essential, and explorers with

their eyes fixed on distant lands were concerned merely to make the best of their way over the intervening waters. It is not, therefore, until towards the close of the eighteenth century, the period of the scientific exploration of the Arctic region and of Cook's great voyages—exploration necessarily carried out mainly on shipboard—that any systematic investigation of the deep seas is found. Phipps, Scoresby, John and James Clark Ross, and especially the last, made deep soundings; but the whole subject of oceanography may be said to have been first organized by Matthew Fontaine Maury (1806–73), an American naval officer, who, after his appointment to the United States Dépôt of Charts and Instruments (which became the Hydrographic Office), systematized the collection of navigators' observations on winds and currents, while his example inspired the establishment of similar collections in other countries. He also devoted himself to the study of the relief of the ocean floor, an investigation which was forwarded by the invention of a compatriot, J. M. Brooke, of the United States Navy, who introduced the principle of sounding in great depths by means of a lead which was detached from the line on reaching the bottom, so that the line might be easily hauled aboard. Maury published his *Physical Geography of the Sea* in 1855. Meanwhile the possibility of connecting England and America by submarine telegraphic cable had been discussed ten years earlier. Communication across the Channel with France had been successfully established in 1851, and in 1856 the first signals passed across the Atlantic. This first trans-oceanic cable survived only for a little, but the investigation of the sea-floor had now acquired a commercial as well as a scientific interest.

As early as 1834 Edward Forbes had made biological investigations in the Irish Sea, and in 1841–42 in the Mediterranean; while in 1868–70 similar studies, together with soundings and observations for water-temperature, salinity, and deposits, were carried on in the British seas, the Bay of Biscay, and the Mediterranean by investigators on board vessels of the Royal Navy—the *Lightning*, *Porcupine*, and *Shearwater*. This and similar work elsewhere was preparatory to the greatest of all marine scientific expeditions, that of H.M.S. *Challenger* in 1872–76. That vessel was commissioned at the instigation of the Royal Society, in command of Captain (afterwards Sir) George Nares, and a scientific staff under Sir C. Wyville Thompson as director, and including Sir John Murray, H. N. Moseley, and J. Y. Buchanan. The Atlantic was the first field of study, and

was crossed several times; the southern ocean was then traversed south-east and east from Cape Town; the *Challenger* was the first steamer to cross the Antarctic circle, and afterwards proceeded into the Pacific. The route now lay from Melbourne to New Zealand, Fiji, Torres Strait, the Malay Archipelago, and Chinese and Japanese waters, after which the Pacific was crossed from Yokohama by Honolulu and Tahiti to Valparaiso. The homeward route lay by the Straits of Magellan, Montevideo, Ascension Island, and the Azores. Every branch of oceanographical research was fully dealt with in the fifty volumes of reports upon the voyage. More lately other vessels of the British, American, German, and other navies have been detailed for scientific research; and cable laying has afforded additional opportunities. Mention must be made of the Dutch expedition in the eastern Malay seas on board the *Siboga* in 1899–1900, the work of the German surveying vessel *Planet* in the Pacific and elsewhere in 1906 and following years, and the Atlantic expedition of Sir John Murray and Dr. Johan Hiort on the *Michael Sars* in 1910. The observations of the last-named expedition, especially on the distribution of life in the sea, are of the first importance. Oceanographical work has remained an integral function of scientific expeditions in the Arctic and Antarctic regions. Among the names of investigators which are specially identified with oceanography (independently of other departments of geographical research) reference is perhaps most justly due to those of Professor Alexander Agassiz in the United States, and the Prince of Monaco. The establishment of the International Council for the Study of the Sea in 1901, nominated by nine European Governments, with its headquarters in Copenhagen, was not only an outstanding event in the history of the science at large, but also draws attention to one of its most important practical applications, for the Council is specially concerned with the study and improvement of the fisheries in the North Sea and other European waters.

The educational value of geography, as we have seen, was recognized in a practical manner by Newton; and towards the close of the eighteenth century physical geography was taken as a lecture-subject by the philosopher Immanuel Kant at Königsberg, and by him was given exalted rank as a “summary of nature.” Alexander von Humboldt (1769–1859) further systematized the theory of the control of land-forms and climate over the distribution and habits of plants, animals, and man, and was able to draw not only upon the collection of facts made by other travellers, but also

upon his own observations. His journey in 1799–1802 in America, during which he explored the Orinoco and discovered its connection with the Amazon through the Casiquiare, and visited Cuba, Quito and Mount Chimborazo, and Mexico, was the practical foundation of his scientific career. In the course of it he collected material for his researches into temperature at different elevations, into plant geography, terrestrial magnetism, volcanic phenomena, and much besides, while he also travelled through Russia to the Yenisei in 1829. In the work of Karl Ritter (1779–1859) is found the importance of establishing comparisons and investigating differences between similar regions in different parts of the world. Oscar Peschel (1826–75) corrected Ritter's marked tendency to give excessive prominence to historical detail. The exposition of theoretical geography was carried on by Ferdinand von Richthofen, Hermann Wagner, and Friedrich Ratzel; and with the work of these and other leaders in the school of German geographical thinkers and teachers is associated the German pre-eminence in cartography during the nineteenth century, in which connection a passing tribute should be paid to Humboldt's introduction to cartographers of the principle of drawing upon maps lines to show areas of equal temperature (isotherms), rainfall, etc.

