



CARBONIFEROUS AGE.—Pages 283 and 333.

MANUAL
OF
GEOLOGY:

TREATING OF THE PRINCIPLES OF THE SCIENCE

WITH FREQUENT REFERENCE TO

AMERICAN GEOLOGICAL HISTORY,

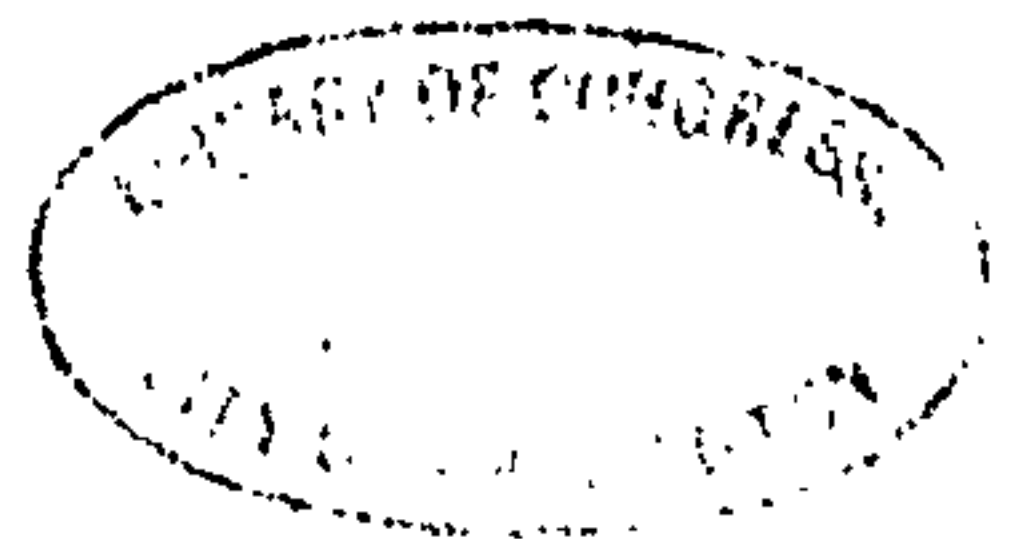
FOR THE USE OF COLLEGES, ACADEMIES, AND SCHOOLS OF SCIENCE.

BY

JAMES D. DANA, M.A., LL.D.

SULLIVAN PROFESSOR OF GEOLOGY AND NATURAL HISTORY IN YALE COLLEGE; AUTHOR OF
"A SYSTEM OF MINERALOGY," OF REPORTS OF WILKES'S EXPLORING EXPEDITION
ON GEOLOGY, ON ZOOPHYTES, AND ON CRUSTACEA, ETC.

*Facet jam oculis quodammodo contempnimus pulchritudinem rerum earum,
quas diu in providentia delectamur constitutas. — C. —
Nunquam aliud dixerat aliud sequebatur. — J. v.*



ILLUSTRATED BY A CHART OF THE WORLD, AND OVER ONE THOUSAND
FIGURES, MOSTLY FROM AMERICAN SOURCES.

PHILADELPHIA:
PUBLISHED BY THEODORE BLISS & CO.
LONDON: TRÜBNER & CO.
1863.

V. ERA OF MIND.—AGE OF MAN.

In the preceding chapters the progress of the vegetable and animal tribes has been followed through the three grand divisions of geological time,—the Palæozoic, Mesozoic, and Cenozoic. In the latter part of the last era the animal kingdom, apart from Man, culminated; for the system then reached the highest grade of development presented by the merely animal type, and brute passion had its fullest display. In the era now opening, the animal element is no longer dominant, but Mind in the possession of a being at the head of the kingdoms of life; and the era bears the impress of its exalted characteristic even in the smaller size of its beasts of prey. At the same time, the ennobled animal structure rises to its highest perfection; for the Vertebrate type, which began during the Palæozoic in the prone or horizontal fish, finally becomes erect in Man, completing, as Agassiz has observed, the possible changes in the series to its last term.

But, beyond this, in Man the fore-limbs are not organs of locomotion, as they are in *all* other Mammals: they have passed from the *locomotive* to the *cephalic* series, being made to subserve the purposes of the head. This transfer is in accordance with a grand law in nature (explained in the note, § 5, p. 593) which is at the basis of grade and development. The intellectual character of Man, sometimes thought too intangible to be regarded by the zoological systematist, is thus expressed in his material structure. Man is therefore not one of the *Primates* alongside of the Monkeys: he stands alone,—the *ARCHON* of Mammals (p. 422).

In order to a correct apprehension of the distinctions and eminence of the era of Mind, a few of the attributes of Man are here enumerated.

Man was the first being that was not finished on reaching adult growth, but was provided with powers for indefinite expansion, a will for a life of work, and boundless aspirations to lead to endless improvement. He was the first being capable of an intelligent survey of nature and comprehension of her laws; the first capable of augmenting his strength by bending nature to his service, rendering thereby a weak body stronger than all possible animal force; the first capable of deriving happiness from beauty, truth, and goodness; of apprehending eternal right; of looking from the finite

towards the infinite, and communing with God his Maker. Made in the image of God, surely he is immeasurably beyond the brute, although it share with him the attribute of reason.

The supremacy of the animal in nature, which had continued until now, here yields, therefore, to the supremacy of the spiritual. As the body, through its development and adaptations, is made for the service and education of the soul that is slowly maturing in connection with it, so with the system of the world, as regards both its inorganic and organic departments, there was reference, throughout its history no less than in its final adjustments, to man, the last, the highest, the spiritual creation. And the earth subserves her chief purpose in nurturing this new creation for a still more exalted stage, that of spiritual existence.

I. Rocks: kinds and distribution.

The following are the formations of the age of Man:—

1. OF MECHANICAL ORIGIN.—(a.) *Marine*.—The extended flats which border many coasts, as from Long Island to Texas, and beyond, and which are now gradually widening the area of the continents; and deltas, which are similar in general character, but are formed about the mouths of rivers.—Sea-beaches.—Sand-drifts or dunes in the vicinity of the ocean. (b.) *Continental*.—Alluvium of the lower river-flats; and, in case a region has undergone elevation during the age, that at higher levels.—Alluvium along the shores of lakes; and, where, through the modern opening of barriers or other cause, the waters have diminished their height, deposits above the lower plain. About large lakes, different formations analogous in every respect to the *Marine* above mentioned, except in having no marine relics.—Glacier drift or boulders and gravel, similar to that of the true Glacial epoch, though of more local distribution.

2. OF ORGANIC ORIGIN.—(a.) *Marine*.—Coral reefs, often of vast extent.—Shell deposits. (b.) *Continental*.—Peat beds, or swamp formations of vegetable character, consisting largely of growing moss in temperate and colder climates, and of diminutive turf-making flowering plants in Alpine and Arctic regions.—Shell beds or shell marl.—Siliceous infusorial deposits.

3. OF CHEMICAL ORIGIN.—Calcareous deposits called *Travertine*, derived from calcareous waters, in some cases scores of feet in thickness.—Stalactites and Stalagmites of similar form and origin in caverns.—Bog deposits of ore called *Bog ore*.

4. OF IGNEOUS ORIGIN.—Lavas and tufas of volcanic regions.

The formations here enumerated, whether along lakes, rivers, or sea-coasts, are usually underlaid by Post-tertiary beds of similar character, situated at varying depths below, often but a few feet, sometimes hundreds of feet; and the modern and Post-tertiary deposits are so closely alike that the limits of the two cannot be easily made out. The difficulty is the greater because the shells of the Post-tertiary were all of species now living. In many cases deposits are proved to belong to the age of Man by containing relics of the peculiar species of the age, as explained beyond.

