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PREHISTORIC ARCHEOLOGY, PAST, PRESENT AND FUTURE[1]

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PREHISTORIC archeology as a method of solving the problems of man's physical origin and cultural development may be traced back almost two hundred years, but it was not until past the middle of last century that the inquiry became a recognized science. The long interval is marked by several important discoveries, as well as by sporadic efforts to get systematic investigations under way; but, owing to the long established adverse speculations of poets and book scholars, little headway was possible in the observational field until after 1859, when the growing prestige of the natural science movement finally swung the balance in favor of the visible facts and so opened the road to free inquiry. Since then the spade has been steadily in service, and by degrees the earth has yielded up an abundance of relics in nearly every quarter. Interpretation of the evidence thus obtained has kept close pace and is continually being rectified as new facts accumulate. The outstanding results of these research activities are that in the short span of seventy-five years the story of human existence has been stretched from the 5,000 years or so covered by written documents to a million years or more and we are beginning dimly to see the general course of progress from near the time when man first took to making implements and thereby differentiated himself once and for all from the rest of animal creation. The picture may never be fully developed as to its minor details, but the grand outline is permanently fixed and is clear enough for any school child to see and appreciate. Under the circumstances, if the astronomers are permitted to startle us with their idea of a rapidly expanding physical universe, there is no

[1] Address of the vice-president and chairman of the Section on Anthropology, American Association for the Advancement of Science, Atlantic City, December, 1936.

reason why the archeologists should not be allowed to point with equal pride to a similarly expanding human world.

The story of this archeological feat has not yet been adequately told. Zeal for gathering facts for and fitting the same into the general scheme of culture history has tended to obscure latent interest in the progress of the investigation itself. The lack is explainable also by the fact that the work until near the beginning of the present century was done as a rule not by seasoned professionals but by amateurs—men and women from every walk of life, scholastically trained and otherwise. This understandable universal appeal of things prehistoric has naturally been a mixed blessing. On the one hand, much of the earlier collected data are without accompanying information and therefore of comparatively little scientific value. On the other hand, the differently trained non-professional workers have contributed a great deal in the way of varied keen observations which are now embodied in archeological technique and which have helped to place the investigation on a broad and sound basis. Out of all this, in the natural course of events, professionally trained teachers and workers have lately come forth, prepared not only to appreciate what has been accomplished but also to plan the researches still required. All in all, the time seems ripe for a brief account of the past history, the present status and the future demands of our science.

Historical Development

The first beginnings of prehistoric archeology, though comparatively recent, are still veiled in obscurity. It must suffice to say that just as astronomy was preceded by astrology and chemistry by alchemy, so archeology was preceded by a similarly pseudo-scientific pursuit which we may call antiquarianism. The antiquarians and other hobbyists are still with us, probably always will be and certainly always have been, for we know from archeological sources that early man—in common with some of the lower animals—was endowed with the instinct for collecting rare and peculiar objects of all sorts. We are not surprised, therefore, to learn that a labeled display of relics was found in one of the rooms recently excavated in the palace at Ur, dating from about 3000 B.C. In addition, there are reasons for believing that fossils and other curios—probably stone implements—were kept in some of the Greek temples of the first millennium B.C. Historians vie in telling us of the somewhat later great museum at Alexandria, though no one seems to know what was in it besides manuscripts. We have read also of the royal curio collections kept at the various medieval European courts and which in modern times have given rise to some of the existing national museums. One might go on to cite contemporary descriptive and explanatory studies of such relics, were they not for the most part of questionable value in that they all fall within the range of endeavor that we have called antiquarianism, as distinguished from archeology proper. The essential difference in aim between the two pursuits lies in this, that while one values specimens chiefly for their own sake, as objects of art or as curios pure and simple, the other regards specimens primarily as means to an end, that end being the elucidation of culture history. Antiquarianism may fulfil a legitimate function, but its interests are sentimental rather than scientific, inspirational rather than informative.

