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1901

Ward's Natural Science Establish-
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Catalogue of the college
collection of palaentology

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CATALOGUE
OF THE
COLLEGE COLLECTION
OF
PALÆONTOLOGY,

WITH SHORT DESCRIPTIONS AND ILLUSTRATIONS.

BY

WARD'S NATURAL SCIENCE ESTABLISHMENT.

ROCHESTER, N. Y

1901.

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PREFACE.

Happily, the time is past when it is necessary to impress upon teachers of Geology the importance of natural objects in their work. All successful teachers recognize the desirability of studying objects instead of studying about them. An eminent geologist lately remarked, when postponing his college work until his burned collection could be replaced, "I have had too much experience to attempt teaching without material for illustration."

But while the desirability of geological material may be positive, the obtaining of a representative collection is difficult. Many teachers, skilled in the use of systematic collections, have neither the time nor opportunity requisite to bring together the objects required. The collecting and collating of geological material is a science in itself, and this work is our chosen field. A careful study and cultivation of the sources of supply, have enabled us, through many years of experience, and by collecting on a large scale, to reduce the cost of collections to a minimum. And it is with no little satisfaction that we call attention to the large systematic collections which we are able to supply at comparatively small cost. No individual could gather a single collection similar to the one described in the following pages without spending months of labor and a far greater amount of money than the price charged by us.

From a perusal of the following catalogue and geological summary, it will be seen that this collection in Palæontology covers the ground very evenly, both biologically and chronologically, from Plants up to Man, and from the Archæan to the present time. Especial care has been taken to select char-

acteristic types from the several geologic formations, and to give at the same time a comprehensive representation of all the classes of animal life. To accomplish this, and place the collection within pecuniary reach of those for whose benefit it was designed, we have made use of plaster copies of the more unique and rare forms,—originals of which it would be impossible in many cases to obtain, and in others too expensive. Moreover, for purposes of illustration, a carefully made copy of a perfect specimen is far better than a poor or fragmentary original. The greater number of forms among the invertebrates and plants we have been able to represent by carefully chosen original specimens, so that the originals in the collection far outnumber the casts in genera and species as well as in individual specimens.

It is believed that this series meets a felt want, and will prove an invaluable adjunct to lectures and text-books in unfolding the march of life through the successive ages. As has been observed, the series is a compend of Palæontological History, presenting in proper proportions the varied forms which life has assumed from the Archæan Protozoan up to Man. The dullest student can detect in this selection biological order and chronological sequence. It is intended to be a *complete cabinet* for the Geological Museum of our Colleges.

The specimens are adapted by their size and form for various positions in a collection. Most of them are suitable for the shelves of a museum; a few of the casts are large slabs, and intended for a place upon the walls, while a small minority are huge objects calculated to stand on pedestals in the central parts of the room. The *display* of this large Geological collection is one of its most noticeable and excellent features.

A clearly printed label accompanies each specimen, giving in full the name of the fossil, the author of the species, its geological formation, and the locality where it was found.

The numbers in brackets are the numbers of casts, as recorded at our Museum, and as published in the old "Cata-

logue of Casts." These numbers will be plainly marked on both the specimens and the labels accompanying them. In all cases where casts have been used, it is distinctly stated in the description; where it is not so stated, originals will be furnished.

Species of small size are usually represented by a number of specimens. The number may slightly vary, but will always be sufficient to fairly represent the species. These small specimens will be mounted on blocks, while many of the larger objects will be furnished with individual pedestals, as indicated in the illustrations.

Occasionally it may be necessary to substitute some allied form for the one listed; but care will be exercised not to thereby diminish the scope or interfere with the sequence of the collection.

In the matter of classification, we have considered it better for the purposes of this catalogue to be conservative and follow well-known authors rather than to always adopt the latest and, perhaps, the more scientific system. For the classification and group descriptions, and for general assistance in the publication of the work, we are indebted to Professor H. L. Fairchild, of the University of Rochester.

The whole collection, mounted and labeled as described above, will be carefully packed and delivered at the railway station in Rochester for the sum of \$1,200.

WARD'S NATURAL SCIENCE ESTABLISHMENT,

30-40 COLLEGE AVE., ROCHESTER, N. Y.

SUBKINGDOM

VERTEBRATA.

The five great Classes usually regarded as forming this province of the Animal Kingdom have a common type of structure, clearly recognizable in most members of the series. The most evident characteristic is an internal jointed skeleton, made up of vertebrae, which with their processes form two cavities—the upper (neural), enclosing the great nervous cord, the lower (hæmal or enteric), containing the viscera.

The history of Mammals, Birds, Reptiles, Amphibians and Fishes, as a sub-kingdom, reaches back to the Upper Silurian Age. Their fossil bones and teeth, have been found in every stage of alteration, from their natural state to that of complete petrification, and demonstrate the existence of numerous tribes of highly organized beings in the early ages of the world, and the continuance of the same general type of organization to the present day. The earliest vertebrate animals were the cold-blooded, water-breathing class in the Upper Silurian. The type, however, began with the generalized forms—the Ganoids and Sharks; the common bony fishes, now swarming in river, lake and ocean, not coming into existence until the Jurassic Period. Amphibians and Reptiles were introduced in the Carboniferous. In the Reptilian Age came the first Birds and the first Mammals, but the typical Birds and Mammals had their full expansion in the Tertiary.

CLASS MAMMALIA.

The fossil relics of this Class consist, for the most part, of single and displaced bones, or groups of bones, the teeth, and the hard products of the skin. It is for this reason, as Cuvier long ago remarked, that the determination of the remains of quadrupeds is beset with more difficulties than that of other fossils; for while shells are often found unbroken, and the skeletons or scaly coverings of fishes occur more or less entire, the complete skeleton of a fossil mammal is rare.

The earliest trace of mammals appears in the Upper Triassic—the *Microlestes*, a very small insectivore, and probably a marsupial, having been discovered in a bone-breccia at Diegerloch, Wirtemberg. Evidences of quadrupeds have been observed in American strata of nearly the same antiquity, such as the tooth of the *Dromatherium*, from North Carolina. The Jurassic of England has furnished twenty species, probably all marsupials or non-placental, for example, the *Amphitherium*, *Amphilestes*, *Phascolotherium* and *Stereognathus*, from the Stonesfield Slates; and *Spalacotherium*, *Triconodon* and *Plagiaulax*, from the Lower Purbeck beds. As yet the Cretaceous rocks have afforded no mammals, and a lapse of time incalculably vast intervened between the Jurassic mammals just mentioned and the *Arctocyon* and *Coryphodon*—the first examples of mammalian life in the Tertiary. From the Eocene to the present day, an extensive and varied mammalian fauna has existed, and left remains in the beds of ancient estuaries and rivers, in the “Lake-beds” of the Rocky Mountain region, in peat bogs, marl pits, and in caves, which served as lairs for predaceous species, and as charnel-houses to their prey. Under the hand of Cuvier the Eocene specimens became the opening chapter to the great volume of Palæontological Science.

ORDER PRIMATES.

SUBORDER BIMANA.

FAMILY HOMINIDÆ.

This family, which justly stands at the head of animated Nature, includes only one genus—*Homo*,—and but one well determined species—*sapiens*, or Man. He is the only animal truly bimanous and biped. In him the vertebrate type, which began during the Palæozoic age in the horizontal fish, finally becomes erect. He is the only living mammal having no diastema in the dental series of the jaw. But his most important anatomical feature is the great size and complexity of the brain; and his distinguishing zoological characteristic is the possession of speech.

The Palæontological history of Man, before it passes over to Archæology, is very brief. His creation must have been extremely modern, for his skeleton, more likely to become imbedded in lacustrine or submarine deposits than that of any other terrestrial vertebrate, is found only, and that rarely, in the most recent formations, in which nearly all the other fossil forms are referable to living species. Human implements in great number and variety are found in the "river drift" of the Post-Pliocene in all the northern continents. The oldest human bones, of undisputed age and character, have been found in "bone-caves."

No. 1. [1]* *Homo sapiens.*

SKULL (cast), discovered in 1857, in a limestone cave in Neanderthal, near Düsseldorf. This is the most famous of human relics, and probably no single fossil has created such a sensation in the scientific world. Over this cranium the anthropologists of Germany, France and England have waged a fierce debate. It is of unusual size and thickness, the forehead is very low and narrow, the brain-case being flattened to a degree unknown before, and the projection of the superorbital ridges (a character hitherto supposed to be peculiar to the highest apes) is enormously great. It is certainly the most ape-like of human skulls, and, in the language of the *Westminster Review*, it is "the ruin of a solitary arch in an enormous bridge which time has destroyed, and which may have connected the highest of animals with the lowest of men." Yet in capacity it is not inferior to the Negro, and it has no signs of the interparietal crest of the Gorilla. Professor King contends that it is specifically distinct from man, and lived in the last division of the glacial epoch; Professor Mayer says that it stood on the shoulders of a rickety Mongolian Cossack; while the conclusion of Huxley is that it belongs to a period antecedent to the time of the Celts in Germany, and was in all probability derived from one of the wild races of Northwestern Europe. The original specimen is now in the possession of Dr. Fuhlrott, of Elberfeld, Rhenish Prussia.

Size, 8 x 6.

No. 2. [2] *Homo sapiens.*

SKULL (cast), discovered in 1834 in the Engis cavern, near Liege, on the left bank of the Meuse. It exhibits the frontal, parietal and occipital regions, as far as the middle of the foramen, and a part of the right temporal bone. It was found in bone breccia, associated with the bones of extinct animals, and is of undoubted antiquity. It, however, approaches very near to the Caucasian type, while the Neanderthal skull, though having no such decided claims to antiquity, departs widely from the normal standard of the human race—the cerebral development falling as far below that of the Australian type as the latter is below the Engis. Of this skull Huxley says, "It is in fact a fair, average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage." The original is now in the museum of the University of Liege.

Size, 8 x 5.

*For explanation of bracket numbers see Introduction.

No. 3. [4] *Homo sapiens.*

SKELETON (cast), found on the north-eastern coast of the main-land of Guadeloupe, in a bed of modern concretionary limestone. The rock contains the detritus of shells and corals of the same species as now inhabit the neighboring sea (some of the coral still retaining the same red color now seen in reefs of living coral which surround the Island), land shells, fragments of pottery, stone arrowheads, carved wooden ornaments, and detached human bones. The parts preserved in this specimen are the spinal column, many of the ribs, the left arm, pelvis, thighs and legs. They are the remains of a Carib, who died in battle some two hundred years ago. These bones still contain some animal matter, and the whole of their phosphate of lime. The original is in the British Museum; the skull is in the Medical College of Charleston, S. C.

Size, 4 ft. 7 in x 2 ft.

SUBORDER QUADRUMANA.

These mammals, the most anthropoid of brutes, are characterized by prehensile feet as well as hands. In all the genera above the Lemurs of Madagascar and the American Monkeys, the same number and kinds of teeth are present as in Man—the deviation being the disproportionate size of the canines and the concomitant break (diastema) in the dental series. The skulls of the great Apes are distinguished by prominent superorbital ridges.

Cuvier held that the *Quadrumana* scarcely, if at all, preceded Man in order of creation. Lyell was the first (1830) to express a doubt of the total absence of fossil anthropomorphous tribes. In 1839 fragments of the lower jaw of a lemuroid monkey (*Cenopithecus*) were discovered by Owen in the Eocene, London Clay, on banks of the Deben, England. Since then, remains of true monkeys have been found in the Miocene strata of Southern France, and in the Pliocene of France, Greece, Brazil, and the Sewalik Hills, India. Lemurs have been discovered fossil in the Eocene lake-beds of Western America; and in the Miocene of Nebraska, at least one species of monkey, genus *Laopithecus*, has been found. But no Primates have been discovered in America later than the Miocene, and none at all of the anthropoid or Old World type.

No. 4. [1251] *Mesopithecus Pentelici*, Wagner.

HEAD (cast), on pedestal. This interesting fossil was discovered by M. Gaudry in the Pliocene deposit, near Pikermi, in Attica. The *Mesopithecus* was a small monkey allied to the Doucs, or ordinary long-tailed monkeys of the East, in the shape of its head, which is rounded, and in its limbs to the Wanderoo of Ceylon. The abundant remains (twenty-five individuals having been found at Pikermi) show that the animal lived in troops and indicate that Greece in Tertiary times was alive with curious monkeys. The original of this interesting specimen is in the Museum of the University of Munich.

No. 5. [5] *Dryopithecus Fontani*, Lartet.

LOWER JAW (cast), with pedestal. Of this extinct monkey, Sir Charles Lyell states "that in anatomical structure, as well as in stature, the *Dryopithecus* came nearer to man than any quadrumanous species, living or fossil, before known to zoölogists." Prof. Owen, however, arrives at a different conclusion; and the generally received opinion is, that it stood intermediate between the Gibbon and Semnopithecus. It was therefore far removed

from the human type, for the *Quadrumana* recede from man in the following order, making cranial character the test; Gorilla, Chimpanzee, Orang, Gibbon. The Canines are less developed than in the Gorilla, and in this respect the *Dryopithecus* makes a nearer approach to Man. The fore part of the coronoid process is slightly convex, as in the Gibbon; in Man, the Gorilla and Chimpanzee, it is concave. This interesting fossil was discovered by M. Fontan, in 1856, in the fresh water Miocene, at Saint Gaudens, Southern France, and is preserved in the Museum of the Garden of Plants, Paris.

ORDER CARNIVORA.

All the Carnivores have incisors, canines and molars—the canines being always longer than the other teeth, and showing at a glance the nature of their appointed food. The molars graduate from a trenchant (as in the Cat) to a tuberculate form (as in the Bear) in proportion as the food deviates from one strictly of flesh to one of a more miscellaneous kind. The more the animal feeds on living prey, the less numerous the molars. The *Felidæ* have $\frac{3}{2}$ premolars, and $\frac{1}{1}$ molars; the *Canidæ* and *Ursidæ* have $p \frac{4}{4}$, $m \frac{2}{3}$. Clavicles

are generally rudimentary or wanting. The feet have usually five toes, always armed with claws.

The carnivores were numerous in Eocene time, but they were generalized types, having marsupial affinities. The *Palaeocyon* from the Plastic clay of England and France, was one of the earliest progenitors of the digitigrades. A forerunner of the plantigrades was *Arctocyon* from the lower Eocene of France; other carnivores, large and small, occur in the Eocene lake-beds of Western America. Many of these early carnivores were of large size and fierce character. The true cats and the typical plantigrades probably were not differentiated until the Miocene. The amphibious carnivores (Seals) have not been found below the Miocene.

The fossil carnivores of Post-Tertiary time are found principally in caves and fissures.

No. 6. [6] *Machairodus neogæus*, Kaup.

HEAD (cast), mounted. This, happily extinct and most formidable of carnivores, belonged to a group of cats which in Tertiary and Quaternary times ranged throughout America, India and Europe. Professor Owen finds its nearest affinities in the Lion. It equaled the Bengal Tiger in size, and had upper canines of thrice the length—the crown alone measuring 7 inches. The canines of the *Machairodus* are, in fact, the most remarkable of all fossil teeth

of large carnivorous mammals that have been discovered; they are long, curved, and compressed, and, provided with a double-cutting edge of serrated enamel, resemble trenchant sabres, whence the generic name. There is a depression on the outside of each ramus of the lower jaw to receive the upper

canines when the mouth is closed. Both sets of teeth are finely preserved in the specimen. The species is identical with *Hyæna neogæa* of Lund, and *Felis smilodon* of Blainville. Some writers place it in the genus *Drepanodon*. Cope includes the nine species found in the Old World in the genus *Drepanodon*, Nesti, and the four American species, all Pliocene, in the genus *Smilodon*, Lund. The original of this specimen, discovered in a bone cavern in Brazil (Post-Pliocene), is in the Museum of the Garden of Plants, Paris.

Size, 14 x 13.

No. 7. [11] *Hyæna eximia*, Wagner.

LOWER JAW, LEFT RAMUS (cast). In Post-Tertiary times troops of gigantic Hyænas roamed over the whole continent of Europe, and especially in England, where the caves were evidently tenanted by successive generations. The floors of these caves were found, when first opened, to be strewn over, like a dog-kennel, with hundreds of teeth and splintered bones, evidently the remains of prey dragged in by these ferocious carnivores. The Kirkdale cavern contained, it is said, remains of some three hundred Hyænas, besides the abundant fragments of their prey.

This fragment, found in a Pleistocene formation at Pikermi, Greece, shows two incisors, two molars, and a canine. The original is in the University Museum, Munich.

6 x 2.

No. 8. [14] *Galecynus Œningensis*, Owen.

SKELETON (cast). This interesting and well preserved fossil rewarded the early geological pursuits (1828) of the distinguished author of the "Silurian System." The novel occurrence of an entire carnivorous quadruped regularly imbedded in stone, as well as some peculiarities in its anatomy, make this a singularly unique specimen. Von Meyer first proposed the name of *Canis palustris*, and M. de Blainville called it *Vulpes Œningensis*; but after careful examination, Professor Owen gave it an intermediate position between the Polecat and Dog. The first premolar is smaller, and the third and fourth larger, than in the Fox, and all the teeth are more closely set than in the genus *Canis*, though the dental formula is the same. The general breadth of the feet, in proportion to their length, is greater than in any canine species, and it is this robust character of the feet which indicate an affinity to the Viverrine group. The tail is longer in proportion than in the Dog, though not so long as in the Fox. The vertebræ number the same as those of the Fox. The fossil was discovered in the lacustrine beds, called "Molasse" (Miocene), at Œningen, near Constance, and is now in the British Museum.

Size, 3 ft. x 2 ft.

No. 9. [16] *Ursus spelæus*, Blumenbach.

SKULL (cast). This "Great Cave-Bear," as it is often called, was larger than the Grizzly Bear of the Rocky Mountains. It is distinguished by prominent frontal sinuses, a sudden sinking of the concave line leading forward to the nasal bones,

long, high pointed crests, narrow zygomas, a wide interval between the formidable canine and the first molar, the complicated crown of the latter, and the great breadth of the fourth molar. The little premolar situated just behind the canine in all living bears except the Grizzly, is always wanting; and the animal probably had but thirty teeth in all. The Brown Bear approaches nearest to the gigantic fossil in the peculiar serpentine line of the profile, and the Black Bear in the cranial crests. The Cave-bear ranged in the Pliocene and Post-Pliocene throughout England and Europe, and its remains are found intimately associated with those of Paleolithic man. This specimen was found in that great depository of osseous remains—the cave of Gailenreuth, Bavaria, and is preserved in the Museum of the Garden of Plants. Size, 20 x 13.

No. 10. *Ursus spelæus*, Blum.

PAIR OF MOLARS. From a cave at Blansko, Moravia.

No. 11. *Ursus spelæus*, Blum.

CANINE. From a cave at Blansko, Moravia.

ORDER CETACEA.

The members of this order, formed for life in the ocean, have, in many respects, the external appearance of fishes. By some authors they, with the *Sirenia*, are called "Mutilates" because their hind limbs are obliterated. The clavicle is wanting, and the pelvis is scarcely represented by two small rudimentary bones. The true whales are characterized by the extremely long bones of the face, and by the nasal bones forming the very highest part of the skull. Teeth are entirely wanting in the adult whalebone whales, but are present in the lower jaw of the sperm whales. They are all carnivorous. The caudal vertebræ differ from those of fishes in re-

taining the transverse processes. The cervical vertebræ are thin and sometimes united in living species. The true *Dolphin* has forty-seven sharp, conical, crooked teeth in each ramus, and are well represented in the Miocene.

The order is confined to the Tertiary and Recent Periods. The most numerous fossil relics (teeth and ear-bones) have been found in the Red Crag, England, but evidently washed out of Eocene strata. The *Balenidæ* appear in the Pliocene.

No. 12. [177] *Zeuglodon hydrarchus*, Carus.

SKULL (cast). This carnivorous whale typifies a distinct family, the only one having teeth implanted by two roots. Its teeth were first described by Scilla in 1747; in 1836 by Harlan under the name of *Basilosaurus* and *Squalodon*; and in 1839 by Owen, who first determined the mammalian and cetacean nature of the animal. When full grown, it was probably seventy feet in length. The skull is long and narrow; the nostril single and looking upward. It was discovered in a marl deposit of the "Jackson epoch" (Middle Eocene) in Claiborne, Alabama, and belongs to the Tylerian Museum at Haarlem.

Size, 35 x 13.

No. 13. [176] *Zeuglodon cetoides*, Owen.

TWO TEETH (cast). The jaws of the *Zeuglodon* are armed with teeth of two kinds, set wide apart; the anterior have subcompressed, conical, slightly recurved, sharp, pointed crowns, and are implanted by a single root; the posterior are larger, with more compressed and longitudinally extended crowns, and with both front and hind borders deeply notched or serrated. The crown is contracted from side to side in the middle of its base, so as to give its transverse section an hour-glass form. The root of the posterior teeth has two fangs. The mode of succession conforms to the general mammalian type more than any existing carnivorous Cetacean: i. e. the deciduous tooth is displaced and succeeded vertically by a second molar. These fossil teeth, one anterior, the other posterior, were found at the same locality as the preceding, and are now in the Anatomical Museum of Berlin.

Size, 6 x 4.

No. 14. [179] *Balænodon gibbosus*, Owen.

CETOTOLITE (cast). This fossil tympanic bone belongs to a large extinct whale, which probably, like some contemporary quadrupeds, retained characters which are embryonic and transitory in existing cetaceans. It was found in the Red Crag (Pliocene) of Suffolk, England; but as it is water-worn and rolled, was doubtless washed out of older strata. The original specimen belongs to the Ward Collection in the University of Rochester.

ORDER SIRENIA.

The Sirenians resemble the Cetaceans in form and mode of life. They are herbivorous and subsist on the vegetation of estuaries and rivers, sometimes crawling on shore to feed. Both jaws are armed with incisors, and molars with flat-ridged crowns, adapted for vegetable diet. The cervical vertebrae are not ankylosed as in the whale. The mammae are pectoral. There is much in the organization of the Sirenians which indicates an affinity with the Ungulates. They first appeared in the Eocene of Europe, and are found in the American Miocene of the Atlantic region. In the Miocene Period the Dugongs and Manatees were abundant and more widely distributed than now. Their fossil bones have the solid structure peculiar to the order. The genus *Rhytina* has only recently become extinct.

No. 15. [175] *Halitherium Schinzi*.

SKULL AND FEMUR (cast). This herbivorous animal, related to the Dugong, lived by the sea-shore and the mouths of rivers. Remains have been found in every deposit above the Calcaire Grossier (Middle Eocene). These specimens were discovered in the Miocene at Flonheim, Rhine Valley. Size, 8 x 8.

ORDER UNGULATA.

This is the most numerous and comprehensive order of larger mammals, both extinct and living, and includes the beasts formerly classed as Ruminants and Solidungula, and all those called Pachyderms, except the Proboscidiens.

The members of this order walk on the extremity of the toes,

which are protected or encased in a greatly expanded nail or hoof (ungula). This apparently superficial character is but one element in the structure of the ungulate foot, which structure is of the utmost value in tracing relationship of fossil mammals, and the study of it one of the most fascinating chapters in Comparative Anatomy.

The number of digits of full size never exceeds four, at least the first digit being always obliterated. As the limbs are used only for locomotion, never for prehension, clavicles are useless and therefore wanting. The molar teeth are massive, with broad crowns suited for grinding vegetable food, although the primitive species were probably omnivorous, like a few living forms. The brain is proportionately small and the food-canal unusually long.

The Ungulates were the most numerous and important mammals of Tertiary time, and those ancient species were the ancestors of the present specialized forms, the line of descent being clearly traced in some cases, especially in the horse, the most highly differentiated species.

The division of this order, proposed by Owen, into Perissodactyla (odd-toed), and Artiodactyla (even-toed), applies also to the extinct forms, which as early as the lowest Eocene were thus separated, notwithstanding their generalization in other respects. *Coryphodon*, found at the base of the Eocene in both Europe and America, having a small brain and five toes, possesses characters which point to the primitive ungulate type.

In the evolution of the present Ungulates there are two elements of special interest. The primitive ancestors of the order were probably omnivorous, like the existing pig, with tuberculated (*banodont*) molars. But the specialized forms, as the horse of the odd-toed, and the ruminants among even-toed, have developed molars better fitted for grinding, which have the enamel disposed on the effective surface in double crescents (*selenodont dentition*), whose convexity is turned inwards in the upper teeth and outwards in the lower. The other factor in the evolution was the relation of the small bones of the wrists and ankles to the surviving digits. In the loss of the side digits, and the enlargement of the central ones, it became necessary for the latter to either appropriate the carpal or tarsal bones belonging to the side digits, or for their own small bones to become properly enlarged. Nature employed both methods; but it has been shown by Kowalevsky, the Russian naturalist, that the first or appropriative method was the better, and that all the species in both sections in which the latter (inadaptive) plan occurred have become extinct.

The lacustrine deposits of the Rocky Mountain region have furnished great variety and numbers of Tertiary ungulates; which have been studied by Leidy, Cope and Marsh. They have found that all the existing genera of Perissodactyla, and the Deer, Camel and Hog families among Artiodactyla are true American types, and might have populated the Old World by migration.

SECTION A—PERISSODACTYLA.

These are the oldest and most abundant ungulates of the Eocene, and as a group are less specialized than the Artiodactyla, although the horse, in feet and teeth, is the most highly differentiated species. In all the living species the hind feet have an odd number (3 or 1) of toes, and the Tapir is the only one with an even number (4) on the fore feet. The axis of the limbs passes through the third digit. In living species there are never less than twenty-two dorso-lumbar vertebræ, and the femur has a third trochanter, and the horns, if present, are placed on the median line of the head, and are not supported on horn cores. In the extinct *Menodus* (*Titanotherium*) there are a pair of horn cores placed transversely. The stomach is simple and the cæcum large.

There are but three families now living, represented by the Horse, Rhinoceros and Tapir, but these are closely connected by numerous extinct forms. Cope enumerated (1883) one hundred and ninety-two species, of which nineteen are living. He regards his *Systemodon* and *Ectocion* as parent types.

FAMILY EQUIDÆ.

The complete pedigree of the Horse has been traced by Marsh, from the little *Eohippus*, of the lower Eocene, with four toes, and the rudiment of the first on the fore feet, and three on the hind feet, through seven intermediate genera of successive horizons in the Tertiary to the modern genus, *Equus*, in the upper Pliocene. *Miohippus*, from the upper Miocene, resembles *Anchitherium* Leidy, and *Protohippus* of the lower Pliocene most resembles *Hipparion*. Marsh finds some forty extinct species in this group. It is certain that the Horse originated in America, and roamed over both continents in Post-Tertiary time, and then for an unknown reason became extinct.

No. 16. *Equus fossilis*.

MOLAR. Remains of the fossil Horse have been found in the uppermost Tertiaries and the Quaternary of many parts of Europe and America. These remains are in the main molar and incisor teeth, which are usually noted under the name of *E. fossilis*, although some authors undertake to distinguish several species. This specimen is from the Quaternary beds of Piedmont, Italy.

No. 17. [83] *Hipparion elegans*, Christol.

LEFT HIND FOOT (cast). This little equine quadruped was tridactyl; for while the two splint-bones alone are retained in the Horse, Zebra and Ass, in the *Hipparion* they terminated in small digits and hoofs. Such a foot was better adapted for swampy soil, as it would not sink so deeply. The hoofs dangled behind like the spurious hoofs of the Ox. The *Hipparion* was the first transitional form discovered between the Eocene Perissodactyla and the modern Horse, and its discovery supplied a powerful argument for the development hypothesis. This specimen was found in the lower Pliocene at Cucurron, France, and belongs to the Museum of Natural History in Lyons. Size, 14 x 13.

No. 18. [85] *Anchitherium Bairdii*, Leidy.

SKULL AND LOWER JAW (cast). This old-toed Ungulate resembles the *Palæotherium* in its dental structure, but is very much like the Horse in its skeleton. The cranium has a short sagittal crest and a large, broad forehead; the skull is relatively shorter than that of the Horse; each jaw contains six incisors, two canines, and seven molars. It is near to *Miohippus*, Marsh. These remains were found in the Mauvaises Terres (Miocene), Nebraska, and are preserved in the Museum of the Academy of Natural Sciences, Philadelphia. Size, 6 x 4.

FAMILY PALÆOTHERIDÆ.

This group is closely related to the early members of the *Equidae*, and Cope includes here some of the supposed ancestors of the Horse. The family is entirely extinct since the Pliocene.

No. 19. [106] *Palæotherium crassum*, Cuvier.

HEAD (cast). The discovery of *Palæotherium*—one of the most characteristic mammals of the Tertiary Age—formed an epoch in the history of fossils, being one of those famous hoofed quadrupeds restored by Cuvier from their fossil remains in the quarries near Paris. The creature resembled the Tapir in the

shape of the head and the possession of a short proboscis; but it had only three toes on the forefoot, and the molars resembled in form those of the Rhinoceros. The canines were longer than the other teeth, and there were consequently vacancies in the series for the lodgment of the crowns of the canines when the mouth was shut. The three species are confined to the middle and upper Eocene and Oligocene of Europe. The fossil head, now in the Garden of Plants, was discovered in the Eocene Gypsum of Montmartre, Paris.

Size, 13 x 10.

No. 20. [111] *Palæotherium crassum*, Cuv.

LEFT HIND FOOT (cast). The *Palæotherium* had three toes before and behind, each terminated by a hoof, the middle one being the largest. This species had short, thick feet, and may have stood about thirty inches in height. It had the limbs of the modern Tapir, with one toe less on the fore-foot. This specimen is from the same locality and museum as the preceding.

Size, 13 x 5.

FAMILY RHINOCEROTIDÆ.

This family has many representatives and a long line of ancestry in the Tertiary. *Amynodon* from the upper Eocene of America is the earliest member of the family, of which there seem to have

been two branches. *Diceratherium* had a transverse pair of horns on the nasal bones. Several species are found in American Pliocene, but none later. The living species have three toes on each foot, and horns on the median line.

No. 21. [89] *Rhinoceros Platyrrhinus*, Falconer and Cautley.

SKULL (cast). This is one of the four new species brought to light by the researches of Falconer and Cautley, in that sepulchre of gigantic Mammals—the Pliocene deposits in the Sewalik Hills, India. This very perfectly preserved skull is now in the British Museum. Size, 30 x 18.

No. 22. [98] *Rhinoceros tichorhinus*, Cuv.

TWO MOLARS (cast). These specimens show the folding of the enamel and the resultant figure of the crown-surface in molars from the upper jaw. From the Diluvium in France. Originals in the Ward Museum, University of Rochester.

FAMILY TAPIRIDÆ.

This is another family of American origin. It began in the Eocene, and exists to-day in South America, and East India. They have three toes on the hind feet, with four on the fore feet, but the axis of the arm passes through the third digit. It is the most generalized type of living Perissodactyla.

No. 23. [102] *Tapirus Arvernensis*, Croiz. and Job.

PALATE AND JAW (cast). This extinct *Pachyderm* differed little from the *Tapir* of Sumatra. The molars show the same bilophodont or two-ridge type. The upper jaw, when full, contains seven molars, one canine, and three incisors. This specimen was found in the Pliocene of Auvergne, Central France, and is in the Garden of Plants. Size, 9 x 12.

FAMILY BRONTOTHERIDÆ (MENODONTIDÆ).

This family is found only in the upper Eocene and lower Miocene of the American lake-beds.

No. 24. [1255] *Menodus* (*Titanotherium*) *Proutii*, Leidy.

HEAD (cast). This creature was one of the largest of the strange Tertiary mammals found in the Lake-beds of the Rocky Mountain region. It was about the size of an elephant, but with shorter legs, its proportions resembling those of the *Rhinoceros*. The skull is large and elongated, being in some specimens three feet long. The maxillaries bear, in front of the orbits, a pair

of stout diverging protuberances, which doubtless indicate horns. The teeth are intermediate in character between those of *Palæotherium* and *Rhinoceros*, excepting the peculiar incisors which have tuberculate crowns, resembling the palatal teeth of fishes. It had no tusks and no proboscis, but probably a *Tapir*-like snout. The fore feet have four short stout toes, and the hind feet three.

These specimens are from the lower Miocene of the Black Hills, Dakota. Original in possession of Ward and Howell. Size, 20 x 26.

FAMILY LOPHIODONTIDÆ.

Cope enumerates fifty species in the *Lophiodontidæ*, all from the Eocene of America and Europe. They vary in size from that of a Rabbit to that of an Ox, and resemble most, among living animals, the Tapirs.

No. 25. [105] *Pliolophus vulpiceps*, Owen.

SKULL AND LOWER JAW (cast). This odd-toed, hoofed herbivore, stood intermediate between the Tapir and *Palæotherium*, and has some affinities to the Hog and Horse. The dentition is like that of nearly all Eocene quadrupeds, a type not exhibited by any later (?) or existing mammal, namely: three incisors, one canine, four premolars, and three molars in each ramus. Six species of this genus are known, five of them being from the American deposits. This interesting fossil was discovered in the London Clay (Eocene), of England, and is now in the British Museum.

SECTION B—ARTIODACTYLA.

In this section the digits are four or two in number, and the axis of the limb passes between the third and fourth, which make a symmetrical pair, and by their compressed form have suggested the term "cloven-footed." The femur has no third trochanter. The dorsal-lumbar vertebræ are usually nineteen. The true horns are in transverse pairs, with osseous "horn-cores." The antlers of the *Cervidæ* are themselves osseous, and deciduous, and are not regarded as "true horns." The stomach is complex and the cæcum small. The hornless species have usually long canines.

Among larger mammals, now living, this section is the most numerous, and is extensively represented in the Tertiary, beginning with the Eocene. The species were few in the Eocene and included no ruminants. The earliest were apparently the ancestors of the Hogs, as the *Eohyus* and *Helohyus*, and they had the tubercular (bunodont) dentition, which was common in the *Artiodactyla* through all the Tertiary, but is now found only in the Hogs and Hippopotami (non-ruminants).