The agency of air, fresh and marine waters, heat and life, in giving origin to these deposits, might be here considered. But these topics are discussed under Dynamical Geology; and to that part of the work the reader is referred.

II. Life.

The approximate number of living species of Plants is 100,000. The number of species of Animals of the sub-kingdom of Radiates is about 10,000; of Mollusks, 20,000; of Articulates, 300,000; of Vertebrates, 21,000; making a total in the Animal kingdom of about 350,000. Of existing Vertebrates the number of species of Fishes is about 10,000; of Reptiles, 2000; of Birds, 7000; of Mammals, 2000 = 21,000.

The increase during the Tertiary period in the extent of dry land and rivers, the height and number of mountains, and the diversities of the zones of climate, augmented greatly the variety of geographical conditions over the globe to which life could be accommodated. This is especially true of the land; but only in a limited degree for the ocean, which has smaller extremes of temperature than the land, and is less affected by its changes of level.

The terrestrial life of the globe should therefore, on this principle, have undergone a vast increase in the course of the later Tertiary and the period of the Post-tertiary, especially in the classes of Insects, Birds, and Mammals, and the tribes of fresh-water Fishes. Reptiles should have undergone less increase, for the species belong mainly to the warmer climates, and this type had already culminated and was on the decline.

Insects and Birds appear to have had their times of culmination in the age of Man, while Mammals, gigantic and ferocious, especially in their larger species, passed their climax in the period next preceding, and disappeared as the age of Man began. Most species of plants and animals have their parasitic insects; and an augmenta-

tion of the numbers of the former was consequently but providing for the appearance of the latter.

Invertebrates.—As to the time of the first appearance of existing Mollusks, it is known only that 15 to 25 per cent. of Miocene species of marine shells are identical with species now living; 40 to 90 per cent. of Pliocene; and all of the Post-tertiary species. This does not necessarily imply that all the species of Mollusks alive now were alive throughout the Post-tertiary; for out of the 16,000 living species only a few hundreds have yet been found in the beds of that period. Future discovery will undoubtedly add much to the number.

Among Articulates, less than 100 living species from Post-tertiary deposits are known out of the 300,000 now in existence. The two tribes latest in appearance among fossil Insects, and rarest even to the last, are that of the Lepidoptera, the tribe of beauty, and that of the Hymenoptera, the tribe of utility, highest instincts, and superior rank. The species of these tribes are less likely to become fossilized than those that frequent wet places, where depositions of silt might be in progress.

Vertebrates.—Very few Fishes, Reptiles, or Birds of the present era are yet known, from any discovery of fossils, to have existed in the Post-tertiary. The species have thus far been but little searched for.

Among Mammals, remains of nearly all the species of modern Europe have been found in beds containing some of the extinct Post-tertiary. The number includes the Hare, Rabbit, Beaver, common Rat and Mouse, the Marten, Wild-Cat, Dog, Fox, Stag, Roebuck, Reindeer, Aurochs, Hog, Horse, and the Glutton and Polar Bear of northern latitudes, besides many others; and probably all existing species were then distributed much as they are now over Europe. Moreover, in Sicily and Malta remains of some African Mammals have been found.

Some of the species may date from the early Post-tertiary; but the majority apparently from the Terrace or transition epoch. Their remains are found in caverns and alluvial beds, associated with bones of the Elephant (*E. primigenius*), Rhinoceros (*R. tichorinus*), and Irish Elk (*Megaceros Hibernicus*), and occasionally with those of the Hyena and Cave Bear. In some cases they have probably been mixed by more modern alluvial action; but in others they lie as they were originally buried. The alluvial beds in England, France, and Switzerland are more recent than the old Glacial drift, the latter being observed in several places as an inferior deposit.

It follows, therefore, not only that some of the large Mammals continued on beyond the time of their meridian nearly or quite through the Terrace epoch, but also that the modern tribes came into existence before their extinction. The progressing Terrace epoch was bringing about the cooler climate required for the modern species; and this change of climate was also causing the disappearance of the tribes of the older era.

The time of greatest expansion of the Post-tertiary races was probably in the Champlain epoch, when they would have found the warm climate over the continents, which they required (p. 567). Now, the modern species correspond to a climate like the present, which is a colder one. The Glutton, of Lapland, the Reindeer, and the Polar Bear were among the earliest of these modern species, showing that when they began this cooler climate existed. Since the faunas of the Post-tertiary and age of Man are thus distinct in the climate which they required, they must have belonged essentially to different epochs,—the modern, of course, to the later. The Terrace epoch was the one in which the change to the colder modern climate was in progress, and therefore that which would have favored the appearance of the modern types and brought about the disappearance of the more ancient.

The cooler climate might have been begun over Europe and Asia in the early part of the Terrace epoch, by an increase of Arctic lands, before the terrace elevations of central Europe had made much progress.

The succession of recent formations in Europe and Switzerland, from the early Post-tertiary onward, is thus given by Professor Guyot from his own and other observations:—

1. The northern European and American Glacial drift, the Glacial epoch.
2. The epoch of subsidence, or Champlain epoch, when the large Post-tertiary fauna was fully developed.
3. The "ancient diluvium" of Switzerland. In some places it is hundreds of feet thick, and generally stratified; part of it is pebbly, with the rounded stones sometimes from the size of an egg to that of a man's head, but none of them are scratched or polished. It covers the plains about Lake Geneva and the lowlands of Switzerland, and underlies the moraines of the great Swiss Glacier (p. 545), and contains, though rarely, bones of the *Ursus spelæus*, *Felis spelæa*, *Elephas primigenius*, *Rhinoceros tichorinus*, *Hippopotamus*, etc., without any remains of modern species.
4. The Drift of the great Glacier of Switzerland, together with the Terraces and Löss or silt of the river-borders. It may belong to the American Terrace epoch. The true Drift is unstratified, and spreads upward over the hills; the stones are scratched and polished, and in part lie in distinct moraines, or are mixed with glacial mud. The alluvium or löss covers this Drift. It is well seen in the valley of the Rhine north of Basle, where it overlies the continuation of the old diluvium of Switzerland. It is sometimes one hundred feet thick, and extends up several hundred feet above the bottom of the valley. It contains a vast amount of land-shells, of existing species; but they have the small size and aspect that belong to those now found in the Alps 6000 feet above the sea.

Near Geneva, at Mattegny, there is a bone-bed ten to fifteen feet below the

surface, which was first explored in 1845 by Pietet. It occurs in gravel whose stones are scratched as by glacier action, and overlies a clay containing scratched pebbles, whence, according to A. Favre, it belongs to the epoch of the great Swiss glacier, or that immediately succeeding it, and not to the "ancient diluvium" of Switzerland. It contains remains of various Mammals of existing species, as the Shrew, Mole, Fox, Rat, Mouse, Hog, Ox, Chamois, Stag, etc. The loess also contains abundant remains of existing Mammals, together with, in some cases, the ancient Elephant, and a few other extinct species.

In North America some of the Mammals appear to date from the Tertiary epoch. Among these, according to Holmes and Leidy, there are probably the modern Horse, or one similar to the common species, the gray Rabbit, and Tapir; and to these Dr. Holmes adds the Bison, Peccary, Beaver, Musk-Rat, Elk, Deer, Raccoon, Opossum, Hog, Sheep, Dog, and Ox. The species, however, have not in all cases been identified with certainty; and it is not settled that the commingling of bones is not of more modern origin. In western Canada, Chapman has found remains of the modern Beaver, Musk-Rat, Elk (*Elaphus Canadensis*), and Moose, in stratified gravel which contained also bones of the Mammoth and Mastodon.

The caverns of the country have afforded some Mammalian remains, but only of recent species, though otherwise supposed until recently. In one, near Carlisle in Pennsylvania, Baird found bones of all the species of Mammals of the State, besides one or two other species not now Pennsylvanian, but known in regions not far remote. As a general rule, the bones appeared to indicate that the size exceeded that of the species at the present time.