The actual rise of prehistoric archeology should some day form an instructive chapter in the history of science. In the occidental world, up until the revival of interest in pagan learning in the fifteenth century, there was no room for even the concept "prehistoric." The world with all it contained was regarded as less than 6,000 years old and its entire history as somehow covered by written documents. These authoritative writings, including the Old Testament, Homer, Herodotus, Aristotle and others, had little to say about stone implements and nothing whatever about a Stone Age. On the other hand, even such enlightened pagan writers as Lucretius and Ovid, who speculated about the rise of man and culture, actually postulating a Stone Age, probably did not recognize *as such* the genuine stone implements that they may easily be supposed to have seen in public and private curio collections of their day. For stone implements were known to the Greeks and Romans, as well as to western Europeans of later times; but from before the beginning of our era down to as late as 1800 they were variously regarded as of superhuman and non-human origin. The oldest and longest-lived explanation was that they were thunderbolts, *i.e.*, objects formed in the air when the lightning flashed and as such endowed with magical properties, including the ability to protect against lightning. This old idea, as is well known, still prevails in many parts of the world. In later times recognized scholars also explained stone implements as natural products generated in the earth in the same way as fossils, as petrified iron implements, as symbols of the weapons wielded by the thunder god Thor, and finally as man-made implements used for ritual purposes, like the Jewish circumcision knife, which in Old Testament times continued to be made of flint.

Into the midst of this dark and scientifically hopeless world view a revealing ray of light had been suddenly thrown, following the year 1492, by the discovery in America and in the Pacific Islands of peoples who carried on for the most part with stone implements. But while this doubtless astounding phenomenon was

observed by Europeans from many walks of life and the news carried home, the acknowledged fact was explained for some time simply as due to cultural degeneration following as the natural result of mankind's dispersal from the Tower of Babel and so lost its significance for the stone implements found in Europe. A hundred years actually passed before Michael Mercati, physician to Pope Clement VIII, in 1593 ventured in the light of the new knowledge to write that the European objects called thunderbolts were implements of stone made and used by early man. In the course of the seventeenth and eighteenth centuries at least ten other writers vainly sought to convince the contemporary book-ridden scholars that Europe had once passed through a Stone Age like that observable in America. However, by 1936, when Director C. J. Thomsen, of the newly founded National Museum in Copenhagen, after twenty years' labor on the pre-Christian antiquities in his charge published anonymously a small pamphlet setting forth substantial evidence for the reality of the successive Stone, Bronze and Iron Ages in northwestern Europe, the whole western world was ready to accept and to apply his chronological scheme almost without comment or criticism. Thus the first step was gained for the conception "prehistory," though at the time the admission of a Stone Age for Europe meant little more than its earlier admission for America. Human existence was still regarded as limited to the estimated 6,000 years and the scattered stone-using peoples, ancient and modern, as no older than the earliest historic nations of the Near East. The former were merely unfortunate groups who had wandered away from the original high centers of culture and as a result lost the art of metallurgy and became users of stone. In the meantime, however, from 1750 onwards—and mostly since 1790—many discoveries had been made, especially in cave deposits and valley terrace gravels, of human skeletal and artifact remains associated with fossilized bones of extinct animals not mentioned in the historical records. The significance of this rapidly accumulating body of data finally became clear to a number of representative English scientists, including Sir Charles Lyell, Sir Joseph Prestwich and Sir John Evans, who accordingly in 1859 announced themselves as convinced beyond all doubt of the geologic antiquity of man. The battle with tradition being thus won at last, prehistoric research on all lines has since gone forward in Europe without hindrance, and scarcely a year has passed that has not witnessed new and important discoveries.

While this to us fantastic struggle between fact and fiction was slowly progressing in Europe, her colonizing citizens were rapidly becoming acquainted with the antiquities of other lands. The American continent was the first to come under scrutiny, and as the conspicuous archeological features here—ruins, earthworks, shellheaps, petroglyphs, etc.—were less ancient and therefore more easily linked with their originators than were the similar features of Europe, their consideration never involved comparable problems. For South America, if we ignore incidental references by early explorers and conquerors to abandoned palatial habitations and to the ancient practice of grave robbing, we have our first formal description of the famous Tiahuanaco ruin in Bolivia dating from 1554. Brief accounts of this and other Andean architectural remains followed from time to time during the next 250 years; but, though small relics were collected and described from about 1850 onwards, planned excavation for such remains is not definitely recorded until 1875. For Middle America we have to wait until 1785, when the equally famous Palenque ruins in Chiapas were first described. This revelation, together with the impetus given by Alexander von Humboldt, a German scientist who traveled in northwestern South America and Mexico from 1799 to 1804 and whose archeological observations were published in 1810, appears to have revived or set on foot a permanent interest in Latin American antiquities. At any rate, following that date, numerous elaborate surveys of ruins were made in Middle as well as in South America; but barring a few desultory attempts, especially by the French during their occupation of Mexico between the years of 1861 and 1867, no elaborate excavations for minor artifacts were undertaken until, as in South America, about the year 1875. From that time onward fieldwork involving excavation of some sort has been widely extended and of late much improved by the introduction of stratigraphic methods.