The selenodont dentition is found in the upper Eocene, but a primitive or transitional form occurred in *Homacodon*, which lived in the middle Eocene, having a nearly continuous series of teeth, and the typical number, 44. *Eomeryx*, from the upper Eocene, is one of the earliest selenodonts, but the most pronounced selenodont of the Eocene is *Oromeryx*, perhaps a ruminant ancestor of the Deers.

The two plans of foot structure are found in the Tertiary with both kinds of dentition, but no species survive with the "inadaptive" plan.

The Camels and Llamas diverged from the primitive stock in the Eocene, and became in the Pliocene the most abundant of the larger animals, except the Horse family. The hollow-horned ruminants appeared in Europe in the Miocene, but have not been found in America earlier than the Pliocene.

The true Sheep, Goats, Giraffe, Hippopotamus, and Old World Suillines (*Sus*, *Porcus*, *Phacocharus*), have not been discovered in America.

FAMILY BOVIDÆ.

No. 26. [48] *Sivatherium giganteum*, Falc. and Caut.

SKULL (Male), (cast). This singular elephantoid Antelope exceeded the Rhinoceros in size, and had some affinity with the Giraffe. The head was very large, broad but short, and carried four horns; the first pair resembled those of the Cow, and was placed just between and above the orbits; behind these was the other pair, palmated and branching, like those of the Elk. The posterior part of the cranium was enormously developed and cellular as in the Elephant. The face was short; the eyes small and lateral; and the nasal bones were prolonged into a pointed arch, indicating a proboscis. The very inclined direction of the front of

the face, in relation to the trituran surface of the teeth, imparts a peculiar physiognomy. The animal must have had a compound stomach, though the teeth seem fitted for bruising and crushing the branches and twigs of trees. The enamel is rugosely furrowed, and the inner crescent presents sinuous plaited flexures. The fossil was discovered in the Valley of Markanda, among the Sewalik Hills of India (Pliocene), and is now in the British Museum.

Size, 21 x 20.

No. 27. [55] *Ovibus* (*Bootherium*) *bombifrons*, Leidy.

CRANIUM WITH HORN-CORES (cast). This ancient Musk-Ox is closely allied to the living species, and was doubtless cotemporary with the gigantic wild oxen of Europe. The specimen was found in the Pleistocene morasses of Big-bone Lick, Kentucky, and is in the Academy of Natural Sciences, Philadelphia.

Size, 18 x 12.

FAMILY CAMELIDÆ.

No. 28. [56] *Pœbrotherium Wilsonii*, Leidy.

SKULL AND LOWER JAW (cast). This specimen belonged to an individual just reaching adult age, of a species which was the earliest progenitor of the camel tribe. The ramus of the lower jaw is remarkable for its breadth and for the angular apophysis as in the Camel, Carnivores and most Rodents. The *Pœbrotherium* had all the incisors and premolars of the primitive ungulate. The original was discovered in 1847, in the Mauvaises Terres (Miocene or White River Group), Nebraska, and is preserved in the Academy of Natural Sciences, Philadelphia.

FAMILY CERVIDÆ.

No. 29 and 30. *Tarandus Rangifer* (Reindeer).

TEETH AND PORTIONS OF LEG BONES. This member of the Deer family, now existing in Arctic Regions, is found fossil in the Post-Tertiary of England and Europe, as far south as Southern France, and associated with Palæolithic man. The association is so intimate and the fossils so abundant that the term "Reindeer Period" has been applied by the European geologists to the portion of time represented by the deposits. These specimens are from a cave in La Dordogne, France.

FAMILY SUIDÆ.

The Suilline type, the most generalized of the Artiodactyla, and with bunodont dentition, began in America with *Eohyrus*, in lower Eocene, and has been abundant ever since, being now represented by the Peccaries. The true Hogs, as *Sus*, *Porcus* and *Phacochærus*, have not been found in America; nor the allied *Hippopotamus*.

No. 31. [63] *Sus scrofa*, Meyer.

SKULL (cast). The fossil remains of the true Hogs appear for the first time in beds of Middle Tertiary (Miocene) age, in the Valley of the Rhine. The fresh water beds (Pliocene) of Auvergne, and the bone caverns and peat bogs of a later date, in France and England, have furnished specimens very similar to or quite identical with the modern Hog. This species was cotemporary with the Mammoth, and cannot be distinguished from the Wild Boar. The fossil was found in a cave at St. Didier, France, and is now in the Museum of Natural History in Lyons.

Size, 16 x 7.

FAMILY HIPPOPOTAMIDÆ.

No. 32. [79] *Hippopotamus major*, Cuv.

LEFT HIND-FOOT (cast). From the Pliocene Tertiary beds of Auvergne. The *Hippopotamus major* had peculiarities in its dentition which distinguished it from the modern species, and it was also nearly twice as large.

The foot of the *Hippopotamus*, with its four functional toes is less specialized than that of the Hog, its living ally, which has the two lateral toes rudimental. The tarsus closely resembles that of the Hog, and has seven bones. The carpus has eight bones.

This foot is quite perfect in preservation.

Size, 1 ft. 9 in. x 11 in. On pedestal.

No. 33. [78] *Hippopotamus major*, Cuv.

RIGHT TUSK (cast). This tusk, from the right ramus of the lower jaw, is of a size which marks it as belonging to an animal much larger than any *Hippopotamus* of the present day. Size, following curve of tooth, 17 x 7.

No. 34. [77] *Hippopotamus*—

MOLAR (cast). The crown of the tooth is divided into two lobes by a wide transverse valley, and each lobe is subdivided by a narrow antero-posterior cleft into two half-cones with their flat sides next each other. Remains of this interesting genus of pachyderm animals have been found in England, and very widely distributed through both Europe and Africa. It does not seem, however, in either of these continents to have visited points as far to the north as did the *Rhinoceros*.

No. 35. [74] *Hexaprotodon Sivalensis*, Falc. and Caut.

SKULL AND FRAGMENT OF LOWER JAW (cast). This animal was essentially a *Hippopotamus*, with six incisors, instead of four, in each jaw. A specific distinction is the shortness of the face. These remains

were found in the Pliocene of the Sewalik Hills, India, and belong to the British Museum.

Size, 24 x 16.

FAMILY OREONTIDÆ.

No. 36. [57] *Oreodon Culbertsonii*, Leidy.

SKULL AND LOWER JAW (cast).

This remarkable ruminant ungulate constitutes one of the links necessary to fill up the wide gap between existing Ruminants and the extinct *Anoplotheria*. The form of the cranium proper approaches that of the Camel; but generally the skull bears most resemblance to the *Anoplotherium*.

It differs strikingly from the latter in the existence of post-orbital arches, in the greater size of the orbits, and in the presence of deep lachrymal depressions. The sagittal crest is prominent, and the forehead is convex. They had four well-developed toes on each foot, and forty-four teeth. The molars have a ruminant character. Canines and incisors exist in both jaws and form with the molars almost unbroken rows, the dentition appearing to characterize a ruminating Hog. This genus represents a family which is the earliest of the Selenodont Artiodactyla, and occurs in prodigious numbers from the Middle Miocene to close of Pliocene in America. This specimen was found in the Mauvaises Terres (Middle Miocene) of Nebraska, and is in the possession of Dr. Leidy.

Size, 8 x 5.

FAMILY ANOPLOTHERIDÆ.

No. 37. [59] *Anoplotherium commune*, Cuvier.

HEAD ON SLAB (cast). This two-toed Ruminant was about the size of a Fallow Deer. It had a long and strong tail, and was probably of aquatic habits. It was hornless, and had separate metatarsal bones. But it is chiefly remarkable for the completeness and regularity of its teeth. It has the typical

number, 44,—neither canine nor any other tooth rising above the general level, and the series is unbroken, a character now manifested only by Man. The grinding surface of the molars retains the transitory and embryonic structure of the ruminant type. It has some affinities with the Hog. The generic name has reference to the absence of tusks, long canines, horns and claws. This very perfectly preserved head is from the Eocene Gypsum Beds of Montmartre, Paris, and is now in the Garden of Plants. Size, 15 x 9.

ORDER PROBOSCIDIA.

The Proboscidians were formerly classed with the *Ungulata*, with which they have many affinities, particularly in their placentation, which, as recently discovered at the birth of an elephant in Philadelphia, 1880, is non-deciduate. In some peculiar anatomical features they approach the Rodents.

They embrace the largest of all living terrestrial creatures, and are characterized by a proboscis, incisor tusks, the absence of canines, a few large transversely ridged molars, and pentadactyl feet, indicated by the divisions of the hoof. The dorso-lumbar vertebrae number twenty-three, of which twenty bear ribs. The centra are extremely flattened.

The only living Proboscidians are two species of *Elephas*, *Indicus* and *Africanus*. The total number of teeth they develop is twenty-eight; the two permanent incisors or tusks being preceded by two deciduous ones. The persistent dentition of *Elephas* is, incisors $\frac{1}{1}$, canines $\frac{0}{0}$, grinders $\frac{6}{6}$ —26. *Mastodon* had the same, excepting sometimes the possession of lower incisor tusks, =26 or 28. *Dinotherium* had i $\frac{0}{1}$ c $\frac{0}{0}$ p $\frac{2}{2}$ m $\frac{3}{3}$ —22.

The molars of *Elephas* consist of vertical plates of dentine covered with enamel and solidified by cementum. Those of *Mastodon* had, as the name implies, nipple-shaped prominences or tubercles.

The molars of *Elephas* show a modification from those of the *Mastodon* similar to the change from the *Palæotherium* to the Horse. Occasionally a rudimentary molar is found in front, which makes the typical seven. Only the last three are true molars. These teeth are replaced horizontally, from behind forwards, and only one or a portion of two are in use at once. The other extreme is found in *Dinotherium*, where all the five molars are in use at once, and the milk molars are displaced vertically. The *Mastodon* exhibits a transitional form.

Three genera of the order are known, the still living *Elephas*, and the extinct *Mastodon* and *Dinotherium*. Some related forms like *Dinocrata* abounded in the Eocene. *Dinotherium* is found only in the Miocene and Pliocene of the Old World. The Elephants (*Mastodon* and *Elephas*) appear suddenly, without immediate ancestors, as far as discoveries now show. While *Dinotherium* is a generalized proboscidian, it may not be considered as in the line of descent of the Elephant. The Eocene and Miocene strata of America, Europe and India, are so well known that some other region seems more likely to supply the missing links.

Mastodon appeared in the Middle Miocene of Europe, and in Lower Pliocene of America. *Elephas* appeared in both continents somewhat later than *Mastodon*. Only in America did *Mastodon* linger through the Quaternary.

Elephas primigenius ("Mammoth") roamed over all the Arctic regions in the Post-tertiary, but the United States and Mexico were occupied by *E. Americanus*. The latter species is, however, regarded by many authorities as only a modification of the mammoth. Two species of *Elephas* have been named from South America.

Three species of *Dinotherium* have been named; some fourteen of *Elephas*, and twenty of *Mastodon*. The last two genera blend together by gradations of structure.

No. 38. [132] *Elephas primigenius*, Blum.

LOWER JAW, YOUNG (cast). This is the latest form of true Elephant which lived in a temperate latitude; the best known of all the fossil species, and the most highly specialized member of the order. The range of the animal was apparently between the 40th and 70th parallels of latitude; and its remains are found exclusively in Pleistocene deposits. The inhabitants of Siberia call it *Mammoth*, or subterranean Mole, believing that it lived under ground. It is not a little singular that Darwin found a theory held by the people of the Pampas that the *Mastodon* was a burrowing animal. The primeval Elephant greatly exceeded in size the living species. It had broader grinders; narrower, more numerous and close-set transverse plates and ridges; a more parallel position of the right and left sockets of the grinders; a greater length of the tusks; a larger and more

prominent tubercle of the lachrymal bone; and more angular and relatively shorter zygomatic processes. Moreover, the outer contour of one ramus meets that of the other at a more open angle. In the structure of the molars, this species comes nearer to the Indian Elephant than the African, the plates being disposed in nearly parallel lines. But the tusks have a bolder and more extensive curvature; some have been found which describe a circle, but the curve being oblique, they thus clear the head, and point outward, downward and backward. The cranium of the *Elephas primigenius* is elongated and the forehead concave. A lower molar can be distinguished from an upper one by the grinding surface being slightly concave in the direction of its longest diameter, that of the upper molar being in the same degree convex. Most of the molars of the New World Mammoth are characterized by thinner and more numerous plates than those of England, but the difference is not constant. The creature was covered with shaggy hair, so that it was fitted to live as near the pole as was compatible with the growth of hardy trees or shrubs, but the sterile region in Northern Siberia, where the remains occur so abundantly, undoubtedly had a warmer climate at the period when the Mammoth lived than at present. This very perfect specimen was disinterred from a Pleistocene deposit at Lippe, Rhenish Prussia, and is in the University Museum at Bonn, Rhine Valley.

Size, 12 x 12.

No. 39. [141] *Elephas primigenius*, Blum.

SIXTH UPPER MOLAR (cast). This unusually perfect and well preserved specimen shows well the distinctive structure of the Mammoth grinder, and the inclination of the plane of the triturating surface to the vertical lines of the enamel-plates, due to the oblique growth of the tooth from the alveolar socket.

The original, weighing fourteen pounds, was found in Siberia, and belongs to the Ward Collection in the University of Rochester.

Size, 11 x 8.

No. 40. [1258] *Mastodon giganteus*, Cuv.

SKULL, TUSKS AND JAW (cast). Mastodon remains were first discovered at Albany, N. Y., and described by Dr. Mather in the *Philosophical Transactions* for 1712. The first remains seen in Europe were found thirty years after, by Longueil, on the edge of a marsh near the Ohio River, and hence the French called the unknown creature, "the animal of the Ohio." Bones have since been found as high as 70° N. But they mainly frequented a more temperate zone; and we have no evidence that any species was specially fitted like the Mammoth to brave a cold climate. The remains occur chiefly in the United

States, Europe and India. Mastodons preceded the Elephants. They are distinguished from the Elephants by their less complex molars; flatter cranium; smaller development of the frontal air-cells, presenting a less intelligent appearance; more elongated body, but not much, if any, higher; and limbs proportionately shorter and stronger. The surface of the teeth, instead of being cleft into numerous thin plates, was divided into wedge shaped transverse ridges, and the summit of these were subdivided into small cones, more

or less resembling nipples, whence the name. When worn, the protuberances became truncated into a lozenge form. Bronn and Owen state that the Mastodon is characterized by lower incisors (tusks), and by molars which are replaced from back to front, excepting one or more milk-molars; while in the Elephant there are no inferior incisors, and *all* the molars are replaced in a horizontal direction. Falconer shows that these generic distinctions are neither absolute nor constant. He makes the Mastodons include all the elephantoid species which have the crowns of the molars comparatively simple and uniformly divided into two subequal divisions by a longitudinal cleft; the ridges limited to three or four in number, and invariably more or less concave across; the enamel thick (in some specimens three times as thick as in the Mammoth), and in conical or compressed points; and the valleys between the ridges deep and empty, or with but a sparing quantity of cement. The Elephants, on the other hand, include all the proboscidiens which have the crowns of the molars more complex, and usually wanting in a longitudinal line of division; the ridges more numerous and less definite, each being composed of a greater number of mammillary points, which are most elevated in the middle, ren

dering the ridges convex across; the processes of enamel thinner, higher, and more divided; and the deep narrow valleys entirely filled up with cement.

The lower molars of the Mastodon are narrower than the upper, and the grinding surface of the upper describe in their longitudinal direction a slight convexity, while the lower have a corresponding concavity. In the upper molars the inner range of tubercles are most worn; in the lower ones, the outer range. By these marks a detached grinder may be referred to the jaw and ramus supporting it.

The finest Mastodon skeleton is in the Warren Museum in Boston. It came from Orange Co., N. Y., the marshes of which locality have also yielded the greater number of remains, including the skeletons of the American Museum of Natural History at New York, and the University of New Jersey, at Princeton, N. J. The skeleton in the British Museum was found in Missouri. That of the Museum of Comparative Zoology at Cambridge, came from New Jersey, and the one in the State Cabinet of Natural History at Albany was from Cohoes, N. Y.

This, one of the largest elephantoid skulls that has ever been discovered, and known as the "Shawangunk Skull," was disinterred from a Post-Glacial fluviatile deposit in Orange County, N. Y. Size of Pedestal 6 ft. x 4 ft. 6 in.

No. 41. [155] *Mastodon giganteus*, Cuv.

SIXTH UPPER MOLAR (cast). This fine specimen was found at the celebrated locality of Big Bone Lick, Ky. (Pleistocene), and is now in the Ward Collection, University of Rochester. It shows in unusual perfection the cusps, the alveolar line, and the long, curved fangs of the tooth. The enamel is little worn, and is as bright as in the teeth of living animals. Size, 7 x 6.

No. 42. [159] *Mastodon longirostris*, Kaup.

LAST UPPER MOLAR, RIGHT RAMUS (cast). This long-snouted, narrow-toothed Mastodon, was the first of the genus, having been found by Kaup in the Middle Tertiary. It once roamed over that part of the earth now called England, France, Italy and Germany. This complex, mammalated molar is from the Middle Miocene, near Lyons, France, and is in the Museum of Natural History of that city. This specimen shows the appearance of the cusps of the tooth after the enamel has commenced to wear off from its upper surface. Size, 7 x 7.

No. 43. [112] *Dinotherium giganteum*, Kaup.

SKULL AND LOWER JAW (cast). This huge beast, though its teeth were discovered more than a century ago, has scarcely found a resting-place in the classification of animals. Cuvier called it a gigantic Tapir; DeBlainville and

Pictet considered it an aquatic] Herbivore, resembling the Dugong, and inhabiting the embouchures of great rivers; Kaup regarded it as intermediate between the Tapir and Mastodon, and truly terrestrial; while Owen says, that "in the general shape of the skull and aspect of the nostril, the *Dinotherium* most resembles the Manatee, but bones of the limb have been found so associated with teeth as to determine the *Dinotherium* to be a hoofed quadruped of probably aquatic habits, and transitional, as it would seem, between the large

Lophiodons and the huge Proboscideans." The scapula resembles that of a Mole. The skull is characterized by a very flat occipital bone (approximating in form the occiput of Cetacea), large nasal aperture opening above, and large suborbital fossæ, which, together with the form of the nose, seem to indicate the presence of a short proboscis. The enormous down-curving tusks are, in fact, two huge recurved incisors implanted in a prolongation of the symphysis of the lower jaw. They were retained in both sexes. "They were probably useful (says Ansted) as pickaxes, enabling the monster to dig for succulent vegetable food by day, while, perhaps, at night they could be attached like anchors to the banks of the river or lake in which the animal habitually dwelt." Cuvier and Kaup calculated that the *Dinotherium* must have attained the extraordinary length of eighteen feet. Its body, doubtless, resembled that of the Hippopotamus, being little raised above the ground, although the huge columns which formed its legs are supposed to have been nearly ten feet in length. Remains of this genus have been found in the Miocene and Pliocene deposits of Germany, France, Austria, Greece, India and Perim Island, associated with the Hippopotamus, Horse, Ox, Antelope, Ape, Hog, Dog, Wolf, Cat, Lamantin, Morse, Sea-Calf and Dolphin—all of extinct species. This magnificent fossil, the head of the *Dinotherium giganteum*, was discovered by Dr. Klipstein, near Eppelsheim, Rhine Valley, in a bed of Pliocene sand and marl, containing marine shells, and is now in the Museum at Darmstadt.

Size, 4 ft. 8 in. x 4 ft.

No. 44. [124] *Dinotherium giganteum*, Kaup.

SECOND UPPER MOLAR, LEFT RAMUS (cast). The two incisors of lower jaw excepted, the teeth of the *Dinotherium* are all molars, numbering five in each ramus, and belong to the two ridged type, as in the Tapir, *Megatherium*, Kangaroos and Manatee. This tooth, from the Upper Miocene at St. Jean le Vieux, France, is in the Lyons Museum.

ORDER RODENTIA.

This order contains the smallest of the mammals, and the largest number of species, and is represented in all quarters of the globe. It is characterized by two long, incurved rootless incisors in each jaw, enameled only in front, and separated by a wide space from the molars. The incisors are based on permanent pulp, and grow during life in order to compensate for the rapid wear. The molars have flat crowns with transverse enameled ridges. Canines are never present. The hind legs are generally much longer than the anterior pair; and, excepting the

Guinea-pig, Porcupine, Hare and Capybara, all have perfect clavicles. The skeleton is slight and feeble. The Beaver and Capybara are now the giants of the order; but the *Muride* are the typical family.

No unequivocal evidence has been obtained of remains of rodents in strata more ancient than the Eocene Tertiary, but they are frequent in the lowest fresh-water Eocene, belonging to the Squirrel family. The hares appear in the Middle Miocene. In the Pliocene most species belong to existing genera. The fossils are chiefly found in lacustrine marls and bone-caves.

No. 45. [21] *Castoroides Ohioensis*, Foster.

SKULL AND LOWER JAW, RIGHT RAMUS (cast). This species is the most gigantic member of the order of rodents hitherto discovered, whether, recent or fossil. It is akin to the Beaver, but differs chiefly in a less development of the cerebrum, in more prominent though more slender, zygomatic arches, and in its dentition. The incisors are fluted, and the molars (numbering four in each ramus) consist of a series of elongated elliptical plates of enamel which include the dentine. The *Castoroides* differs from all other rodents in the size and conformation of the pterygoid processes and fossæ. All the processes and fossæ of the lower jaw are remarkably developed. The genus abounded in North America throughout the Post-tertiary. The original specimen, supposed to belong to an animal nearly six feet in length, was found in 1841, in the Montezuma Marsh, near Clyde, N. Y., with shells of existing species, and is preserved in the Cabinet of Geneva College, N. Y.

Size, 10 x 7.

ORDER EDENTATA.

The Edentates, the lowest of the placental mammals, are distinguished by the inferior character of their teeth, which have no complete roots, no true enamel, and are usually monophydont (without successors). There are no incisors, with the exception that in the Armadillo the front pair of upper teeth enroach upon the intermaxillary bones, and assume the position of lateral incisors. Two genera have no teeth at all, the Ant-eater (*Myrmecophaga*) and the Pangolin (*Manis*), while the Armadillos

exhibit the dental inferiority by multiplication of the simple molars, which in the Great Armadillo (*Dasypus gigas*) reaches the number one hundred. Excepting the Sloths, the order is carnivorous. The order is limited in number of species, and forms a very small proportion of living mammals.

There are two groups of this order, the product of two lines of descent. The Old World group contains the Aard Varks (*Orycteropus*) of Africa, and the Pangolins (*Manis*) of Africa and Asia. A gigantic ancestor of the latter is the *Macrotherium* of the European Miocene. The New World group consists of the Sloths, the Armadillos and the Ant-eaters. No fossil Edentates have been surely found in the Eocene, but the Miocene and Pliocene of the Western States have yielded remains of huge forms, *Moropus* and *Morotherium*, for example. The order was well represented in the Post-pliocene of the Southern States, but culminated in the numerous gigantic species of the Post-pliocene of South America, which continent is the present home of the greatly reduced order. The fact of no Tertiary Edentates in South America would indicate that the order populated that continent, where it found a more congenial home, by migration from North America.

No. 46. [26] *Megatherium Cuvieri*, Desmarest.

TOOTH (cast). The gigantic fossil represented by this specimen was first made known to the scientific world in 1789. Its skeleton was discovered in the Pampean (Pleistocene) deposit, on the banks of the Luxan, near the city of Buenos Ayres. Transmitted to Madrid, it was for more than half a century a problem in comparative anatomy, which the *savans* of Europe could not solve. The merit of finally assigning a true position to this remarkable fossil belongs to the celebrated English Geologist, Professor Owen. He conclusively proved that the *Megatherium* was a "Ground Sloth," and fed on the foliage of trees, uprooting them by its great strength, or pulling down the branches with its formidable fore-arms, resting on its hind-legs and tail as on a tripod. The mounted skeleton of the *Megatherium* measures about 18 feet. It had 18 teeth, all molars and in structure like those of the living Sloth. They were long, square, slightly curved prisms with wedge-like crowns, and consisted of dentine enclosed by a wall of cement. The original of this tooth belongs to the British Museum.

Size, 7 x 2.

No. 47. [32] *Megatherium Cuvieri*, Desm.

FORE-CLAW (cast). In no respect does the *Megatherium* differ more strikingly from existing quadrupeds of corresponding bulk than in the vast proportions of its fore-arms. They were furnished with prehensile feet having five toes—the 2d, 3d and 4th of which were armed with claws.

This specimen, representing the last phalanx and the core of the claw, is from the same locality and museum as the last.

Size, 11 x 6.

No. 48. [35] *Megalonyx Jeffersonii*, Harlan.

TWO CLAWS (cast). The remains of this huge terrestrial Sloth, so called from the great size of its claw, are found chiefly in the Upper Tertiary of Virginia, Tennessee, Kentucky, Mississippi, Alabama and Texas. The genus was established by President JEFFERSON in a communication read to the American Philosophical

Society, 1797, entitled "*A Memoir on the Discovery of certain Bones of a Quadruped of the clawed kind in the Western Parts of Virginia.*" The *Megalonyx* resembled the *Megatherium* in general form and habits, but was a third smaller. The originals were found in a cave in Greenbrier county, West Virginia. Size, 7 x 4.

No. 49. [36] *Glyptodon (Schistopleurum) typus*, Nodot.

CARAPACE, HEAD, TAIL AND HIND-LEG (cast). This gigantic fossil edentate was a representative in Pleistocene times of the Armadillos of South America. It was furnished with a huge carapace or coat of mail, formed of hexagonal plates united by sutures, and constituting an impenetrable covering for the upper part of the body and part of the tail. The carapace differs from that of modern Armadillos in having no greaves or joints, for the purpose of contracting or rolling up its body. The head was defended by a tessellated bony casque. The tail possessed an independent dorsal sheath or cuirass made up of very prominent tubercles disposed in distinct whorls. This arrangement of the component parts of the sheath permitted a slight flexibility, and made the tail a formidable weapon. The bones of the leg and foot were perfectly adapted to bear the steady pressure of this enormous weight. The latter is admirably contrived to form the base of a column, and at the same time to allow a degree of motion required for the scratching and digging operations of dasypoid animals. It is pentadactylous, four of the digits being furnished

No. 49. [36] Glyptodon (Schistopleurum) typus, Nodot.

with long flattened nails, similar to those of the Elephant. The teeth, numbering eight on each side of each jaw, are sculptured laterally by two wide and deep channels, which divide the grinding surface into three portions. The generic name is derived from the fluting of the molars. The lower jaw is of singular shape, its angle being elevated to a level with the grinding surface of the teeth. But the most remarkable characteristic of the skull is the long, strong process descending from the base of the zygomatic process. The animal measured from snout to the end of the tail, following the curve of the back, eleven feet; the tessellated trunk armor being six feet eight inches in length and nine feet across. The Glyptodons do not appear to have emigrated from the central regions of South America, but formed a local fauna of the highest interest, which is now only faintly represented by the living Armadillos. The carapace of these edentates probably weighed more than a thousand pounds. The original was found in 1846, near Montevideo, on the banks of the Luxan. It was presented by order of the Dictator Rosas to Vice-Admiral Dupotet, who gave it to the Museum of his native city—Dijon, France, where it is still preserved.

ORDER MARSUPIALIA.

(NON-PLACENTAL MAMMALS).

The Marsupials possess a peculiar feature which places them lowest in the mammalian series. This feature is the premature production of their young, which are matured in a pouch, supported by two peculiar bones attached to the pubis. These characteristic bones are found in all marsupials—male as well as female, except the *Thylacinus*. The order presents a remarkable diversity of structure, there being herbivorous, carnivorous and insectivorous species, suggesting many of the higher orders of mammals. In the herbivorous species, the canines are usually wanting. With the exception of the opossums (*Didelphidæ*), of which twenty species are found in North and South America, marsupials are now confined to Australia, Tasmania, and New Guinea, and some adjacent islands.

Marsupials were the first of mammals—the *Microlestes* having been discovered between the Lias and Keuper Sandstone near Stuttgart, while the *Dromatherium* was found in the Upper Triassic coal-field of North Carolina. They are also found in the Jurassic of both hemispheres. None have been found in cretaceous strata, but they again occur in the Eocene, and then disappear from Europe. The American Eocene forms, as well as the Post-tertiary ones from the caves of South America, are related to the Opossums.

No. 50. [181] *Diprotodon Australis*, Owen.

SKULL AND LOWER JAW (cast). This gigantic Kangaroo—nearly equaling the Hippopotamus in size—was discovered in the Pleistocene beds at Darling Downs, Australia. While retaining the dental formula of its living homologue, it shows remarkable modifications of its limbs. The hind limbs were shorter and stronger, and the front limbs were longer and stronger than those

of living Kangaroos; yet the ulna and radius were so articulated as to give the forepaw the rotatory action. The dental formula was $i \frac{3}{3}, c \frac{0}{0}, p \frac{1}{1}, m \frac{4}{4}=28$. The front upper incisors were very large and scalpriform, as in the Wombat; the premolars were soon shed; and the molars had two ridges disposed as in the Tapir and Kangaroo, but more compressed and prominent. The *Diprotodon*, in this last respect, approached the pachyderms, furnishing, says Pictet, a new proof of parallelism existing between the monodelphs and didelphs. The original of this fine specimen is in the British Museum. A part of the right lower ramus is wanting. Size, 3 ft. 5 in. x 1 ft. 10 in.

CLASS AVES.

Existing Birds are, perhaps, the most distinct class of animals, their superficial characters being so evident and peculiar that their identity is always clear, even to the most unscientific person. They seem to form a "closed" group. However, their reptilian affinities are numerous and important, and the palæontological discoveries of recent years have bridged the gap between the living reptiles and birds, and leave no doubt that birds are a highly specialized branch of the reptilian trunk.

The oldest known bird is the *Archæopteryx*, in the Jurassic. It is very reptilian, as shown by the possession of teeth, finger claws, and a long series of caudal vertebrae.

Professor Marsh has described another Jurassic bird, *Laopteryx priscus*, from the Atlantosaur beds of Wyoming Territory. It was somewhat larger than the Blue Heron, and probably had teeth and biconcave vertebrae.

The *Odontornithes*, of Marsh, from the Cretaceous of Kansas are very remarkable birds. *Ichthyornis* is the type of an order having teeth in distinct sockets, in long slender jaws, and with vertebrae bi-concave. It was the size of a pigeon, aquatic, with power of flight. The *Hesperornis regalis* is the only representative yet found of a quite different type, being wingless, aquatic, and with teeth in a groove. It was six feet long. Marsh calls it a "carnivorous swimming ostrich." The cretaceous beds of the Atlantic coast have supplied other species of birds. Altogether twenty species are known from American Cretaceous, and two from Europe.

All the known Jurassic birds are land birds, while all the Cretaceous ones are aquatic; and the four oldest (*Archæopteryx*, *Laopteryx*, *Hesperornis*, *Ichthyornis*), differ more widely than any two existing birds. (Marsh).

The remains of Tertiary birds are numerous, and chiefly belong to surviving groups.

Most extraordinary additions to the palæontology of this class have been obtained from New Zealand—an island remarkable for possessing but one indigenous land-mammal, and but a few diminutive reptiles. Colossal birds, ranging from three to ten feet in height, akin to the ostrich, but tridactyl and tetradactyl, have left remains in the recent Alluvium.

No. 51. [1278] *Archæopteryx macrura*, Owen.

SKELETON (cast). This, the earliest specimen of bird remains, was found in 1861 in the Jurassic lithographic limestone at Solenhofen, Germany. It is of the greatest interest, not only on account of its great antiquity, but because of its remarkable reptilian character. In the general construction of the skeleton, the structure of the legs and feet, and in the possession of feathers, the *Archæopteryx* was distinctively avian; but it had the long jointed tail, separate fingers and toothed jaws of a reptile.

The creature was about the size of a crow. The tail, instead of consisting of some seven shortened vertebrae, with radiating feathers, had twenty movable vertebrae, with a pair of feathers for each joint, and exceeded the body in length. The

hand of living birds consist of three digits, the first one, or thumb, being distinct, the second and third being consolidated, and all being used to support the feathers. The hand of the *Archæopteryx* had three digits, all of them being free and bearing claws. The teeth were conical, and probably borne in sockets in the elongated jaws. The vertebrae were bi-concave. (Marsh).

Another specimen of this species was found in 1877, in the same strata, and is preserved in the Berlin Museum. A fragment of another is in the possession of the Museum of the University of Munich. The original of the specimen is in the British Museum.

Size, 18 x 24.

No. 52. [1277] *Odontopteryx toliapicus*, Owen.

PORTION OF HEAD (cast). From the London clay of the Isle of Sheppey (Lower Eocene). In this early bird the dentition is intermediate between the reptilian toothed birds of the Jurassic and Cretaceous, and the differentiated species now existing, consisting only of

serrations of the bony edges of the beak. Original in the British Museum.

No. 53. *Dinornis (Meionornis) casuarinus*, Owen.

FEMUR, TIBIA AND TARSO-METATARSUS. This genus of strange gigantic birds was founded by Owen in 1839, upon a fragment of a femur, brought from New Zealand. The form of this bone, and its peculiar cancellated inner structure, led him to refer it to the order Cursores, and to the family of *Struthi-*

onida. He ventured, upon the suggestion of this fragment alone, to assert that there had existed in New Zealand "a struthious bird, nearly if not equal in size to the ostrich." Subsequent discoveries have abundantly confirmed this induction of the great English anatomist. Many hundreds of bones have since been found in the alluvium beds along the shores of New Zealand, and every part of the colossal bird is now known.

In 1875, Dr. Haast, Director of the Canterbury Museum, proposed two families, with two genera in each family, thus:—Family *Dinornithidæ*: (a) genus *Dinornis*; (b) genus *Meionornis*, and family *Palapterygidæ*: (a) genus *Palapteryx*; (b) genus *Euryapteryx*.