A few species of animals have become extinct in recent times, and partly through the agency of Man. Among these there are the *Moa* (*Dinornis*), and other birds of New Zealand, and the *Dodo* and some of its associates of Mauritius and the adjoining islands in the Indian Ocean. The species are of the half-fledged Ostrich tribe. Fig. 844 (copied from Strickland's "Dodo and its Kindred") is from a painting at Vienna made by Roland Savery in 1628.

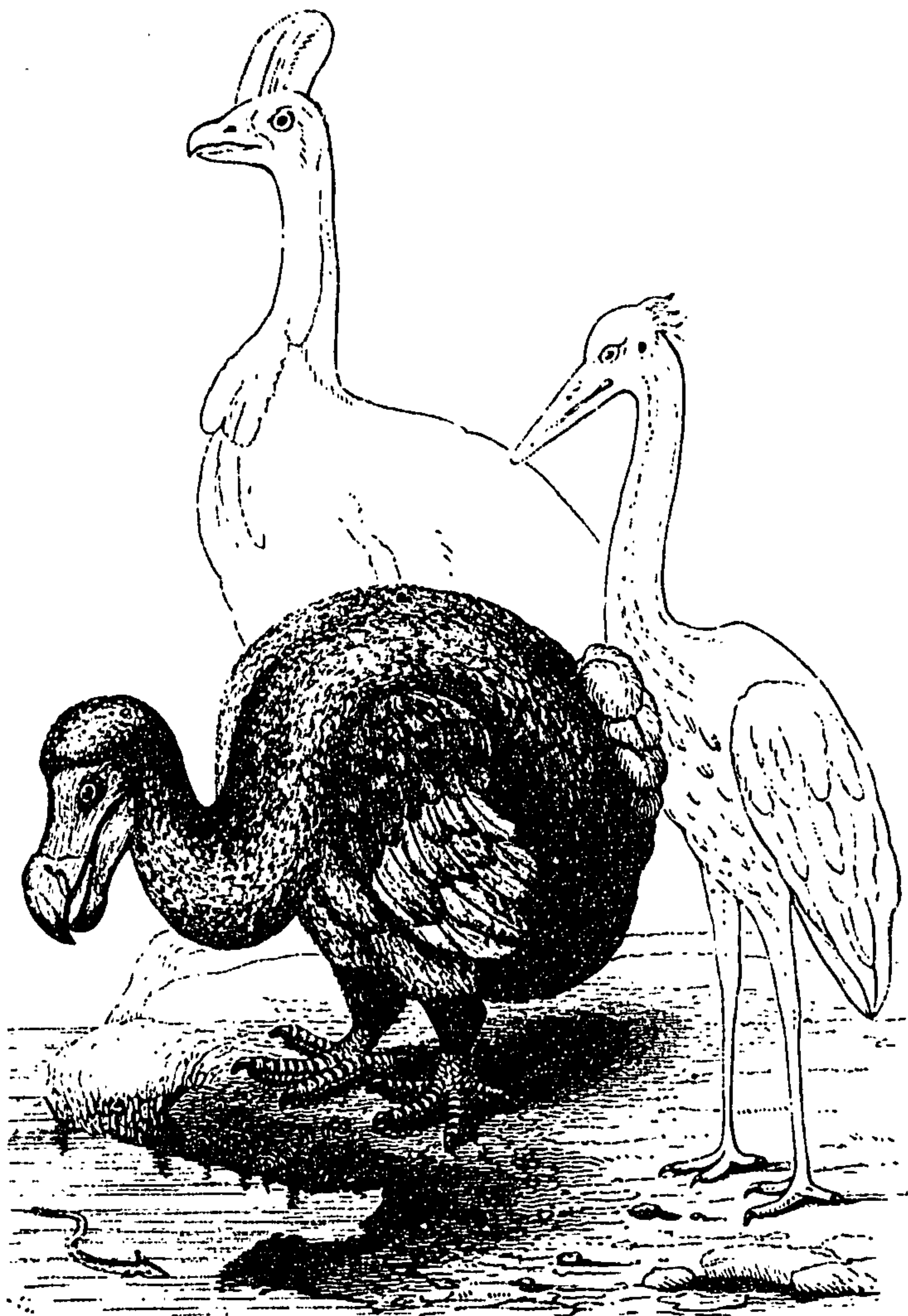
The *Dodo* was a large, clumsy bird, some fifty pounds in weight, with loose, downy plumage, and wings no more perfect than those of a young chicken. The Dutch navigators found it in great numbers in the seventeenth century. But after the possession of the island by the French, in 1712, nothing more is heard of the Dodo; a head, two feet, and a cranium are all that is left, except some pictures in the works of the Dutch voyagers.

The *Solitaire* is another exterminated bird of the same island.

The *Moa* (*Dinornis giganteus*) of New Zealand exceeded the Ostrich in size, being 10 to 12 feet in height. The tibia (drumstick) of the bird was thirty to thirty-two inches in length, and the eggs so large that it is said "a hat would make a good egg-cup for them." The bones were found along with charred wood, showing that they had been killed and eaten by the natives. The name *Dinornis* is from *deinos*, terrible, and *ornis*, bird.

Besides the *Dinornis giganteus*, remains of other extinct species of the genus

Fig. 844.



Dodo, with the Solitaire in the background.

have been found; also extinct species of *Palapteryx* and *Notornis*. *Palapteryx* is related to *Apteryx*; and both *Apteryx* and *Notornis* have living species.

On *Madagascar* another species of this family of gigantic Ostrich-like birds formerly existed. The species has been called *Epiornis maximus*. From the bones of the leg it is supposed to have been at least twelve feet in height. The egg was over a foot (thirteen and a half inches) in length.

The great Auk of the North Sea (*Alca impennis*) is reported to be an extinct bird by Prof. Steenstrup. The last known to have been seen were two taken near Iceland in 1844. The bones occur in great numbers on the shores of Iceland, Greenland, and Denmark, showing that it was once a common bird.

A species of Manatee, *Rytina Stelleri* Cuvier, known in the last century on the Arctic shores of Siberia, is now supposed to be extinct.

The Aurochs (*Bos Bison*) of Europe, one of the contemporaries of the old Elephant (*E. primigenius*), would have long since been exterminated from Europe but for the protection of Man. Though once abundant, it is now confined on that continent to the imperial forests of Lithuania, belonging to the Russian emperor. It is said to exist also in the Caucasus. The *Bos primigenius* of the Post-tertiary is supposed to be the same with the *Urus* (Ure-Ox or *Bos Urus*) described by Caesar in his Commentaries, and stated to abound in the Gallic forests, and is a distinct species from the Aurochs, with which it has been confounded. The species is now quite extinct. It is said to have continued in Switzerland into the sixteenth century.

The American Buffalo (*Bos Americanus*) formerly covered the eastern part of the continent to the Atlantic, and extended south into Florida, Texas, and Mexico; but now it is never seen east of the Missouri, excepting its northern portion, and its main range is between the Upper Missouri and the Rocky Mountains, and from northern Texas and New Mexico to Great Martin Lake in latitude 64° N. (Baird.)

The spread of the farms and settlements of civilization is gradually limiting, all over the globe, the range of the wild animals, especially those of large size, and must end in the extermination of many now existing.