Coming to North America north of Mexico, and particularly the United States, the story of archeology is less spectacular, though scientifically more satisfactory. Observation, here as elsewhere, began with the conspicuous superficial features and only by slow degrees arrived at the systematic excavation and study of movable artifacts. Leaving out of account nearly all individual reports, however significant, ranging from those of the Norsemen in Greenland of the year 982 onward, the first sign of general interest in our antiquities was a prolonged discussion, beginning about 1680, bearing on the New England petroglyphs, such as those on Dighton Rock in Massachusetts. The second flare-up of popular interest came about the year 1780, or immediately after the Revolutionary War, when General Rufus Putnam and other military officers took up land in the Ohio Territory and at once began to send descriptive accounts of the mysterious earthworks of that region. This interest in the Mound-builder remains died down at least twice, though it is

now again probably more alive than ever before. The third and last preliminary phase dates from 1849, when Lieutenant J. H. Simpson turned in the first detailed report on certain of the large ruins in the Southwest. This equally exciting though less mysterious discovery also suffered brief periods of neglect, but the field is at present receiving more scientific and popular attention than any other. The fourth or present phase, dating from about 1870, marks the beginning of shellmound investigations in California, in the Aleutian Islands, in Florida and elsewhere—a type of work which for results required much digging. Since that time, *i.e.*, since 1870, excavation methods—recorded from time to time as far back as 1784 when Thomas Jefferson employed them on a Virginia mound—have been applied in gradually improved form in all the indicated major fields. Also the investigation, here as in Latin America, has been geographically extended and to-day includes the outer borders of Canada, as well as Alaska, Greenland and the West Indies.

The particular aspect of American archeology concerned with the geologic antiquity of man deserves special mention. Until recently the inquiry has been handled mostly by geologists and paleontologists with results far from satisfactory. The topic was suggested in concrete form as early as 1772, when Peter Kalm published his notes on certain long previously reported finds of artifacts in the Quaternary deposits of New Jersey. It was broached again in 1835 by P. W. Lund's discoveries in several Brazilian caves of a considerable amount of human skeletal material apparently associated with bones of extinct animals of Pleistocene age. Neither contribution appears to have stirred up any comment at the time, however, and the subject did not become really alive until after 1850, when the occurrence of cultural and skeletal material, including the famous Calaveras skull, began to be reported from the Tertiary gold-bearing gravels of California. These alleged discoveries were reviewed between the years 1866 and 1879 by the geologist J. D. Whitney, who in 1880 published his report accepting the evidence as proving man's existence in America perhaps as early as Miocene times. During the same period, or between the years 1861 and 1867, French scientists contributed a number of suggestive finds from Mexico, which, though briefly reported by E. G. Tarayre in 1884, appear never to have been discussed. More successful in gaining notice were the numerous startling discoveries, beginning in 1870, by Florentino Ameghino in the Pampean and earlier formations of Argentina, on the basis of which man's, or rather proto-man's, antiquity was traced back to Eocene times! Almost simultaneously with these extravagant claims, *i.e.*, in 1872, Dr. C. C. Abbott began to report the occurrence of supposed stone implements of Paleolithic type in the Quaternary gravels of Trenton, New Jersey. Other widely scattered finds of lesser import have been reported from time to time before and since, until to-day there are at least two hundred of them recorded in the literature. But in the meantime the lively discussion, started about 1870, died down by 1890 and was not revived again in full force until 1916, with new and better authenticated discoveries, this time in Florida. Since 1927 the centers of interest have been transferred to Ecuador and to the Rocky Mountain states, archeologists have joined in the search, and the investigation is now at last placed on a thoroughly sound footing, with results that are more nearly in keeping with what is known from the rest of the world.

The remainder of the habitable world, in spite of its size, need not detain us long because prehistoric studies are here of relatively recent date. Europeans were comparatively slow to invade both Asia and Africa, though in one way or another they had known something about these realms since long before America was discovered. But even after their arrival they found in those continents only a few conspicuous monumental remains such as had excited attention in Europe and America. Nevertheless, referring to Africa, surface collecting can be traced back to 1855 in Cape Colony, to 1866 in Egypt, to about 1885 in Algeria and the northwest, to 1893 in East Africa and to about the same date in the Congo region. However, the first planned excavations appear to date back only to about the beginning of the present century and to have been at first confined mainly to Egypt and the French northwest. Adequate stratigraphic work is an achievement of the last ten years and at present is receiving special though not exclusive attention in Egypt and East Africa.