Under these four genera, as proposed by Dr. Haast, there have been about twenty species described. These species are founded mainly on the size and proportion of the bones—particularly the bones of the leg, and it is not improbable that as more careful comparisons are made of larger series of bones, the number of species will be reduced. It is an interesting fact that Cook's Straits, which separates the two islands, "seems to have been an effectual bar to any migration from one island to the other, as the same species are not found on both islands. Moa is the common name applied to these great wingless birds from New Zealand. They had the general proportions—long, stout legs, heavy, rounded body, and long neck—of the Ostrich or Emeu. Like this latter they had three toes. The smallest species was no larger than the Emeu, while the largest species (*Dinornis giganteus*), attained a height of over ten feet and must have been able to stretch to a height of fourteen feet.

Portions of dried skin and a few feathers of the Moa have been found; the color of the barbs of the feathers are chestnut red and the rounded portion of the tip is white. These feathers, according to Capt. Hatton, show the bird to have been more nearly allied to the American Rhea and Emeu than to any of the struthious birds of the old world.

No. 54. [1276] *Dinornis* ———, Owen.

EGG (cast). Fragments of Moa eggs are quite numerous, particularly in the kitchen middens of the Moa-hunters, and a few nearly or quite perfect specimens have been found. Dr. Hector describes one 8.9x6.1 inches in diameter, which contained the remains of an embryonic chick. Another specimen measured 9.5 inches long.

These are certainly monstrous eggs, and yet the fossil bird of Madagascar (*Epiornis*), although no larger bird than the great *Dinornis*, laid a much larger egg, two specimens of which are in the Garden of Plants, Paris, and measure respectively 13x9 and 12x10 inches in diameter. And yet, after all, neither of these birds laid as large an egg in comparison to its size as does the *Apteryx* at the present day.

According to Owen "the Cuckoo lays the smallest egg in proportion to its size, the *Apteryx* the largest: in this species it weighs 14½ ozs.; the entire bird, 60 ozs.; so that the egg is nearly equal to one-fourth of the parent."

No. 55. [186] *Æpiornis maximus*, St. Hilaire.

EGG AND TARSO-METATARSUS (cast). These remains indicate a three-toed, cursorial bird, which must have stood twelve feet high. They were discovered in 1850, in Madagascar, in alluvial banks of streams, and belong to the Garden of Plants. Size of the tarso-metatarsus, 8 x 5; of the egg, 13 x 9. One of these eggs is equal to 148 hen's eggs, and will hold two gallons of water, and are the largest known birds eggs.

No. 56. [184] *Didus ineptus*.

HEAD (cast). The Dodo has been extirpated and become one of the extinct fossil forms within the last 150 years. At the beginning of the seventeenth century it abounded in Mauritius and adjacent islands. One was exhibited alive in London in 1638, as a great curiosity. Now

the only known relics that remain are the head and foot of an individual in the Ashmolean Museum, Oxford, England, the leg of another in the British Museum, and a skull in the Royal Museum at Copenhagen. It was an aberrant form of the Pigeon family (*Columbæ*), as determined by the researches of Reinhardt, Strickland and Melville. As the Greenland whale may be called a permanent suckling, the teeth never penetrating the gums, though in youth they are distinctly traceable in the dental groove of the jaws; as the Proteus is a permanent tadpole, so the Dodo was a permanent nestling, clothed with down instead of feathers, and with the wings and tail so short and feeble as to be utterly insufficient for flight. We cannot form a better idea of it than by imagining a young duck or gosling enlarged to the dimensions of a swan. It was at first believed to belong to the ostrich tribe, and Professor Owen placed it among the vultures. It had a strong, predaceous bill, hooked at the tip, and the face was covered with naked skin. The nearest living approach to the Dodo is the *Didunculus* of the Navigator's Islands.

Size, 9 x 5.

No. 57. [185] *Didus ineptus*.

RIGHT FOOT (cast). From the same locality and museum.

Size, 9 x 3.

CLASS REPTILIA.

This class is alone among the vertebrates in comprising a greater number of extinct than of living orders. The Mesozoic era is well named the Reptilian Age, for reptiles then had a most wonderful development in variety, number and size. They were not only the largest creatures of the time, but some of them were undoubtedly the largest land-animals that ever lived. The class began in the Permian, culminated in the Jurassic and Cretaceous, with generalized forms, combining features possessed by birds and mammals, and has now become much degraded in size and numbers, although perhaps more highly specialized.

It is impossible to briefly define even the living reptiles so as to exclude the amphibians upon the one hand, and the birds and mammals upon the other. Their affinity with birds is so close that the two classes are grouped together as the *Sauropsida* (see page 35). Notwithstanding their external dissimilarity they are linked by many characters, among which are the following: Oviparous, or ovoviviparous; eggs large and similar; aerial respiration; nucleated red blood-corpuscles; compound rami; jaw articulated to the skull by quadrate bone; single occipital condyle.

Some of the characters which separate reptiles from birds are as follows:—blood cold; skin usually bearing scales or plates, never producing feathers, heart with usually imperfectly divided ventricle, but always some mingling of venous and arterial blood; lungs not connected with air sacs; thorax and abdomen not distinguished; limbs sometimes wanting, and anterior pair never as wings.

For some reason unknown the orders characteristic of the Mesozoic disappeared with the Cretaceous, and those of the Eocene were mostly remnants of the lesser types. But there has been yet a decadence in the existing orders, in America, since the Miocene.

The Ophidia are the latest type, and most characteristic of the Tertiary and Quaternary. None have been found in America

earlier than the Eocene, where they were apparently numerous. The genus *Titanophis* comprised several marine species of huge size, one at least thirty feet in length (Marsh). One species of serpent has been found in the Cretaceous of France.

The reptiles may be divided into the following orders:—

ORDERS ENTIRELY EXTINCT.

1. Dinosauria.
2. Pterosauria (Ornithosauria).
3. Theromorpha.
4. Ichthyopterygia.
5. Sauropterygia.
6. Mosasauria (Pythonomorpha).

ORDERS WITH LIVING REPRESENTATIVES.

7. Crocodilia.
8. Lacertilia.
9. Rhynchocephalia.
10. Chelonia.
11. Ophidia.

The Rhynchocephalia includes only one living species, the *Hatteria* or *Sphenodon* of New Zealand. The Triassic *Rhynchosaurus* and *Hyperodapedon* belong here. Related to the lizards, they have, however, a more primitive structure.

ORDER DINOSAURIA.

This group includes such a variety of forms that Professor Marsh regards it as a sub-class. In 1882 he wrote as follows: "The great number of subordinate divisions in the group, and the remarkable diversity among those already discovered, indicate that many new forms will yet be found. Even among those now known there is a much greater difference in size and in osseous structure than in any other sub-class of vertebrates, with the single exception of the placental mammals. Compared with the Marsupials, living and extinct, the Dinosauria show an equal diversity of structure, and variations in size from by far the largest land animals known—fifty or sixty feet long, down to some of the smallest, a few inches only in length.

According to present evidence the Dinosaurs were confined entirely to the Mesozoic Age. They were abundant in the Trias-

sic, culminated in the Jurassic, and continued in diminishing numbers to the end of the Cretaceous period, when they became extinct.

The Dinosaurs were all terrestrial, mostly of large size, and the probable progenitors of the birds. In the conformation of the pelvis and hind limbs they were much like the ostriches. In many species the fore limbs were so small proportionately as to be of little use in locomotion. These creatures, walking upon their hind legs alone, produced the bird-like tracks so abundant in the Triassic brownstone of Connecticut and New Jersey.

The order includes both carnivores, like *Laelaps* of America, and *Megalosaurus* of Europe, and herbivores, as *Iguanodon* of Europe, and *Hadrosaurus*, *Brontosaurus*, *Stegosaurus* and *Atlantosaurus* of this country. The latter is the largest yet discovered. It was at least fifty or sixty feet long and thirty feet high, when erect. The huge, bulky, herbivorous monsters were probably kept in subjection by the more active, ferocious, well-armed and possibly warm-blooded carnivores.

No. 58. [200] *Iguanodon Mantelli*, Meyer.

LOWER JAW (cast). This great Dinosaurian was brought to light by Dr. Mantell, in 1834. It was an oviparous, herbivorous, terrestrial quadruped, "a crocodile lizard of the dry land." With other huge Dinosaurs, it occupied in the Reptilian Age the same relative station in the scale of being, and fulfilled the same general purposes in the economy of nature as the Mastodons, Mammoths and Megatheriods of the Pleistocene Period, and the existing gigantic Ungulates and Proboscidi-ans. Fragments of coniferous trees, aborescent ferns and cycadeous plants have been found with its remains, showing the nature of its food. Prof. Owen estimates the length of the head at three feet, of the trunk at twelve feet, and of the tail at thirteen feet. Some individuals were much larger. An almost complete skeleton (one of a number found a few years since in the Wealden of Belgium), has been put together in the Brussels Museum, showing a length of over 30 feet. It is supposed to have been aquatic in habit. The known species are all European. This almost perfect specimen of the lower jaw is interesting, showing as it does that in the small extent of the symphysis the *Iguanodon* resembles the Lizards, and differs from the Crocodiles, while in the position of the symphysis and its sloping edentulous character the *Iguanodon* differs from all modern Reptiles. It was found in the Wealden strata, Sussex, England, and belongs to the British Museum. Size, 20 x 11.

No. 59. [204] *Iguanodon Mantelli*, Meyer.

TOOTH (cast). The teeth of the *Iguanodon* differ in structure from those of every other known Reptile, but somewhat resemble in form those of the living

Iguana, whence the name. They are characterized by the prismatic, slightly curved form of the crown, the presence of from two to four longitudinal ridges on the enameled face, and the serrated margins and summit. The teeth of the upper jaw are curved in the opposite direction to those of the lower, and have their convexity external.

From the Wealden clay of Sussex, England.

No. 60. [1293] *Iguanodon Mantelli*, Meyer.

LEFT HIND FOOT (cast).

The *Iguanodon* had large hollow limb-bones and unguliculate feet, the hind pair having only three well developed toes. The small manus had five functional digits. This unique specimen was found associated with the undoubted leg bones of this great herbivorous reptile in the Wealden of the Isle of Wight, and has been pronounced by Prof. Owen

to be the foot, probably hind foot, of a young *Iguanodon*.

Size, 24 x 12.

No. 61. [191] *Brontozoum giganteum*, Hitchcock.

SINGLE TRACK, on slab (cast). This is the largest tridactyl impression ever discovered, although many thousands of "Bird-tracks" are found in the Triassic rocks, especially in the valley of the Connecticut. It measures eighteen inches in length, embracing an area of thirteen inches square within its outlines, and is capable of holding two quarts of water. The print is remarkably well defined, having all the fidelity of a plaster cast. Most of the so-called bird-tracks of the Trias were certainly made by Dinosaurs, and it is believed that all of them were. This probably belonged to a bipedal Dinosaur that lived by the shore of an estuary which deposited the Triassic

sandstones of the Connecticut Valley. The stride was thirty-eight inches, so that the same limb covered at each step nearly seven feet. This impression was discovered by Dexter Marsh, in the Sandstone at Northampton, Mass., and belongs to the Boston Society of Natural History. Size, 20 x 15.

No. 62. [192] *Brontozoum Sillimanium*, Hitchcock.

TRACKS, on slab, in relief (cast). This specimen exhibits about fifty tracks with the phalangeal and claw impressions exceedingly distinct. The smaller tracks were made by the *B. Sillimanium*, and the larger by *B. exsertum*, Hk. The length of the middle and outer toes of the former is between four and five inches, of the foot about six inches, and of the step twenty-three inches. Width of the trackway, four and a half inches. The middle and outer toes of the latter measure six inches; the foot nearly three inches; and the step thirty inches. The slab also contains the crooked trackway of the *Cunicularius retrahens*, Hk., and mud veins. The original was discovered in the micaceous sandstone (Trias) at Middletown, Conn., and is in the Appleton Cabinet at Amherst.

Size, 4 ft. 10 in. x 3 ft. 1 in.

No. 63. [195] *Anomœpus major*, Hitch.

TRACKS, on slab (cast). This dinosaurian reptile had tridactyl hind-feet with clawed toes, heels, and phalanges of a bird; but the fore-feet (not represented on this slab) had five toes. In walking on its hind legs only the creature brought the whole tarsus and heel on the ground, in the manner of a kangaroo. From a fifth, heart-shaped, impression behind, it is inferred that it possessed a stout caudal appendage. The length of the hind-foot is $16\frac{1}{2}$ inches. The original was discovered in the red sandstone (Trias) at Gill, Mass., and is in the Appleton cabinet at Amherst.

Size, 2 ft. 3 in. x 19 in.

No. 64. [1287] *Compsognathus longipes*, Wagner.

SKELETON, on slab (cast). This species is the most bird-like of the discovered Dinosaurs, and indeed was once thought to be a bird. It has a length of about two feet, a small head upon a slender neck, and toothed jaws. The fore limbs are small, but the hind limbs are long, and strikingly like the legs of birds in their structure. Huxley says "it is impossible to look at the conformation of this strange reptile and to doubt that it hopped or walked in an erect or semi-erect position, after the manner of a bird, to which its long neck, slight head and small anterior

limbs must have given it an extraordinary resemblance."

This most interesting and very perfect specimen is unique, and the species is the only representative of the Sub-order Compsognatha. It was found in the lithographic limestone of Bavaria, and is in the museum of the University of Munich.

Size, 12 x 14 inches.

ORDER PTEROSAURIA (Ornithosauria).

The extraordinary characteristic of this order is the power of flight, and no other reptiles, extinct or modern, possessed this ability. They were veritable dragons—the bats among reptiles. The wing was an expanse of skin (patagium) supported by the hind limbs and the greatly elongated outer finger. The remaining three digits of each manus were free, provided with claws, and adapted for grasping.

These reptiles possessed many affinities with birds, for example, the shape of the skull, the form of the brain, the structure of the shoulder girdle, the keeled sternum, and in some species the probably horny beak. The pneumatic bones give force to the suggestion that the animals were warm-blooded. On the other hand, the pelvis, hind limbs and vertebrae are distinctly reptilian, as is the general *ensemble* of the characters. No remains have been found of any derma-skeleton.

The order is limited to the Jura and Cretaceous. Six species have been found in the Cretaceous chalk of Kansas, all toothless, probably with horny beaks, and forming a group so distinct from the Old World forms that Professor Marsh places them in a separate order—Pteranodontia.

One species of Pterodaetyl, *Dermodaetylus montanus*, Marsh, has been found in the Upper Jurassic of Wyoming.

Some authors have regarded the Pterodaetyls as the progenitors of the birds. Others have thought them to be the ancestors of the flying birds (Carintæ), and only the struthious birds (Ratitæ), to be descended from the Dinosaurs. Professor Marsh holds that the Pterodaetyls were not in the avian line of descent. He writes as follows concerning the relationship of the genera: "The oldest European form, *Dimorphodon*, from the Lower Lias, had the entire jaws armed with teeth, and was provided with a long tail. The later genus, *Pterodaetylus*, retained the teeth, but had essentially lost the tail; while *Rhamphorhynchus* had retained the elongated tail, but had lost the teeth from the fore part of the jaws. In the genus *Pteranodon*, from the American Cretaceous, the teeth are entirely absent, and the tail is a mere rudiment. In the gradual loss of the teeth and tail these reptiles followed the same path as birds, and might thus seem to approach them, as many have supposed. This resemblance, however, is only a superficial one, as a study of the more important characters of the Pterodaetyls shows that they are an aberrant type of reptiles, totally off the line through which the birds were developed."

The European forms are mostly of small size, the expanse of wing measuring from three feet down to the size of a sparrow. The Pteranodons are mostly gigantic, some of them being estimated to have an expanse of nearly twenty-five feet.

No. 65. [241] *Pterodaetylus crassirostris*, Goldfuss.

SKELETON, on slab (cast). The Pterodaetyl was one of the most extraordinary of all the reptiles yet discovered, and its strange combination of characters has been the cause of much difference of opinion regarding its true nature. Collini, in 1784, was the first to investigate the characters of this strange animal; he considered it a fish. Blumenbach decided it was a bird; Sommering, a mammal, Spix, that it was intermediate between monkeys and bats; Macleay, a link between mammals and birds; and Agassiz thought it a strictly marine reptile. Cuvier, in 1800, determined the place and name it now holds.

The *Pterodactylus crassirostris* is distinguished by a very large head, a comparatively short neck, and a dental formula of $\frac{11}{5}:\frac{11}{5}$. According to the restoration of the animal by Goldfuss, it would measure three feet from tip to tip of the wings. This remarkably perfect specimen was discovered in the Lithographic limestone (Middle Oolite), at Solenhofen, Bavaria, associated with the remains of dragon

flies, and is now in the University Museum at Bonn, Rhenish Prussia.

Size, 10 x 7.

No. 66. [1286] *Rhamphorhynchus phyllurus*, Marsh.

SKELETON, on slab (cast). This genus possessed long sharp teeth; large eye orbits; and the eyes were doubtless well developed.

A peculiar feature in this species is the greatly elongated tail, bearing at the termination a vertical fin-like expansion, which is thought to have been used as a rudder in directing the flight of the reptile.

This specimen is unique and remarkable in showing very perfectly the wing membrane. It was found in 1873, at Eichstadt, Bavaria, in the Jurassic lithographic limestone slates which yielded the *Archæopteryx*, and is in the museum of Yale College.

Size, 10 x 16 inches.

ORDER THEROMORPHA.

These are the earliest positively known reptiles, being found in the Permian of Illinois, Texas and New Mexico, and the Triassic of South Africa, and are very synthetic types, combining characters of various reptilian orders, as well as of amphibians and mammals.

The name of this order, signifying beast-form, has reference to the possession of mammalian characteristics. Several features

of the skeleton ally them to the Monotremes, and some zoologists find in them the ancestors of the marsupial mammals of the Triassic.

Some of these reptiles resemble turtles in the shape of the head, and the horny beak, replacing teeth; others had a pair of maxillary tusks; while still others had a division of teeth anticipating the dentition of carnivorous mammals. The last group forms Owen's order, Theriodontia. The order Anomodontia of some authors includes the two former groups.

No. 67. [278] *Dicynodon lacerticeps*, Owen.

SKULL (cast). This singular reptile, hitherto found only in the Trias of South Africa, exhibits in the modifications of the skull, characters of the Crocodile, Tortoise and Lizard. It has the occipital of the first, the short, round head of the second, and the separated nasal apertures of the last. The cranium is compressed in front as in the Lizard, and the occipital condyles have a similar form. The only teeth are two pointed tusks growing downwards from the upper jaw; the lower jaw was armed, like the Tortoise, with a sheath of horn. This specimen, found near Fort Beaufort, Cape Colony, is in the Museum of the Geological Society of London.

Size, 6 x 4.

ORDER ICHTHYOPTERYGIA.

As indicated in the name of the order, and of the type genus, described below, these reptiles have some fish-like characters. In general form and in their predatory pelagic habits they much resembled the whales, which replaced them. They are confined to the Mesozoic, and abound especially in the Jurassic of Europe. No true Ichthyosaur has been found in America, but an allied toothless form, with six digits in all extremities, has been found in the Jurassic of Wyoming. It is named *Baptanodon* (*Sauranodon*).

Some specimens have a length of forty feet, but many were only a few feet long. The teeth are placed in grooves, and may number two hundred. The eye-orbits are immense, sometimes fifteen inches in diameter, and the eye was protected, and possibly focussed, by a ring of sclerotic plates.

Their petrified excrements known as "coprolites" consist of bony fragments of fishes and other marine animals.

No. 68. [207] *Ichthyosaurus intermedius*, Conyb.

SKELETON, on slab (cast). The Ichthyosaurs are distinguished by a long head, short neck, large abdomen, polydactylous paddles, and a powerful finned tail. They have a single occipital condyle; one vomer; thin, biconcave, ossified vertebrae; stout, conical, striated teeth implanted in a common alveolar groove; a large eye with a compound circle of overlapping sclerotic plates. The general form of the cranium resembles that of the Dolphin; the essential difference lies in the small size of the cerebral cavity, in the vast depth and breadth of the zygomas, and in the distinctness of the cranial bones. The mouth is very wide, and the jaws are armed with numerous teeth, indicative of a predatory and carnivorous nature. The lower jaw is made up of twelve pieces. The scapular arch resembles that of the *Ornithorhynchus*, and gave great strength to the chest and paddles, permitting the animal to crawl on the sea-shore—a thing impossible to the mammalian sea monsters. The vertebrae number over an hundred, and the end of the tail was flattened vertically, and lengthened out as in the Crocodiles. The very frequent displacement of the caudal vertebrae, about one-fourth of the way from the extremity, is owing to the perishable caudal fin falling over as the animal dies. The *Ichthyosaurus* was probably naked like the Whale, but carried a prominent ridge on the dorsal surface, like that of the male Pond-Newt. When full-grown, it may have reached the length of forty feet. Of no extinct vertebrata are the materials for a complete and exact restoration more abundant and satisfactory than of the Ichthyosaurs. This species is the most common form, but has not been found over nine feet in length. This splendid specimen, now in the British Museum, was discovered by Thomas Hawkins in the Lias at Street, near Glastonbury, England. The cranium and jaws, spinal column gently arched, and the four entire paddles, are very perfectly represented. According to Hawkins, there are one hundred and ten teeth in the upper jaw, and one hundred in the lower; one hundred and eleven vertebrae; thirty-nine ribs; ninety-five bones in the anterior paddle, and thirty-nine in the posterior.

Size, 9 ft. 1 in. x 2 ft. 11 in.

No. 69. [215] *Ichthyosaurus platyodon*, Conyb.

HEAD (cast). This species is one of the most gigantic of Ichthyosaurs, attaining the length of thirty feet. It derives its name from the crown of the tooth being more flattened than in other species. The bodies of the vertebrae are also more compressed. The head is relatively larger than in *Ichthyosaurus communis*; the lower jaw is remarkably massive and powerful, and projects backwards beyond the joint, as far as it does in the Crocodile. The fore and

hind paddles are of equal size. This fossil head is one of the largest ever found belonging to an Enaliosaurian. The muzzle is entire, and armed with $4\frac{5}{8}$ - $1\frac{1}{2}$ teeth. The eye—seven and a half inches in diameter—is girt by a zone of

sclerotic plates. The original was found in that ancient cemetery—the Lias beds of Lyme-Regis, England, and belongs to the Museum at Melbourne, Australia. Size, 5 ft. 1 in. x 1 ft. 9 in.

No. 70. [214] *Ichthyosaurus communis*, Conyb.

PADDLE (cast). The anterior paddles of this species were three times longer than the posterior, and were made up of 200 bones. From the Lias in Boll, Wurtemberg, and now in the Imperial Museum at Vienna.

Size, 11 x 5.

No. 71. *Ichthyosaurus* ——— .

VERTEBRA. The vertebrae of the Ichthyosaurs are numerous (over one hundred), very short or compressed, deeply bi-concave or amphicælus. In the latter character they resemble fishes. The neural arches are united to the centra by sutures. There is no sacrum.

This specimen from the Lias, Weymouth, England.

No. 72. *Ichthyosaurus* ——— .

TOOTH. The teeth of this genus are placed in a groove instead of being implanted in sockets. They are very numerous, strong, striated and pointed, indicating an animal diet.

From the Lias of Lyme-Regis, England.

No. 73. *Ichthyosaurus* ——— .

COPROLITE. The fossil excrements of fishes and reptiles are very abundant in some of the Jurassic deposits of England, and they were puzzling objects until Buckland discovered their nature and named them. The coprolites of the Ichthyosaurs are sometimes several inches in length, and composed of the bones, scales and teeth of the ganoid fishes and smaller reptiles which served as food for the Ichthyosaurs. In color they are gray to black. Upon the outside they show traces of a spiral or twisted structure produced by passing through the "spiral valve" in the small intestine.

From the Lias of Lyme-Regis, England.

ORDER SAUROPTERYGIA.

The type of this order is the genus *Plesiosaurus*, which is sufficiently described below.

The group ranges through the Jurassic and Cretaceous of Europe, where the greater number of species are found, sixteen species occurring in Great Britain alone. Thirteen species have been named from the American Cretaceous, but they are more related to the European *Pliosaurus* than to the type genus. They are all marine, and some of vast dimensions; the *Elasmosaurus* of America was forty-five feet long.

It is supposed that the members of this order could inhale a large quantity of air so as to bear submergence for some time; although they kept to shallower waters, unlike in the latter respect to the *Ichthyosaurus*. No trace of any derma-skeleton has been found.

No. 74. [225] *Plesiosaurus dolichodeirus*, Conybeare.

SKELETON, on slab (cast). The *Plesiosaurus* was first discovered in 1823, by Conybeare and De la Beche. Cuvier thought "its structure the most singular, and its characters the most anomalous that had been found amid the ruins of a former world." "To the head of a Lizard (wrote Buckland) it united the teeth of a Crocodile, a neck of enormous length, resembling the body of a Serpent, a trunk and tail having the proportions of an ordinary quadruped,

the ribs of Chameleon, and the paddles of a Whale." The skull is three times longer than its breadth, and subcompressed. The cranium is quadrate; nostrils small and situated near the eye; teeth slightly recurved, striated, sharp, long, and slender, lodged in distinct alveoli,—the anterior being the longest. The swan-like neck consists of from twenty to forty vertebrae, while living reptiles have not over nine cervicals. The pectoral arch is remarkable for the greatly

elongated and broad coracoid bones. The clavicle is united to the scapula, as in Chelonia. Next to Turtles, the *Plesiosaurus* exhibits the greatest development of abdominal ribs. The ribs are articulated as in Lizards. The digits of the fore paddle support respectively 3, 5-7, 8 or 9, 8, and 5 or 6, phalanges; those of the hind-paddle have 3, 5, 8 or 9, 8, and 6. The *Plesiosaurus* differs from the *Ichthyosaurus* in being pentadactylous, in having a long neck, longer and more flexible paddles, a shorter tail, vertebrae longer and nearly flat, with two pits on the under side, and more slender teeth. The latter is generally found lying on the side; the former, extended on its back. The *Plesiosaurus dolichoteirus* is characterized by its extremely long neck and very small head. The proportion of the parts is nearly thus: taking the head as 1, the neck will be 5, the body 4, and the tail 3; the whole length being thirteen times that of the head. The four paddles are equal in size. The original of this specimen, in the British Museum, was discovered in the Lias at Glastonbury, England.

Size, 6 ft. x 2 ft. 9 in.

No. 75. [227] *Plesiosaurus macrocephalus*, Conyb.

SKELETON, on slab (cast). This species is distinguished by the relatively larger size of the head and thicker neck. The neck is three times the length

of the head; and the posterior paddles are longer than the anterior pair. In this very perfect specimen, belonging to the Earl of Enniskillen, Ireland, the vertebral column is thrown into an arched position; the cervicals and dorsals form a continuous series; the tail is imperfect. Three paddles are exposed, and the upper part of the cranium with the orbits and jaws and teeth are clearly defined. The original was discovered in the Lias of Lyme-Regis, England, by Miss Mary Anning, and described by Dr. Buckland.

Size, 2 ft. 9 in. x 2 ft. 6 in.

No. 76. [235] *Nothosaurus mirabilis*, Munst.

SKULL (cast). This Triassic sea-saurian had very large temporal, orbital and nasal cavities. The pre-maxillary teeth were unusually long,

strong and sharp; there were two similar teeth in each maxillary; the remaining serial teeth were small but acute. All the teeth were inserted in distinct cavities. The animal attained the length of seven feet. This specimen is from the Muschelkalk at Bayreuth, Bavaria, and is in the Tylerian Museum of Haarlem.

Size, 15 x 6.

No. 77. [231] *Pliosaurus brachydeirus*, Owen.

PADDLE (cast). This big-headed, short-necked amphiœlian reptile was more closely lacertilian than the *Ichthyosaurus*. With the exception of the teeth, which are thicker and stronger, of the vertebra of the neck, which like those of the *Ichthyosaurus* are compressed, and of the more massive proportions of the jaws and paddle-bones, the skeleton of the *Pliosaurus* resembles that of the *Plesiosaurus*. Some individuals attained the length of more than forty feet. This huge paddle was found in the Kimmeridgian bed (Upper Oolite) near Dorchester, England, and is in the Museum of that city.

Size, 7 ft. 2 in. x 1 ft. 9.

No. 78. [233] *Pliosaurus grandis*, Owen.

TOOTH (cast). This is the largest reptilian tooth among either actual or extinct forms, and rivals in size the teeth of the full grown Sperm-whale. It belonged to a big-headed, short-necked Lizard, resembling the *Plesiosaurus*. This fine typical specimen was found in the Upper Oolite (Kimmeridge clay) of Dorsetshire, England, and is now in the British Museum.

Size, 12 x 3.

No. 79. [237] *Placodus gigas*, Agassiz.

SKULL (cast). This reptile (formerly called a fish) was a Plesiosaurian, according to Owen, breathing the air like Cetaceans. No part, save the head has been found. The cranium is as broad as long, the figure viewed from above being that of a right-angled triangle with the corners rounded off. No other number of the class has such wide temporal fossae and strong zygomatic arches; the lower jaw, moreover, presents an excessive development of the coronoid process. These developments, for great size and power of action of the biting and grinding muscles, relate to a most extraordinary form and size of the teeth, which resemble paving stones, and were evidently adapted to crack and bruise shells and crusts of marine Invertebrates. The palatal teeth, three on

each side, are of large size; the maxillary teeth, four in number, are much smaller; the premaxillary teeth, three in each ramus, are elongated and conical. The palatal are relatively larger than the teeth of any known animal, living or fossil. All these teeth are implanted in distinct sockets. This skull was found in the Muschelkalk (Trias) at Laineck, Bavaria, and belongs to the University Museum of Munich.

Size, 7 x 5.

ORDER MOSASAURIA (Pythonomorpha).

This order includes the huge elongated creatures typified by the *Mosasaurus*, and formerly classed with the *Lacertilia*. They were eel-like in form and movements, and probably the most elongated of reptiles, some attaining a length of perhaps eighty feet. The feet were modified to form slender paddles. Small scales probably covered the body. The head was pointed, flat, with eyes nearly vertical. Four rows of rootless teeth were borne in the upper jaw, and each half of the lower jaw had a unique articulation near the middle whereby the creature was enabled to swallow large prey, for while, like serpents, the rami were loosely joined in front by ligaments there was not as free movement of the quadrate bone. Their affinities are with Lizards and Snakes, and slightly with *Sauropterygia*. Cope makes six genera of the order.

The *Mososauria* seem to have been the most abundant and

dominating reptiles of the American Cretaceous, fifty American species being enumerated by Cope, but only four from European Cretaceous.

No. 80. [263]. **Mosasaurus Hoffmanni**, Mantell.

LOWER JAW, RIGHT RAMUS (cast). This is the most remarkable generalization of the lacertilian type in the Cretaceous Period. It had large pointed teeth, pyramidal and slightly recurved, expanding at the base, which was ankylosed to the top of the alveolar ridge. In the lower jaw there were fourteen teeth on each side, and in the upper, eleven; and Cuvier supposed that the intermaxillary bone, which was wanting, contained three more. In addition to these, the gigantic reptile had its pteryoid bone armed with teeth, like the Iguana. The vertebrae were concavo-convex like those of living Crocodiles, Monitors and Iguanas. The length of this species has been estimated at twenty-five feet. The jaw is part of the celebrated specimen now in the Garden of Plants, which was discovered in 1780 by Dr. Hoffman, in the Upper Chalk, near Maestricht, Netherlands. Size, 3 ft. 1 in. x 11 in.

No. 81. [1292] **Liodon** ———.

HEAD, on slab (cast). This genus is distinguished, according to Cope, by compressed teeth, lenticular in cross-section; vertebral processes not articulating; chevron bones free; and the humerus small and slender. The form is rare in Europe, but abounds in America. *L. dyspelor*, Cope, and *L. proriger*, Cope, are two of the largest species.

The original of this cast is in possession of Ward & Howell, and has not been studied, but probably belongs to one of the two species mentioned above.

From the Cretaceous chalk of Trevo Co., Kansas. Size, 2.7 x 1.9.

ORDER CROCODILIA.

Here belong the highest and largest of living reptiles. In the structure of the heart, brain and stomach they approach the birds. They are covered with a cuirass of square plates placed in longitudinal lines; the jaws are united into a solid mass; the premaxillary is double; the teeth are set in sockets in a single row; the vertebrae of Cretaceous, Tertiary and living species are concavo-convex; of all others, either doubly flat, doubly concave or convexo-concave.

Three genera are commonly recognized in the living forms, *Gavialis* and *Crocodylus*, of which there are several species, the latter in every continent, and *Alligator*, with a single species. Some authors make *Caiman* (*Jacare*) a separate genus, and *Tomistoma*, of Borneo, still another.

The order is represented in the Triassic of both Europe and America by *Belodon*, with biconcave vertebræ, and the line of descent was continued throughout *Teleosaurus* in the Jurassic, which group became extinct in the Upper Cretaceous. *Diplosaurus* of Upper Jurassic was a link between the Triassic and modern species. The Gavial type was well established in the Upper Cretaceous, in *Thoracosaurus*. Cope enumerates five genera and fourteen species of the order from the American Cretaceous.

The modern type with procælian vertebrae reaches back only to the Upper Cretaceous. Gavials and crocodiles abounded in the Eocene. The Alligators, a specialized form of *Crocodylus*, appeared in Europe in the Tertiary, but are not found in America until later time. The earlier forms were doubtless marine.

No. 82. [248] *Thoracosaurus neocesariensis*, DeKay.

(*Crocodylus clavirostris*, Morton).

SKULL (cast). This is one of the earliest Crocodylians with cup and ball vertebræ. This specimen was found in the Cretaceous beds of New Jersey, and is in the Museum of the Academy of Natural Sciences at Philadelphia.

Size, 25 x 13.

No. 83. [249] *Crocodylimus robustus*.

SKELETON, on slab (cast). Original from the Lithographic Limestone (Middle Oolite) in the Department of Ain, France, and now in the Museum of Natural History at Lyons.

Size, 18 x 10.

No. 84. [253] *Teleosaurus Mandelslohi*, Bronn.