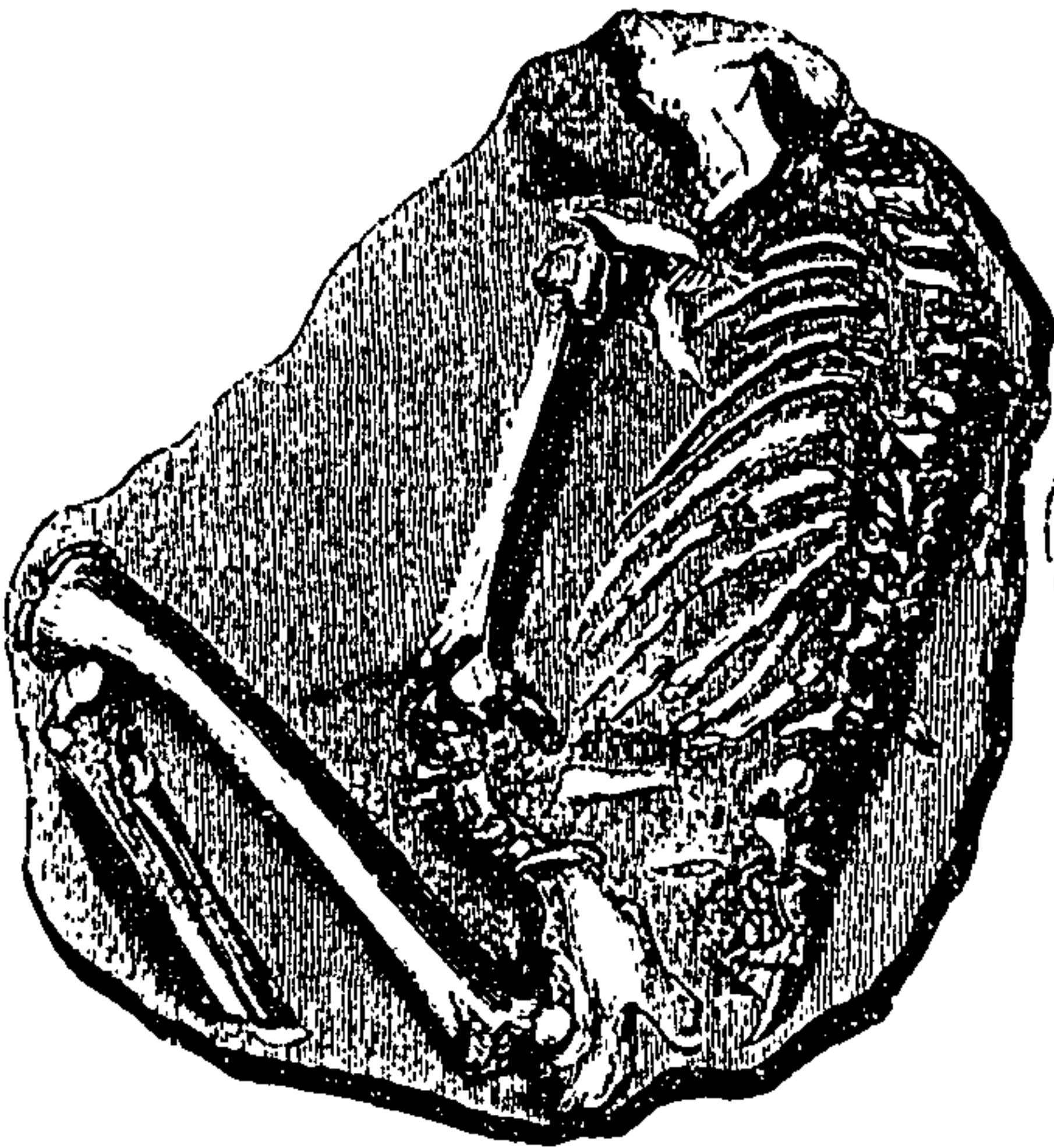
Man.—Some of the fossil relics of Man are skeletons or isolated bones,—stone arrow-heads and other implements,—pieces of wood, bone, or stone, hacked or otherwise marked with a tool,—pottery,—bronze implements,—coins,—engraved tablets of stone,—buried cities, such as Nineveh and Pompeii.

One of the most perfect of fossil skeletons found in solid rock is represented in fig. 845. It is from a shell limestone of modern origin, and now in progress, on the island of Guadaloupe. The specimen is in the Museum at Paris. The British Museum contains another from the same region, but wanting the head, which is in the collection of the Medical College at Charleston in South Carolina. They are the remains of Caribs killed in a fight with a neighboring tribe about two centuries since. In the county of Cork, Ireland, a skeleton was formerly obtained beneath a bed of peat eleven feet thick. Fig. 846 represents a ferruginous conglomerate

containing silver coins of the reign of Edward I. and some others, found at Tutbury, England. It was obtained at a depth of ten feet below the bed of the river Dove.

The earliest remains of Man and his art occur with the bones of extinct Post-tertiary animals, in the same conditions as the bones of the modern Mammals above mentioned. They are flint arrow-heads, stone axes, pieces of bone and wood cut or marked, and

Fig. 845.



Human skeleton from Guadalupe.

Fig. 846.



Conglomerate containing coins.

also some of the bones of skeletons. They have been found in England, France, Switzerland, and some other countries in Europe. The associated extinct animals include the *Elephant* (*E. primigenius*), *Rhinoceros* (*R. tichorinus*), *Irish Elk* (*Megaceros*), and *Cave Hyena*. The localities are bone-caverns and beds of alluvium. The facts appear to place it beyond doubt that Man began to exist before the extinction of the Post-tertiary races, as before stated.

Localities of human relics in stratified deposits.—(1.) Near Abbeville, France, in the valley of the Somme, at Menheecourt and elsewhere, first investigated by B. de Perthes.—The excavations occur in a bed of alluvium (stratified loam, sand, and gravel), situated about ninety feet above the valley; the layers apparently had not been disturbed since their formation under the action of fresh waters. Land-shells (*Helix*, *Pupa*, *Clausilia*) occur in the bed with the arrow-heads; and bones of the old *Elephant* were found in the overlying

sandy layer, and a nearly entire skeleton of a *Rhinoceros* in the inferior bed of gravel.

(2.) Near Amiens, at St. Acheul, and elsewhere in the same valley.—The beds are similar, and are situated eighty-nine feet above the bottom of the valley. Their thickness is twenty to thirty feet. The arrow-heads and hatchets are in gravel resting on chalk; and in the same deposits were found bones of the ancient *Elephant*, *Rhinoceros*, and *Hippopotamus*. Other localities of flint arrow-heads occur in the valley of the Seine near Châtillon-sur-Seine, and in that of the Oise, at Preey.

(3.) At Hoxne, England, five miles east of Diss.—Flint implements occur here in alluvium with land and fresh-water shells and some Mammalian bones,—part of them of extinct species; and it is probable that the deposits date back to the age of the Post-tertiary Mammals. The beds, according to Prestwich, are more recent than the “boulder-clay” of the Glacial period. The period, he observes, “was amongst the latest in geological time,—one apparently immediately anterior to the surface assuming its present form so far as it regards some of the minor features.”

Prestwich also remarks that “the evidence” from the occurrence of human relics with the bones of extinct animals, “as it at present stands, does not seem to me to necessitate the carrying of Man back in past time, so much as the bringing forward of the extinct animals towards our own time; my own previous opinion, founded on an independent study of the superficial drift or Pleistocene (Post-tertiary) deposits, having likewise been certainly in favor of this view.”

(4.) About several of the Swiss lakes there are the remains of “Lake-habitations,” in the shape of piles and platforms for their support, which are in view at occasional low stages of the water. In connection with the structures numerous human relics have been found, such as stone arrow-heads, lance-heads, axes, hammers, bone harpoons, bone arrow-heads, pieces of pottery, but nothing made of metal. According to Keller, 24 of these lake-habitations have been found on Lake Geneva, 26 on Lake Neufchatel, 16 on Lake Constance, 11 on Lake Bienné, besides many on the other lakes. Part, however, belong to the later or “Bronze age.”