Archeological developments in Asia, if we omit reference to historic or classical studies, cover about the same length of time; but progress here has been more slow and steady than in Africa. Of preliminary surface collecting little is known except for early paleoliths first reported in India in 1863 and for neoliths first brought from Yunnan in 1870. But already during the decade 1860 to 1870 Wilhelm Radloff had made random excavations in Neolithic, Bronze and Iron Age sites in western Siberia. This was followed in 1879 by E. S. Morse's introduction of shellmound excavation in Japan and by the beginning of French excavations in the Caucasus region, by Upper Paleolithic discoveries in Siberia in 1884 and by Eolithic discoveries in Burma in 1894. With the turn of the century, in 1902, excavations began in the Neolithic and possibly Paleolithic caves and shellheaps of French Indo-China and also in a large partly

Neolithic mound at Susa in Mesopotamia. The latter type of work was duplicated in 1904 in two large Neolithic and Metal age mounds at Anau in Russian Turkestan. Finally, in 1905, several caves thought to exhibit Upper Paleolithic remains were tried out in the island of Ceylon. There followed apparently a brief lull in most places, incidental perhaps to the Great War, but since then activities have picked up again and are going forward on a grand scale in various sections of northern, middle and southern Asia. Incidentally, the work here as everywhere else was initiated by occidentals but is now taken part in if not, as in Japan, conducted entirely by native-born investigators.

When we turn finally to the great island world occupying the Pacific and Indian oceans our story is still more brief. Conquest and settlement of the Philippine and East Indian portions date from the sixteenth century, but Australia and the rest were not occupied until 1788 and later. Leaving the *Pithecanthropus erectus* find in Java out of account as perhaps a missing link not yet provided with implements, little archeological information has been available about this vast region until the present century. Early knowledge was limited, on the one hand, to a number of more or less remarkable ruins and monumental remains scattered through the East Indies, Melanesia, Micronesia and parts of Polynesia, and, on the other hand, to a few surface pickings of stone implements chiefly from Australia, Tasmania, New Zealand and Hawaii. Since 1903, however, minor excavations have been made in Celebes, the Philippines, Formosa and perhaps farther east; but the only really stratigraphic excavations have been carried out in Java and Australia respectively within the last ten and six years.

Present Status

After all these mostly dry historical details it will be a relief to consider briefly what prehistoric archeology has actually accomplished during its short period of activity. From what has been said it should be apparent that most of the habitable world has been at least superficially explored and that to-day we have a fairly clear idea of the archeological possibilities of even the most inhospitable regions. Thus, omitting the little known interiors of Borneo and New Guinea, we have for all the rest of the world, including tropical jungles and arctic tundras, at least some descriptive information about conspicuous architectural and other fixed antiquities. The less forbidding localities, like the great deserts, have yielded in addition large collections of surface-gathered artifacts. Regions nearer the present centers of civilized life, particularly those of the temperate zones, have been subjected besides to more or less extensive random excavation for the purpose primarily of obtaining small relics. Lastly, in not a few places and naturally those favored for long periods by early man, systematized excavations, embodying stratigraphic methods where possible, are also well under way. This intensification of fieldwork, ranging geographically from the less favored towards the more favored regions of the world, is reflected also by the time order of research developments in the several main centers of archeological activity. That is to say, the general order of inquiry has everywhere been about as follows: first, discovery and description of monumental remains, as in our mound area; second, surface collecting and typological studies of movable remains, resulting sometimes, as in Africa, in the identification of culture centers; third, random excavation for small relics with the same end in view and including perhaps the approximate bounding, as in America, of culture areas; and, fourth, stratigraphic excavation, making possible a determination of the time order, if not also the technological evolution of the industrial stages within the given culture areas, as achieved for example in our own Southwest. Both of these general modes of progress have been more or less inevitable, not only because it was natural to begin with the conspicuous monumental remains but partly also because monumental remains often defy interpretation as to date and purpose except in terms of the small implemental objects that accompany them. For instance, in order to discover the function, say, of an earthmound, excavation may be necessary to learn that it was used for burial purposes. Again, to discover the relative date of the mound with its known skeletal and cultural contents it may next be necessary to excavate a local stratified culture deposit, such as a refuse heap, to obtain the time position of the implemental trait combination as found in the mound. In other words, because the evolution of stone implements or of pottery is longer, more uniformly varied and therefore more easily understood with respect to the all-important element of time order, chronological determinations for all other associated culture traits are most easily worked out through the employment of these better known media.