SKELETON, on slab (cast). The *Teleosaurus* (called *Mystriosaurus* by Kaup) was a large, amphibious, loricated reptile, represented most nearly at the present day by the long, slender-jawed Crocodile of the Ganges—the “Gavial” of the Hindoos. Its name, given by St. Hilaire, has reference to his belief that it formed one extreme (the earliest) of the crocodilian series. We now find it was preceded by *Belodon*, in the Trias. The jaws are armed with numerous, long, slender, sharp-pointed, slightly curved teeth. In the lower jaw the teeth are alternately longer and shorter, counting from the fourth tooth; in the upper jaw they are of equal size, except the first two, which are small, and the third, which is very large. The nostrils are situated nearer the end of the upper jaw than in the modern Gavial; the fore limbs are shorter, and the hind limbs are longer and stronger, which indicates that it was a better swimmer. The vertebrae are united by slightly concave surfaces, whence it would seem that it lived more habitually in the water, and seldom moved on dry land; and as its fossil remains have been found only in the sedimentary deposits from the sea, it may be inferred that it was more strictly marine than the Crocodile of the

Ganges. This entire skeleton of the *Teleosaurus Mandelslohi* was discovered in the Lias at Holzmaden, Wurtemberg, and belongs to the Krantz Collection of Bonn, Rhenish Prussia.

Size, 7 ft. 2 in. x 2 ft. 6 in.

No. 85. [254] *Teleosaurus minimus*, Quenst.

SKULL (cast). This relic of the smallest *Teleosaurus* yet described, shows well the orbital sockets and the nasal fossæ. It is from the Lias of Wurtemberg, and is now in the University Museum of Munich. Size, 6 x 4.

No. 86. [259] *Leptorhynchus giganteus*, Falc. and Caut.

MUZZLE (cast). This fossil was found in the Sewalik Hills, India (Pliocene), and is in the British Museum.

Size, 2 ft. 6 in. x 11 in.

No. 87. [271] *Belodon* (*Phytosaurus*) *Kapffii*, Meyer.

SKULL AND LOWER JAW (cast). This genus, with

Steganolepis, were the earliest representatives of the order. This species had a long, slender muzzle, like the Gavial, and long, con-

ical, curved teeth, which plainly point to a carnivorous nature. This skull was discovered in the Keuper sandstone (Upper Trias) at Stuttgart, Wurtemberg, and is in the Royal Museum of that city. The lower jaw is in the British Museum.

Size, 2 ft. 6 in. x 13 in.

ORDER LACERTILIA.

The lizards may be described as having bodies elongated, and terminated with a tail; the legs usually developed and always with a pectoral arch; the vertebræ procœlus (rarely amphicœlus), not more than two sacral ones, and ribs single headed; the mandibles united in front, quadrate bone articulating with skull, and teeth in grooves; two nostrils, and usually movable eyelids. The skin is covered with horny scales or tubercles (sometimes bony).

Formerly the order was grouped with the crocodiles as the *Sauria*. Some twenty families and toward one thousand species are now recognized, chiefly belonging to the tropics.

The *Lacertilia* appear in Europe certainly as early as the Jurassic. None have been found in American Cretaceous, but they are abundant in the Eocene lake-beds, some of large size, and some, like the *Glyptosauridæ*, being mailed with ornamented plates of bone. In Miocene and Pliocene they are rare.

No. 88. [276] *Saurophidium Thollieri*.

SKELETON, on slab (cast).
From the lithographic lime-
stone in the Department of Ain,
France, and now in the Museum
of Natural History at Lyons.

Size, 2 ft. 7 in. x 11 in.

ORDER CHELONIA.

This is the most circumscribed order of reptiles, and most easily distinguished by the solid immovable armor encasing the greater part of the body, and the toothless, horny beak. The scapular and pelvic arches are within the bony box formed of the united vertebrae and ribs, which causes the scapula to be singularly placed inside the ribs.

The dorsal shield or carapace is least complete in marine turtles, which fact affords an important aid in the discrimination of fossil Chelonians. Excepting in the Soft or Mud-Tortoises, the whole armor is covered with dermal plates or ossified skin ("tortoise-shell") homologues to the scutes of the crocodile. The lower jaw is one solid arch. The only movable vertebrae are the cervical and caudal. Some of the cervicals are convexo-concave, others concavo-convex, one biconcave (usually the 8th). The caudals are procoelian. The plastron is broad in the land species, narrow in the marine. They all possess limbs, and the land species furnish the first instance of real walking in the vertebrate series, unless the running of some toads be considered as such, for Salamanders, Lizards and Crocodiles depend partly on the wriggling of the spinal column. The feet of the marine Chelonians are fin-shaped; of the fluviatile and marsh species, palmated; of the land species, club-shaped. Over two hundred species are known, the fresh-water forms being most numerous.

The two shields, usually in fragments, are the chief evidence of extinct Chelonians. The beaks are sometimes found solitary, in the Chalk.

Fossil forms are abundant in American Cretaceous and Eocene, some of great size, and a species of *Compsemys* occurs in Upper Jurassic. They occur at a lower horizon in Europe.

Some of the tortoises of the Tertiary are of immense size, *Colossochelys*, for example, being twelve feet long and six high.

No. 89. [281] *Testudo hemispherica*, Leidy.

CARAPACE AND PLASTRON (cast). The Carapace is high and convex, and the vertebral plates from the second to the eighth inclusive, are hexahedral. This specimen was found in the Mauvaises Terres of Nebraska (Lower Miocene), and is in the Ward Collection, University of Rochester. Size, 9 x 7.

No. 90. [283] *Emys Hamiltonoides*, Falc. and Caut.

CARAPACE AND PLASTRON (cast). This tortoise was found in the Sewalik Hills, India (Miocene), and is now in the British Museum. Size, 12 x 8.

No. 91. [1289] *Platichelys Oberndorferi*, Wagner.

CARAPACE (cast). This specimen shows the dorsal scales or scutes, which are in low pyramidal relief and quite ornate, as in the modern *Emys insculpta*. From the same locality and museum as the preceding. Size, 12 x 11.

No. 92. [286] *Chelonemys ovata*.

CARAPACE, ventral surface (cast). In this unusually perfect specimen the body is preserved entire, with the head and extremities extending beyond the contour of the shell. From the lithographic quarries (Middle Oolite) at Cirin, France, and now in the Museum of Natural History of Lyons. Size, 10 x 8.

CLASS AMPHIBIA.

The animals of this class were formerly grouped with the reptiles. Their stronger affinity is, however, with the fishes, making with the latter, Huxley's province Ichthyopsida.

Their most striking characteristic is the metamorphosis which they undergo after leaving the egg. Like fishes, they develop gills upon the visceral arches for a longer or shorter period, but unlike most fishes their "air-bladder" changes to a lung in the adult, and the gills disappear in the higher orders.

In the structure of the skull and the limbs they compare with the higher vertebrates. The skull is broad and flat, with two occipital condyles; there is no distinct neck; the vertebrae are concavo-convex (Frog), or convexo-concave (Pipa), or biconcave (Siren), or differing in the same individual; the ribs are absent or only vertebral, never sternal. The legs may be four or two, or wanting. They have no fixed type of external shape. The teeth vary greatly, or may be lacking. The only dental characters unlike reptiles is the location of teeth on the vomer.

The Amphibians may be roughly grouped under four orders. Urodela ("tailed-amphibians," as salamanders); Anura (frogs and toads); Ophiomorpha (caecelians); and the extinct Labyrinthodonts. Prof. Cope makes a larger number of orders. Prof. Huxley thinks that the class originated from some stock common to the Elasmobranchs, Ganoids and Dipnoi, and probably as early as the Devonian age. Their earliest distinction was the pentadactyl type of limb, and footprints probably amphibian are found in American subcarboniferous.

Amphibians were abundant, and the characteristic animals of the Carboniferous age, but remains are rare in America since the Permian. The Tertiary forms are of modern type. The tailless forms are more abundant now.

ORDER LABYRINTHODONTIA (STEGOCEPHALI).

These were Amphibians of large size, and sometimes gigantic, one skull being three feet long. They abounded in the Carboniferous and the Trias. The American remains yet found are not large, but the footprints indicate the largest forms.

Their form was usually salamandroid, the limbs weak and tail long; some forms were probably serpent-like; none were frog-like, as formerly supposed. Many genera had large pectoral plates and a ventral armor of scales; and some had the head protected with a helmet of bony plates. The skull varied in different genera from much elongated as in *Archegosaurus*, to short, as in *Brachyops*. The vertebrae were biconcave. Huxley enumerates thirty-eight undoubted genera, and fifteen which are questionable.

No. 93. [293] **Labyrinthodon (Mastodonsaurus) Jægeri**, Owen.

HEAD (cast). This is the largest known Amphibian species, having labyrinthine teeth, i. e., a convergence of numerous inflected folds of the external layer of cement towards the pulp-cavity. The form of the animal was salamandroid. The body equaled the largest crocodile in size and was protected beneath by bony plates and scales. The head was triangular; the nostrils very small; and the orbits situated nearly halfway between the fore and back part of the skull. In this specimen the skull and lower jaw are firmly closed. It was found in the Upper Trias (Keuper), near Stuttgart, Wurtemberg, and is in the Museum of that city.

Size, 2 ft. 6 in. x 2 ft.

No. 94. [294] **Cheirotherium Barthi**, Kaup.

TRACKS, on slab, in relief (cast). These remarkable foot-marks strikingly resemble the impression of the human hand, whence the generic title (Hand-beast). The tracks of the hind foot are about eight inches long and five wide. Less than two inches in advance of them are the prints of the fore-feet, which are only four inches long and three wide. The footprints follow one another in pairs, about fourteen inches apart. Dr. Kaup, who first described these ichnites, conjectured that the animal might have been a large species of the Opossum; but in the didelphic quadrupeds the thumb is on the inner side of the hind-foot. Bones of *Labyrinthodon* have been found in the same locality as the footprints; and it is now regarded as certain that the Cheirotherian tracks are those of Labyrinthodont Amphibians. This specimen, discovered in the New Red Sandstone (Lower Trias) at Jena, Germany, belongs to the Ward Collection in the University of Rochester.

Size, 7 ft. 2 in. x 18 in.

No. 95. [301] *Sauropus primævus*, Lea.

TRACKS, on slab (cast). These reptilian foot-prints were discovered in 1849 in a formation of red shales (Mauch Chunk Red Shales), at the base of the Coal Measures near Pottsville, Penn. The animal appears to have had five toes on its fore feet and four toes on the hind pair. There being no trace of

dragging of the feet, it probably had longer legs than the crocodile. A groove-like impression was left by a slender tail. The stride, from toe to toe, measures thirteen inches; and the tracks are three and one-half inches long. The hind-feet stepping upon nearly the same spot as the fore-feet partially obliterated the first impression. The original is in the private collection of the late Isaac Lea of Philadelphia, by whom it was discovered and described.

Size, 26 x 17.

No. 96. [291] *Archegosaurus Decheni*, Goldf.

HEAD AND PART OF TRUNK (cast).

This species disputes with the *Sauropus* of Lea and the *Dendroperpeton* of Dawson for the honor of being the first of air-breathers. It seems to

have had permanent gills and persistent notochord, paddles instead of legs, and to have been adapted for an aquatic life. Goldfuss considered it a Saurian; Agassiz claimed that even in its limbs—its most reptilian feature—it is closely like Ganoid fishes of the genus *Polypterus*; while the majority of naturalists regard it as a proteoid Labyrinthodont. It had sculptured bony plates on the head and bony scales on the body, like Ganoid fishes; and the greater part of the skeleton retained its cartilage. The skull is depressed and triangular, and the lower jaw differs from that of fishes in the great length of the angular pieces, but resembles it in simplicity. The teeth are conical and of labyrinthic structure, and implanted in sockets. Apparently it was a generalized form, connecting the amphibians and the sauroid fishes. Prof. Owen places it in a distinct order, the *Ganocephala*. This specimen was discovered in the coal-field of Saarbruck, Rhenish Prussia, and is in the Ward Collection of the University of Rochester.

Size, 12 x 5.

ORDER URODELA.

In this group the larval tail is persistent in the adult. The skin is naked; the vertebrae amphicœlus or opisthocœlus, with short vertebral ribs. They have four legs, or sometimes only the anterior pair, and the bones of the fore-arm, and of the shank, remain distinct.

The order may be divided into the perennibranchiata, which retain their external gills through life, as the Axolotl (*Siredon*), *Proteus*, *Necturus* and *Siren*, and the cadueibranchiata, which lose the gills in the adult, as the Newts and Salamanders.

Remains of the order occur through the Tertiary, and Prof. Cope reports a salamandroid form from the Laramie.

No. 97. [297] *Andrias Scheuchzeri*, Tschudi.

SKELETON, on slab (cast). This noted fossil—the *Cryptobranchus* of Van der Hoeven—was a perennibranchiate salamander. It was a large specimen of this extinct animal which was erroneously supposed by Scheuchzer to be a human skeleton, and was described by him nearly a century and a half ago as "*Homo diluvii testis*." Cuvier demonstrated its near affinities to the Water-Salamander (*Menopoma*) of the United States. It is perhaps closer related to the Giant-Salamander (*Cryptobranchus Japonicus* or *Megalobatrachus maximus*) of Japan. This specimen consists of the cranium, vertebral column with ribs, the four extremities, and vestiges of the tail. It was obtained from the Miocene lacustrine deposits at Eningen, Switzerland, and is in the British Museum.

Size, 3 ft. x 8 in.

No. 98-103. [302-308] **Restorations of Fossil Reptiles.**

Pterodactylus, *Megalosaurus*, *Labyrinthodon*, *Ichthyosaurus*, *Plesiosaurus dolichodeirus* and *P. macrocephalus*. They are reduced (one inch to the foot) from the gigantic models in London, constructed, to a scale, by B. Water-

No. 98. [303] **MEGALOSAURUS.**

house Hawkins, F. G. S., from the form and proportions of the fossil remains, and in strict accordance with the scientific deductions of Professor Owen. Preliminary drawings, with careful measurements of the originals in the Royal

No. 99. [302] **PTERODACTYLUS.** No. 100. [305] **LABYRINTHODON.**

College of Surgeons, British Museum, and Geological Society, were prepared, and sketch models made at a fraction of the natural size, and submitted to the above high authority. Clay models were then made of the natural size.

Nos. 101-103. [306-308] **ICHTHYOSAURUS WITH PLESIOSAURI.**

It gives us some idea of the size of these monsters to know that the mould of one of them was converted into a *salle a manger*, in which Prof. Owen, Prof. Forbes, and twenty other scientific gentlemen sat down to dinner. These beautiful restorations are faithful copies, in miniature, of the gigantic group in London. They are in four pieces.

ICHTHYOSAURUS WITH PLESIOSAURUS:	Size, 22 x 14.
MEGALOSAURUS: - - - - -	" 23 x 12.
LABYRINTHODON: - - - - -	" 13 x 8.
PTERODACTYLUS: - - - - -	" 9 x 9.

CLASS PISCES.

This group is so heterogeneous, if we include all the vertebrates below the Amphibians, that it is difficult to characterize it. Broadly speaking, Fishes may be designated as vertebrates, aquatic and water-breathing, with a heart composed of one auricle and ventricle, and with limbs represented by fins.

The lowest living vertebrate is the aberrant Lancelet (*Amphioxus lanceolatus*). It is about two inches long, and destitute of skeleton, skull, jaws, fins and heart, and a brain scarcely represented. The notochord is persistent. Some recent writers make this animal the type of a branch, *Acerania*, of the subkingdom Vertebrata, with all other vertebrates as *Craniota*.

Huxley divides fishes into the following orders:

Dipnoi (Lung-fishes): *Ceratodus*, *Protopterus*, *Lepidosiren*.

Elasmobranchii (Placoids): Sharks and Rays.

Ganoidei: Sturgeons, Gar-pikes, Mud-fishes, *Polypterus*.

Teleostei: Bony Fishes.

Marsipobranchii (Cyclostomata): Hag-fishes and Lampreys.

Pharyngobranchii (Leptocardii): Lancelet.

Gunther and Newberry unite the Dipnoi with the Ganoidei; and some recent authors make the Marsipobranchii and Pharyngobranchii separate classes.

The Ganoidei and Elasmobranchs were the earliest fishes, and the latter are still numerous, and the largest and most powerful. These two orders, with Dipnoi, possess the greater number of reptilian features, but the Teleosts are the most highly specialized, and the characteristic fishes of Tertiary and later time.

The fossil fishes fall into the above orders. The earliest vertebrate and fish remains are fragments of Sharks and Cephalaspids in the uppermost Silurian of England and Europe. The earliest American remains are from the lower Devonian, and in the Carboniferous, fishes are well represented. Devonian fishes from America are less numerous, but larger than those from Europe. All Devonian fishes, as well as those from the Carboniferous, Triassic and Jurassic, belong to either Dipnoi, Elasmobranchs or

Ganoids, and hence all have cartilaginous skeletons, and vertebrated or heterocercal tails. Many, however, were remarkable for their heavy bone armor.

During the Carboniferous the sharks were predominant, over one hundred species being known from the lower Carboniferous, but in the Mesozoic they were under subjection to the huge reptiles. The largest sharks lived during the Tertiary, the *Curcharodon megalodon* being estimated at fifty to sixty feet long.

The Teleosts, the characteristic modern fishes, appeared in the Cretaceous period, and modern types abounded in the Tertiary.

About 9,000 species of fishes are now living, of which only about one hundred are Ganoids (seven genera), and four (three genera) are Dipnoi. However, one genus (*Ceratodus*), of the latter class has survived from the Triassic, and the sharks have endured all geologic changes since the Silurian, and seem to be enjoying themselves to-day.

ORDER DIPNOI.

The members of this small order have so many features in common with the Amphibia that the oldest known form (*Lepidosiren*) was regarded as the lowest of that order. They have no ossified vertebrae, but a persistent notochord; the limbs are jointed paddles, or filiform bodies; the heart has two auricles; and in addition to gills they possess true lungs, whence the name "Lung Fishes."

The discovery, since 1870, of living individuals of the Triassic genus *Ceratodus*, enabled ichthyologists to trace relationship with some of the early ganoids, and Dr. Gunther, on account of this affinity has placed the Dipnoi in the order Ganoidei. The Devonian fishes, *Dinichthys*, *Dipterus* and *Holoptychius*, were early members of the group.

The living species are *Lepidosiren paradoxa*, from the Amazon, *Protopterus annectens* of Africa, and *Ceratodus Fosteri* and *C. miolepis*, of Australia.

No. 104. [340] *Ceratodus* ———.

TWO TEETH. (Cast). The teeth of this Dipnoan are puzzling from the variety of shapes they assume. They have in general an uneven or undulating upper surface of dentine and enamel, and an under-layer of reticulated osseous tissue. The genus is found by Cope in Upper Carboniferous of Illinois, and by Marsh in the Jurassic of Wyoming. These specimens are from the Upper Trias (Keuper) at Stuttgart, Wurtemberg, and are now in the Ward Collection of the University of Rochester.

ORDER GANOIDEI.

This order derives its name from the character of the derma-skeleton. This consists usually of rhomboidal scales or plates, sometimes detached spines, &c., but always consisting of a layer of bone covered by a layer of peculiar enamel. Some Teleosts have scales of the same character.

The Ganoids have the vertebra-skeleton more or less cartilaginous, the vertebræ being cartilaginous throughout life in the Palæozoic forms. The Bony Pike (*Lepidosteus*) has vertebræ convexo-concave (opisthocœlus), a reptilian feature, and the highest vertebral structure of any fish. The ventral fins are always placed far back and distant from the pectoral fins, and are often lobed, with a surrounding fringe, whence Huxley's division, Crossopterygidae. The tail is usually vertebrated, and was entirely so before the Triassic.

The oldest known fishes belong partly to this order, and they are represented to-day by seven genera; one (*Accipenser*) common to the Northern Continents, four in North America, and two in Africa (Newberry).

The classification of the Ganoids is very difficult. A simple division is customary into Placo-ganoids, characteristic of Palæozoic time, and Lepido-ganoids, which range through all time since the Devonian. The Placo-ganoids of the Devonian were burdened with a defensive armor of immense thickness and weight, but that method of defense has now been superseded by swiftness and agility.

No. 105. [309] *Holoptychius nobilissimus*, Agassiz.

BODY AND HEAD, ON slab (cast). The Holoptychians were ganoid fishes, belonging to Huxley's group Crossopterygia ("fringe-finned"), and have affinities with the Dipnoi, being most closely represented now by *Ceratodus*.

Rhizodus, *Dipterus* and *Dinichthys* belong in the same sub-order. This genus is characterized by the large, deeply corrugated scales covering the body, and the sculptured and granulated plates defending the head. The teeth are of two kinds—small, serial teeth and large laniaries, the latter placed

behind the former. The ventral fins are nearer the tail than in any other ganoid. This splendid specimen, one of the ornaments of the British Museum, was discovered in the Old Red Sandstone at Clashbinnie, Scotland, and is figured in Murchison's "*Silurian System*." The creature lies on its back. "The body (says Hugh Miller) measures a foot across by two feet and a half in length, exclusive of the tail, which is wanting; but the armor in which it is cased might have served a Crocodile or Alligator of five times the size." The head is short and obtuse; the lower jaw, the mouth, and the two branchial rays or plates are exposed. The scales are very large and deeply wrinkled.

Size, 2 ft. 9 in. x 4 in.

No. 106. [313] *Cephalaspis Lyellii*, Agassiz.

BODY AND HEAD, on slab (cast). This famous Devonian Fish is placed among the Placoganoids. The first specimen of this genus was discovered by Hugh Miller. The most striking feature is the enormous buckler (made up of plates usually hexagonal) covering the head and prolonged backwards into lateral points. The head comprises fully one-third the creature's entire length. The body was protected by plates arranged transversely, and the tail carried a heterocercal fin. The dentition is unknown; but the mouth was probably placed beneath the head and suctorial, as in the Sturgeon. The eyes were placed closely together near the middle of the head. This fossil, now in the British Museum, was found in the Old Red Sandstone in Forfarshire, Scotland.

Size, 9 x 5.

No. 107. [1303] *Cephalaspis Dawsoni*, Lankester.

In this species the head is proportionately very large, and the body seems to have been covered with very fine tubercles.

From the Lower Devonian at Gaspé, Canada.

No. 108. [311] *Rhizodus Hibberti*, Owen.

LOWER JAW, LEFT RAMUS (cast). The generic term *Rhizodus* is applied to those ganoids of the Coal Measures which have stout serial teeth and slender laniaries. The great strength of the cephalic plates and of the jaws and teeth shows that this was a powerful carnivorous fish. Prof. Newberry has recently named an equally large species (*R. anceps*) from the Mountain Limestone of Illinois. The genus seems characteristic of the Lower Carboniferous. This fragment of the lower jaw was disinterred from the Carboniferous Limestone, near Edinburgh, and is in the British Museum.

Size, 19 x 7.

No. 109. [1301] *Lepidotus Maximus*, Wagner.

SKELETON, on slab (cast). This was one of the largest of the ancient ganoid fishes, and was in shape much like the modern carp. Its vertebræ were well ossified, and its body was encased in a cuirass of highly polished, imbricated, rhomboid scales, forming an impenetrable armor. Its mouth was small, with

blunt, spheroidal teeth; it had a short dorsal fin opposite the anal, and a homocercal tail. This, the only perfect specimen of this species ever found, was discovered in 1869, in the lithographic quarries (Middle Oolite) of Solenhofen, Bavaria, and is in the Museum of the University of Munich.

Size, 6 ft. x 2 ft. 6 in.

No. 110. [317] *Lepidotus minor*, Agassiz.

BODY AND HEAD, on slab (cast). This fine specimen of a homocercal lepidoganoïd—distinguished by its small, shining scales, and unusually perfect in all its parts—was discovered in the Purbeck limestone (Upper Oolite) on the Isle of Portland, England, and is in the the British Museum,

Size, 17 x 10.

No. 111. [319] *Aspidorhynchus speciosus*, Agassiz.

BODY AND HEAD, on slab (cast). This homocercal ganoid is characterized by a long body of nearly equal

size throughout, by a pointed head, and by the disposition of the scales in

unequal rows. The scales are wrinkled, and sometimes hexagonal, sometimes tetragonal. This specimen belongs to the Krantz Collection, and is from the lithographic limestone of Eichstätt, Bavaria.

Size, 2 ft. 2 in. x 7 in.

No. 112. [320] *Microdon (Pycnodus) elegans*, Agassiz.

SKELETON, on slab (cast). This beautiful ganoid, with homocercal tail, and small, uniform teeth, is a true *Pycnodus*, according to Wagner. The specimen is from the lithographic limestone (Upper Oolite) of Kelheim, Bavaria, and is now in the Museum of the University of Munich.

Size, 10 x 10.

No. 113. [324] *Gyrodus circularis*, Agassiz.

SKELETON, on slab (cast). This fish has the exterior form of *Pycnodus*. The anal and dorsal fins are sustained by long rays in front, and diminish rapidly; the caudal is deeply notched. The teeth are elliptical, and are character-

ized by a groove running around the summit. This fine specimen, from the lithographic slates of Solenhofen, Bavaria, is in the Museum of the University of Munich.

Size, 2 ft. 6 in. x 1 ft. 5 in.

No. 114. [326] *Gyrodus umbilicus*, Agassiz.

PALATAL TEETH, on slab (cast). This species is characterized by a depression in the middle of the teeth. This fine series of palatal teeth was found in the Upper Oolite at Durrheim, Grand Duchy of Baden, and is in the same Museum as the preceding.

ORDER ELASMOBRANCHII.

The Sharks, Rays and Chimæræ which compose this class (called *Selachia* by Müller, and *Plucoidei* by Agassiz), agree in general structure with the Ganoids. They differ chiefly in the character of the derma-skeleton and the arrangement of the gills, the former consisting of scattered bony or tooth-like grains, tubercles or spines, and the latter being fixed and contained in sacs or pouches communicating with the pharynx, and externally by slits. In the Chimæræ there is only one external aperture. Like the Dipnoans and Ganoids the Elasmobranchs combine reptilian features with embryonic fish characters.

Being Cartilaginous, they have left little behind save spines, teeth and scales. The fossil spines are called *Ichthyodorulites*, and abound in the Secondary deposits. The *Cestracionts* began in the Lower Devonian, and culminated in the Trias. The *Hybodonts* began in the Carboniferous and culminated in the Mesozoic. The *Squalodonts*, or True Sharks, began in the Jurassic and culminated in the Miocene. The *Rays* first appeared in the Carboniferous, and *Chimæroids* in the Oolite.

No. 115. *Carcharodon megalodon*.

TOOTH. The huge teeth of this largest shark are found in great numbers in the Marine Tertiary of the Atlantic border. Some of them are six inches long and broad, and indicate sharks fifty or sixty feet long. From the Eocene of Ashley River, South Carolina.

No. 116. *Lamna elegans*, Agassiz.

TEETH. From Eocene of Ashley River, South Carolina.

No. 117. [343] *Edestes vorax*, Leidy.

PORTION OF DORSAL SPINE (cast). This remarkable ichthyodorulite was discovered in the Coal Measures of Indiana, and is preserved in the Cabinet of Amherst College. It is distinguished for the large proportional size of the marginal teeth and their close resemblance to the jaw-teeth of *Carcharodon*, their enameled border being finely denticulate.

Size, 9 x 3.

No. 118. [345] *Ichthyodorulite*.

FOSSIL DORSAL SPINE, on slab (cast). From the Lias of Lyme-Regis, England, and now in the Ward Collection of the University of Rochester.

Size, 20 x 5.

No. 119. [1304] *Pelecopterus perniciosus*, Cope.

PECTORAL SPINES (cast).

This represents one of a few species of large fishes, known only by their spines and shoulder girdles, which Cope makes the type of a family, *Pelecopteridæ*. This remarkably perfect specimen shows the pectoral girdle complete. From the Upper Cretaceous (Colorado group), of Trego Co., Kansas, and now in the Museum of Columbia College.

Size, 4 ft. 1 in. x 2 ft. 6 in.

No. 120. [1308, 1310] *Rhyssodus* (*Cochliodus*) *latus*, Leidy.

TWO TEETH (cast). These are examples of the broad, crushing "pavement" teeth, which were characteristic of the Devonian and Carboniferous Sharks, and are now found in the *Cestracion* of Australia. From Keokuk division of the Subcarboniferous, Warsaw, Illinois.

Original in the A. H. Worthen Collection.

No. 121. [181] *Acrodus Anningiæ*, Agassiz.

LOWER JAW (cast).

This remarkably fine specimen exhibits an almost complete series of teeth, retaining the position they occupied during life. There are eight transverse rows on each side, with a central row at the junction of the two rami. The teeth of the

posterior row are marked with the striæ characteristic of the genus. The specimen was found in the Lower Lias, Lyme-Regis, England, and belongs to the E. C. H. Day Collection, Charmouth, England.

No. 122. *Ptychodus decurrens*, Agassiz.

TWO TEETH. The teeth of this cestraciont are large and quadrangular. The crown is deeper than the root, and the margin is granulated. From the chalk of Kent, England.

No. 123. [330] *Squatina acanthoderma*, Fraas.

BODY AND HEAD, on slab (cast). This extinct Placoid approached the Ray family, by the situation of the eyes on the dorsal face and by the development of the pectoral fins. The mouth was at the end of the muzzle. The contour and outer border of the body has left a full impression on the stone. This fine fossil was discovered in the Lithographic Slate (Upper Oolite), at Eichstädt, Bavaria, and is in the Tylerian Museum at Haarlem, Holland.

Size, 2 ft. 4 in. x 1 ft. 8 in.

ORDER TELEOSTEI.

The great majority of living fishes, and nearly all of the more familiar species belong in this order. No forms are positively known earlier than the Cretaceous, since which time the group has been continually increasing.

The Teleosts may be broadly described by the following characters: The vertebra-skeleton is well ossified, and the skull consists of distinct bones; a lower jaw is always present; the limbs, which are usually present, are represented by fins; the gills are free and comb-like and protected by a bony cover (operculum); the heart has an auricle and ventricle, and the *bulbus arteriosus* is not regularly contractile. The scales of the teleosts may be ganoid, but usually are imbricated, unenameled horny plates, developed in a fold of the skin; those with plain margins being called "cycloid," those with the hinder margin fringed with spines, or comb-like, being called "ctenoid." The nasal sacs never communicate with the throat.

No. 124. *Diplomystus altus*, Leidy.

The lacustrine deposits of the Western Tertiary are sometimes exceedingly rich in fish remains, the skeletons being frequently preserved in great perfection. This species, closely related to the Herring, is from the Green River Shales, (Eocene) Wyoming Territory.

No. 125. Fish.

Another species from the same locality as the preceding.

No. 126. [346] *Beryx superbus*, Dixon.

GROUP, on slab (cast). The genus *Beryx*, of which there are two existing species in the Australian seas, represented the Perch family during the Cretaceous period. The characteristics are a large, blunt head, one dorsal fin, with several spinous rays in front of the soft ones, and large, round pectinated scales. This

specimen was found in the Lower Chalk, at Lewes, England, and is in the Private Cabinet of S. H. Beckles, Esq., of Brighton, England.

Size, 23 x 14.

No. 127. Coprolite, Buckl.

This specimen is undoubtedly the fossil excrement of a fish, according to Mantell, of the Ganoid *Macropoma*. It has a conical form and a convoluted appearance, arising from the fact that the intestinal canal was spirally twisted. The analysis of Prout shows these fecal remains to be composed chiefly of phosphate of lime. This coprolite was found in the Lower Chalk, Rochester, England.

SUBKINGDOM

ARTICULATA (Annulosa).

The Articulata—incomparably the most numerous division of the Animal Kingdom—include all the invertebrates having jointed bodies. The body, more or less elongated and bilaterally symmetrical, is usually divided into segments or articulations. The appendages, jaws, limbs, &c. are arranged bilaterally. The nervous system consists of one or two ganglia in the anterior part of the body, or of a double chain of ganglia in the ventral side. The skeleton is external, the skin hardened in most cases into a chitinous crust, affording the necessary fulera to the muscles of locomotion. This derma-skeleton is typically in the form of successive rings, which, in the higher orders, are soldered together, so that only two or three divisions, or perhaps one solid shield, can be discovered.

This very comprehensive subkingdom may be divided as follows: I. Arthropoda (including the classes Insecta, Myriapoda, Arachnida, Crustacea). II. Anarthropoda (class Annelida). III. Scoleida (class Annuloida). Some authors separate the first division far from the other two, which are placed in relationship with the lower mollusks.

The palæontological history of the articulata is much behind that of the other divisions of the animal kingdom. So universally distributed and numerically abundant at the present day, they are least perfectly represented among the relics of the past. Their manifold organization, which in the recent state fits them so admirably for generic and specific comparisons, is fatal to their entire preservation, and the fossil examples are often so fragmentary as to admit of little more than the determination of their class and family. The number discovered forms but a small proportion of those which have probably existed. The oldest fossiliferous rocks (Cambrian) bear many tracks and burrows of marine worms, and a variety of specialized crustacea (Trilobites). Air-breathing articulates doubtless came into being along with land plants, Insects being found in the Devonian. Representatives of each class are found in the Palæozoic rocks. In fact, every main type of invertebrate animal is present in the Lower Silurian.

CLASS INSECTA (HEXAPODA).

The name *Insecta* is used by some authors to include the Myriapods and Arachnids, the class as here restricted being termed *Hexapoda*.

True insects are distinguished as follows: The body always has three distinct divisions, head, thorax, abdomen; the thorax bears all the locomotive organs, which are never more than three pairs of legs and two pairs of wings. Respiration is by means of air-tubes (tracheæ).

The number of known species of insects is about 190,000, including 90,000 species of Coleoptera, and about 25,000 each of Hymenoptera and Lepidoptera, and 24,000 of Diptera.

The oldest insect fossils are from the Devonian of New Brunswick. These have neuropterous wings with orthopterous stridulating organs. Nearly all orders are known from the Carboniferous, nineteen species being found in the American Coal-Measures. Over 140 species are known from the European Jurassic, chiefly Beetles. The earliest Butterfly is from the Stonesfield slates. In Eocene fresh-water shales at Florissant, Colorado, and of Green River, Wyoming, have been found the richest insect-beds. The shales are black with drifted remains, and 1,000 species are recognizable (Scudder). Similar deposits are known in European Miocene, which have yielded 1550 species, over 900 of them from the bed at Eningen. Hymenopters and Coleopters are most abundant, and the species indicate a tropical climate. Extinct species are common in amber, but the species in copal and the later resins are living forms.