Rutimeyer states that 66 species of vertebrate animals have been identified in connection with the earliest ruins,—10 of Fishes, 3 of Reptiles, 17 of Birds, and the rest (36) Mammals. Eight of the latter were probably domesticated,—the *Dog*, *Pig*, *Horse*, *Ass*, *Goat*, *Sheep*, and two species of *Oxen*; and among the rest occur bones of the *Aurochs* and *Bison*. As these two species were contemporaries of the ancient *Elephant*, it is possible, as Rutimeyer observes, that the structures date back to the earliest tribes of Men in Europe. Yet the absence of the remains of the *Elephant* and *Mastodon* seems to show that they belong to a later date than the deposits of Amiens.

Caverns.—Near Aray, in the Department of Aube, according to De Vibraye, a human jaw was found in the same bed which contained remains of *Rhinoceros* and the *Cave Bear* and *Hyena*. In Kent's Cavern near Torquay, England, there are flint arrow-heads; at Brixham, Devonshire, in the superficial stalagmite; and in one near Liege, explored by Schmerling. Other human relics, as fragments of rude pottery and bones, have been found with bones of the ancient Mammals; and they occur in each case in such connections as appear to show

that Man existed before the extermination of the Post-tertiary species. Lartet has described a cave near Auvignac in the vicinity of the Pyrenees (Department of Haute-Garonne), which contains human skeletons, and flint and bone or horn implements, along with fragments of bones or teeth of the *Cave Hyena*, *Cave Bear*, *Cave Felis*, *Fox*, *Wild Boar*, *Bison*, *Stag*, *Reindeer*, *Irish Elk*, and others. The bones are supposed to have been carried in by the human inhabitants, and the most of them were from their food. Many show that they had been split open to get out the marrow. Lartet remarks that the people must have been cotemporaries of the Rhinoceros, Hyena, and Gigantic Elk; and even of the Cave Bear, the species among the great Mammals of the Post-tertiary which was probably the earliest to disappear.

Near Palermo, Sicily, there is a cavern containing human relics, along with some remains of extinct animals.

In North America there are no known facts sufficiently well authenticated to be here repeated.

In some of the South American caverns Dr. Lund found human bones along with those of extinct species, and has published as his conclusion that the bones belonged to an ancient tribe which was coeval with some of the extinct Mammals.

As the implements among these early relics are all made of stone, the age in which they occur has been called the *Stone period* (or *Stone age*), in distinction from the later *Bronze* or *Archaic period*, and still later *Iron* or *Teutonic period*. But until Asia has been fully explored, and found to afford corresponding facts, the term should be regarded as belonging to European history rather than to that of the human race; and so also with all conclusions with regard to the characteristics of the earliest of mankind derived from the forms of bones or skulls. Geology here passes over the continuation of the history of Man to Archaeology.

The observations thus far made appear to accord with the view, already expressed, that in the Terrace epoch there occurred both the decline of the Post-tertiary races and the introduction of the modern tribes of Mammals, together with the creation of Man. Other animal tribes must have been at the same time replenished, especially those of Birds and Insects, which are terrestrial. Among fruits and flowers it is not improbable that many kinds were introduced that added both to the beauty and wealth of the finished world.

As Man was in the prospect through all the progressing changes of earlier time, it is not too much to say that in the final fitting up of the earth with life there was still a reference to him. If creation was the plan of a being of omniscience and wisdom, the end was in the beginning, and in each succeeding step.

In order to appreciate the distinctive features of the age of Man,

or of an age in any history, it is not right to look to its beginning, when the past and future are commingled and the progressing stages are obscured, but onward to a time when the past has faded and the age stands forth in its own true characters. Thus viewed, the Cenozoic and present eras stand widely apart. Both are, approximately, on the same broad foundation of the lower orders of life. But, while the former rises to an eminence in the size and ferocity of its higher brute races, the latter—with more adornment in its tribes, as we may believe, and less bulk by three-fourths in its largest animals, as we know,—with an assemblage of life stripped largely of the animal,—noted neither for Leviathan reptiles, like the meridian of the Mesozoic era, nor for great beasts of prey, like the Cenozoic—culminates in Man, with whom all is in harmony. It has its true affiliation not so much with the past as with the unending future.

Man of one species.—This oneness of species is sustained by the following considerations:—

(1.) The fact of an essential identity among men of all races in physical and mental characteristics.

(2.) The capability of an intermixture of races with continued fertile progeny. The inferior race in case of mixture with a superior may dwindle, the people becoming from their position discouraged, debased, and, in their poverty and superstition, an easy prey to disease; and it may possibly die out, as the weaker weeds disappear among the strong-growing grass: such decay is hence no evidence that there is a natural limit to the fertility of “mixed breeds,” as some have urged.

(3.) Among Mammals, the higher genera have few species, and the highest group next to Man, that of the Ourang-outang, contains only eight; and these eight belong to two genera,—*five* of them to the genus *Pithecus*, of the East Indies, and *three* to the higher genus *Troglodytes*, of Africa. Analogy requires that Man should here have pre-eminence. If more than one species be admitted, there is scarcely a limit to the number that may be made.

The investigations of Darwin on the variations of species, and other facts of like character, set aside objections to an origin from one stock arising from the diversities of the races.

These are some of the reasons for believing that Man stands alone—the one sole species—at the head of the kingdoms of life.

Origin on only one of the two great continents.—Among the higher Mammals no species is known to have existed originally within the tropics or temperate zones on both the oriental and occidental continents (the former including Europe, Asia, and Africa, the latter,

North and South America); and, more than this, species have a limited range on that particular continent to which they are confined.

The same species among the Monkeys—the tribe at the head of brute Mammals—in no instance occurs on both; nor even the same genus; nor even the same family; for the American type is that of the inferior *Platyrrhines*, while the African is that of the *Catarrhines* (p. 422), which most approach Man in their features and structure. This is only the highest of an extensive range of facts in Zoology sustaining the principle in view. If, therefore, Man is of one species, he should be restricted also to one continent in his origin.

Moreover, Man's capability of spreading to all lands, and of adaptation to all climates, renders creation in different localities over the globe eminently unnecessary and directly opposed to his own good. It would be doing for Man what Man could do of himself. It would be contracting the field of conquest before him in nature, thereby lessening his means and opportunities of development.

Origin on some part of the Oriental continent.—The Orient has always been the continent of Progress. From the close of the Palaeozoic its species of animal life have been three times as numerous as those of North America, and more varied in genera. In the early Tertiary its flora in the European portion had an Australian type, and there were Marsupials and Edentates there. In the middle and later Tertiary it represented recent North America in its flora. But from this condition it emerged to a higher grade. In the Post-tertiary it became the land of the Carnivores, while North America was the continent as distinctively of Herbivores,—an inferior type,—South America, of Edentates,—still lower,—Australia, of the lowest of quadrupeds,—the Marsupials. In the closing creations Australia remained Marsupial, though with dwindled forms; South America was still the land of Edentates, but of smaller species, and with inferior Carnivores and the inferior type of Monkeys or Quadrumana; North America, of Herbivores, also small compared with the Post-tertiary; while the Orient, besides its new Carnivores, received the highest of the Quadrumana. Thus the Orient had successively passed through the Australian and American stages, and, leaving the other continents behind, it stood in the forefront of progress. It is therefore in accordance with all past analogies that Man should have originated on some part of the great Orient; and no spot would seem to have been better fitted for Man's self-distribution and self-development than southwestern Asia,—the centre from

which the three grand continental divisions of Europe, Asia, and Africa radiate.

No creations since that of Man.—It is not known that any new species of plants or animals have appeared on the Earth since the creation of Man.