Turning to the different areas of the world field, present achievements may be briefly summarized. In the case of western Europe all known monumental features, including cave art, have been described, immense collections have been accumulated, typological studies have long been in progress and stratigraphic investigations are in an advanced state, as is indicated by chronologically arranged museum exhibits. The stratigraphic method has been applied wherever possible: to artifact inclusions in geologic formations, to artificial cave debris, to shellheaps, to pile-dweller deposits and to superposed ruins. In some countries,

like Denmark, the available chronological outlay from the Iron Age back through the Bronze Age, the Neolithic period, and into the final phase of the Mesolithic period appears to be completely set in order; while elsewhere, as in France, the preceding Paleolithic succession is gradually being pieced together and extended until it seems as if the whole story of cultural evolution is complete at least as far as time order is concerned. All these cultural stages and sub-stages have been tentatively correlated with the whole range of oscillating climatic changes characterizing the Quaternary geologic period, now estimated to have endured for about a million years; and those who champion eoliths have taken cultural beginnings back several million more years, through Pliocene and into Miocene times. Incidentally, in Sweden an absolute chronology has been worked out for post-glacial time by the counting of annual silt deposits. Also incidentally, at least some light has been thrown on the general succession of racial types in Europe. These accomplishments have all been made intelligible to the interested public through museum exhibits and through a series of semi-popular handbooks such as are available for no other part of the world.

In America the archeological field has been cultivated, if perhaps less intensively, at least as long and as extensively as in Europe. As evidence of this we have long possessed elaborate descriptions of ruins, mounds and petroglyphs; we have several more recent studies of mines, quarries, workshops, cave habitations and village sites, including shellheaps; and our very large semi-scientific collections have received typological treatment in both formal reports and semi-popular handbooks. Lastly, our stratigraphic investigations, begun in earnest about thirty years ago, have now been applied to both natural and artificial deposits and are well under way, for example, in the Southwest, in California, Florida, New York and Nebraska, in Mexico valley, in Andean South America and even of late in Alaska and Tierra del Fuego. One important result of all this labor is that man and culture in America can now safely be carried back some as yet uncertain distance into post-glacial time. Another is that we perceive here an independently developed segment of cultural evolution embracing what in Old World terms might be called the Late Paleolithic, Neolithic, Copper and Bronze Ages.

In Africa, except for bare descriptions of Mediterranean shore dolmens and a little excavation in some late Rhodesian ruins like those of Zimbabwe, archeological investigation has until lately been confined to Stone Age remains. These remains include shellheaps, cave-wall art and small artifacts. Of the last large surface collections have been made and independent preliminary typological studies of these have resulted in a confusing lot of names for localized and slightly differentiated culture complexes, seemingly in need of correlation and simplification. But assistance is now apparently on the way, for during the last few years much stratigraphic work of one kind or another has been carried out, especially in the Nile valley gravel terraces and in various types of natural and artificial deposits in Kenya Colony. In the latter region it is claimed, incidentally, that human existence, as judged by both cultural and skeleton discoveries, can be traced back, as in Europe, to the beginnings of Pleistocene if not to Tertiary times. Speaking generally, Africa seems to be strong on Lower Paleolithic flint industries, weak, except in the northwest, on typical Upper Paleolithic material and only moderately strong on Neolithic material. Some indications of early work in copper and other natural metals appear to be present, but the Bronze technique is absent. In other words, the Iron Age followed directly on the Stone Age.

Asia, like Africa, has furnished at least some descriptions of fixed remains such as mounds, megalithic monuments and cave-wall art. Partly described surface collections ranging from the Lower Paleolithic upwards are also available from various localities, especially Mongolia; but most of our published information has until recently been derived from random excavations in sites representative of the Middle and Upper Paleolithic as well as of the Neolithic, Bronze and Iron Ages, with the Bronze Age apparently omitted in some places here as in Africa. Now, however, within the past ten years large collections have been delivered to us in orderly fashion from two of the thickest stratified deposits yet found anywhere in the world and which have yielded an abundance of both cultural and skeletal remains. One, a cave deposit in Palestine, measured over 70 feet in depth, and its cultural contents take us from historic times well back into the Lower Paleolithic stage. The other is a cave deposit near Peiping, China, which, judged by accompanying faunal remains, is regarded as dating back at least to the Middle Pleistocene. In addition, a culture stratum of similar age has been found elsewhere in North China in a geologic deposit no less than 180 feet below the soil surface. In view of all this, Asia's traditional claims to being the birthplace of man are much strengthened, a fact which has a direct bearing on our own problem of the antiquity of man in America.