No. 128. [451, Cast]. *Aeschna eximia*, Hagen.

This beautiful fossil "Dragon-Fly" was found in the lithographic limestone (Middle Oolite), at Solenhofen, Bavaria. It is a neuropterous insect of the genus *Aeschna*, which differs from the *Libellula* proper only in the equal division of the lower lip. The eyes are large and close together, and the wings remain horizontal in a state of repose. In this specimen, the wings, both pairs of which are finely preserved, spread six inches. Size, 7 x 5.

No. 129. [452, Cast]. *Locusta speciosa*, Munst.

This fossil locust was discovered in the lithographic limestone (Middle Oolite) at Eichstadt, Bavaria. Like the Dragon-Fly above, it was doubtless blown far out from the shore which bordered the marine waters of the old Solenhofen sea. The calcareous mud at the bottom of this sea was of the most impalpable fineness, and enveloped closely all organisms which became imbedded in it, copying with beautiful exactness their most perishable portions and most delicate linings.

Size, 7 x 7.

No. 130. Insects.

From Eocene Shale of Green River, Wyoming.

CLASS CRUSTACEA.

In this class the skeleton has the form of an external crust or shell, which covers even the antennæ, hairs, jaws and teeth. In the smaller species it is chitinous; in others it is hardened by the addition of carbonate and phosphate of lime. The normal number of segments is twenty-one, seven each for the head, thorax and abdomen. But most frequently the anterior segments form one piece called the cephalothorax, leaving the abdomen jointed, and terminated by a tail-piece (*telson*). Respiration is by means of gills, or by the surface of the body, and all crustaceans are organized for life in the water, though many live chiefly on land. They have two pairs of antennæ. The locomotive appendages are more than eight in number, and are usually borne by the segments of the abdomen as well as by the thorax. This is a very large and varied class, and contains many orders, of which only three are herein represented. The earliest forms were Trilobites.

In general we may say that the Palæozoic Trilobites are followed by Lobsters in the Carboniferous, and by Crabs in the Jurassic. The articulates which came latest are the Barnacles and Hermit-Crabs, which began in the Cretaceous. The Ostracoda are represented from the Cambrian to the present time.

ORDER DECAPODA.

This order includes the crustacea which possess only five pairs of legs. They have the gills beneath the "carapace" which covers the cephalothorax; and the compound eyes borne upon eye-stalks, whence they are called *Podophthalmata*. The order is subdivided into *Macrura* (long-tail), as the Lobster; *Anomura* (irregular-tail), the Hermit-Crab; and the *Brachyura* (short-tail), the crabs. The Macrourans abound in the Oolite and Cretaceous strata, while the Brachyurans attain their maximum development in Tertiary beds and modern seas.

No. 131. *Lobocarcinus Paulo-Wurtembergensis*, Meyer.

This interesting and well-preserved fossil Crab occurs in considerable numbers in the Lower Tertiary (Nummulitic) beds of the Gebel Mokattam in the suburbs of Cairo, Egypt, from whence this specimen is derived.

No. 132. *Palæocorystes Stokesii*, Mantell.

CARAPACE. A small Crustacean—intermediate in form between the *Brachyura* and *Anomura*, and quite abundant in the Upper Greensand and Gault of England. Two specimens, from the Upper Greensand, Cambridge, England.

No. 133. [354, Cast]. *Eryon propinquus*, Germar.

This remarkable form of Crustacean bears a long, flattened shield, with a round, fissured front. It is from the Lithographic limestone (Middle Oolite) of Eichstädt, Bavaria.

Size, 6 x 5.

No. 134. [358, Cast]. *Pemphix Seurii*, Meyer.

This extinct Lobster has a carapace divided into three parts, of which the anterior corresponds to the abdominal region, the middle to the heart and genital regions, and the posterior to the branchial. It was by these long-bodied forms (*Macrura*) that the Decapod Crustaceans were at first represented in the Geological Series. The specimen is from the Muschelkalk (Middle Trias), Crailsheim, Wurtemberg. Original in the Ward Collection of the University of Rochester.

Size, 6 x 3.

No. 135. [1202, Cast]. *Hoploparia (Astacus) longimana*, Sow.

This long-tailed Decapod resembles the Lobster. The cheeks are prolonged in the shape of semi-cylindrical horns; and the fore-arms are very long and unequal. From the Greensand, Lyme-Regis, England.

Size, 10 x 3.

No. 136. [360, Cast]. *Megachirus locusta*, Germar.

This Decapod from the Lithographic limestone (Middle Oolite), Solenhofen, Bavaria, is the *Locustina marina* of Bayer. It has a long tail, and a carapace prolonged in front into a beak. But it is chiefly remarkable for the extreme length of the anterior legs, which are clawless, and terminated with fin-like appendages.

Size, 9 x 5.

ORDER MEROSTOMATA.

The Merostomata are a generalized type, with some resemblances to the Arachnoids and to the larvæ of the Decapods. They use for mastication the bases of the thoracic legs. The sub-order Eurypterida appeared in the Upper Silurian and passed out of existence with the Palæozoic. They were the largest of crustaceans, some being over six feet long. The King-crab (*Limulus*) is the only living representative of the order.

No. 137. [370, Cast]. *Pterygotus acuminatus*, Salter.

This genus was established by Prof. Agassiz in 1844. It derives its name from the peculiar character of its foot-jaws, which, from their scale-like sculpture, were at first mistaken for the remains of a fish. Like the *Eurypterus*, the *Pterygotus* may be described as a "lobster-like Crustacean," since it has an elongated body composed of a cephalo-thorax, an abdomen with a dozen segments, and a tail-plate. It differs from the *Eurypterus*, in having a less number of joints in the feet, in the eyes being marginal, and in the large size of the antennæ. This fine specimen was discovered in the Upper Silurian beds of Leshmahago, Lanarkshire, Wales.

Size, 24 x 13.

No. 138. *Eurypterus remipes*, DeKay.

The genus *Eurypterus*—the *Idotea* of Scouler—was established by DeKay in 1825. The name is an allusion to the broad, oar-like, swimming feet. The body is composed of an anterior oval carapace, six thoracic and six abdominal segments, and a somewhat obtuse tail-spine. The eyes were on the surface of the carapace. There were five appendages, all oral, of which the hinder pair were dilated into paddles. The basal joints of the first four legs performed the work of mastication, as in the King-Crab. This specimen was found in the Water-Lime Group (Upper Silurian), Buffalo, N. Y.

No. 139. [1314, Cast]. *Eusarchus scorpionis*, Grote and Pitt.

This member of the Eurypterida is regarded by the authors of the genus as somewhat more specialized than the typical *Eurypterus*, as indicated by the narrowness of the cephalothoracic portion and the abrupt constriction of the posterior segments. The original is from the Water-lime group, Buffalo, N. Y.

Size, 12 in. x 8 in.

No. 140. [364, Cast), *Limulus giganteus*, Munst.

This ancient "King-Crab," like those of the present day, was covered by a cephalothorax shield; the appendages were all oral; and the eyes were sessile and placed in the upper surface of the shield, while the legs served the purpose of jaws and gills. It doubtless lived along the shore of the ancient sea in which were deposited the beds of lithographic limestone (Middle Oolite), which are now worked at Eichstätt, Bavaria, from which locality the original of this fine specimen is derived.

Size, 20 x 12.

No. 141. [1316, Cast]. *Euproops Danæ*, M. & W.

This ancient King-Crab is interesting on account of its resemblance to the larval form of the modern *Limulus*, and still closer to the Carboniferous Trilobite *Prestwichia*.

The original is from the Coal Measures of Grundy Co., Ill., and in possession of Ward & Howell.

ORDER TRILOBITA.

These extinct crustaceans were the earliest members of the class, meeting us in the first formations in which we have any abundant forms of marine life. They resemble both the Entomostracans and Isopods, and are nearly related to the Merostomata, being likened to the larvæ of the Horse-Shoe Crab. The structure of the tergal part only of their body is well known. The longitudinal division into three lobes is not always distinct; but the head, thorax and abdomen (or tail) are generally well

defined. The eyes are sessile and compound. The head is covered by a crescent shaped shield or *buckler*; the thorax consists of from two to twenty-six segments; and the *pygidium*, or abdominal shield, is composed of a number of joints more or less anchylosed. The buckler is divided by a longitudinal depression into *cheeks*, or lateral areas, and the *glabella*, or middle area. A suture running from the anterior and posterior sides of the eye outward is called the *facial suture*; a prominent accessory piece on the under surface of the head, covering the mouth, is the *hypostoma*. The union of the head-crust by sutures is a remarkable peculiarity of Trilobites,—not being traceable in any other Crustaceans, and only found in true Insects of the present time. The genera of Trilobites are distinguished mainly by the form and markings of the head and tail, and by the eyes. Variations in the length of the cephalic and caudal spines, and in the prominence of the head-lobes, have been considered indications of difference of sex. No antennæ have been detected. Thoracic jointed limbs and branchiæ have recently been discovered, and the abdomen probably bore membranous respiratory swimmerets. They probably lived gregariously in the shallow waters of bays and coasts, and from the form of the labrum mouth, it is inferred that they were carnivorous. The embryos are simple discs. Barrande has made out the probable eggs. More than 500 species of Trilobites are known, grouped in about 70 genera. The order appeared in the Cambrian, culminated in the Upper Silurian, and disappeared in the Carboniferous. The spinous feature reached its maximum in the Devonian. Trilobites, incapable of rolling themselves up, are of more ancient geological date than those which can; they are chiefly found in the lower Silurian. Those having the power of rolling themselves up, have larger and more projecting eyes, a tougher horny membrane, and a caudal shield resembling the buckler.

No. 142. [376, Cast]. *Asaphas megistos*, Locke.

This specimen shows well the long posterior processes of the cephalic shield, which in this specimen extends nearly to the end of the tail. It is from the Cincinnati group (Lower Silurian), Cincinnati, Ohio.

No. 143. *Asaphas gigas*, Dalman.

PYGIDIUM. From Trenton Limestone, Trenton Falls, N. Y.

No. 144. [373, Cast]. *Asaphas gigas*, Dalmann.

This huge Trilobite, the *Isotelus gigas* of DeKay and *Isotelus megistos* of Locke, has an oval form and convex surface; the head and tail nearly equal, and both subtriangular; well developed eyes; eight body segments; and no glabella, nor any ribs on the tail. This cast is a restoration by Professor Locke from fragments discovered in the Trenton limestone (Lower Silurian), in Adams County, Ohio. It is well adapted for lecture purposes, exhibiting on a large scale the prominent parts of these ancient Crustaceans.

Size, 22 x 14.

No. 145. [386, Cast]. *Acidaspis Buchii*, Barrande.

This Trilobite is distinguished generically by its small but strongly arched body-rings, and by the surface being covered regularly with tubercules. This specimen is from the Lower Silurian slate at Beraun, Bohemia.

No. 146. [390, Cast]. *Bumastus (Illænus) Barriensis*, Murch.

This genus of Trilobites is characterized by the great breadth and convexity of the cephalic and caudal plates, and the faintness of the longitudinal, trilobite markings. The genus closely resembles *Illænus*, and this species is only distinguished from *Illænus crassicauda* by the fact that the broad axis is not strictly separated from the lateral lobes. The specimen is from the Niagara Group (Upper Silurian), New York.

No. 147. *Calymene niagarensis*, Hall.

TWO SPECIMENS. From the Niagara Group at Grafton, Ill.

No. 148. *Calymene senaria*, Conrad.

TWO SPECIMENS. From the Cincinnati Group, Waynesville, Ohio.

No. 149. [394, Cast]. *Calymene Blumenbachii*, Brongniart.

This well known genus derives its name from the obscurity which long hung over the real nature of these crustaceans. In this species, the cephalic shield is large, convex, rounded in front, with a well marked border, boldly three-lobed, and having prominent, but not very large eyes, set widely apart; the thoracic portion consists of thirteen segments; and the pygidium is small and nearly semi-circular. It is often found coiled up. This specimen is from the Upper Silurian at Dudley, England. The original is in the Ward Collection in the University of Rochester.

No. 150. [398, Cast]. *Ceraurus pleurexanthemus*, Green.

This genus is closely allied to the *Acidaspis* of Murchison. In this species the buckler is crescent form; the eyes small, distinct and granulated; the glabella deeply furrowed on each side; the thorax has eleven articulations, and the caudal shield four. This specimen is a restoration by adjustment of fragments from different individuals discovered in the Trenton Limestone and Hudson River Group (Lower Silurian).

No. 151. [407, Cast]. *Dalmania (Phacops) limulurus*, Green.

This Trilobite, also called *Asaphus limulurus*, is one of the most common forms. It has a sublunate buckler, a lobed glabella, eyes of medium size, eleven body articulations, and fifteen caudal. The body and caudal portion is more frequently found separated from the cephalic shield. This specimen is from the Niagara Group (Upper Silurian) at Lockport, N. Y.

No. 152. [409, Cast]. *Dalmania myrmecophora*.

PYGIDIUM. This specimen shows the broad, moderately convex caudal shield, with thirteen rings beautifully ornamented with a double row of nodes.

No entire specimen of this species—"the largest trilobite by far," says Hall, "which occurs in the higher rocks of our system"—has ever been found. From the Upper Helderberg Group (Devonian), Genesee Co., N. Y.

Size, 9 x 8.

No. 153. [410, Cast]. *Dalmania nasutus*, Conrad.

BUCKLER. From the Lower Helderberg (Upper Silurian) in Schoharie County, N. Y.

Size, 7 x 6.

No. 154. [412, Cast]. *Dalmania nasutus*, Conrad.

Pygidium, with spine; impression and relief. From the same locality as the preceding.

No. 155. [405, Cast]. *Dalmania* (*Cryphæus*) *calliteles*, Green.

Pygidium, showing the lobes more deeply cleft than in the preceding species. From the Hamilton Group, York, N. Y.

No. 156. [416, Cast]. *Dikelocephalus Minnesotensis*, Owen.

Central portion of the head with cheek, placed on the same slab with tail. The body segments are wanting in this specimen, and portions of the cheeks and tail are restored. This is one of the earliest of the Trilobite forms. From the Potsdam Sandstone (Lower Silurian), Maozmania, Wisconsin.

Size, 9 x 8.

No. 157. *Elipsocephalus Hoffi*, Schlotheim.

From Lower Silurian, at Ginetz, Bohemia.

No. 158. [421, Cast]. **Harpes unguia**, Barrande.

HEAD. From the Upper Silurian Limestone at Kronieprus, Bohemia. In this genus the head, which occupies more than a third in length of the whole animal, is surrounded by a broad, flat margin, which is produced posteriorly nearly to the extreme end of the body. The body-segments and tail are usually wanting, as is the case in this specimen. Original in the Ward Collection of the University of Rochester.

No. 159. [423, Cast]. **Homalonotus delphinocephalus**, Murch.

This genus is so named because the three-lobed aspect, so characteristic of the family, is, in a great measure obliterated, and the back appears smooth and uniform. The cephalic and caudal shields are hyperbolic; the rings number thirteen. This species is characterized by the distinct trilobation of the tail in all its stages of growth, as well as by its slender body and acute caudal extremity. The specimen is from the Upper Silurian at Dudley, England.

Size, 7 x 4.

No. 160. [426, Cast]. **Illænus giganteus**, Brong.

The general form of this species is variable, from its contractility. It has ten articulations; prominent eyes, and large, convex buckler and caudal shield. This specimen is from the Lower Silurian, Angers, France, and is in the Ward Collection of the University of Rochester.

No. 161. [428, Cast]. **Lichas Boltoni**, Green.

This beautiful Trilobite is easily recognized by its peculiar scabrous surface, depressed body and head, and the free extremities of the segments pointing backwards. The thorax is large and is divided into eleven segments. It is from the Niagara Group (Upper Silurian), Lockport, N. Y., where it is a characteristic fossil, although not often found entire.

Size, 7 x 6.

No. 162. [431, Cast]. *Lichas pustulosus*, Hall.

PYGIDIUM. From the Lower Helderberg (Upper Silurian), Schoharie County, N. Y.

No. 163. [437, Cast]. *Paradoxides Bohemicus*, Bock.

This genus is distinguished by a broad, club-shaped glabella, large head-spines, oblong eyes, from sixteen to twenty flat body-rings, and a very small pygidium. It includes some of the largest Trilobites known, which, to the number of about twenty species, characterize the Lower Silurian formation of Bohemia, Sweden and England. From the Lower Silurian at Ginetz, Bohemia.

Size, 6 x 3.

No. 164. *Phacops bufo* (Var. rana.), Green.

HEAD AND TAIL. Trilobites of the genus *Phacops* have very large, prominent, granulated eyes, forming a segment of a cone, distinct trilobation, and eleven body-rings. This species, the *Calymene macrophthalma* of Brongniart, and perhaps identical also with the *Phacops latifrons* of Bronn, has a very convex head, occupying one-third of the whole length, a tuberculated glabella, and the eleven pleuræ bent down at the extremities. There are 66 lenses in each eye. These specimens are from the Hamilton Group (Devonian), Otisco, N. Y.

No. 165. [445, Cast]. *Prætus longicaudus*, Hall.

In this genus, the eyes are of a moderate size, very prominent, smooth, and joined rather closely to the glabella; and the body has ten segments. This specimen (coiled) is from the Hamilton Group (Devonian), Iowa.

No. 166. [447, Cast]. **Sphærexochus mirus**, Beyrich.

This curious Trilobite has a globular head, projecting eyes, and ten pointed body-rings. It is from the Upper Silurian, Beraun, Bohemia.

No. 167. **Triarthrus Becki**, Green.

A fine specimen of this typical Trilobite. From Utica Slate, near Utica, N. Y.

No. 168. **Trinucleus ornatus**, Burm.

In this genus the pygidium is enlarged at the expense of the thorax; the former is triangular; and the latter has only six rings. The animal is never found fully rolled up. From Lower Silurian, Lodenitz, Bohemia.

No. 169. **Trinucleus concentricus**, Eaton.

HEADS. From the Hudson River Group, Rome, N. Y.

No. 170. [1296, Cast]. **Climactichnites Wilsoni**, Logan.

These tracks are now generally regarded as having been made by Trilobites. From the Potsdam Sandstone, Beauharnois, Canada. Size, 22 in. x 18 in.

CLASS ANNELIDA.

The name Worms (Vermes) is popularly applied to all the diverse organisms of an elongated and segmented character, but the lowest forms, including the so-called intestinal or parasitic worms and the rotifers, are properly separated and form the heterogeneous class Scolecida. The higher forms, included in this class (annelida or annulata), have distinctly segmented cylindrical bodies, but without division into thorax and abdomen. When lateral appendages exist they are not jointed, nor articulated to the body. The nervous system is a chain of ventral ganglia; and a system of tubes (pseudohæmal vessels), containing a colored plasma, takes the place of heart and blood vessels. Respiration may be through the skin, as in the Leech and Earthworm (Abranchiata), or by means of external gills, as in the marine forms (Branchiata).

Worms have left traces in every deposit in the form of shelly coverings, burrows, or imprints. Worm-holes abound in the Potsdam sandstones; they were made at tide-level, vertically, and often in pairs. The most common kind is the *Scolithus linearis*. Many supposed annelid borings and tubes have been named, the character of which are still uncertain. *Serpula* and *Spirorbis* seem to have existed since the Upper Silurian.

No. 171. *Scolithus linearis*, Hall.

These tubes were believed by Dr. Hall to be fucoid, but they are now generally regarded as the borings of "Errant" annelids. The burrows are nearly straight and extend vertically through the neck. From the Potsdam Sandstone, York, Penn.

No. 172. *Serpula*.

This still living genus secretes a long, shell-like tube of carbonate of lime, more or less tortuous, which are attached to some foreign body. It is one of the "Tubicolous" annelids; and its supposed tubes have been found in all the formations above the Lower Silurian. This specimen from the Quaternary, Palermo, Italy.

SUBKINGDOM

MOLLUSCA.

This subkingdom ranks side by side with the articulata, and the lowest forms of the two subkingdoms have such relationship that by some authors they are grouped as a distinct subkingdom. Linnæus placed all the mollusks with the vermes, and they are, perhaps, a specialized group of the latter. The highest mollusks are superior to the highest articulates; while in both, the lowest are inferior to many radiates. In articulates, there is an advance manifested in the powers of locomotion and in intelligence; in the mollusks the energies are expended chiefly in the functions of nutrition and reproduction.

Mollusks have the centres of the nervous system scattered unsymmetrically, and this is often accompanied with an unsymmetrical form of the unsegmented body. They have a complete alimentary canal, with mouth, stomach, intestine and vent; a liver, but no absorbent system; a chambered heart propeling a colorless blood through a system of arteries and veins; and either lungs or gills. They are hermaphrodite or bisexual, oviparous or viviparous. Two-thirds of the species are aquatic; many are exclusively oceanic, some are restricted to the brackish water of estuaries; others live only in fresh water, and some on land. Every region has its appropriated tribe; and so has each zone of depth in the sea, from the floating Pteropods to the Terebratulæ, sometimes found at 100 fathoms. Deep water shells are mostly small, and have a wide range and high antiquity. In compensation for the low condition of the perceptive energies, the body of the mollusk is commonly protected by one or more plates or shells, variously adjusted upon the soft parts of the animal.

Living species of mollusks number about 20,000, of which three-fourths are univalves; the others are mostly bivalves. The bivalves are all aquatic.

Mollusks are separable into the cephalous and acephalous. The former are nearly all univalves, and are subdivided according

to the modifications of the locomotive organs, into Cephalopoda, Gasteropoda and Pteropoda. Headless mollusks are bivalves chiefly, and are divided into Lamellibranchiata (Conchifera), Brachiopoda, Tunicata and Polyzoa. The last three classes constitute the division Molluscoida, the others being "true mollusks."

The natural families of mollusks now verging toward extinction, are the *Rhynchonellidæ*, *Trigoniadæ* and *Nautilidæ*. The following have already passed away: *Productidæ*, *Orthidæ*, *Spiriferidæ*, *Hippuritidæ*, *Orthoceratidæ*, *Ammonitidæ* and *Belemnitidæ*. Lamellibranchs have superseded Brachiopods; and Gasteropods vastly outnumber Cephalopods. The extinct families and genera attained their maximum more rapidly than their minimum.

The remains of shell-bearing mollusks are the most common of all fossils, and afford the most complete series of "medals" for the identification of strata. All the grand divisions of the sub-kingdom, even to the highest, are represented in the lowest rocks. Both the highest and lowest groups were abundant in the Palæozoic; the Lamellibranchs and Gasteropods attain their climax in existing seas. Fossil species number about 19,000, most of them being marine. They passed their culmination in the latter half of the Mesozoic; but the largest number of species occur in the Miocene.

CLASS CEPHALOPODA.

The Cephalopods are the most highly organized of mollusks. We recognize elements which belong to the higher and lower forms of life; the beak and complex eye, the tongue and ear, the crop and gizzard, the partial segmentation of the yolk, the Chameleon habit of changing color, the cartilaginous brain-case, point to the vertebrates; while the pharyngeal ganglion, the shell and phragmocone, the tentacles and suckers, and the odontophore have analogues in the invertebrates.

Cephalopods are marine and carnivorous; nocturnal and social; oviparous and bisexual—the females being larger and more numerous than the males. The locomotive organs are attached to the head, but the animal is able to swim by means of fins, and also by ejecting the respiratory water from the “funnel.” Unlike many other mollusks, they are symmetrical; and the shell is usually straight or coiled in a vertical plane, instead of being spiral as in the unsymmetrical Gasteropods. The Nautilus and Argonaut alone of living species have external shells; the rest are naked.

ORDER DIBRANCHIATA.

The members of this order have a pair of gills, and with the single exception of the *Argonauta* have an internal shell, secreted by the thick mantle, which is sometimes called the skeleton, but which has nothing to do with protecting the nervous centres. The “cuttle-bone” of *Sepia*, the “pen” of the Squid (*Loligo*), and the fossil *Belemnites* are examples. The unique shell of the Paper Nautilus (*Argonauta*) is secreted by two webbed tentacles of the female. They are well protected by eight or ten powerful arms, furnished with suckers, a parrot-like horny beak, perfect organs of vision, vigorous circulation, and the power to secrete an inky fluid with which to cover their retreat. The Giant-cuttle is the largest of all animals not supported by a jointed skeleton. Specimens of *Architenthis* have been found with a length of forty feet, and jaws of much larger individuals have been found in the stomachs of Sperm Whales. The order first appeared in the Lias, and is now the ruling group of the mollusks.

No. 173. [463, Cast]. *Beloteuthis subcostata*, Munst.

OSSELET. This flattened Calamary receives its generic name from its supposed affinity to the living Squid. The osselet, or rudimental shell, represented in this specimen, is broad and rounded at each end, and in its form approaches nearly to the osselet of the living *Sepia* of the Mediterranean. It was found in the Lias at Holzmaden, Wurtemberg.

Size, 6 x 3.

No. 174. [466, Cast]. *Belemnosepia* — Agassiz.

An undescribed species. The osselet of this genus is characterized by a wide shaft, and is frequently accompanied by a well-preserved ink-bag. This specimen shows the muscular tissues of the body, fins and arms, with traces of the non-nacreous pen. It is from the Oxford Clay (Middle Oolite), Christian Malford, England, and is in the private Geological Cabinet of Mr. Ward, Rochester.

Size, 10 x 4.

No. 175. [456, Cast]. *Belemnites Owenii*, Pratt.

GUARD. The Belemnite is the most complicated of Cephalopod shells. The chambered part, or *phragmocone*, is a straight, attenuated cone with numerous septa, resembling a pile of watch-glasses, concave towards the base. The whole is enveloped in a sheath; and the two together are lodged in a conical cavity or alveolus, excavated in the base of a long spathose body (corresponding to the *muco* of the cuttle-bone), resembling the head of a javelin, whence the generic name. The exterior of this "guard," as it is called, has usually a longitudinal groove; and the septa of the phragmocone are perforated by a marginal siphuncle generally situated on the side nearest the groove; but in certain species, characterized by a flattened guard, the siphuncle is on the opposite side. Besides these fossil parts, there have been found remains of the ink-bag, pen, mantle, mandibles, arms and hooks. The Belemnitidæ culminated in the Mesozoic. This specimen, now in the Ward Collection of the University of Rochester, is from the Oxford Clay (Upper Oolite), at Christian Malford, England. The fractured upper portion shows the alveolar cavity with the phragmocone in place.

Size, 6 x 2.

No. 176. [460, Cast]. *Belemnites dilatatus*, Blainv.

GUARD. This Belemnite has a compressed guard and the longitudinal furrow situated on the margin opposite the siphuncle. The form is characteristic of the Neocomian beds. These specimens (three in number) are from the Lower Neocomian (Cretaceous), France, and belong to the Ward Collection, University of Rochester.

No. 177. *Belemnites hastatus*, Blainv.

* In this species the conotheca seems to have been extended in a broad, simple plate. From the Oolite, Weymouth, England.

No. 178. *Belemnites densus*, M. & H.

The guards of this species which are quite common in some of the Jurassic beds of the Black Hills region, appear to be very variable in thickness and to be closely related to *B. Panderisnus*, d'Orb. From Rapid City, Dakota.

No. 179. *Belemnites elongatus*, Miller.

From Middle Lias, Charmouth, England.

No. 180. *Belemnite* ———, Lamarek.

INK-BAG. The sepia of the dibranchs is frequently found fossilized, and yet capable of being used as an ink-bag. Some ink-bags are nearly a foot long. From Lyme-Regis, England.

No. 181. *Belemnitella mucronata*, Schlot.

"The guards of this genus are mainly distinguished from those of *Belemnites* by their ventral slit and vascular markings. And the genus appears to be entirely confined to the horizon of the true Chalk and the Upper Greensand of English geologists, and has an almost world-wide geographical range, wherever beds of these horizons occur. Like *Belemnites*, these mollusks seem to have been gregarious in their habits." These specimens are from the Greensand (Upper Cretaceous) of Marlborough, N. J.

ORDER TETRABRANCHIATA.

The tetrabranchs have two pairs of gills; numerous retractile tentacles devoid of suckers, and a head retractile within an external shell. This shell is a long cone, straight, folded or coiled, and divided into chambers by a series of curved septa, connected by a siphuncle which is central, ventral or dorsal. The animal lives in the outer chamber, but holds connection with the deserted rooms of its dwelling by means of the siphuncle. The shell is

* When the species is of small size it will be represented by a number of specimens,—in all cases sufficient to illustrate it.

believed to be filled with air and to act as a float. The exact function of the siphuncle is still unknown. The members of this order possess no ink-bag. There is only one living tetrabranch—the *Nautilus*, and this is one of the few genera which have existed at every period of the world's history. Toward 5,000 species have been named, but many of them may be the internal shells of dibranchs. This order came first, and culminated as the more highly organized Cuttles made their appearance. The four-gilled type began in the straight *Orthoceras* and half-coiled *Lituities* of the Silurian, culminated in the complex *Ammonites* of the Jurassic, and declined in the Cretaceous through the half-coiled forms and the straight *Baculites*. The straight tetrabranchs must have lived habitually in a nearly vertical position, while the discoidal genera would also creep over the sea-bed with their chambers above them.

FAMILY AMMONITIDÆ.

This is the most remarkable family of Secondary mollusks. Some twenty or more genera, and several thousand species, have been identified. They range from the Devonian to the Cretaceous, inclusive, becoming totally extinct at the close of the Reptilian Age. The family includes the following principal genera in the order of their appearance: *Goniatites*, *Ammonites* proper, *Ancyloceras* and *Helicoceras*, *Crioceras*, *Toxoceras*, *Scaphites*, *Hamites*, *Baculites* and *Ptychoceras*, and *Turrilites*. The type began in the discoidal *Goniatites*, culminated in the compactly coiled and elaborate *Ammonites*, and expired in the half-uncoiled forms as *Scaphites*, the spiral *Turrilites*, and the straight *Baculites*.

This division of chambered shells is distinguished from the succeeding families by more varied and more highly ornamented forms, with crumpled septa, lobed sutures, and dorsal siphuncle. The shells are most beautiful when of middle growth, the ornamental characters being less developed in the young, and lost in the very old; and on account of this change of form and ornamentation with age, the old classification of von Buch and d'Orbigny is no longer satisfactory. Efforts have been made by several naturalists to systematize the family. Prof. A. Hyatt

and Dr. Paul Fischer would raise the family to the rank of an order. Excepting the *Goniatites*, the family is peculiar to, and co-extensive with, the Secondary strata. *Ammonites* proper inhabited involute shells, having undulating septa, lobed and foliated sutures, a dorsal siphuncle (ventral as regards the animal), and a small nucleus, the whorl being compact from the first. According to d'Orbigny, the compressed specimens are males, and the inflated, females. Supposed opercula (*Aptychi*) are frequently found associated with these shells. The shell of the *Ammonites* is generally thinner and more delicate than that of the *Nautilus*; the partitions are consequently more complicated, and the ribs are adorned and strengthened with spines, tubercles and bosses. With few exceptions, those having the back keeled, with a furrow on each side, mark the Lias period; while those with sharp, square or round backs are Oolitic. *Ammonites* are rare in the Jurassic of America, but abound in Europe, and they have been seen in Oolitic deposits on the Himalayas, 16,200 feet above the sea. The Jurassic *Ammonites* were of far higher grade than the living *Nautilus*.

No. 182. *Goniatites Ixion*, Hall.

The *Goniatites* were the earliest of the family *Ammonitidæ*. This specimen closely resembles *G. rotatorius* of DeKoninck, and is a very characteristic fossil of the *Goniatite Limestone* at Rockford, Indiana.

No. 183. *Goniatites Oweni*, Hall.

The most prominent feature separating this species from the preceding is the presence of an umbilicus. *Goniatite Limestone*, Rockford, Indiana.

No. 184. *Ceratites nodosus*, De Hann.

This genus is distinguished by having the lobes of the sutures serrated, while the intervening "saddles" are simple. This specimen is from the *Muschelkalk* (Trias), at Niederbronn, Alsace.

No. 185. [467, Cast]. **Ammonites armatus**, Sowerby.

This species is typical of Von Buch's Group "*Armati*." From the Lower Lias, Charmouth, England.

No. 186. [470, Cast]. **Ammonites athletus**, Phillips.

From the Kelloway Rock (Middle Oolite), Yorkshire, England, and now in the Ward Collection, University of Rochester.

No. 187. **Ammonites Batesii**, Thrash.

This is a very typical species of the California Cretaceous. From Cottonwood Creek, Shasta Co., California

No. 188. **Ammonites bifrons**, Bruguiere.
(A. Walcotii, Sow).

This species is characteristic of the lower portion of the Upper Lias, and belongs to Von Buch's Group "*Fulciferi*." The specimen is from the Upper Lias, Whitby, England.

No. 189. [473, Cast]. **Ammonites bisulcatus**, Brug.

This Ammonite is frequently known by Sowerby's name of *A. Bucklandi*. It is the type of the group, "*Arietes*" of Von Buch. From the Lower Lias, Rautenberg, Brunswick.
Diameter, 13 in.

No. 190. [475, Cast]. *Ammonites Blagdeni*, Sow.

This fine specimen closely resembles *A. coronatus*, and belongs to the same group, "*Coronati*." It is from the Lower Oolite, Dorsetshire, England, and now in the Ward Collection, University of Rochester.

Diameter, 7.

No. 191. [476, Cast]. *Ammonites Birchii*, Sow.

This elegant form, with the outer markings of the shell visible upon all its whorls, and a double row of spines, belongs to the group "*Armati*." It is from the Lower Lias, Charmouth, England, and belongs to the Ward Collection, University of Rochester.

Diameter, 8.

No. 192. [478, Cast]. *Ammonites Brongniarti*, Sow.

This curiously inflated species is from the Lower Oolite, Yeovil, England.
Diameter 10.

No. 193. [479, Cast]. *Ammonites concavus*, Sow.

This species belongs to the group "*Disci*." From the Lower Oolite, Bridport, England, and now in the Ward Collection, University of Rochester.