III. Changes of level on the Earth's surface.

Although the earth, in this its last age, has reached a state of comparative stability, changes of level in the land still take place. The movements are of two kinds:—

1. Secular, or movements progressing slowly by the century.
2. Paroxysmal,—taking place suddenly, in connection usually with earthquakes.

1. *Secular.*—The secular movements which have been observed are confined to the middle and higher temperate latitudes, and are evidently a continuation of the series which characterized the Post-tertiary period. In this and other dynamical changes the Post-tertiary and the age of Man have intimate relations. The movements of the former were directly anticipatory of the latter.

The coast of Sweden and Finland on the Baltic has been proved, by marks made under the direction of the Swedish government, to be slowly rising. The change is slight at Stockholm, but increases northward, and is felt even at the North Cape,—an extent north and south of one thousand miles. Lyell, in 1834, estimated the rise at Uddevalla at nearly or quite four feet in a century, and he made it still greater to the north. The fact of the slow elevation was first suspected a century and a half since. Here, then, is slow movement by the century, such as characterized the great changes of level in past ages.

Beds of recent shells are found along the coast at many places, at heights from 100 to 700 feet. Part of these may be of Post-tertiary date. Two miles north of Uddevalla, Lyell found barnacles on the rocks over 100 feet above the sea; and there are shell-beds at a height of 400 feet. The former at least belong probably to the present era. Southwest of Stockholm other beds of shells occur, and the same dwarfish species that now live in the partly-freshened waters of the Bothnian Gulf.

There are also near Stockholm proofs of a former subsidence since fishing-huts were built on the coast. A fishing-hut, having a rude fireplace within, was struck, in digging a canal, at a depth of sixty feet. It is a common belief that over southern Sweden a very slow subsidence is now in progress.

In Greenland a slow subsidence is taking place. For 600 miles from Disco Bay, near 69° N., to the Firth of Igaliko, $60^{\circ} 43'$, the coast has been sinking for four centuries past. Old buildings and islands have been submerged, and the Moravian settlers have had to put down new poles for their boats, and the old ones stand, Lyell observes, "as silent witnesses of the change."

On the North American coast south of Greenland, along the coasts from Labrador to New Jersey, it is supposed that similar changes are going on; though more investigation is required to establish fully the fact. G. H. Cook concludes from his observations that a slow elevation is in progress along the coast of New Jersey, Long Island, and Martha's Vineyard (*Am. Jour. Sci.* [2] xxiv. 341); and, according to A. Gesner, the land is rising at St. John's in New Brunswick; sinking at the island of Grand Manan; rising on the coast opposite, at Bathurst; sinking near the Bay of Fundy and Basin of Mines in Nova Scotia, except, perhaps, on the south side, and rising at Prince Edward's Island.

The Coral Islands of the Pacific are proofs of a great secular subsidence in that ocean. The line C C C (*Physiographic Chart*) between Pitcairn's Island and the Pelews divides coral islands from those not coral; over the area north of it to the Hawaiian Islands all the islands are atolls, excepting the Marquesas and three or four of the Carolines. If then the atolls, as will be shown on a future page, are registers of subsidence, a vast area has partaken in it,—measuring 6000 miles in length (a fourth of the earth's circumference) and 1000 to 2000 in breadth. Just south of the line there are extensive coral reefs; north of it the atolls are large, but they diminish towards the equator and disappear mostly north of it; and as the smaller atolls indicate the greater amount of subsidence, and the absence of islands still more, the line A A may be regarded as the axial line of this great Pacific subsidence. The amount of this subsidence may be inferred, from the soundings near some of the islands, to be at least 3000 feet. But as two hundred islands have disappeared, and it is probable that some among them were at least as high as the average of existing high islands, the whole subsidence cannot be less than 6000 feet. It is probable that this sinking began in the Post-tertiary period.

Since this subsidence ceased—for the wooded condition of the islands is proof of its having ceased—there have been several cases of isolated elevations. The following are some of the islands that have been elevated:—Oahu (Hawaiian Islands), 25 feet; Elizabeth Island, Paumotu Archipelago, 80 feet; Metia or Aurora, 250 feet; Atiu, Hervey Group, 12 feet; Mangaia, 300 feet; Rurutu, 150 feet;

Eua, Tonga Group, nearly 300; Vavau, 100; Savage Island, 100. Many others have been raised to a less amount.

2. *Parorysmal*.—The changes of level about Pozzuoli near Naples, at Cutch in the Delta of the Indus, and on the Chilian coast, South America, are noted examples of modern change of level. The first appears to have been gradual in its progress; but, if so, it is not properly secular in the sense in which that term is used. The cases at Cutch and in Chili were connected with earthquakes; the other is in the volcanic region of southern Italy.

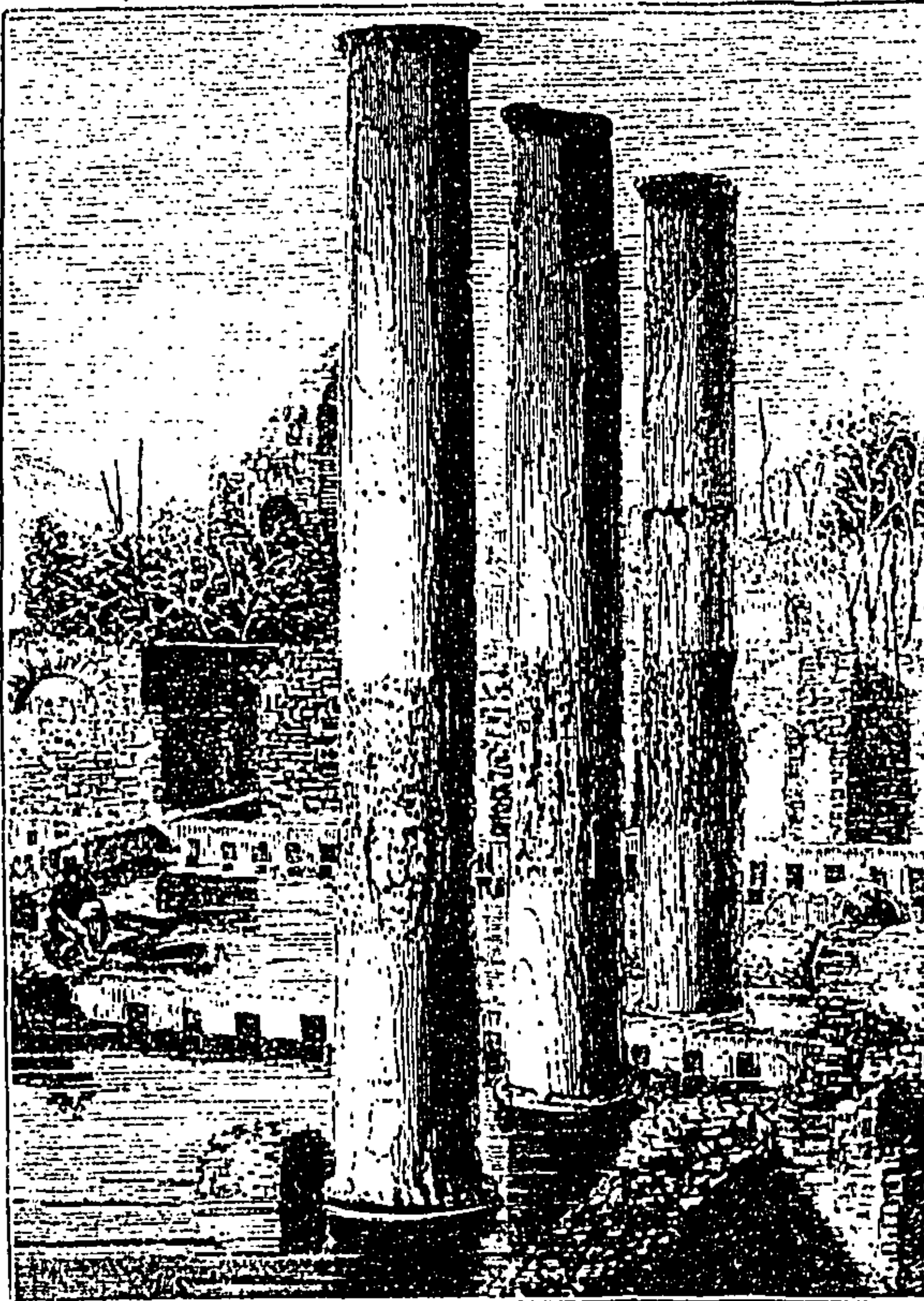
The temple of Jupiter Serapis at Pozzuoli was originally 134 feet long by 115 wide, and the roof was supported by forty-six columns each forty-two feet high and five in diameter. Three of the columns are now standing: they bear evidence, however, that they were once for a considerable time submerged to half their height. The lower twelve feet is smooth; for nine feet above this they are penetrated by lithodermous or boring shells, and remains of the shells (a species now living in the Mediterranean) were found in the holes. The columns when submerged were consequently buried in the mud of the bottom for twelve feet, and were then in water nine feet deep. The pavement of the temple is now submerged. Five feet below it there is a second pavement, proving that these oscillations had gone on before the temple was deserted by the Romans. It has been recently stated that for some time previous to 1845 a slow sinking had been going on, and since then there has been as gradual a rising.