Oceania must be dismissed with a mere glance. As already indicated, we have descriptions from certain northerly sections of this vast area of both ruins and monuments, as well as of surface collections of stone implements that by courtesy may be called archeological; but it is only the larger southern and western islands nearest the Asiatic mainland that in addition

have yielded clear indications of prolonged habitation. In Australia, for example, these as yet undated evidences are reported in the form of cave-wall art, shell-heaps of some size, seemingly primitive human cranial material and excavated rock-shelter culture deposits reaching as much as twenty feet in thickness. Thus far, however, it is the island of Java alone that has furnished both primitive skeletal remains and Lower Paleolithic stone implements of undoubted Pleistocene age.

The conclusions to be derived from this brief and superficial world survey must necessarily be very general. In view of the emphasis constantly placed upon *antiquity* and *cultural characteristics,* it is in order to suggest first of all that the evidence thus far recovered tends to confirm the long-prevailing view that man originated in the Old World in pre-Pleistocene times, that he reached the New World only after the last glacial retreat, when he was still a roaming hunter but in possession of a fully developed flintworking technique, and that he arrived in the eastern Pacific and other outlying archipelagoes relatively late, in fact in what for the continental regions were largely post-Neolithic times. Another safe conclusion is that our chronologically ordered discoveries have given us a fairly complete account of the evolution of the world's stoneworking processes, ranging from crude to highly skilled percussion flaking, through pressure chipping to pecking, grinding and polishing, thus giving us a clue not only to the technological but also to the relative time position of any given culture complex containing stone objects. We have learned also that the Three-Period system of Europe, embracing the Stone, Bronze and Iron Age sequence, does not apply uniformly to all places, especially in Africa and Asia. Last of all, in view of what is now known about the progress of material culture as a whole, it seems certain that the important economic shift from the original nomadic hunting or food-gathering existence to our present settled mode of life based chiefly upon agriculture took place first about midway in the great desert zone stretching from Morocco to Mongolia and that it was the result probably in part of the gradual desiccation and consequent food scarcity which followed the last glacial retreat. Just when this change, giving rise to division of labor and so by relatively swift steps to modern civilization, began is still uncertain, but present estimates vary all the way from 5500 to 18000 B.C.; and the truth doubtless lies somewhere between the two extremes.

Future Requirements

There remains to suggest briefly what prehistoric archeology has still to achieve in the field, in the museum and in the study. With so much actually accomplished what precisely is now lacking? The answers are many and varied. Thus far, naturally enough, the investigation has been mainly one of fact-finding, but even in this department there are important gaps in our knowledge and therefore doubtless serious defects in our interpretations. For instance, we do not yet know *when* or how far back in geologic time man and culture originated, whether in the Pliocene or the Miocene. Stated in another way, we need more light, for example, on the Eolithic problem; and this, indirectly, might well come from the New World, *i.e.,* from studies of flaked pebbles in corresponding Tertiary deposits, here supposedly long antedating the coming of man. We are equally ignorant as to *where* the decisive step first took place. Europe, Asia and Africa all present their special claims. Until these problems are settled we can not definitely say *how* or in what time order our two connected phenomena spread over the world, and in particular when or in what culture stage man first reached the American continent. Unanswered also are such secondary questions as to what became of the Neanderthal race and, more important still, from where did Cromagnon man or *Homo sapiens* suddenly arrive in western Europe? The field, in other words, obviously requires further investigation. We are in need, for example, of collections from many little-known areas such as the jungle, tundra and desert regions in various parts of the world. Collections are especially required from such strategic localities as northeastern Siberia, Alaska, the western plains of Canada, our own Great Basin and northern Mexico, to name only those nearest home. And, most important of all, we need stratigraphic work done in all but a few of our recognized culture areas throughout the world in order to establish first the relative and next the absolute chronologies that shall enable us finally to plot the place of origin and early movements of man and culture in visible form on the geologic column.