No. 194. *Ammonites complanatus*, Brug.

From the Upper Lias, Millan, France.

No. 195. [481, Cast]. *Ammonites Comptoni*, Pratt.

This species is closely allied to the well-known *A. Jason*, but it is distinguished from it by wanting the spines which ornament that species. Like it, it has long, narrow, lateral processes extending from the lip of the shell. It is associated with *A. Jason* in the Oxford Clay (Middle Oolite), Christian Malford, England.

No. 196. *Ammonites cordatus*, Sow.

These young shells show the cordate keel from which the specific term is derived, and which assigns the species to the group "*Amalthei*." From the Middle Oolite at Viel St. Remy, France.

No. 197. [484, Cast]. *Ammonites cordatus*, Sow.

Internal cast of the adult shell showing the foliations. This species varies in size, among adult individuals, from one to eight inches in diameter. From the Oxford Clay (Middle Oolite), Calvados, France, and now in the Ward Collection, University of Rochester.

No. 198. [486, Cast]. *Ammonites coronatus*, Brug.

This species from the Middle Oolite, very much resembles *A. gigas*, Ziet, of the Upper Oolite. It is the type of Von Buch's group "*Coronati*." From Villere, France, and now in the Ward Collection, University of Rochester.

No. 199. [488, Cast]. *Ammonites cornucopiæ*, d'Orb.

This elegant Ammonite very closely resembles *A. fimbriatus*, Sow., but is considered by d'Orbigny a distinct species. Its several whorls are coiled quite loosely, and taper very rapidly towards the center of the shell. From the Upper Lias, Verpillière, France, and now in the Ward Collection, University of Rochester.

No. 200. *Ammonites communis*, Sow.

This species is very frequently found forming the central nucleus of discoid concretions of slaty limestone. These concretions owe their origin to the attracting and cementing power of the decomposing mollusk. From the Upper Lias, Whitby, England.

No. 201. [490, Cast]. *Ammonites fimbriatus*, Sow.

This species is characteristic of the group "*Fimbriati*." The specimen shows the ornamental characters of the external shell. The lines of periodical enlargement or growth are very marked on this shell. From the Middle Lias, Charmouth, England.

No. 202. [492, Cast]. *Ammonites gigas*, Zieten.

This species belongs to the group "*Coronati*." From the Upper Oolite, Yonne, France.

Diameter, 9.

No. 203. [494, Cast]. *Ammonites giganteus*, Sow.

This is assigned to the group "*Planulati*" of Von Buch. From the Upper Oolite, Isle of Portland, England.

Diameter, 26.

No. 204. [495, Cast]. *Ammonites Goliathus*, d'Orb.

On pedestal. This specimen, an inner cast of a species allied to the *A. modiolaris*, shows well the outer markings of the lobes, and the floor of one of the septa. The original is from the Middle Oolite of Dives, France.

No. 205. *Ammonites Henleyi*, Sow.

Pictet refers this to the group "*Macrocephali*." This is one of the most symmetrically ornate of Ammonites. From the Middle Lias, Charmouth, England, and now in the Ward Collection, University of Rochester.

Diameter, 6.

No. 206. [499, Cast]. *Ammonites heterophyllus*, Sow.

This specimen shows well the elegant and leaf-like foliations which characterize the group "*Heterophylli*." It also shows the floor of one of the chambers, with the arrangements of the saddles and lobes. From the Upper Lias, Reutlingen, Wurtemberg. Diameter, 7.

No. 207. *Ammonites Humphriesianus*, Sow.

This species belongs to the group "*Coronati*." It is one of the few *Ammonites* which have preserved the full contour of the front aperture or "mouth" of the shell. From the Lower Oolite, Yeovil, England.

No. 208. [503, Cast]. *Ammonites interruptus*, Brug.

The varieties of this very variable form have been described under many different names, such as *A. Delucii*, Brong., *A. dentatus*, Sow., *A. Bennetianus*, Sow., *A. serratus*, Sow., etc. From the Lower Cretaceous, St. Florentin, France, and now in the Ward Collection, University of Rochester.

No. 209. [505, Cast]. *Ammonites Jason*, Reinecke.

This beautiful species belongs to the group "*Ornati*" of Von Buch. The specimens from the Oxford Clay of Christian Malford, England, where this was found, are compressed in the marl, but show well two lateral shelly processes developed on each side of the aperture. This feature is found in the young of many species of *Ammonites*, but is lost on their attaining the adult form. Original in the Ward Collection, University of Rochester.

No. 210. *Ammonites Lamberti*, Sow.

From the Oxford Clay (Oolite), Weymouth, England.

No. 211. *Ammonites laticostatus*, Sow.

This is most probably identical with *A. capricornus* of Schlotheim, and is very typical of the group "*Capricorni*." In its adult stage, this species loses its characteristic form, and assumes one somewhat resembling *A. Buchii*, Sow. In this state it has received various synonyms, but it is best known as *A. heterogenus*. From the Middle Lias, Charmouth, England.

No. 212. *Ammonites latus*, Park.

From the Gault (Cretaceous), Folkestone, England.

No. 213. *Ammonites macrocephalus*, Schloth.

This is the type of Von Buch's group "*Macrocephali*," which resemble the "*Coronati*," but are ordinarily more inflated, and have tubercles nearer the umbilicus. From the Middle Oolite, Wurtemberg.

No. 214. *Ammonites mammilatus*, Schloth.

From the Lower Cretaceous of Macheromenil, France.

No. 215. *Ammonites Mantelli*, Sow.

The Cretaceous Ammonites appear to have had such tendency to variation, that specific names have been needlessly multiplied, and hence this well known Ammonite has been described under several synonyms. It belongs to the group "*Rhotomagenses*." From the Lower Chalk, St. Florentin, France.

No. 216. *Ammonites margaritatus*, Mumfort.

Synonym of *A. amaltheus*, Schloth, and type of group "*Amalthei*," of Von Buch, or Ammonites with cordate keels. This is an exceedingly variable species. From the Middle Lias, Charmouth, England.

No. 217. [521, Cast]. *Ammonites obtusus*, Sow.

This Ammonite is well known from the Lower Lias of England, where the casts of the interior, preserved in beautifully colored calc spar, are known as "Tortoise-shell Ammonites." It belongs to the group "*Arietes*." This specimen is from the Lower Lias, Charmouth, England.

Diameter, 9.

No. 218. [519, Cast]. **Ammonites modiolaris**, Luid.

Also known as *A. sublaevis*, Sow. This is one of the most inflated, yet deeply umbilicated, of all Ammonite forms. From the Kelloway Rock, Wiltshire, England, and now in the Ward Collection, University of Rochester.

No. 219. **Ammonites Murchisonæ**, Sow.

This shell, so characteristic of the inferior Oolite of Europe, probably belongs to the group "*Dentati*," the culmination of which is in the Cretaceous series. From Bridport, England.

No. 220. [523, Cast]. **Ammonites peramplus**, Mant.

This gigantic specimen is from the Chalk, Germany.

Diameter, 31.

No. 221. [524, Cast]. **Ammonites perarmatus**, Sow.

From the Oxford Clay (Middle Oolite) Calvados, France.

Diameter, 6.

No. 222. **Ammonites placenta**, DeKay.

This is one of the most characteristic fossils of our Western Cretaceous. From the Black Hills, Dakota.

No. 223. **Ammonites planicostatus**, Sow.

This small form would appear to belong to the group "*Capricorni*," but as it increases in age, it assumes a single row of spines, in some instances very largely developed, and thus puts on the character of the group "*Armati*," and becomes the *A. Dudressieri*, d'Orb. This specimen is a slab covered with numerous shells, and is from the Lower Lias, Dorset.

No. 224. *Ammonites Rothomagensis*, Brong.

This is the the type of the group "*Rothomagenses*," the members of which are characterized by having a series of tubercles along the dorsal line in place of a keel. They belong chiefly to the Cretaceous period. From the Lower Chalk, Dover, England.

No. 225. [530, Cast]. *Ammonites Rothomagensis*, Brong.

An internal cast of part of one whorl, showing the foliations. From the same locality, and now in the Ward Collection, University of Rochester.

Diameter, 7.

No. 226. *Ammonites semisulcatus*, d'Orb.

From the Cretaceous, Drome, France.

No. 227. [531, Cast]. *Ammonites serpentinus*, Schloth.

This is the type of the group "*Falciferi*," which have a compressed shell with sharp keel. The folds of the shell are numerous, and usually bend with an abrupt curve in the middle of their course. From the Upper Lias, Charmouth, England.

Diameter, 7.

No. 228. *Ammonites splendens*, Sow.

This variable Ammonite, is a characteristic fossil of the Gault (Cretaceous), Folkestone, England.

No. 229. [1203, Cast]. *Ammonites tornatus*, Brown.

This Ammonite belongs to the group "*globosi*," characterized by being very closely coiled, umbilicus quite small or wanting, surface smooth or feebly striated, and devoid of ribs and tubercles. It is from the Trias at Hallstadt, Austria, and is now in the Ward Collection, University of Rochester.

No. 230. *Ammonites Woollgari*, Mant.

This species is one of the most marked forms in the group "*Rothomagenses*." It has much resemblance to *A. Rothomagensis*, particularly in the young stage; but differs from it by having less closely coiled whorls, and the ribs fewer, more salient, and more angular on either side of the dorsal plane. From the Cretaceous of Smith's Branch, Texas.

No. 231. *Ammonites*.

POLISHED SECTION, showing the septa. From the English Lias.

No. 232. *Trigonellites (aptychus) latus*, Park.

These objects were described by Meyer as bivalve shells, under the name *Aptychus*, and by Deslongchamps under the name *Munsteria*. d'Orbigny and Pictet regard them as *Cirripedes*. Deshayes considers them the gizzards of Ammonites; Coquand compares them with *Teudopsis*; Ruppell, Voltz, Quenstedt and Zieten, regard them as the opercula of Ammonites. Woodward, Owen and the majority of English geologists are of this last opinion, specimens having occasionally occurred in which the aperture of the shell was closed by the Aptychus. The name *Trigonellites* was given by Parkinson in 1811. This specimen consists of two pairs, showing both sides. From the Lithographic Limestone (Middle Oolite), Solenhofen, Bavaria.

No. 233. [550, Cast]. *Crioceras* ———, Leveillé.

On pedestal. The original of this specimen was brought by Humboldt from the Lower Cretaceous at Santa Fe de Bogata, S. A. Size, 12 x 10.

No. 234. [552, Cast]. *Crioceras Duvalii*, Leveillé.

This genus has all the essential characters of the Ammonites, save that its whorls are open, not touching each other in the enrolling of the shell. From the Lower Neocomian (Cretaceous), Escragnoles, France.

Size, 11 x 8.

No. 235. [451, Cast]. *Ancyloceras gigas*, Sow.

This magnificent and perfect specimen (called by Sowerby *Scaphites gigas*), is from the Lower Greensand (Cretaceous), Atherfield, Isle of Wight. Size, 18 x 12.

No. 236. [563, Cast]. **Scaphites Ivanii**, Puzos.

In this genus the shell is first discoidal, with close whorls, the last chamber detached and recurved. From the Lower Greensand, Barrême, France.

No. 237. **Scaphites aequalis**, Sow.

This is from the Grey Chalk (Lower Cretaceous), Rouen, France.

No. 238. **Scaphites nodosus**, Owen.

From the Cretaceous, Cheyenne River, Black Hills, Dakota.

No. 239. [560, Cast]. **Helicoceras rotundum**, Sow.

The whorls of this genus, when not distorted by pressure, are separate and spiral, not discoidal. From the Gault (Lower Cretaceous), Folkestone, England.

No. 240. [567, Cast]. **Turrilites costatus**, Lamarck.

The eccentric, spiral coiling of the shell in this genus is a feature peculiar to it among all the many and varied cephalopod forms, and gives it in external appearance not a little the look of a Gasteropod. From the Chalk Marl, Lower Cretaceous, Rouen, France, and now in the Ward Collection, University of Rochester.

Size, 6 x 3.

No. 241. [557, Cast]. **Hamites (Hamulina) cinctus**, d'Orb.

From the Upper Neocomian (Cretaceous), Barreme, Basses Alps, France.

Size, 14 x 4.

No. 242. [545, Cast]. *Baculites anceps*, Lam.

The Ammonitidæ, whose forms have been gradually more and more unrolled as we ascend in the geological series, terminate in the Upper Chalk with this perfectly straight form. The shell of this fossil seems to have been very thin, and usually, as in the present specimen, the cast of the chambers alone remains. The original, from the Upper Chalk of France, is in the Ward Collection of the University of Rochester.

Size, 19 x 3.

No. 243. *Baculites compressus*, Lay.

This species is larger and less slender than the above, and the specimens show a portion of the outer shell. From the Crétaceous, Black Hills, Dakota.

FAMILY NAUTILIDÆ.

This family includes those chambered cephalopod shells having simple, concave septa, smooth sutures, and an internal, simple, nearly central siphuncle. With the exception of *Nautilus* and *Aturia*, it is almost entirely confined to the Palæozoic rocks.

The first true *Nautilus* with regular spiral appeared in the Upper Silurian; and the Nautiloid form has survived to the present day. The family culminated in the Carboniferous Age. The *Nautilus* is the only representative in the existing seas of that vast assemblage of chambered siphonated shells which swarmed in the ancient oceans. There are six living species of *Nautilus*, *pompilius* being the common one, and nearly 300 fossil species.

The horny beaks of the family are frequently found fossil; the upper beaks are called *Rhyncholites* and the lower ones *Conchorhynchus*.

No. 244. [570, Cast]. *Nautilus elegans*, Sow.

This very characteristic species of the Lower Chalk is from Havre, France.

Size, 10 x 9.

No. 245. [574, Cast]. *Nautilus pseudo-elegans*, d'Orb.

This fine specimen is an inner cast, and shows the septa of the shell. From the Chalk of Rouen, France, and now in the Ward Collection, University of Rochester.

Size, 6 x 5.

No. 246. *Nautilus semistriatus*, d'Orb.

This large specimen is from the Middle Lias, Charmouth, England.

No. 247. [595, Cast]. *Nautilus Maximus*, Conrad.

This species is more loosely coiled than any of the preceding. The umbilicus is wide and deep, and the chamber of habitation is very large. From the Hamilton Group (Devonian), of Madison Co., N. Y. Diameter, 14.

No. 248. [580, Cast]. *Lituities undatus*, Conrad.

This rare and remarkable shell is a Palæozoic ally of the *Nautilus*, from which genus it differs mainly by the complete exposure of all its whorls, and the straightness of the last chamber. It appeared in the earliest Silurian. From the Black River Limestone (Lower Silurian), Middleville, N. Y.

FAMILY ORTHOCERATIDÆ.

These tetrabranch cephalopods were the princes of mollusks in Palæozoic times, being more abundant and attaining a larger size than any other fossil shell. They resemble in general uncoiled *Nautilidæ*, being conical shells divided by simple septa, concave next the outlet. The siphuncle is usually central, but sometimes marginal, and always complicated. The shell is sometimes curved, but never completely coiled as in the *Nautilus*; and the animal was probably unable to withdraw itself into the shell—the body chamber being relatively smaller than that of the *Nautilus*. The shell, however, was essentially external. They appear in the Cambrian, culminate in the Silurian and disappear in the Triassic. 1200 species have been named. Some authors include them under *Nautilidæ*.

These tetrabranchs were probably the chief agents in performing the duties allotted to the marine carnivora. The New York specimens are most numerous in the Trenton Limestone. Those with a large siphuncle are wanting in England, France, Ireland and Bohemia, but abound in America, Russia and Sweden.

No. 249. *Orthoceras Duseri*, H. & W.

In this type genus the shell is straight; siphuncle complex and nearly central, and the aperture sometimes contracted. From the Cincinnati Group, Waynesville, Ohio.

No. 250. [585, Cast]. *Orthoceras amplicameratum*, Hall.

On slab. This handsome specimen from the Trenton Limestone (Lower Silurian) of Middleville, N. Y., shows the entire length of the last chambers, with faint traces of the mouth. The shell being gone, the chambers of the posterior portion are visible. The original is now in the Ward Collection, University of Rochester.

Size, 9 x 4.

No. 251. *Eudoceras proteiforme*, Hall.

This genus has the shell elongated and cylindrical, and the siphuncle large, eccentric, and containing conical tubes or diaphragms. From Utica Shale (Lower Silurian), Holland Patent, N. Y.

No. 252. [592, Cast]. *Gomphoceras inflatum*, Quenst.

This genus is characterized by a form spindle-shaped or sub-spherical, produced by an abrupt tapering or contraction of the last chamber towards the mouth; which latter is frequently of a very sinuate and irregular form. This specimen, which shows the septa and the last chamber, is from the Middle Devonian of the Eifel, Rhine Valley, and is now in the Ward Collection of the University of Rochester.

No. 253. [598, Cast]. *Cyrtoceras macrostomum*, Hall.

The *Cyrtoceras* differs from *Orthoceras* chiefly in the eccentric siphuncle, and in the direction of its shell, which is simply arched or bowed like a horn, but never rolls up in a spiral. Barrande has described nearly two hundred and fifty species from the Silurian of Bohemia. This specimen is from the Trenton Limestone (Lower Silurian), Mineral Point, Wisconsin.

No. 254. [602, Cast]. *Gyroceras trivolvis*, Hall.

This shell is nautiloid; whorls separate, and the siphuncle eccentric and radiated. The genus is very closely related to *Lituites*. From the Upper Helderberg (Devonian) of Schoharie Co., N. Y.

Diameter, 6.

CLASS GASTEROPODA.

These "belly-footed" mollusks are the types of the subkingdom. The characteristic mode of locomotion is exemplified by the common Snail, which crawls by the alternate expansion and contraction of its foot. The head is usually furnished with eyes, tentacles and odontophore. Respiration is either by gills, exposed or covered, or by a skin-lung (in the Pulmonata). Gasteropods are terrestrial or aquatic; bisexual or hermaphrodite; oviparous or ovo-viviparous.

Bilateral symmetry is marked in the naked gasteropods, but with few exceptions, the visceral part is asymmetrically coiled up in a shell, usually spiral and univalve. The apex of the cone (save in the Nucleobranchs), is always oblique and eccentric; this departure from a perfect spiral is owing to the unequal development of the two sides of the animal. The spirals are mostly right-handed. No shell is multilocular like the Ammonites, but it may be simply a cone (*Patella*), or multivalve (*Chiton*). The muscular impression is crescent-shaped. The operculum is equivalent to the dextral valve of Lamellibranchs.

The class is divided into orders distinguished chiefly by the form and position of the respiratory organs. The living species have world-wide range, inhabiting the bottom and surface of the sea, sea-shore, fresh water and dry land, and in number rank next to insects. The fossil species are found in every fossiliferous rock from the Cambrian upward. The marine forms with entire (unnotched) apertures (Holostomata), mostly vegetarian, predominate in the Palæozoic strata; the siphonated species (Siphonostomata), indicated by the notched or produced apertures, mainly carnivorous, are more abundant in the Mesozoic and later time, and are at their maximum to-day. The remains of gasteropods are highly important to the geologist, as they afford him unequivocal evidence of the terrestrial, fluvial, lacustrine or marine condition under which strata were formed.

ORDER PROSOBRANCHIATA.

No. 255. *Murex caticulata*, Broc.

The Muricidæ commence in the Mesozoic, and characterize the Tertiary and recent time. There are 160 fossil species and 200 living. Pliocene, Fosetta, Italy.

No. 256. *Fusus longaevus*, Lam.

300 species of the genus are known since the Cretaceous, and 65 now living in the tropics, or subtropics. The genus is the type of the family Fusidæ. Eocene, Grignon, France.

No. 257. *Fusus antiquus*, Müller.

(Contrarius, Sow.)

An interesting reversed form, and a very characteristic shell of the Red Crag (Pliocene Tertiary), Walton, England.

No. 258. *Fusus antiquus*, Muller.

(Contrarius, Sow.)

Quaternary, Palermo, Sicily.

No. 259. *Buccinum stromboides*, Lam.

The family Buccinidæ, with the Muricidæ, is characteristic of the Tertiary and recent time. Eocene, Grignon, France.

No. 260. *Pisania plicata*, Broc.

The subfamily Pisaninæ to which the genus belongs is included in the family Buccinidæ. Pliocene, Modena, Italy.

No. 261. *Nassa senilis*.

This genus is the type of family Nassidæ. It dates from the Eocene. These specimens are from the Miocene, Montegibia.

No. 262. *Nassa limata*, Chemn.

Pliocene, Modena, Italy.

No. 263. *Voluta cithara*, Lam.

250 fossil species of this type genus of the family Volutidæ are known from the Cretaceous and later strata. The genus exists in the tropics to-day. Eocene, Grignon, France.

No. 264. *Oliva Greenoughii*, Lea.

This genus dates only from the Eocene. It is the type of the family Olividæ. Eocene, Claiborne, Alabama.

No. 265. *Columbella nassoides*, Bell.

A large and varied genus in present seas, and represented in the Tertiary. Family Columbelloidæ. Miocene, Baden.

No. 266. *Pleurotoma demidiata*, Broc.

This genus, of which 500 species are now living, has a fusiform shell with a long canal, and eyes at the base of widely-separated tentacles. It is the type of the family Pleurotomidæ. Miocene, Soos, Austria.

No. 267. *Pleurotoma turricula*, Broc.

Miocene Tertiary, Baden.

No. 268. *Conus striatulus*, Broc.

The large family Conidæ are principally tropical. This genus dates from the Cretaceous. Upper Pliocene, Colli, Artesi, Italy.

No. 269. [608, Cast]. *Rostellaria carinata*, Mant.

This genus belongs to the family Strombidæ, and was nearly twenty times more abundant in former geological times than in our own; during the Cretaceous period it was represented by some very extreme forms, of which the present specimen is one. From the Gault, Folkestone, England.

No. 270. *Rostellaria fissurella*, Lam.

Eocene, Grignon, France.

No. 271. *Aporrhais pes-pelicans*, Lam.

Only four species are living of this genus which has existed since the early Jurassic. It belongs to the Strombidæ. Quaternary, Palermo, Sicily.

No. 272. *Cassidaria echinophora*, Lam.

30 fossil forms of this genus of the Cassidæ family are known from the Cretaceous and later strata. Postpliocene, Ficarizzi, near Palermo, Sicily.

No. 273. *Pyrula bulbus*, d'Orb.

The genus is named from the thin, pear-shaped shell. Eight species are still living. It is found in Cretaceous strata. Family Doliidæ. Eocene, Grignon, France.

No. 274. *Pyrula (Tudicea) rusticula*, Bast.

Miocene, Grund, Hanover.

No. 275. *Natica sigaretina*, Desh.

This genus of predaceous blind mollusks, with subglobular shells, has had a world-wide distribution since the Silurian, 500 being fossil and 200 living. Family Naticidæ. Eocene, Paris basin, France.

No. 276. *Natica millepunctata*, Lam.

Quaternary, Palermo, Sicily.

No. 277. *Natica helicina*, Broc.

Miocene, Soos, Austria.

No. 278. *Crepidula cornu-arietes*.

A septum covers the posterior half of the interior of the shell in this genus, which is widely distributed now, living since the Cretaceous. Family Calyp-teidæ. Eocene (Claiborne Epoch), Claiborne, Alabama.

No. 279. *Xenophora crispa*, Chem.

The genus, found fossil since the Devonian, is small to-day. It belongs to the family Onustidæ. Quaternary, Mt. Pelegrini, Sicily.

No. 280. [622, Cast]. *Euomphalus pentangulatus*, Sow.

This genus, now entirely extinct, was present in considerable numbers in the Palæozoic seas, from the Lower Silurian to the Trias. Its discoidal form, angular whorls, and large umbilicus, make it a shell easily recognizable, and a serviceable fossil in the determination of the age of strata in which it occurs. This specimen is from the Carboniferous Limestone of Kildare, Ireland.

No. 281. *Raphistoma lenticulare*, Sow.

Trenton Limestone, Jefferson Co., New York.

No. 282. *Opalia varicostata*, Stearns.

Tertiary, San Diego, California.

No. 283. *Opalia anomala*, Stearns.

Tertiary, San Diego, California.

No. 284. *Turritella turris*, Bast.

The family Turritellidæ dates from the Triassic, and this type genus has the same range.

Miocene, Grund, Hanover.

No. 285. *Turritella Mortoni*, Con.

Claiborne Epoch (Eocene), Monroe Co., Alabama.

No. 286. *Turritella terebra*, Linn.(*Turritella triplicata*, Born.)

Quaternary, Palermo, Sicily.

No. 287. *Cyclonema bilix*, Con.

Forty species are known of this genus, from the Palæozoic. Family Littoridæ. Cincinnati Group (Lower Silurian), Waynesville, Ohio.

No. 288. [618, Cast]. *Cerithium giganteum*, Lam.

This genus, which abounded in Geological periods from the Trias to the present time, was distributed widely then as now in the seas over all parts of the globe. It had its culmination in numbers, as well as in size of individuals and variety of forms, during the Tertiary period. 460 fossil species are known. Family Cerithiidae. This magnificent specimen—the largest of all fossil gasteropods—is from the Eocene Tertiary at Damery, France.

Size, 22 x 7.

No. 289. *Cerithium Bronni*, Partsch.

Miocene, Steinabrunn, Austria,

No. 290. *Ampullaria vulcani*, Br.

This is the type genus of a family of fresh water mollusks, which are widely distributed in the tropics. The Paludinidae represent them in temperate latitudes. Eocene, Ronco, Italy.

No. 291. *Pyrgulifera humerosa*, Meek.

Upper Cretaceous, Sulphur Creek, Wyoming.

No. 292. *Turbo rugosus*, Linn.

This genus begins in the Silurian, and still exists. 400 fossil species are known. Family Turbinidae. Quaternary, Ficarizzi, near Palermo, Sicily.

No. 293. *Trochus podolicus*, Dubois.

This genus has a pyramidal shell with a flat base; 360 fossil species are known since the Silurian; 250 species living. Family Trochidae. Miocene, Vienna, Austria.

No. 294. *Trochus magus*, Linn.

Quaternary, Palermo, Sicily.

No. 295. *Pleurotomaria sulcomarginata*, Con.

The shell of this genus, the type of a family, is distinguished by its subquadrate aperture, with a slit in its outer lip; 400 species are known from the Palæozoic and Mesozoic. Hamilton Group, Onondaga Co., New York.

No. 296. *Pleurotomaria ornata*, Defrance.

This species takes its name from the row of tubercles which crowns its spiral whorls. From the Inferior Oolite of Calvados, France.

No. 297. *Pleurotomaria conoidea*, Deshayes.

Lower Oolite, Bayeux, France.

No. 298. *Murchisonia bellicinata*, Hall.

Shell elongated, many-whorled, and variously sculptured. The genus is characteristic of the Palæozoic; 50 species known. Family Pleurotomariidæ. Cincinnati Group, Waynesville, Ohio.

No. 299. *Bellerophon bilobatus*, Sow.

In this Palæozoic genus the shell is symmetrical, globular or discoidal, whorls few, dorsally keeled, aperture notched on the dorsal side; 150 species are known, all from the Palæozoic. Family Bellerophontidæ. Trenton period, Beloit, Wisconsin.

No. 300. *Bellerophon hiulcus*, Sow.

Carboniferous Limestone, Tournay, Belgium.

No. 301. *Maclurea Bigsbyi*, Hall.

In this singular genus of the family Macluridæ (Atlantidæ of old authors), the shell is discoidal, and the spire deeply sunk. It possesses other interesting characters. Tryon makes it the type of a distinct family. It is confined to the Lower Silurian. From the Maclurea Limestone (Trenton Period), Knoxville, Tenn.

No. 302. *Dentalium elephantum*, Linn.

These "tooth-shells" are placed by Huxley with the Pteropods. Some authors make them a distinct class, Scaphopoda. They are straight or slightly curved tubes, open at both ends and resemble the cases of Annelids. They have been described from the Palæozoic. Quaternary Palermo, Sicily.

No. 303. *Dentalium hexagonum*, Sow.

Tertiary, San Diego, California.

ORDER PULMONATA.

No. 304. *Helix Turonensis*, Desh.

Of this inoperculate pulmoniferous genus, 3400 species are living. They are fossil since the Cretaceous. Family Helicidae. Miocene Tertiary, Grund, Hanover.

No. 305. *Helix Tryonii*, New.

Tertiary, Santa Barbara Is., California.

No. 306. Gasteropod, enlarged by silica.

The curious phenomena of the enlargement of shells, crinoid joints, &c., by a separation of the parts by intruded silica, requires further explanation. This example is from the Carboniferous of Barren Co., Ky.

CLASS PTEROPODA.

These small cephalous mollusks are named from the resemblance of their chief organs of motion to a pair of wings. They are either naked, or provided with a delicate translucent shell. In their first stages, they exactly resemble the gasteropod fry, and accordingly Lamarek, De Blainville and Owen regard them as a sub-class of the "crawlers"; but Cuvier, Woodward and Tryon give them a higher rank. The shell, when existing, resembles either a univalve or a bivalve in which the two valves have been cemented along the hinge. These "sea-butterflies," as they have been called, float in mid-ocean, forever out of sight of land, and are the food of northern whales and sea-birds.

There are several hundred fossil species, some of them appearing in the earliest Silurian or in the Cambrian, and being characteristic of the Silurian and Devonian.

No. 307. *Conularia Trentonensis*, Hall.*

This is one of the largest and most extraordinary of the Pteropods. The shells are sometimes nearly a foot long. They are distinctly four-sided and finely striated with transverse lines. They occur in the Mesozoic, but are characteristically Palæozoic, beginning in the earliest Silurian. About one hundred species are known. Trenton Limestone, Trenton Falls, N. Y.

No. 308. *Tentaculites irregularis*, Hall.

This genus has been referred to the tubicular annelids, and its true position is still in question. It resembles the annelid *Cornulites*. The shell is a thin, straight conical tube, with numerous annulations or thickened rings. They are of small size, from a couple of lines to an inch in length. They occur in the Devonian, but are chiefly Silurian. In some strata the tiny shells are found in myriads. This slab, covered with specimens, is from the formation to which they have given the name Tentaculite Limestone (Upper Silurian), Schoharie, New York.

*It may be necessary, in making up collections, to occasionally substitute some other species or the same species from a different locality than the one called for.

CLASS LAMELLIBRANCHIATA.

These mollusks, called also *Conchifera* and *Pelecypoda*, are the common bivalves. They are all acephalous and aquatic, breathing by leaf-gills,—whence the name,—usually a pair of gills on each side of the body. The mantle, in this class, forms two lobes either side of the animal, and secretes the shells upon their outer surfaces. The shells are mostly symmetrical or equivalve, the exceptions occurring in the stationary species.

Each valve is subconical, inequilateral, and the two are articulated, dorsally, by a ligament and teeth. The valves are closed by one or two powerful adductor muscles, which leave characteristic muscular scars. Nearly all have a muscular foot for locomotion, which in some groups contains a gland for secreting tough fibres, the byssus, which serve as a fastening to the rocks. The mantle lobes are sometimes prolonged posteriorly as tubes (siphons), which enable the owner to breathe and feed while the body is buried in the sand; this being indicated by an inbending of the pallial line. The Lamellibranchs do not readily group themselves into natural orders; the similarity of type is great, but the points of difference are not constant. The usual division is into the *Asiphonida* and *Siphonida*. The *Veneridæ* are the typical and most highly organized Lamellibranchs.

The bivalves, though less numerous now specifically, are far more abundant individually, than the gasteropods. They are all marine, excepting a few widely dispersed fresh-water genera (10 out of 90), and are found on every coast and in every climate, and from low water to the depth of 200 fathoms. The fossil forms constitute a third part of fossil shells. The living species number 4,000, and the fossil species about 7,800. The genera are seven times more numerous in the newer Tertiary than in the Silurian.

ORDER SIPHONIDA.

No. 309. *Teredo amphistæna*, Goldf.

Type genus of the family Teredidæ. From the Upper Chalk of Kent, England.

No. 310. *Panopæa Jurassi*, d'Orb.

This genus belongs to family Saxicavidæ, and dates from the Jurassic, with 140 fossil species. Oolite, Bayeux, France.

No. 311. *Pholodomya Aequalis*, Sow.

Calcareous Grit (Middle Oolite). Weymouth, England.

No. 312. *Tellina (Arcopagia) Texana*.

The type genus of the family Tellinidæ, and widely distributed since the Jurassic. 170 species fossil, 300 living. Cretaceous, Comanche Hills, Texas.

No. 313. *Venus lævigata*, Nyst.

The family Veneridæ, to which this genus, the common clam, belongs, is the most typical of the class; 200 species are found fossil since the Jurassic. Miocene, Grignon, France.

No. 314. *Cytherea nitida*.

Eocene, Paris Basin, France.

No. 315. *Artemis (Dosinia) exoleta*, Linn.

Quaternary, Ficcarizzi, near Palermo, Sicily.

No. 316. *Cardium echinatum*, Linn. Var. *Deshayesi*, Payr.

This type genus of the family Cardiidæ supplies 330 extinct species since the Silurian. Quaternary, Ficcarizzi, near Palermo, Sicily.

No. 317. *Cardium multistriatum*.

Cretaceous, Lampasas Hills, Bell Co., Texas.

No. 318. *Chama calcarata*, Lam.

This genus, the type of the family Chamidæ, began in the Cretaceous, and is represented by 40 fossil species. Eocene, Grignon, France.

No. 319. [662, Cast]. *Caprina adversa*, d'Orb.

This specimen of this most singular genus has both valves present, one of them very large, elongate and sinistrally coiled, the other so short and stunted as to resemble more the overgrown operculum of some Gasteropod shell. From the Lower Chalk of Clarente, France.

Size, 9 x 7.

No. 320. *Corrallochama Orcutti*, White.

This new genus of the family Chamidæ has been lately described by Dr. C. A. White, from Middle Cretaceous fossils of California.