At the earthquake in 1819 about the Delta of the Indus, an area of 2000 square miles became an inland sea, and the fort and village of Sindree sunk till the tops of the houses were just above the water. Five and a half miles from Sindree, parallel with this sunken area, a region was elevated ten feet above the delta, fifty miles long and in some parts ten broad. The natives, with reference to its origin, call it Ullah Bund, or Mound of God. In 1838 the fort of Sindree was still half buried in the sea; and during an earthquake in 1845 the Sindree Lake was turned into a salt marsh.

In 1822 the coast along by Concepcion and Valparaiso, for 1200 miles, was shaken by an earthquake; and it has been estimated that the coast at Valparaiso was raised three or four feet. In February, 1835, another earthquake was felt from Copiapo to Chili, and east beyond the Andes to Mendoza. Captain Fitzroy states that there was an elevation of four or five feet at Talcahuano, which was reduced by April to two or three feet. The south side of the island of Santa Maria, near by, was raised eight feet, and the north ten,

and beds of dead mussels were found on the rocks ten feet above high-water mark.

Fig. 847.



Temple of Jupiter Serapis.

Thus the earth, although in an important sense finished, is undergoing changes from paroxysmal movements and prolonged oscillations. The changes, while more restricted than in the ages of progress, are yet the same in kind.

COSMOGONY.

THE science of cosmogony treats of the history of creation.

Geology comprises that later portion of the history which is within the range of direct investigation, beginning with the rock-covered globe, and gathering only a few hints as to a previous state of igneous fluidity.

Through Astronomy our knowledge of this earlier state becomes less doubtful, and we even discover evidence of a period still more remote. Ascertaining thence that the sun of our system is in intense ignition, that the moon, the earth's satellite, was once a globe of fire, but is now cooled and covered with extinct craters, and that space is filled with burning suns,—and learning also from physical science that all heated bodies in space must have been losing heat through past time, the smallest most rapidly,—we safely conclude that the earth has passed through a stage of igneous fluidity.

Again, as to the remoter period: the forms of the nebulae and of other starry systems in the heavens, and the relations which subsist between the spheres in our own system, have been found to be such as would have resulted if the whole universe had been evolved from an original nebula or gaseous fluid. It is not necessary for the strength of this argument that any portion of the primal nebula should exist now at this late period in the history of the universe: it is only what might have been expected that the nebulae of the present heavens should be turning out to be clusters of stars. If, then, this nebular theory be true, the universe has been developed from a primal unit, and the earth is one of the individual orbs produced in the course of its evolution. Its history is in kind like that which has been deciphered with regard to the earth: it only carries the action of physical forces, under a sustaining and directing hand, further back in time.

The science also of Chemistry is aiding in the study of the earth's earliest development, and is preparing itself to write a history of the various changes which should have taken place among the elements from the first commencement of combination to the formation of the solid crust of our globe.

It is not proposed to enter either into chemical or astronomical

details in this place, but, supposing the nebular theory to be true, briefly to mention the great stages of progress in the history of the earth, or those successive periods which stand out prominently in time through the exhibition of some new idea in the grand system of progress. The views here offered, and the following on the cosmogony of the Bible, are essentially those brought out by Professor Guyot in his lectures.

Stages of progress.—These stages of progress are as follow:—

(1.) *The BEGINNING OF ACTIVITY IN MATTER.*—In such a beginning from matter in the state of a gaseous fluid the activity would be intense, and it would show itself at once by a manifestation of light, since light is a resultant of molecular activity. A flash of light through the universe would therefore be the first announcement of the work begun.

(2.) *The development of the EARTH.*—A dividing and subdividing of the original fluid going on would have evolved systems of various grades, and ultimately the orbs of space, among these the earth, an igneous sphere enveloped in vapors.†

(3.) *The production of the EARTH'S PHYSICAL FEATURES,*—by the outlining of the continents and oceans. The condensible vapors would have gradually settled upon the earth as cooling progressed.

(4.) *The introduction of LIFE under its simplest forms,*—as in the lowest of plants, and perhaps, also, of animals. As shown on page 396, the systems of structure characterizing the two kingdoms of nature, the *Radiate* of the Vegetable kingdom, and the *Radiate, Molluscan, Articulate, and Vertebrate* of the Animal, are not brought out in the simplest forms of life. The true *Zoic* era in history began later. As plants are primarily the food of animals, there is reason for believing that the idea of life was first expressed in a plant.

(5.) *The display of the SYSTEMS in the Kingdoms of Life,*—the exhibition of the four grand types under the Animal kingdom, being the predominant idea in this phase of progress.

(6.) *The introduction of the highest class of Vertebrates,*—that of the **MAMMALS** (the class to which **MAN** belongs),—viviparous species, which are eminent above all other Vertebrates for a quality prophetic of a high moral purpose,—that of suckling their young.

(7.) *The introduction of Man,*—the first being of moral and intellectual qualities, and one in whom the unity of nature has its full expression.

There is another great event in the Earth's history which has not yet been mentioned, because of a little uncertainty with regard to its exact place among the others. The event referred to is the first shining of the sun upon the earth. after the vapors which till

† See Edgar A. Mearns' "Cosmogony"

then had shrouded the sphere were mostly condensed. This must have preceded the introduction of the Animal system, since the sun is the grand source of activity throughout nature on the earth, and is essential to the existence of life, excepting its lowest forms. In the history of the globe which has been given on page 196, it has been shown that the outlining of the continents was one of the earliest events, dating even from the Azoic age; and it is probable, from the facts stated, that it preceded that clearing of the atmosphere which opened the sky to the earth. This would place the event between numbers 3 and 5, and, as the sun's light was not essential to the earliest of organisms, probably after number 4.

The order will, then, be—

- (1.) Activity begun,—light an immediate result.
- (2.) The earth made an independent sphere.
- (3.) Outlining of the land and water, determining the earth's general configuration.
- (4.) The idea of life expressed in the lowest plants, and afterwards, if not contemporaneously, in the lowest or systemless animals, or Protozoans.
- (5.) The energizing light of the sun shining on the earth,—an essential preliminary to the display of the systems of life.
- (6.) Introduction of the systems of life.
- (7.) Introduction of Mammals,—the highest order of Vertebrates,—the class afterwards to be dignified by including a being of moral and intellectual nature.
- (8.) Introduction of Man.