The archeological museum requires work in several different departments, such as the laboratory, the storerooms and the exhibition halls. In the laboratory, besides the improvement of normal routine, more study and experimental work are needed, for example, on the art of percussion flaking and pressure chipping in order that we may come to a fuller understanding of the varying degrees of expertness involved and so be better able to estimate the technological status of our individual specimens. In our storerooms, it is safe to say, is to be found a great deal of neglected work, in fact, neglected opportunities. Museums have hitherto been so exclusively intent upon exhibition facilities that they have given little thought to the adequate housing of study collections. As a result curators come and go at the larger museums, while immense

accumulations of costly specimens sometimes remain unnoticed. Probably much the same condition obtains with respect to most of the smaller collections, both public and private. The opportunity to enter the open field, even if previously investigated, is generally more inviting than the dusty attic. Nevertheless, it can hardly be denied that our fieldwork could be done more intelligently and more economically if we had our storage collections classified and arranged geographically, chronologically and typologically. More than that, it is only by complete familiarity, especially with our chipped stone material, that we are ever likely to become able to separate our intentionally designed implements from the merely accidental forms or to develop a really satisfactory classificational terminology. Stated in another way, the real advancement of our science depends much more upon what we do with our storage than upon what we do with our exhibits. However, in the museum proper we are actually confronted with a variety of more and more pressing problems. Hitherto we have offered the public for the most part only miscellaneous mass displays, astonishing enough perhaps as collections of meaningless curiosities but of little educational value. These exhibits, as our collections increase, must necessarily be condensed and simplified. Towards this end we should present chronological displays wherever possible, with typological subdivisions showing the order of appearance and general course of evolution of all the different arts and industries. For the culture areas lacking chronological determinations we might at least substitute synoptic exhibits with similar subdivisions for the various activities represented. Instructive also would be typological displays showing the complete geographic range of all the different inventions. Finally, we need to develop technological exhibits showing the normal order of gradual improvement of early man's skill in dealing with the various raw materials, such as stone, shell, bone, wood and fiber, skin, clay and the natural metals. In this connection the utilization of fire in the industrial processes, such as those of ceramics and metallurgy, would seem to need special emphasis, because it was this application alone that made modern industrial civilization possible.

We have finally to consider the study and the library. The requirements here also are twofold: those pertaining to the progress of the science of archeology itself and those pertaining to the education of the public. For the use of professional students, particularly in the United States and Canada, we need a complete bibliography, regional and subject, so that when any man or institution wishes to undertake a regional study or a piece of work in a given culture area it may be possible quickly to learn what has already been done in that particular field. Also we need an all-round good text-book on prehistoric archeology, an undertaking now almost beyond the capacity of any single scholar because before he can finish the last of his surveys the first is likely to be out of date. For more general use we need a new handbook in English for the American continent, somewhat like those long available for Europe. More especially we need a handbook for the United States and Canada, such as was begun by W. H. Holmes and the second and most important part of which lies perhaps partly finished. We need also for America, or at least for North America north of Mexico, an album illustrating all the principal forms of our antiquities. Such an album, with brief textual legends giving both time and space distribution for all incorporated inventions, might be patterned after that published for Europe by G. de Mortillet as long ago as 1881; but probably it would be more serviceable if its contents were arranged by industries, such as flaked and chipped stone, shellwork, bonework, woodwork, skinwork, basketry, textiles, ceramics and metallurgy. Additional topics might be included, as called for, relating to such skilled activities as hunting and fishing, agriculture and animal husbandry, medicine and surgery, quarrying and mining, architecture and engineering, decorative and pictorial arts, religious symbolism, and so on. The different sections might very well be issued separately to meet the varying demands which now exist. Such separates, provided with suitable general introductions, might even serve as popular guide leaflets to all the various basic arts and industries originated and developed by prehistoric man.