It agrees with *Caprina*, and other genera, in the general character of the hinge and of the ligamental grooves, and the presence of an outer prismatic shell-layer. The test is thick, of three layers, the outer prismatic, the middle cellular, and the inner porcelanous. The middle layer constitutes the bulk of both valves, and has a tubular structure which causes the fossil to somewhat resemble the coral *Flavozites*. The shells grow separately or in clusters, fixed by the apex of the lower or right valve. From the shore of Todos Santos Bay, Lower California.

No. 321. [655, Cast]. *Hippurites radiosa*, Desmoulins.

The Hippuritidæ, to which family this form belongs, are entirely extinct and confined to the Cretaceous strata. They have an unequivocal, unsymmetrical shell, with two muscular impressions, and are the most remarkable and problematic of fossil Lamellibranchs. 30 species of the genus are known. This specimen, showing both valves, is from the Lower Chalk, Dordogne, France, and is now in the Ward Collection, University of Rochester. Size, 6 x 4.

No. 322. [659, Cast]. *Radiolites (Sphæculites) crateriformis*, d'Orb.

LOWER VALVE. This genus belongs to the strange family Hippuritidæ; 42 species are known. This specimen shows the peculiar form of growth which this shell undergoes, the whole organism being much modified—from the normal bivalve construction—by its sessile character and its permanent attachment to the rock on which its station was chosen in an early period of its development. This lower valve shows the several lines of its foliaceous growth, as also the "birostre," or internal mould, still filling the central cavity. From the same locality and Museum as the preceding. Size, 6 x 6.

No. 323. *Megalodon cuculatus*, Sow.

This specimen belongs to the family Megalodontidæ, characterized by a somewhat regular, ovoid, equivalve shell, with from one to three cardinal teeth and two muscular impressions. Fourteen fossil species are known from the Upper Silurian and Devonian. From the Lower Devonian, Cologne, Rhenish Prussia.

No. 324. *Crassatella protexta*, Con.

This genus has the ligament internal. It commences in the Cretaceous and abounds to-day, and is the type of a family. Eocene, Claiborne, Alabama.

No. 325. *Astarte obliqua*, Desh.

This genus is to-day represented by twenty species, widely distributed in the Northern seas; 285 fossil species are known, beginning with the Carboniferous. Family Astartidæ. Lower Oolite, Bayeux, Calvados, France.

No. 326. *Venericardia rotunda*, Lea.

This belongs to the family Astartidæ, and the genus dates from the Cretaceous. Eocene, Claiborne, Alabama.

No. 327. *Cardita Partschii*, Goldf.

Miocene, Steinabrunn, Austria.

No. 328. *Opis lunulata*, Sow.

Confined to, and characteristic of the Mesozoic; 42 species are known. Lower Oolite, Feuguerolles, Calvados, France.

ORDER ASIPHONIDA.

No. 329. *Trigonia costata*, Park.

This belongs to the Trigoniidæ, the shell of which is equivalve and trigonal, with the umbones directed posteriorly; 100 fossil species are known, dating from the Devonian, but only three living forms. From the Lower Oolite, Eschingen, Wurtemberg.

No. 330. *Trigonia incurva*, Sow.

From the Upper Oolite, Swindon Wilts, England.

- No. 331. *Myophoria* (*Schizodus*) *Kefersteinii*, Munst.

This genus, of the *Trigonidæ*, is restricted to the Triassic, with 16 species. Trias., Raibl, Carinthia, Austria.

- No. 332. *Arca biangulata*, Lam.

In the *Arcidæ* family the shell is equi-valve and the hinge line has a long, even row of teeth. These specimens are from the Eocene at Grignon, France.

- No. 333. *Arca diluvii*, Lam.

Pliocene, Bagalo, Italy.

- No. 334. *Nucula strigillata*, Goldf.

Tryon takes this genus from *Arcidæ* and makes it the type of the family *Nuculidæ*; 250 fossil species are found ranging from the Palæozoic. From the St. Cassian Beds (Trias), Tyrol.

- No. 335. *Pectunculus pulvinatus*, Lam.

This is a comparatively modern genus, dating from the Cretaceous; of the very old and abundant family *Arcidæ*. Eocene Tertiary, Grignon, France.

- No. 336. *Modiola minuta*, Quenstedt.

Family *Mytilidæ*; 70 species living and 150 fossil. From the Trias at Nürtingen, Wurtemberg.

- No. 337. [685, Cast]. *Dreissensia* (*Congeria*) *subglobosa*, Partsch.

This globose and finely modeled form of bi-valve shell, resembles *Mytilus*, but lacks the pearly lining. It abounds in the "Tegel," or sandy loam (Miocene Tertiary) of Brunn, Austria, and is now in the Ward Collection, in the University of Rochester.

- No. 338. *Ambonychia radiata*, Hall.

This is a Palæozoic genus of the *Avicula* family. From the Cincinnati Group, Cincinnati, Ohio.

- No. 339. *Perna mytiloides*, Lam.

Portland Beds (Upper Oolite), Swindon Wilts, England.

- No. 340. *Inoceramus Sagensis*, Owen.

A characteristic Cretaceous genus; 75 species known. Cretaceous, Cheyenne River, South Dakota.

No. 341. *Gervillia socialis*, Lyc. and Mor.

This genus is entirely fossil, ranging from the Carboniferous to the Cretaceous; 37 species being known. From the Muschelkalk, Munchingen, Wurttemberg.

No. 342. [667, Cast]. *Gervillia anceps*, Deshayes.

A characteristic bivalve fossil, from the Lower Greensand of Atherfeld, Isle of Wight, England. Size, 8 x 2.

No. 343. *Lima rigida*, Deshayes.

The type genus of the Limidæ; 300 species fossil, ranging from the Carboniferous. From the Calcareous Grit (Jurassic), Oxford, England.

No. 344. *Pecten opercularis*, Lam.

This genus, the type of the Scallop family (Pectinidæ), has 450 extinct species, beginning in the Devonian, and 200 still living. Quaternary, Palermo, Sicily.

No. 345. *Pecten expansus*, Dall.

Tertiary, San Diego, California.

No. 346. *Pecten (Neithea) quadricostata*, Sow.

This typical Cretaceous shell, from College Hill, Texas, closely resembles Janira Neocomiensis of d'Orbigny, from the Lower Cretaceous of France.

No. 347. *Ostrea Marshii*, Sow.

The family Ostreidæ have shells unequivocal and unequilateral, and one muscular impression. They are commonly regarded as the lowest of the Lamellibranchs. This type genus began in the Carboniferous and has supplied 200 extinct species and 70 living. From the Lias, Stufenberg, Wurttemberg.

No. 348. *Ostrea larva*, Lam.

From the Rotten Limestone (Cretaceous), Alabama River.

No. 349. *Ostrea*, ———

From the Raised Beaches (Quaternary), Gebel Zeit, Gulf of Suez.

No. 350. *Ostrea*, ——

From the Petrified Forest, Nummulitic Eocene, near Cairo, Egypt.

No. 351. *Gryphea arcuata*, Lam. (*Gryphea incurva*, Sow.)

This genus, belonging to the Oyster Family (*Ostreidæ*), is exclusively Mesozoic; 30 species known. The left valve has a prominent incurved umbo. From the Lias, Lyme-Regis, England.

No. 352. *Gryphea vesicularis*, Lam.

Upper Cretaceous, Marlborough, N. J.

No. 353. *Exogyra arietina*, d'Orb.

In this member of the Oyster family, also restricted to the Cretaceous, the beak is reversed or turned posteriorly. From the Cretaceous, Griffith Ravine, Texas.

No. 354. *Exogyra costata*, Say.

From the Greensand, Marlborough, N. J.

CLASS BRACHIOPODA.

These headless mollusks are enclosed in bivalved shells, which are equal on either side of a vertical line let fall from the beak (equilateral), while the valves are almost always unequal (inequivalved). The larger one is called the ventral, and the smaller the dorsal. While in the Lamellibranchs one valve is applied to the right side and the other to the left side of the animal, in this class, one valve is applied to the back, the other to the belly of the animal. The ventral valve has generally a prominent notched or perforated beak, through which passes, in most species, a pedicel or byssus to attach the animal to some foreign body, for brachiopods are deprived of the power of locomotion. No living species are free. The one or two accessory pieces occupying a triangular opening under the beak, form an area called the *deltidium*; the form and structure, the presence or absence of this, and the muscular impressions, afford good generic characters. The shells are perforated vertically by canals, which connect the inner and outer surfaces. The animal has usually two long spiral prehensile arms developed from the sides of the mouth, whence the name of the class. In many brachiopods these "arms" are supported by a more or less complicated framework. It is claimed by some eminent embryologists that brachiopods belong with the articulates, near the annelids, and some later systematists remove them from the mollusks and place them with the worms. (See page 90). Unlike the polyzoa they are never composite. Brachiopods, of all the mollusks, enjoy the greatest range in climate, depth and time. They are all marine, and mostly inhabit the deep sea, so that less than 100 living species are known. They are among the oldest of existing forms of animal life. Over 4,000 extinct species have been described, distributed through all rocks of marine origin from the Cambrian upwards. They attained their maximum (both of generic and specific development) in the Silurian age, and are the most numerous fossils of the Silurian deposits. The hingeless genera (as *Lingula*) are

most highly developed in Palæozoic time. Of the articulated genera, those having spiral arms appeared first; those with calcareous spires disappeared with the Lias. Brachiopods furnish the most numerous instances of recurrence, owing to their tenacity of life, some species persisting through a whole geological formation. The genus *Lingula* has existed since the Cambrian.

"Of the families of the Brachiopoda, the *Productidæ* and *Strophomenidæ* are exclusively Palæozoic. The *Spiriferidæ* are mainly Palæozoic, but extend into the Lias, where they finally disappear. The *Lingulidæ* commence in the Cambrian period, and have survived to the present day. The *Rhynchonellidæ*, *Craniadæ* and *Discinidæ* commence in the Silurian period, and are represented by living forms in existing seas. The *Koninckinidæ* are exclusively Triassic. The *Thecididæ* extend from the Trias to the present day; and the *Terebratulidæ* appear to commence in the Devonian, and are well represented by living forms." (Nicholson).

ORDER ARTHROPOMATA.

Valves united along a hinge-line, articulating by hinge-teeth; mantle lobes not free; intestine ending cæcally (no anal aperture).

FAMILY TEREBRATULIDÆ.

Shell minutely punctuate, usually round or oval, smooth or striated; the ventral valve having a prominent beak with a foramen; two curved hinge-teeth; the arm-supports having the form of a loop.

No. 355. *Terebratula grandis*, Blum.

The shell of this genus is smooth and convex; the beak perforated; foramen circular; deltidium of two pieces; loop simple. Eight species are found living, and many fossilized since the Triassic. From the Miocene Tertiary of Bunde, Westphalia.

No. 356. *Terebratula semiglobosa*, Sow.

Chalk (Upper Cretaceous), Rouen, France.

No. 357. *Terebratula biplicata*, DeFr.

Upper Greensand, Cambridge, England.

No. 358. *Terebratula sphæroidalis*, Sow.

Fuller's Earth, Oolite, Noyen, France.

No. 359. *Terebratella umbonella*, Lamk.

Lower Oolite, Calvados, France.

No. 360. *Terebratula gregaria*, Suess.

Lower Lias, Hindelang, Bavaria.

No. 361. *Leptocœlia hemispherica*, Sow.

A mass of rock composed entirely of this shell. From the Clinton Group, Rochester, N. Y.

No. 362. *Rensselaeria ovoides*, Eaton.

In this extinct genus of the Silurian and Devonian, eleven species are known. Oriskany Sandstone, Schoharie, New York.

FAMILY STRINGOCEPHALIDÆ.

Shell suborbicular, the hinge-margin rounded; under valve with deltidium and opening under the prominent beak; cardinal process large.

No. 363. [728, Cast]. *Stringocephalus Burtini*, Defrance.

TWO SPECIMENS. In this genus the ventral valve is prolonged upwards into a very prominent, tapering beak, which is sometimes so curved forward as to rest upon the dorsal valve. This latter has a very long cardinal process which quite crosses the interior of the shell, and is forked at the extremity to meet the ventral septum. From the Devonian of Paffrath, Germany.

FAMILY RHYNCHONELLIDÆ.

Shells oblong or trigonal, beaked; hinge-line curved; no area; valves articulated, convex, often sharply plaited; foramen beneath the beak, usually completed by a deltidium; elongated spiral arms.

No. 364. *Rhynchonella alta*, Hall.

Hamilton Period, Solon, Iowa.

No. 365. *Rhynchonella dentata*, Hall.

Cincinnati Group, Richmond, Ind.

No. 366. *Rhynchonella capax*, Con.

(Rhynchonella increbescens, Hall).

This genus begins in the Lower Silurian; 500 species are found fossil, and only six living. These specimens are from the Cincinnati Group, Waynesville, Ohio.

No. 367. *Rhynchonella pleurodon*, Phil.

Carboniferous, Longniddry, near Edinburgh, Scotland.

No. 368. [737, Cast]. *Rhynchonella speciosa*, Munst.

From the Middle Oolite, Kelheim, Bavaria.

No. 369. *Rhynchonella varians*, d'Orb.

Oolite, Voegisheim, Baden.

No. 370. *Pentamerus oblongus*, Sow.

This fossil has a very wide distribution across the Silurian basin of the New York system, where it serves to mark and name a constant horizon—that of the "Lower Pentamerus limestone." The genus is represented by 52 species in the Devonian and Upper Silurian. From the Niagara Group (Upper Silurian), Yellow Springs, Ohio.

No. 371. *Pentamerus oblongus*, Sow.

Clinton Group, Rochester, N. Y.

FAMILY ATRYPIDÆ.

Shell fibrous; beak curved; hinge-margin curved, with strong teeth; no area; dorsal valve with spiral lamellæ directed toward opposite valve. Very similar to Rhynchonellidæ.

No. 372. *Atrypa aspera*, Schloth.

Shell impunctate, oval, usually plaited; dorsal valve gibbous; beak small, often incurved and concealing the round foramen. Occurs from Lower Silurian to Trias, 21 species. Devonian, Gerolstein, Prussia.

No. 373. *Atrypa primipilaris*, d'Orb.

Devonian, Gerolstein, Prussia.

No. 374. *Atrypa reticularis*, Linn.

Devonian, Eifel, Prussia.

No. 375. *Atrypa reticularis*, Linn.

Unusually large specimens, from the Corniferous, at Charleston, Indiana.

No. 376. *Zygospira modesta*, Say.This genus differs from *Atrypa* only in the minute character of the spiral arm-supports. Cincinnati Group, Waynesville, Ohio.

FAMILY SPIRIFERIDÆ.

Shell furnished internally with two spiral processes directed outwards, toward the sides of the shell, to support the fixed oval arms. Extinct since the Lias.

No. 377. *Spirifer micropter*.

In this genus the shell is transversely oval or elongated, trilobed, beaked, bi-convex; hinge-line wide and straight; foramen angular; 300 species are distributed from the Lower Silurian to the Trias. Devonian, Gerolstein, Prussia.

No. 378. *Spirifer mucronata*,
[Con.]

Hamilton Group, Widder, Canada.

No. 379. *Spirifer Owenii*, Hall.

Corniferous, Charleston, Indiana.

No. 380. [690, Cast]. *Spirifer pinguis*,
[Sow.]

From the Carboniferous Limestone of Kildare, near Dublin, Ireland, and now in the Ward Collection of the University of Rochester.

No. 381. *Spirifer speciosus*, Schloth.

Devonian, Gerolstein, Prussia.

No. 382. [698, Cast]. *Spirifer striatus*, Martin.

This large specimen of *S. striata* (the type of the genus), was found in the Carboniferous Limestone of Enniskillen, Ireland.

No. 383. *Athyris ambigua*, Sow.

The hinge-line of this genus is curved; no area; foramen round; deltidium obsolete; 100 species fossil; from Silurian to Jurassic. Carboniferous Limestone, near Edinburgh, Scotland.

No. 384. *Athyris concentrica*, Buck.

Devonian, Romersheim, Gerolstein, Prussia.

No. 385. *Athyris spiriferoides*, Eaton.

Hamilton Group, Moscow, N. Y.

No. 386. *Athyris subtilita*, Hall.

Carboniferous, Ruby Valley, Nevada.

No. 387. *Athyris vittata*, Hall.

Corniferous, Clarke Co., Indiana.

No. 388. *Meristella barrisi*, Hall.

Corniferous, LeRoy, N. Y.

No. 389. *Retzia evax*, Hall.

Niagara Group, Waldron, Ind.

No. 390. *Uncites gryphus*, Defr.

In the Devonian of Europe. Devonian, Paffrath, Germany.

FAMILY STROPHOMENIDÆ.

Shell transversely oblong; depressed; hinge-line wide and straight; beak small; valves plano-convex or concavo-convex; area notched.

No. 391. *Strophomena alternata*,
[Con.

Shell of this genus semicircular, widest at the hinge-line; concavo-convex; area double; ventral valve notched; 129 species known, all Palæozoic. Cincinnati Group, Covington, Ky.

No. 392. *Strophomena planumbona*, Hall.

Cincinnati Group, Waynesville, Ohio.

No. 393. *Leptaena sericea*, Sow.

Cincinnati Group, Cincinnati, Ohio.

No. 394. *Orthis Eifleensis*, Vern.

300 species are known of this genus, restricted to the Palæozoic. The shell is transversely oblong; radiately striated or plaited; bi-convex; hinge-line narrower than the shell. Middle Devonian, Eifle, Prussia.

No. 395. *Orthis laticosta*, James.

Mr. Meek considered this and the following species as varieties of *Orthis biforota* (*Terebratulites biforota*), Schlotheim. Cincinnati Group, Waynesville, Ohio.

No. 396. *Orthis lynx*, Eichwald.

Cincinnati Group, Waynesville, Ohio.

No. 397. *Orthis occidentalis*, Hall.

Cincinnati Group, Cincinnati, Ohio.

No. 398. *Orthis plicatella*, Hall.

Cincinnati Group, Cincinnati, Ohio.

No. 399. *Orthis subquadrata*, Hall.

Cincinnati Group, Waynesville, Ohio.

No. 400. *Orthis testudinaria*, Dalman.

(Orthis emacerata, Hall).

Cincinnati Group, Cincinnati, Ohio.

FAMILY PRODUCTIDÆ.

Shells concavo-convex; hinge-line straight; ventral valve convex; dorsal concave. Extinct.

No. 401. *Productus horridus*, Gein.

The members of this genus were mostly free when adult. The shell is auriculate, large beaked, and with linear indistinct hinge-line; no hinge teeth; 81 species. Permian, Gera, Saxony.

No. 402. *Productus longispinus*, Sow.

Carboniferous, near Peru, Ill.

No. 403. *Productus Prattenianus*, Norwood.

Coal Measures, Knox Co., Ill.

No. 404. *Productus semireticulatus*, Mart.

Carboniferous Limestone, Longniddy, near Edinburgh, Scotland.

ORDER LYOPOMATA.

Valves not united along a hinge-line; mantle lobes free; intestine with an anal aperture.

FAMILY CRANIDÆ.

Shell orbicular; no hinge. dorsal valve limpet-shaped. Animal attached to objects by the ventral valve.

No. 405. *Crania scabiosa*, Hall,

Dating from the Lower Silurian, with 37 fossil species; the group is still living. Cincinnati Group, Cincinnati, Ohio.

FAMILY DISCINIDÆ.

Animal attached by peduncle passing through the ventral valve; arms fleshy. Ranging from the Silurian to the present time.

No. 406. *Discina nitida*, Phil.

Upper valve limpet-shaped; lower or ventral valve flat or conical; 64 fossil and 10 living species, ranging from the Silurian age. Coal Measures, Springfield, Ill.

FAMILY LINGULIDÆ.

Animal fixed by a pedicel passing out between the beaks of the valves. Valves sub-equal, horny.

No. 407. *Lingula cuneata*, Conrad.

SLAB, SHOWING A NUMBER OF SPECIMENS. Shell oblong; compressed; dorsal valve somewhat shorter, horny, greenish. The genus began in the Cambrian and has continued to the present. 140 species fossil, and 16 living Medina Sandstone, Medina, N. Y.

No. 408. *Lingula* (*Lingulepis*) *prima*, Con,

Potsdam Sandstone, Keeseville, N. Y.

CLASS TUNICATA.

These "cloaked" mollusks, represented by the Ascidians and Salpians, are invested in a leathery test which takes the place of the shells of the other classes. This test is remarkable for containing a considerable proportion of a substance identical with cellulose. The blood is carried back and forth along the same simple tube, as was supposed to be the case in the human system before the time of Harvey. The nervous system consists of a single ganglion placed near the oral aperture.

There are various points of resemblance between the embryos of Tunicates and those of vertebrates; and some embryologists are led to regard the Tunicates as degenerate vertebrates.

They exist in all seas, from low water to a considerable depth. On account of the absence of any consistent skeleton, they have not certainly been found fossil.

CLASS POLYZOA (BRYOZOA).

The animals of this class are minute, compound, aquatic and mostly marine. They usually form moss-like or coral-like calcareous or chitinous masses, each cell containing a worm-like animal.

The digestive tract is bent so as to bring the anal aperture near the mouth. Retractor and adductor muscles draw the body in and out of the cell. A crown of tentacles surrounds the mouth. There is no heart or vascular system, but a nervous system of one or two ganglia and radiating nerves. They are bisexual, and multiply by budding or by eggs. The avicularia or "bird's-head process" is a peculiar appendage of uncertain function.

The derma-skeleton (cœnœcium or polyzoarium) of the polyzoa resemble and are often mistaken for "corals"; but the separate beings or zooids of the polyzoön are connected only by the integument, and not through the body cavity as in the cœlenterates.

In one fresh-water type (*Cristatella*) the colony creeps upon a flattened base. Some marine forms live at great depths. The type began in the Cambrian and has persisted without great change. The class probably culminated in the Cretaceous period, over 200 species occurring in the chalk.

No. 409. *Archimedes laxa*, Hall.

Sub-carboniferous, Logan Co., Ky.

No. 410. *Fenestella retiformis*, Schloth.

This is the most common genus of the Palæozoic forms, and especially characteristic of the Carboniferous. Permian, Poesneck, Thuringia.

No. 411. *Gorgonia antiqua*, Hall.

Trenton Limestone, Holland Patent, N. Y.

No. 412. *Ptilodictya Shafferi*, Meek.

This genus is especially characteristic of the Carboniferous. The cœnœcium is flattened, foliaceous or often dichotomously branched. Cincinnati Group, Cincinnati, Ohio.

SUBKINGDOM

ECHINODERMATA.

This and the following subkingdom have been erected from Cuvier's Radiata. The name was given by Brugières because many of the species are spine-clad. The skin is characteristically hardened by secretion of lime in the form of plates, as in the Sea-urchin and Crinoid, or in the form of granules and spicules, as in the Sea-cucumber. They are however associated by another and more general character—the skin is almost always perforated by foramina through which the “tube-feet,” communicating with a system of water vessels (“water-vascular system”) can be protruded or retracted, constituting the organs of adhesion and locomotion.

When young the members of this group show a bilateral symmetry, which, in the higher Echinoids, is in some degree retained, but which is usually concealed in the adult by the radial arrangement of the parts (usually five) of the body and its internal organs.

The Echinoderms are all marine. Some are rooted to the sea-bottom and thus resemble the polyps, others are free, with forms globular, or truly rayed and covered with prickly armor; and these lead to soft elongated organisms that mimic the mollusk or seem to stand at the lowest step of the articulate division.

Unlike the Cœlenterate the Echinoderm has the digestive canal, with or without an anal opening, distinct from the general cavity of the body. They are the lowest animals possessing a true stomach and masticating organs. The mouth is usually central and sometimes surrounded by tentacles. The nervous system consists of a cord forming a ring about the pharynx, with branching filaments.

The subkingdom has been represented in all geologic ages. The Echinoids succeed the Crinoids and Asteroids. The Crinoids abounded in the Palæozoic seas but are now reduced to a few genera; the Asteroids began in the Silurian, but now the seas of all latitudes swarm with them; while the Echinoids increase to the Cretaceous and then decline.

CLASS HOLOTHUROIDEA.

These vermiform echinoderms, vulgarly called "Sea-cucumbers," constitute the highest order of the class. They may be compared to Sea-urchins deprived of the spines, with the shell softened, and elongated by separation of the anus and mouth. The body is either cylindrical or pentagonal, with scattered calcareous spicules or imbricated scales.

The only examples of fossilization are small fragments of dermal ossifications from the Upper Oolite of Bavaria, the Chalk of Warminster, and the northern drift of Bute, Scotland.

CLASS ECHINOIDEA.

The body of the Echinus or "Sea-urchin" is enclosed in a firm hollow shell, formed of polygonal plates united by sutures in twenty vertical series, arranged in ten pairs. This shell has a spherical, oval, pentagonal, hemispherical, conoidal or discoidal form. Five broad zones (interambulacral) alternate with five narrow zones (ambulacral.) The former are studded with tubercles bearing spines which articulate by a ball and socket joint. The latter have a few smaller tubercles and spines, or none at all, and appear like "walks" through the spinous tracks—whence the name given by Linnæus. They are traversed by numerous pores for the exertion of suckers or "tube-feet," which are used for locomotion, and which are appendages of the water-vascular system. At the summit of the test is a disk composed of five genital plates, and five ocular plates notched for lodging the eyes. One of the genital plates, larger than the others and perforated, is the entrance of the ambulacral or water-vascular system. The mouth has five sharp angular teeth, tipped with enamel. These representatives of molars and incisors move upon each other; and the entire pyramidal mass can

be protruded and retracted. This description of the Echini will not accurately apply to the irregular forms. In the latter the ambulacra are only half of the typical number, and often only partial in their extent. In many, too, the oral and anal openings lose their central position, and approach the margin. The mouth, also, is sometimes toothless. The mouth is central and dental in the *Cidaridæ*, *Echinidæ*, and *Clypeasteridæ*; it is more or less eccentric and edentulous in the *Echinonidæ*, *Collyritidæ* and *Spatangidæ*.

The fossils of this order are usually divided into three groups: *Cidaridæ* or Turban-shaped Echini, *Clypeasteridæ* or Buckler-shaped Echini, and *Spatangidæ* or Heart-shaped Echini. These include over 70 genera and about 700 species. They are rare in the Palæozoic,—the oldest occurring in the Upper Silurian,—and attained their maximum in the Oolite and Cretaceous strata. The regular forms appeared first; the elongated forms are more recent.

No. 413. *Ananchytes ovata*, Lam.

A Spatangoid, distinguished by having a high, conical form, and much compressed laterally. The mouth is eccentric, in front; spines minute. This genus, says Desor, is the most characteristic of all fossil Echini, and the one most useful to Geologists, not only from its frequent occurrence, but also from its well defined characters. It is limited to the Mesozoic. This specimen is from the Upper Chalk of Kent, England.

No. 414. *Cidaris coronata*, Goldf.

SPINES. In the *Cidaris* proper the form is symmetrical, the tubercles are perforated, the ambulacra narrow, and the two lines of pores close together. This species is depressed, and its tubercles are few in number and of large size. These specimens are from the Coral Rag (Middle Oolite), Nattheim, Wurtemberg.

No. 415. *Cidaris dorsata*, Brown.

SPINES. The spines of *Cidaris* are few in number, large and mostly club-shaped. Trias (St. Caspian), Tyrol, Italy.

No. 416. *Cidaris glandifera*, Goldf.

SPINES. The spines of this species are called "Jew-stones" by the Pilgrims, who bring them in large numbers from the Holy Land. They are pyriform, and covered with granules. From the Jurassic (?), Mount Carmel, Palestine.

No. 417. [771, Cast]. *Cidaris Suevica*, Desor.

A distinctive feature in this Urchin is a double row of granules of unequal size along the ambulacra. From the Middle Oolite, Wurtemberg.

No. 418. *Clypeaster Ghizehensis*,

This genus, one of the true *Olypeastridae*, includes the largest of sea-urchins. The shell is oblong; mouth angular and furnished with well developed teeth; tubercles, mere granules, and the spines proportionally small. The shell of this species is subpentagonal, and the ambulacral portion is much elevated. From the Eocene Tertiary, Ghizeh, Egypt.

No. 419. [814, Cast]. *Clypeaster umbrella*, Agass.

This inflated form, with interambulacra rising into ribs, is from the Miocene Tertiary, Sardinia, and belongs to the Ward Collection, University of Rochester. This genus of the buckler-shaped group includes the largest of sea-urchins. The mouth is armed with well developed teeth.

No. 420. *Cyphosoma Texana*.

Cretaceous, Lampasas Co., Texas.

No. 421. *Discoidea subuculus*, Leske.

This Echinus has a hemispherical test, and very small tubercles arranged in concentric series. From the Upper Greensand (Cretaceous) of Yonne, France.

No. 422. *Echinobrissus (Nucleolites) scutatus*, Gmel.

TWO SPECIMENS. This genus is a section made at the expense of *Nucleolites*, to include those shortened and square forms with united poriferous zones. From the Coral Rag (Middle Oolite) of Weymouth, England.

- No. 423. **Echinobrissus (Nucleolites) cunucularis**, Blainv.
Lower Oolite, Yonne, France.

- No. 424. **Echinolampus affinis**, Desm.
Eocene, Vaugirard, France.

- No. 425. **Galerites albogalerus**, Lam.

This lofty, almost turreted form, with central mouth and marginal anus, is from the Upper Chalk, Kent, England.

- No. 426. **Hemicidaris intermedia**, Fleming.

This large, depressed genus belongs to the *Cidari-dæ* with narrow ambulacra. The distinctive feature is the existence of small tubercles on the lower half of the ambulacra. The spines are cylindrical and finely striated. From the Oolite of Calne (Wiltshire), England.

- No. 427. [842, Cast]. **Hemipneustes radiatus**, Agass.

This is a heart-shaped, inflated Urchin, as high as broad, and nearly perpendicular in front, where there is a deep, narrow furrow. The ambulacral summit is central; the ambulacra are very large and winding; the tubercles small, and the anus is on the posterior border. From the Upper Chalk of Maestricht, Holland, and now in the Ward Collection, University of Rochester.

- No. 428. **Micraster cor-anguinam**, Agass.

This genus is so termed from the star-like arrangement of its four small ambulacra. The test is heart-shaped, and wider before than behind, with a furrow in front; the tubercles are small, and irregularly distributed; the mouth is transverse, situated anteriorly, and protected by a projection of the odd inter-ambulacrum. From the Upper Chalk, Kent, England.

- No. 429. [781, Cast]. **Palæechinus (Melonites) multipora**,
[Nor. and Owen.]

GROUP, ON SLAB. This gigantic Echinoid—some specimens measuring five and a half inches in vertical diameter and four transversely—has an ovoid form, central mouth and anus, ten areas; the ambulacral plates hexagonal and rhomboidal; interambulacral plates mostly hexagonal, and in several rows. The ranges of plates number 65, and each plate is perforated by two holes. This genus is limited to the Upper Silurian and Carboniferous. Only one other genus (Archæocidaris) is known from the Palæozoic. From the St. Louis limestone (sub-carboniferous), St. Louis, Mo. Size, 12 x 11.

- No. 430. **Pygaster semisulcatus**, Phil.

Pea Grit (Lower Oolite), Chrichley Hill, England.

- No. 431. [789, Cast]. **Rhabdocidaris copeoides**, Desor.

(Cidaris copeoides, Agass.)

THREE SPECIMENS OF SPINES. This Urchin belongs to the *Cidaridæ* having narrow umbulacra. The spines vary very much in size and form on different parts of the test, and at different stages of development. From the Oxfordian (Middle Oolite), Latrecy, France.

- No. 432. **Scutella disca**, Mather.

This American Clypeastroid is from the Tertiary of Georgia.

- No. 433. **Toxaster Texana**.

Cretaceous, Lampasas Co., Texas.

CLASS ASTEROIDEA.

The "Star-fishes" well represent the sub-kingdom. The common form is that of a star with five rays, which are prolongations of the body,—the viscera extending into them. Beneath each ray is a groove from which is protruded the tube-feet. The dorsal and lateral surfaces of the animal are covered by a coriaceous skin, strengthened by a net work of calcareous plates. These ossicles have a persistent arrangement in the various genera, so that they afford good evidence of the rank of the owner among the Echinoderms, as do the bones of reptiles or mammals among vertebrates. There is one ossicle, situated on the side of the center of the disc, which differs from all the others in being marked with radiating slits, and is called the madreporiform plate. It is the opening of the water-tube system. In the center of the ventral surface is the toothless mouth, surrounded by a bony ring. The eyes are generally situated at the end of the rays.

Fossil Star-fishes, though less common, have a wider range than fossil Sea-Urchins. They are found in every geological period from the Lower Silurian, attaining their maximum in the present seas. The Palæozoic species differ from recent ones in having the plates perforated by pores. No family of Star-fishes has become extinct.

No. 434. [863, Cast]. *Solaster Moretonensis*, Forbes.

This beautiful and well preserved fossil seems as if it were the head of a Crinoid with out-spread arms, crushed flat. A nearer inspection shows that it is really a Star-fish, resembling the living *Uraster helianthus* from the Pacific coast of South America. From the Great Oolite, Windrush Quarry, Gloucestershire, England.

Size, 6 x 6.

No. 435. (1320, Cast). *Renaster margaritatus*.

Lower Devonian, Lahnstein, Germany.

CLASS OPHIUROIDEA.

In the *Ophiuroidea*, the long slender serpent-like arms are special organs of locomotion, being independent of the visceral cavity; and they are not grooved for the emission of tube-feet. The "disc" contains all the vital organs. A masticatory apparatus is present in the inferior mouth; but there is no anal aperture. The madreporiform tubercle is inferior; according to some naturalists, the family holds the same relation to the Crinoids that the Star-fishes hold to the Sea-urchins.

The class is represented in the Upper Silurian by the genus *Protaster*. They become common in the Mesozoic and Tertiary.

No. 436. [860, Cast]. *Ophioderma Egertoni*, Broderip.

This genus differs from the *Ophiura* proper in having four (instead of two) genital fissures in each interval between the arms. This specimen is from the Lias of Lyme-Regis, England.

CLASS CRINOIDEA.