Cosmogony of the Bible.—There is one ancient document on cosmogony—that of the opening page of the Bible—which is not only admired for its sublimity, but is very generally believed to be of divine origin, and which, therefore, demands at least a brief consideration in this place.

In the first place, it may be observed that *this document, if true, is of divine origin.* For no human mind was witness of the events; and no such mind in the early age of the world, unless gifted with superhuman intelligence, could have contrived such a scheme;—would have placed the creation of the sun, the source of light to the earth, so long after the creation of light, even on the *fourth* day, and, what is equally singular, between the creation of plants and that of animals, when so important to both; and none could have reached to the depths of philosophy exhibited in the whole plan.

Again, *If divine, the account must bear marks of human imperfection, since it was communicated through man.* Ideas suggested to a human

mind by the Deity would take shape in that mind according to its range of knowledge, modes of thought, and use of language, unless it were at the same time supernaturally gifted with the profound knowledge and wisdom adequate to their conception; and even then they could not be intelligibly expressed, for want of words to represent them.

The central thought of each step in the Scripture cosmogony—for example, Light,—the dividing of the fluid earth from the fluid around it, individualizing the earth,—the arrangement of its land and water,—vegetation,—and so on—is brought out in the simple and natural style of a sublime intellect, wise for its times, but unversed in the depths of science which the future was to reveal. The idea of vegetation to such a one would be vegetation as he knew it; and so it is described. The idea of dividing the earth from the fluid around it would take the form of a dividing from the fluid above, in the imperfect conceptions of a mind unacquainted with the earth's sphericity and the true nature of the firmament,—especially as the event was beyond the reach of all ordinary thought.

Objections are often made to the word "day,"—as if its use limited the time of each of the six periods to a day of twenty-four hours. But in the course of the document this word "day" has various significations, and, among them, all that are common to it in ordinary language. These are—(1) The light,—“God called the light day,” v. 5; (2) the “evening and the morning” before the appearance of the sun; (3) the “evening and the morning” after the appearance of the sun; (4) the hours of light in the twenty-four hours (as well as the whole twenty-four hours), in verse 14; and (5) in the following chapter, at the commencement of another record of creation, the whole period of creation is called “a day.” The proper meaning of “evening and morning,” in a history of creation, is *beginning and completion*; and, in this sense, darkness before light is but a common metaphor.

A Deity working in creation like a day-laborer by earth-days of twenty-four hours, resting at night, is a belittling conception, and one probably never in the mind of the sacred penman. In the plan of an infinite God, centuries are required for the maturing of some of the plants with which the earth is adorned.

The order of events in the Scripture cosmogony corresponds essentially with that which has been given. There was first a void and formless earth: this was literally true of the “heavens and the earth,” if they were in the condition of a gaseous fluid. The succession is as follows:—

(1.) Light.

(2.) The dividing of the waters below from the waters above the earth (the word translated *waters* may mean *fluid*).

(3.) The dividing of the land and water on the earth.

(4.) Vegetation; which Moses, appreciating the philosophical characteristic of the new creation distinguishing it from previous inorganic substances, defines as that "which has seed in itself."

(5.) The sun, moon, and stars.

(6.) The lower animals, those that swarm in the waters, and the creeping and flying species of the land.

(7.) Beasts of prey ("creeping" here meaning "prowling").

(8.) Man.

In this succession, we observe not merely an order of events, like that deduced from science; there is a system in the arrangement, and a far-reaching prophecy, to which philosophy could not have attained, however instructed.

The account recognizes in creation two great eras of three days each,—an *Inorganic* and an *Organic*.

Each of these eras opens with the appearance of *light*: the *first*, light cosmical; the *second*, light from the sun for the special uses of the earth.

Each era ends in a "day" of two great works,—the two shown to be distinct by being severally pronounced "good." On the *third* "day," that closing the Inorganic era, there was first the *dividing of the land from the waters*, and afterwards the *creation of vegetation*, or the institution of a kingdom of life,—a work widely diverse from all preceding it in the era. So on the *sixth* "day," terminating the Organic era, there was first the *creation of Mammals*, and then a second far greater work, totally new in its grandest element, the *creation of Man*.

The arrangement is, then, as follows:—

1. *The Inorganic Era.*

1st Day.—LIGHT cosmical.

2d Day.—The earth divided from the fluid around it, or individualized.

3d Day.— { 1. Outlining of the land and water.
 { 2. Creation of vegetation.

2. *The Organic Era.*

4th Day.—LIGHT from the sun.

5th Day.—Creation of the lower orders of animals.

6th Day.— { 1. Creation of Mammals.
 { 2. Creation of Man.

In addition, the last day of each era included one work typical of the era, and another related to it in essential points, but also

prophetic of the future. Vegetation, while, for physical reasons, a part of the creation of the third day, was also prophetic of the future Organic era, in which the progress of life was the grand characteristic. The record thus accords with the fundamental principle in history that the characteristic of an age has its beginnings within the age preceding. So, again, Man, while like other Mammals in structure, even to the homologies of every bone and muscle, was endowed with a spiritual nature, which looked forward to another era, that of spiritual existence. The *seventh* "day," the day of rest from the work of creation, is man's period of preparation for that new existence; and it is to promote this special end that—in strict parallelism—the Sabbath follows man's six days of work.

The record in the Bible is, therefore, profoundly philosophical in the scheme of creation which it presents. It is both true and divine. It is a declaration of authorship, both of Creation and the Bible, on the first page of the sacred volume.

There can be no real conflict between the two Books of the GREAT AUTHOR. Both are revelations made by Him to man,—the *earlier* telling of God-made harmonies coming up from the deep past, and rising to their height when man appeared, the *later* teaching man's relations to his Maker, and speaking of loftier harmonies in the eternal future.

APPENDIX.

A.—Animal Kingdom (p. 147).

1. *Distinctions between Animals and Plants.*—Since the discovery that the spores (or seed-cells) of some Algae have locomotion like animalcules, and that there are unicellular locomotive plants (the Diatoms, etc.), some have thought that the two kingdoms of life blended together through their inferior species. But the fact is that they are diverse throughout,—the *opposite* but mutually dependent sides or parts of one system of life. The following are some of their distinctions:—

(1.) Plants excrete oxygen, a gas essential to animal life; animals excrete in respiration carbonic acid, a gas essential to vegetable life.

(2.) Plants take inorganic material as food, and turn it into organic; animals take this organic material thus prepared (plants), or other organic materials made from it (animals), finding no nutriment in inorganic matter.

(3.) Plants in passing from the unicellular state by growth *lose* in power, becoming usually fixed. Animals, in the same change, or in development from a germ, increase in power, augmenting in muscular force, and also, in the case of species above the lowest grade, in nervous force,—until an ant, for example, becomes a one-ant power, a horse a one-horse power; whence an animal is a self-propagating piece of machinery of various power according to the species.

(4.) The Vegetable kingdom is a provision for the storing away or magazing of force for the Animal kingdom. This force is acquired through the sun's influence or forces acting on the plant, and so promoting growth; mineral matter is thereby carried up to a higher grade of composition, that of starch, vegetable fibre, and sugar, and this is a state of concentrated or accumulated force. To this stored force animals go in order to carry forward their development; and, moreover, the grade of composition thus rises still higher to muscle and nerve (which contain nitrogen in addition to the constituents of the plant), and this is a magazing of force in a still more concentrated or condensed state. There are thus five states of stored force in nature,—three in *inorganic*, the solid, liquid, and gaseous; and two in *organic*, the vegetable and animal.*

The Animal type differs from the Vegetable (though not all animals from plants) in this: that, while the latter has the *superior-and-inferior* polarity of simple growth,—the stem growing upward and the root downward,—the former

* From a paper by the author on the "Anticipations of Man in Nature," published in the New Englander, May, 1859.