Geography as an educational subject of widely-recognized value is coming by its rights, though the majority of the last generation may recall it as affording little else than superficial instruction in the position of countries, places, mountains, and rivers. But now, not only in Germany, but in Great Britain and elsewhere, it has been widely adopted as an examination-subject in both primary and secondary education, as well as for certain specific purposes, and geographical chairs or lectureships have been established in a number of universities. The fostering of geography as an educational subject has been one of the great tasks, and that of furthering exploratory and other research another, of the many geographical societies which have been founded throughout the civilized world in the nineteenth century and after. That of Paris in 1825, and that of Berlin in 1827, are the oldest of these now flourishing, though with the Royal Geographical Society in London (1830) was merged the older African Association.

The theory of evolution, as set forth by Charles Darwin, Alfred Russel Wallace, Sir Joseph Hooker, and others in the middle of the nineteenth century, has clearly the closest relationship with the geographical theory of

the control exercised by environment; it has become, indeed, its fundamental principle. Darwin accompanied the *Beagle* surveying expedition round the world in 1831–36, and his observations during the voyage qualified him for his life-work. Wallace's study of the distribution of animals brings at once to the mind his line of demarcation between faunal regions passing through the Malay Archipelago. Hooker was prepared for his interest in plant geography by his voyage with Ross to the Antarctic, by his travels in northern India (1847–51), and other journeys of wide range. Such men were geographers though their fame does not name them so. The application of geographical method is either essential or at least valuable in every branch of natural science; in itself it fulfils functions which the other natural sciences, taken individually, do not, and that is its justification.

SHORT BIBLIOGRAPHY OF GEOGRAPHY

A GENERAL history of geography (mainly, however, concerned with exploration and mapping) is Vivien de Saint-Martin's *Histoire de la Géographie* (Paris, 1873); a short historical review dealing more especially with geographical theory will be found in H. Wagner's *Lehrbuch der Geographie* (Leipzig, 1900). No English parallels to these works are to be cited, but reference may be made to H. R. Mill's *International Geography* (1897) and his article on "Geography" and E. G. Ravenstein's on "Map" in the *Encyclopædia Britannica* (eleventh edition). On the earliest period see E. H. Bunbury, *History of Ancient Geography* (2 vols., London, 1879), and H. F. Tozer, *History of Ancient Geography* (1897), in the Cambridge Geographical Series; on the "dark age" and down to 1460, C. R. Beazley, *Dawn of Modern Geography* (3 vols., London, 1897–1906); the sixteenth century is principally covered by the voluminous literature on Columbus, such as Sir C. R. Markham's *Life of Christopher Columbus* (London, 1892), E. J. Payne's *History of the New World called America* (Vol. I., Oxford, 1892); on the seventeenth and eighteenth centuries, E. Heawood, *Geographical Discovery in the Seventeenth and Eighteenth Centuries* (Cambridge Geographical Series, 1912). Some of the earlier theoretical works have been cited in the text; a few modern works representative of the various departments of geography may be mentioned here. Those of which the prime purpose is description are represented by E. Reclus's *La Nouvelle Géographie Universelle* (19 vols., Paris, 1876–95; there is an English translation) and by *Stanford's Compendium of Geography and Travel* (various authors.) F. Ratzel, *Anthropogeographie* (2 vols., Stuttgart, c. 1891); Ellen C. Semple, *Influences of Geographic Environment* (London, 1911); E. Suess, *Das Antlitz der Erde* (translated as *The Face of the Earth*, Oxford, 1904); G. G. Chisholm, *Manual of Commercial Geography* (1890 and later editions); and volumes of the Cambridge Geographical Series already referred to may be taken as representative of various departments of geography of which an outline has been attempted in the last chapter of this

book. A. R. Clarke's *Geodesy*, the section of the article on "Map" in the *Encyclopædia Britannica* by the same writer, and Col. C. F. Close, for projections, and H. M. Wilson's *Topographic Surveying* (New York and London, 1901) are to be referred to in the department of mathematical geography, but this subject has to be pursued mainly in official publications and scientific journals. For illustrations of cartographical method it is unnecessary in order to study the highest development of large-scale mapping to go beyond the Ordnance Survey of Great Britain and (particularly as illustrating the layer system of showing relief) the reduction therefrom by Bartholomew (Edinburgh), whose cartographical methods in such special scientific applications as meteorology, the distribution of population, etc., also render it unnecessary to consider sources other than English. But for best examples of the map-making art combined with the most careful use of existing data in the compilation of topographical atlases, such a work as Stieler's Hand Atlas (Justus Perthes, Gotha) must be studied. There are examples of cartographical work from all periods in E. A. Reeves's *Maps and Map-making* (London, Royal Geographical Society, 1910), a series of three lectures on the history and methods of surveying and cartography. Ancient methods may be studied in several facsimile atlases, such as A. E. Nordenskiöld's (Stockholm, 1889). The student of oceanography must consult the "Narrative" of the *Challenger* expedition by Sir John Murray, forming two of the fifty volumes of the Report of that great undertaking. Special treatises on the subject are those by Otto Krümmel, *Handbuch der Oceanographie*; Murray and Hjört, *The Depths of the Ocean*; Fowler, *Science of the Sea* (elementary); Richard, *L'Océanographie*; Thoulet, *L'Océan, ses Lois et ses Problèmes*. On limnology (the study of lakes) see Forel's *Handbuch der Seenkunde*.

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