Summary and Conclusion

The attempt has been made in the foregoing paragraphs to outline the whole history of prehistoric archeology: its crude beginnings in ancient times, its steadily accelerating progress during the past two hundred years, and its present achievements. Special emphasis has been placed on the rôle played by the discovery of surviving primitive industries in America and elsewhere in bringing about a rational attitude towards Stone Age antiquities and a beginning of their systematic investigation. The creation and growth of the organization and personnel promoting and conducting this world-wide research must be left untouched except to say that to-day probably every civilized country has its museums and university teaching staffs. Public interest in man's prehistoric past was never greater than to-day and only financial support is necessary to afford opportunity for the increasing numbers of young men and women who are constantly pleading for a chance to take part in the work. Accordingly, though the task before us is still very great it is not so hopeless as in the case of some other

purely natural sciences like astronomy and entomology. For not only is the earth spherical and therefore limited in extent but man's period of occupancy is relatively short. In other words, while prehistoric archeology of necessity was one of the last special branches of research to get really under way, it is likely to be the first to finish its task. Indeed, if archeological investigations, historic and prehistoric, continue to progress at the same accelerating rate as in the past, it would seem that the next hundred years or so might easily see us in possession of all the essential facts. Those more or less indestructible facts or documents once in hand and the spade set aside, archeologists may have to change their titles to those of curators or something even less high-sounding. At all events, those professionally concerned may then devote their entire time to the permanent arrangement and final interpretation of all the available material culture traits, with a view to offering a visible demonstration of how, step by step from small beginnings, things as they are in the human world actually came to be so. That accomplished, when every one has become familiar with our recreated past, we shall be more nearly free and in the best possible position to give our whole-hearted attention to the really major creative problems of the present and the future.

HOW BREATHING BEGINS AT BIRTH[1]

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ONE of the oldest problems of science is: Why does the baby begin to breathe at birth? The purpose is clear; but the cause and means are obscure.

Half an answer has long been available. It is well established that for many weeks or even months before birth the fetus makes distinct rhythmic respiratory movements. Ahlfeld[2] in 1915 published excellent graphic records of these movements. They were taken from the surface of the mother's abdomen. And a number of recent investigators have obtained moving pictures of respiratory movements in animal fetuses delivered by Cesarean section in a bath of warm saline.[3] But these movements are ineffective in expanding the lungs and keeping them expanded. The question then becomes: How are the feeble and ineffective respiratory movements of the fetus transformed into the effective breathing of the newborn?

The answer, I believe, is to be found in the fact that a certain function is deficient in the fetus; and that this function is quickly developed at birth and is then continually maintained throughout life. It is a function of critical importance alike for respiration, circulation and metabolism: the function of muscle tonus.

Many years ago I found that, when a man or animal dies, the muscles lose their tonus within five or ten minutes.[4] I was investigating various forms of manual artificial respiration. What I found was that only so long as tonus continues do the thoracic muscles and diaphragm retain a sufficient degree of elasticity to keep the lungs well expanded. And only so long as the lungs are thus held to a fair degree of expansion is manual artificial respiration effective. Pressure upon the chest, abdomen or back squeezes air out of the lungs. The inspirations that occur between compressions are produced wholly by the tonic elasticity of the victim's own muscles that pull the chest back to mid-expansion. After the body is entirely flaccid no form of manipulation can induce the slightest inspiration. When tonus is lost, the cubic capacity of the chest decreases and the lungs are correspondingly deflated. Even if the lungs are then inflated with a bellows, they deflate again as soon as the inflation is ended.[5] In normal breathing a large volume of air is held in the lungs even during expiration: the so-called stationary air.

The maintenance of a considerable volume of stationary air is extremely important. Unless the lungs are continually held in a sufficient degree of inflation, adequate aeration of the blood, either by artificial or by natural respiration, is impossible. Hess[6] has shown that even the movements of normal breathing may be regarded as essentially due to rhythmic variations in the degree of tonus in the respiratory muscles and particularly in the diaphragm. Extending this idea we may consider that the extent of the inflation

[1] Read before Connecticut Academy of Arts and Sciences, New Haven, Conn., December 10, 1936.

[2] F. Ahlfeld, *Monatsschr. f. Geburtsh. u. Gynäk.*, 21: 143, 1915.

[3] J. Barcroft, "The Brain in Its Environment," Yale University Press (in press).

[4] Y. Henderson, *Jour. Amer. Med. Assoc.*, Vol. 67: 1, 1916.

[5] The fact that no form of manual artificial respiration can directly induce an appreciable degree of inspiration affords no valid reason for the use of apparatus for artificial respiration. So long as tonus is present, manual methods are effective. When tonus disappears, the victim is dead beyond recall. Such apparatus as the pulmotor and others that apply suction to the lungs, promote, not recovery, but a further deflation of the lungs. For resuscitation in cases of atonic asphyxia of the newborn (*asphyxia pallida*) intratracheal insufflation is much more effective than any form of artificial respiration.

[6] W. R. Hess, "Die Regulierung der Atmung," Leipzig, 1931.