The Crinoids are among the most remarkable fossils that lie entombed in the earth; and it is only within the last century and a half that their place in nature began to be understood. For ages the superstitious or imaginative peasantry called them "St. Cuthbert's beads," "rosary beads," "giants tears," "fairy stones," "wheel-stones," "screw-stones," and "pulley-stones." By early naturalists they were termed "Trochites," "Entrochus,"

and "Ecrinus." Their animal origin was established by Rosinus in 1719; and their classification first correctly made by Miller in 1821.

In a typical specimen there are three parts: the root—a calcareous secretion which fixes the animal to the sea-bottom; a hollow jointed stem, and a corolla-shaped body provided with five to ten solid arms, independent of the visceral cavity, and adapted to prehension. The mouth is central and opens upwards; the vent is situated on the side. The normal position of the Crinoid is the reverse of the Star-fish and Echinus. There were three modes of existence: some were fixed in the midst of coral-banks at great depths, as *Encrinurus liliiformis*; others were free, yet clinging to the bottom of the ocean, as the young *Comatula* (*Antedon*); and others still were disposed in such a way that their bulbiform body was buried in the mud, as *Marsupites*. The geographical extent of the Crinoids is very limited, and in their geological range also they appear to be more restricted than other forms. No forms pass from the Palæozoic to the Secondary. They are among the earliest relics of animal organization, and after the Protozoa and Actinozoa they have taken the largest share in accumulation of rock material. Like the corals, their chief function seems to have been the secretion of lime from the ocean,—whole strata of limestone being almost entirely made of their remains. They appear first in the Cambrian (Potsdam), and culminate in the Lower Carboniferous. The column is round in nearly all the Palæozoic forms, but pentagonal discs commence in the Lower Silurian. Fixed Crinoids began with the Silurian period and decreased; free Crinoids began in the Oolite. The appearance of arms has been regarded as a stage of progress in development; from that moment, the variety of forms augments with astonishing rapidity. The solid calyx of *Cystidea* diminishes steadily, and in *Pentacrinus* barely forms a basis for the internal parts. Finally, in the Upper Jurassic, it frees itself from the pedicle, and in the form of *Comatula* (*Antedon*) enjoys the faculty of locomotion. The *Comatula*, *Pentacrinus Caput-medusæ*, and *Rhizocrinus* are the living representatives of the class. The Cystids, as also the Blastoids have been separated from the true crinoids (Brachiata) into distinct orders.

ORDER BRACHIATA.

The true Crinoids have a calyx, with large pinnulated arms, grooved on the upper surface, and bearing the reproductive organs. The class description applies particularly to this order; also as relating to geological distribution. Eight genera are now known to be living. *Rhizocrinus* is a widely distributed deep sea form, being found as deep as 1,000 fathoms. *Comaster*, *Actinometra* and *Antedon* (*Comatula*), are free when adult.

No. 437. [864, Cast]. *Actinocrinus proboscideal*is, Hall.

The Actinocrinoids, found chiefly in the Carboniferous limestone, are sometimes provided with thorn-like side arms, which project from the column at irregular distances. The receptacle is of an irregular subspherical form, and frequently having arms passing off at right angles like the spokes from the nave of a wheel. This species is from the Burlington limestone (Carboniferous), Burlington, Iowa.

No. 438. *Actinocrinus verneulianus*, Shum.

Burlington Limestone (Sub-Carboniferous), Burlington, Iowa.

No. 439. [898, Cast]. *Apiocrinus Parkinsoni*, Schloth.

Two bodies and two stems branching from one root; young. The "Pear-encrinites" have a complicated, expanded root, a long column composed of numerous ossicles, and a pyriform receptacle, with arms well developed and regularly bifid. The stem is round and not pentagonal, and the articulating surfaces of the joints are marked by simple ridges. The last joints increase in diameter until they equal the breadth of the calyx. In this species the stem is comparatively short. This specimen, consisting of two individuals of nearly equal development, is from the Great Oolite, Bradford, England.

Size, 6 x 3.

No. 440. [904, Cast]. *Astrocoma Cirini*.

This beautiful Comatula or "Feather-star," with its numerous arms gracefully spread out, is from the Lithographic Limestone (Middle Oolite), Cirin, France.

Size, 7 x 4.

No. 441. *Batocrinus rotundus*, Y. and S.

Burlington Limestone, Burlington, Iowa.

No. 442. *Dorycrinus unicornis*, O. and S.

Burlington Limestone, Burlington, Iowa.

No. 443. [911, Cast]. *Crotalocrinus rugosus*, Miller.

BODY, STEM AND ROOT, ON PEDESTAL. This ancient Crinoid is so called from its peculiar shape and structure. The subdivisions of the arms begin at the very edge of the cup, and become so numerous as to form a perfect network in the shape of a convoluted funnel-like organism of the finest basket-work, instead of the rayed arrangement of the common Encrinite. The stem is made up of tuberculated joints. From the Upper Silurian, Dudley, England.

Size, 18 x 3.

No. 444. [917, Cast]. *Encrinus liliiformis*, Schloth.

BODY AND STEM, ON SLAB. This beautiful and well-known Crinoid has a smooth body in the form of a depressed vase. Its base is composed of five plates, upon which rest three successive series of other plates, with the uppermost of which the arms articulate. The stem is long and formed of numerous perforated round ossicles, articulated to each other by radiated grooved surfaces, and becoming somewhat pentagonal and alternately larger and smaller towards the summit. This specimen was found in the Muschelkalk (Middle Trias) of Brunswick, Germany, and is now in the Ward Collection of the University of Rochester.

Size, 8 x 2.

No. 445. [920, Cast]. *Encrinus liliiformis*, Schloth.

SLAB, WITH THREE BODIES AND STEMS. This is one of the most choice and perfect specimens of the "Lily-Encrinite" which has ever been found. From the same locality as the preceding, of which geological horizon it is characteristic.

Size, 18 x 9.

No. 446. [932, Cast]. *Ichthyocrinus lævis*, Conrad.

This interesting fossil, related to *Cyathocrinus*, has five triangular basal plates, and a round, smooth, slender column, enlarging towards the cup. This specimen, showing body and stem, is from the Niagara shale (Upper Silurian), Lockport, N. Y.

No. 447. [938, Cast]. **Mariacrinus nobilissimus**, Hall.

This species, constituting the type of this genus, is one of the largest and finest known Crinoids in the Silurian system. It bears a general resemblance to *Glyptocrinus*; but it has four basal plates, three pentagonal and one hexagonal. The column is round, consisting of joints, gradually growing thinner towards the body. A remarkable feature is that the main arms give origin to armlets or fingers which bear the tentacles. This magnificent specimen of a nearly entire individual is from the Lower Helderberg (Upper Silurian, Litchfield, N. Y.

No. 448. **Melocrinus (Ctenocrinus) typus**, Bronn.

This genus is peculiar to the Devonian. Lower Devonian, Eifel, Prussia.

No. 449. [945, Cast]. **Pentacrinus (Extracrinus) Briareus**, Miller.

Size, 2 ft. 2 in. x 1 ft. 10 in.

The Extracrinoids of Austin are Pentacrinoids with unequal radial plates. The majority of the individuals found are much distorted, and their arms tangled and broken by the action of the waves before they were buried in the mud. This slab, containing a multitude of beautifully preserved bodies, is from the Lias of Whitby, England, and is now in the Ward Collection, University of Rochester.

No. 450. **Pentacrinus Briareus**, Miller.

A smaller specimen of this beautiful crinoid from Lyme-Regis, England.

No. 451. **Pentacrinites cingulatus**, Munst.

STEMS. The columns of this genus are five-sided, and the articulating facets of the joints are marked by crenated ridges, making a pentapetalous figure. The column is provided with "side-arms." Oolite, Boellert, Wurtemberg.

No. 452. [942, Cast]. **Pentacrinus subangularis**, Miller.

BODY AND STEM, ON SLAB. This genus of five-sided Crinoids, is still represented by a few species in the deeper waters. The number of plates or ossicles in a single skeleton has been computed at 100,000. The body-plates are firmly articulated together; the rays of the disc are fixed immediately to the summit of the column by special ossicles; and the stem is composed of angular pieces, generally pentagonal. The arms are very long, and thickly beset with side-arms and minute pinnæ. This specimen, of unusual size and perfection, is from the Lias, Boll, Wurtemberg.

Size, 4 ft. 5 in. x 1 ft. 6 in.

No. 453. *Platycrinus planus*, O. & S.

BASAL PLATES. Burlington Limestone, Burlington, Iowa.

No. 454. *Platycrinus*.

JOINTS. In most Palæozoic crinoids the column, composed of joints, was round, but in this genus it is oval or elliptical. The articulating facets are marked striæ radiating from near the center, which is characteristic of the Palæozoic forms. Sub-Carboniferous, Barren Co., Ky.

No. 455. *Crinoid*.

STEMS. Burlington Limestone, Burlington, Iowa.

No. 456. *Crinoid*.

ROOTS. Sub-Carboniferous, Barren Co., Ky.

No. 457. *Crinoid*.

ENLARGED JOINTS. Sub-Carboniferous, Barren Co., Ky.

ORDER BLASTOIDEA.

The Blastoids connect the Cystideans with the true Crinoids. They have no arms, a short stalk, and the closed calyx resembles a flower-bud. Five areas radiate from the summit, and carry jointed pinnulæ. This order began in the Upper Silurian, after the Cystideans had declined. They culminated in the early Carboniferous and disappeared in that age. *Pentremites* is the characteristic genus.

No. 458. *Granatocrinus Norwoodi*, O. & S.

Burlington Limestone, Burlington, Iowa.

No. 459. *Neucleocrinus Verneuli*, Troost.

Devonian, Columbus, Ohio.

No. 460. *Pentremites cervinus*, Hall.

This large form is from the Chester Limestone (Sub-Carboniferous), at Chester, Illinois.

No. 461. *Pentremites Godonii*, DeFr.

Sub-Carboniferous, Huntsville, Alabama.

No. 462. *Pentremites pyriformis*, Say.

Sub-Carboniferous, Cumberland Co., Tenn.

ORDER CYSTIDEA.

The body, in this order, was enclosed in a box of calcareous plates joined by their edges. True arms were rarely present, and smaller than in the Brachiata. The Cystideans are confined to the Palæozoic ages. They appear in the Cambrian and culminate in the Lower Silurian.

No. 463. *Agelacrinus Cincinnatiensis*, Roemer.

Cincinnati Group (Lower Silurian), Covington, Ky.

No. 464. *Caryocrinus ornatus*, Say.

BODY, WITHOUT COLUMN. In this genus all the plates of the calyx are perforated with many pores. This beautifully marked specimen is from the Niagara Group (Upper Silurian), Lewiston, N. Y.

No. 465. [936, Cast]. *Lepadocrinus (Apiocystites) Gebhardi*,
[Conrad.]

This Cystidian has an oblong, oval body, compressed at the sides, four unequal basal plates, four arms, and a column of two distinct parts,—the upper being flexible, the lower, larger, longer, and inflexible. This specimen, showing the body, with a short stem, is from the Lower Helderberg (Upper Silurian), Schoharie County, N. Y.

SUBKINGDOM

CŒLEENTERATA.

In this division of the animal realm radial symmetry is more marked than in Echinodermata. Its members are distinguished from the latter division and from all higher animals by the more simple structure of the body. They have no true separate stomach, their digestive cavity being, as in the "Jelly-fishes" simply the general body-cavity, or in the higher forms, as the sea-anemone, a more or less distinct portion of that cavity; but in all cases the "stomach" freely communicates with the body-cavity. The animals are virtually digestive sacs. They have no circulating organs, the nourishment being distributed by diverticula of the general cavity. A water-vascular system is sometimes present. Hollow tentacles, communicating with the somatic cavity, frequently surround the mouth, and are prehensile organs. A nervous system may be entirely wanting, or represented by scattered nerve cells, or at the best by a ganglionated ring. There are two fundamental layers of the body wall, an inner layer, endoderm, and an outer layer, ectoderm. Reproduction is largely non-sexual, or by budding. Defense is by means of "nettle-cells" (cnidæ).

This division embraces the greater number of animals popularly called Zoöphytes, and the producers of "coral," and is divided into Actinozoa and Hydrozoa.

CLASS ACTINOZOA.

This class is wholly marine, and comprises the Sea-anemones, Coral-polyps, Sea-pens, &c. They have a digestive sac which opens below into the general somatic cavity. The space surrounding the stomach—lying between it and the body wall, is divided into vertical compartments by septa (mesenteries) springing from the outer wall. To the free edges of some of these partitions the reproductive bodies are attached, which are thus

internal. True sexual reproduction occurs in all members, but in many forms colonies are produced by a process of continuous budding or fission, the zooids remaining connected. The life of the individual is combined with the life of the whole, and the nutriment prepared by each organism is made to contribute to the nourishment of the community of which it forms a part. Such composite organisms, of very soft tissue, require a sustaining skeleton, hence an endodermic skeleton of carbonate of calcium is commonly secreted in the body walls and mesenteries, which copies the structure of the polyp; this is the true "coral" (corallum).

Four orders are recognized, Zoantharia, Rugosa, Aleyonaria and Ctenophora. The latter are active swimmers; and of the first order the Anemones have a limited power of locomotion. The Aleyonaria include the precious corals. Corals abounded in the Lower Silurian, but were most abundant, probably, in the Devonian.

ORDER ZOANTHARIA.

In this order the tentacles are usually simple, smooth and numerous, and like the mesenteries, in multiples of six. The Zoantharia malacodermata include those without a skeleton, as the sea-anemones (*Actinidae*). Zoantharia sclerodermata are those which secrete a corallum within the body, and include the common reef-forming corals. Zoantharia sclerobasica have the corallum as a central axis or base supporting the investing polyps. The latter appear in the Tertiary. The second group has been abundant since Lower Silurian time.

No. 466. *Astrocerium pyriformis*, Hall.

Niagara Group, Waldron, Indiana.

No. 467. *Chætetes lycoperdon*, Say.

According to Meek, and others, this is Pander's species *petropolitanus*, and many of our best authorities place it under d'Orbigny's genus *Monticulipora*. Trenton Group, Decorah, Iowa.

No. 468. *Dendropora ornata*, Rom.

Corniferous, Clarke Co., Indiana.

- No. 469. *Favistella stellata*, Hall.

Cincinnati Group, Nashville, Tenn.

- No. 470. *Favosites Emmonsii*, Rom.

Corniferous, Clarke Co., Indiana.

- No. 471. *Favosites*.

POLISHED SPECIMEN. Hamilton Group, Iowa City, Iowa.

- No. 472. *Halysites catenulatus*, Linn.

This is the well known "chain-coral" so characteristic of the Niagara Group. From the Niagara of Western New York.

- No. 473. *Michelinia cylindrica*, E. and H.

Corniferous, Falls of the Ohio.

- No. 474. *Monticulipora Dalei*, E. and H.

Cincinnati Group, Cincinnati, Ohio.

- No. 475. *Monticulipora mammilatus*, d'Orb.

Cincinnati Group, Cincinnati, Ohio.

ORDER RUGOSA.

This group has no undoubted representatives to-day, and very few in rocks of the later ages. It is preeminently a Palæozoic order, and includes the abundant and characteristic Cyathophyllidæ. The members agree with Zoantharia in possessing a sclerodermic skeleton, but differ in having the radiations of the body some multiple of four. In the latter character they agree with the Alcyonaria.

No. 476. *Acervularia Davidsoni*, E. and H.

Hamilton Group, Cedar Rapids, Iowa.

No. 477. *Acervularia Davidsoni*, E. and H.

POLISHED SPECIMEN. Hamilton Group, Iowa City, Iowa.

No. 478. *Calciola sandalina*, DeFrance.

This anomalous form is of doubtful relations, and has been put by Davidson into a distinct family—the Calceolidæ. It is provided with an operculum, closing the mouth of the calice, and was once referred to the Brachiopods. These specimens are from the Middle Devonian, Gerolstein, Prussia.

No. 479. *Caryophyllia clavus*, Mch.

Quaternary, Mt. Pelegrini, Sicily.

No. 480. *Cyathophyllum helianthoides*, Goldf.

Middle Devonian. Gerolstein, Eifel, Rhenish Prussia.

No. 481. *Cyathophyllum Murchisoni*.

POLISHED SECTION. Carboniferous Limestone, Bristol, England.

No. 482. *Cyclolites elliptica*, Lam.

Lower Chalk, Beausset, France.

No. 483. *Hadrophyllum d'Orbigny*, E. and H.

Carboniferous, Clarke Co., Indiana.

No. 484. *Heliophyllum epigium*, Hall.

Carboniferous (Devonian), Charlestown, Ind.

No. 485. *Heliophyllum Halli*, E. & H.

Hamilton (Moscow Shale), Moscow, N. Y.

No. 486. *Lithostrotion Canadense*, Castelnau.

This is one of the most widely distributed and characteristic fossils of the Sub-Carboniferous, marking characteristically the horizon of the St. Louis Group, and ranging from Northern Iowa to Alabama.

Henry Co., Iowa.

No. 487. *Streptelasma corniculum*, Hall.

This genus is related to *Zaphrentis*, and should be regarded, says Hall, as a sub-genus. Cincinnati Group, Waynesville, Ohio.

No. 488. *Zaphrentis corniculum*, E. and H.

Corniferous, Falls of the Ohio.

CLASS HYDROZOA.

The members of this class are various and complicated, but they are briefly characterized as having the digestive cavity and the body or somatic cavity identical, and the reproductive bodies external. In its simplest form the body is a sac, attached at its aboral end, composed of three cell-layers and provided with hollow tentacles. A nervous system is rarely present as a ring about the center of the disk. Nettling-cells (cnidæ) are characteristic.

The class includes the Hydroidea, as the fresh-water *Hydra*, and its marine allies, the hydroid zoöphytes; the Discophora, which include the Sea-Jellies; and the Siphonophora, which are swimming colonies of zooids of various functions, as the Portuguese Man-of-war (*Physalia*). The Graptolites are regarded as a sub-class.

Most members of the class multiply by continuous gemmation; and some secrete a polypidom which may resemble true coral. Many Sea-Jellies are only the free reproductive zooids (gonophore) of hydroid forms; and these furnish the best example of alternation of generation with gemmation.

The class is represented in the lowest fossiliferous rocks.

ORDER DISCOPHORA.

These soft, gelatinous Hydrozoa, known as "Jelly-fishes," "Sea-nettles," "Sea-blubbers," "Medusæ," etc., vary in size from an almost invisible dot to a yard in diameter. Large ones often weigh 50 lbs.; yet they are little more, as it were, than "coagulated water," for when dried, nothing is left but a film of membrane, thin as a gossamer, and weighing but a few grains. The animal is covered by a very delicate epidermis, under which are situated the nettling capsules. There is a distinct muscular system; but the only motion consists of an alternate contraction and dilatation of the disc, performed with great regularity about fifteen times a minute.

Acalephs have left few traces in stratified deposits, owing to the extraordinary softness of their bodies.

No. 489. [962, Cast]. *Acalepha deperdita*, Bey.

TWO SPECIMENS. The remains of this frail creature are circular imprints, composed of very regular concentric circles, on the borders of which are eight rays. These are the only sure remains of a true Acaleph which have been found fossil. From the Lithographic limestone (Middle Oolite), Eichstädt, Bavaria.

SUB-CLASS GRAPTOLITIDÆ.

The Graptolites were first considered of vegetable origin; subsequently they were regarded as extremely slender Orthoceratites; but Portlock has pointed out their analogy with *Sertularia*, or the lowest forms of compound Hydroids. They consist of sessile polypite cells (hydrothecæ) arranged in one or two rows on flexible, tubular stems, which radiate from a central disc. They seem to have been free-floating colonies. The specimens usually observed are fragments of stems in a flattened condition, presenting only a serrated edge; they seldom preserve more of their substance than a carbonaceous or corneous film of extreme tenuity. Graptolites are exclusively and characteristically Cambrian and Silurian fossils, and prevail in argillaceous deposits.

No. 490. *Graptolithus (Monoprion) clintonensis*, Hall.

In this genus the polypidom is a long, narrow blade with a row of cells on one side. Clinton Group, Rochester, N. Y.

No. 491. *Climocograptus typicalis*, Hall.

The cells of this genus appear to have their mouths sunk, the surface of the polypidom forming a row of openings on each side. Cincinnati Group, Cincinnati, Ohio.

No. 492. *Diplograptus pristis*, Hall.

In this genus the polypidom possesses a row of cells on each side. This and the preceding genus range from the Cambrian to the Upper Silurian. Utica Slate, near Utica, New York.

SUBKINGDOM

PORIFERATA (SPONGIÆ).

The Sponges are many-celled animals without a true digestive cavity. They consist of protoplasmic matter in three cell-layers, supported in most cases by a framework of horny (keratode) fibres, or calcareous or siliceous spicules. The body-mass is traversed by ciliated passages, which are dilated at intervals to form chambers, lined with flagellated monad-like cells. Food is obtained by currents of water, which is drawn in at multitudes of inhalent orifices (pores), and expelled through a single or several large openings (oscula). There are no further digestive or circulatory systems, and no definite nervous organs.

Reproduction takes place in the sponges by gemmation, and also by fertilized ova. They are hermaphroditic.

Sponges are divided into Calcispongiæ and Carneospongiæ. In the former the skeleton is calcareous spicules, disposed in lines or columns at right angles to the walls, and the permeating ciliated canals are without sacs. The latter class have a thick mesoderm, cilia restricted to the chambers, and either no skeleton or a horny or siliceous framework.

The Calcispongiæ are mostly extinct, and include the Palæozoic forms, *Receptaculites* and *Stromatopora*.

Carneospongiæ include the only known fresh-water genera, *Spongilla* and *Siphydora*, the common sponges of commerce (*Spongia*), the boring *Cliona*, and the "glass-sponges," of which the most beautiful is the Venus' flower-basket (*Euplectella*).

Several hundred species of fossil sponges are described, ranging from the Cambrian.

No. 493. *Astraeospongia meniscus*, Roem.

Meniscus Limestone (Niagara Group), West Tennessee.

No. 494. *Chenendopora fungiformis*, Lamour.

Lower Greensand, Faringdon, Berks, England.

No. 495. [1164, Cast]. *Brachiospongia digitata*, Owen.

This large and remarkable fossil sponge, with eleven beautifully radiating and recurved hollow branches, is from the Lower Silurian, Franklin County, Ky.

According to Mr. Beecher the number of branches or arms in this species vary from 8 to 12, and the specimens range in size from $3\frac{1}{2}$ to 11 inches in diameter.

Size of this specimen, 11 x 11.

No. 496. [1165, Cast]. *Cœloptychium agaricoides*, Goldf.

These mushroom-like Sponges have the upper surface marked by pores in transverse lines, and the lower one rayed. From the Chalk, Haldem, Westphalia, and now in the Ward Collection of the University of Rochester.

No. 497. *Cryptozoon protiferum*, Hall.

This sponge was long known as *Stromotopora rugosa*, and was assigned to the Calciferous Epoch, instead of the Potsdam as at present. Saratoga, N. Y.

No. 498. *Dictyophyton nodosum*, Hall.

Chemung Group, Bath, Steuben County, New York.

No. 499. *Dictyophyton tuberosum*, Hall.

This interesting sponge was formerly supposed to be a plant, as the name signifies. It is the internal cast of a sponge which had a network somewhat like the living *Euplectella*. The genus is known by eight or ten species. In the present species (as also in *D. nodosum*) the body expands at intervals, and is protruded into tubercles or nodes, with a longitudinal axis and moderate elevation. From the Chemung Group (Upper Devonian), of Steuben County, N. Y.

Size, 7 x 5.

No. 500. [1168, Cast]. *Polypothecia dichotoma*,
[Benett].

This genus is allied to *Scyphia*. The species presents considerable diversity of shape. This beautiful specimen shows several branches springing from one root. Upon breaking these stems transversely, sections of parallel longitudinal tubes are exhibited as in *Siphonia*. From the Upper Greensand, Warminster, England.

Size, 7 x 4.

No. 501. *Receptaculites Oweni*, Hall.

This sponge was hollow; of a discoidal, cylindrical or globular shape, and with a small protuberance near the center of the lower side which is thought to indicate the point where growth began.

The body-wall has a complex structure. It consists of three layers. The inner and outer integuments are composed of numerous rhomboidal calcareous plates, so peculiarly arranged as to give fragments the appearance of an engine-turned watch-case. Numerous small, straight, hollow spicula connect the inner and outer layers. The animal has some points of resemblance to the Foraminifera. It ranges through the Silurian. Trenton group, Rockford, Ill.

No. 502. [1174, Cast]. *Siphonia* (Hallirhoa) *costata*, Lamoureux.

Syn. *Polypothecia septemloba*, Benett.

The fossil Sponges belonging to this genus, have a comparatively symmetrical form. The body is bulbous and supported by a slender stem, which is composed of very fine parallel longitudinal tubes, terminating on the surfaces of the central cavity. The base of the stem was fixed by root-like processes. The genus does not occur above the Chalk. From the Upper Greensand, Westminster, England.

No. 503. [1177, Cast]. *Siphonia pyriformis*, Goldf.

These pear-shaped Sponges are from the Upper Greensand, Blackdown, England (a locality which has furnished many very interesting and peculiar forms of Sponges), and are now in the Ward Collection of the University of Rochester.

No. 504. *Stromatopora* ——— .

This genus forms globular or hemispherical masses of large size. It consists of thin concentric laminae, penetrated by minute tubes. The genus ranges from the Lower Silurian to the Trias. This specimen is from the Hamilton Group, near Shueyville, Iowa.

No. 505. [1185, Cast]. *Ventriculites* ——— .

The *Ventriculites* are the largest group of Cretaceous Sponges. They are shaped like a mushroom or funnel, tapering to a point below, and attached by rootlets. The astonishing complication of their surface is shown by the fact, pointed out by Toulmin Smith, that in one specimen, only three inches high, nine millions of fibres were found! Like *Siphonia*, this genus is not found above the Cretaceous. From the Upper Chalk of Bridlington, England, and now in the Ward Collection of the University of Rochester.

Size, 10 x 3.

SUBKINGDOM

PROTOZOA.

This division, created by Von Siebold in 1845, has been generally adopted by naturalists as a convenient receptacle for those lowest minute forms of animal life which do not readily fall into any one of the other subkingdoms. From their extreme simplicity the Protozoa possess few positive characters. They are unicellular, and consist of slightly modified protoplasm called "sarcode." In the lowest forms (Monera) even the nucleus of the cell is wanting, and the animal is termed a cytode.

In the typical Protozoa, the outer layer of the cell is denser and more homogeneous than the internal protoplasm, which is filled with dark particles called "granules," and clear spaces termed "vacuoles." Many of the latter are only temporary, but usually one is larger than the rest, permanent and fixed, and dilates and contracts at regular intervals. It is termed the "contractile vesicle." There may be more than one contractile vesicle, and more than one nucleus. No tissues are present. The highest organization is seen in the Infusoria, which possess merely a rudimental food-cavity, and permanent cilia. The nucleus and contractile vesicle seem to be rudimental organs of reproduction and circulation. Notwithstanding the lack of organs and structures possessed by the higher animals, the Protozoa carry on all the primary animal functions.

The Protozoa may be divided into the classes Infusoria, Gregarinida, Rhizopoda and Monera. The Monera are sometimes placed with the Rhizopods, near the Amœba. They, however, are simpler than the Amœba, as they possess no nucleus or contractile vesicle. Only the Rhizopods occur as fossils.

CLASS INFUSORIA.

These animalcules were first observed by Lewenhöck in 1675; and our present knowledge is chiefly due to the labors of Ehrenberg, Pritchard, Dujardin and Bailey. The later researches have tended to diminish the numbers of the so-called Infusoria; many forms have been shown to be only larval worms, while whole genera (as *Diatomaciæ* and *Bacillariæ*) have assumed under the microscope a vegetable character. They are distinguished by having bodies of a definite form, by moving chiefly by means of vibratile organs (cilia), instead of prolongations and digitations of the sarcode, and by the possession of a mouth and gullet and rudiments of digestive, circulatory and reproductive organs.

Infusoria inhabit both fresh and salt waters, and are not found fossil,—the fossil organism often called Infusorial, being Foraminifers, Polycystines and Diatoms.

CLASS GREGARINIDA.

These are parasitic forms without mouth or power of emitting pseudopodia. They have a definite cell-wall and nucleus, but no contractile vacuole. They reproduce by encysting and production of moner-like young which undergo metamorphosis.

The Gregarinida resemble worms, and are internal parasites of various animals, particularly the earth-worm and cockroach. They are sometimes ranked as the lowest of the subkingdom, but they may be forms degraded by their mode of life. Having no hard parts they do not occur fossil.

CLASS RHIZOPODA.

The members of this typical class are characterized by the absence of a mouth, and the possession of pseudopodia. The latter are thrown out at will as long, delicate, contractile filaments, resembling roots (whence the name Rhizopod), and are used like the tentacles of the Polyp for locomotion, and for the introduction of food. The majority have the power of secreting a testaceous envelope, either siliceous or calcareous; a few are naked; while fewer still are strengthened like the Sponge by spicules.

The class is divided into the Amœbea, which are naked, with blunt finger-like pseudopodia, and the Foraminifera and Radiolaria, which secrete a test and have thread-like and anastomosing pseudopodia. The latter order has siliceous tests or spiculæ, and includes Polycystina and other marine groups, and the fresh-water Heliozoa.

The Protozoans with calcareous shells constitute the interesting group of *Foraminifera*. The existence of these microzoa was first made known to naturalists by Beccarius nearly 150 years ago. They were first ranked as minute forms of Nautili, and even d'Orbigny, in his first memoir (1825) described them as Cephalopods. It was reserved for Dujardin, ten years after, to demonstrate their Rhizopod type of structure. Since then our knowledge has been greatly extended by the elaborate researches of Williamson and Carpenter.

The Foraminifer is a marine animal, dwelling in shells of extreme beauty, sometimes simple, but usually consisting of an aggregate of chambers which intercommunicate by minute apertures, whence the name. These chambers grow by successive gemmation from a primordial segment, sometimes in a straight line, more commonly in a spiral or discoidal form. D'Orbigny's classification, founded on the numerical increase of the chambers, has been set aside. Carpenter divides the order into two primary groups according as the envelope is *perforated* or *imperforated*.

The former include a large proportion of the Foraminifers which come under general observation, namely, the three families *Lagenida*, *Globigerinida* and *Nummulinida*. They are characterized by a calcareous shell perforated by tubular openings. The extraordinary multiplication of *Nummulites* in the Eocene gives the last family a place of no mean importance as a member of its fossil fauna. The imperforated Foraminifers include the families *Gromida*, *Miliolida* and *Lituolida*, in which the nature of the envelope is membranous, porcellaneous or arenaceous. The *Miliola* is now the most universally diffused Foraminifer; its type can be traced back to the Lias.

Upwards of 700 fossil species of Foraminifers have been described. They commence in the Palæozoic, increase in number and variety with successive strata, and attain their maximum in the present seas. Indeed, they are so abundant in the most common materials, as chalk for example, as to justify the expression of Buffon, that the very dust has been alive. The calcaire grossier—the building stone of Paris, and the material of the pyramids are full of these minute chambered shells; while the deep-sea soundings show that the bed of the Ocean is composed of little else than shells of *Globigerinæ* and the shields of *Polycystinæ*.

No. 506. *Eozoon Canadense*, Dawson.

This has been described by Principal Dawson as a gigantic *Foraminifer*. Its organic nature is still doubted, and in the opinion of a large number of our best authorities, is entirely disproved. The fossil, if such it be, is described as consisting of a chambered calcareous skeleton, infiltrated by silicates, chiefly pyroxene, serpentine and Loganite, which occupy the spaces formerly filled by the sarcodæ of the living animal. These chambers are arranged in tiers, one above the other, and the fossil seems thus to have formed great reef-like masses, and might have originated whole beds of limestone. It is the oldest animal fossil known, occurring in the crys-

talline rocks of the Archæan of America and Europe. Laurentian, Petite Nation, Canada.

No. 507. *Fusulina cylindrica*, Fischer.

Sub-Carboniferous, Greenwood Co., Kansas.

No. 508. *Nummulites nummularia*, Brug.

The genus derives its name from the Latin for "coin." The "Nummulitic Limestone" is a distinct formation of great thickness, in some places several thousand feet, which stretches from France to China. The great pyramids are built of this rock. An example is seen in the plinth or base of Cleopatra's Needle in Central Park, New York. Eocene, Great Pyramid, Egypt.

No. 509. *Nummulites striata*, d'Orb.

Eocene, Conizac near Alet, France.

No. 510. *Orbitolites*.

Chalk, Gravesend, England.

No. 511. *Infusorial Earth*.

"About one hundred species of Diatoms have been described by Ehrenberg and Bailey from this earth, beside a few Polycystines (siliceous Foraminifers) and many sponge spicules." Miocene, Richmond, Va.

ENLARGED MODELS.

The following twenty specimens are *models*, very greatly enlarged from the originals, most of the latter being too small for examination without the aid of a microscope.

No. 512. [966] *Amphistegina vulgaris*, d'Orb.

Miocene: Bordeaux, France.

No. 513. [999] *Cassidulina serrata*.

Miocene: Austria.

No. 514. [1002] *Clavulina communis*, d'Orb.

Pliocene: Nussdorf, Austria.

No. 515. [1059] *Cristellaria cassis*, Ficht.

(Young). Pliocene: Sienna, Italy.

No. 516. [968] *Fusulina cylindrica*, Fischer.

Carboniferous: Russia, Belgium, Ohio, Nebraska, Kansas, &c.

No. 517. [1007] *Globigerina bulloides*, d'Orb.

Miocene: Austria. Pliocene: Italy. Living: Adriatic.

- No. 518. [1077] *Globulina gibba*, d'Orb.
Eocene: Grignon, France. Miocene: Bordeaux, France. Pliocene: Castel-Arquato, Italy. Living: Adriatic.
- No. 519. [1094] *Nodosaria inflata*, Reuss.
Upper Chalk.
- No. 520. [1097] *Nodosaria oblonga*, Reuss.
Eocene.
- No. 521. [1098] *Nodosaria radícula*, Lam.
Gault.
- No. 522. [1138] *Orbitolites macropora*, Lam.
Chalk: Maestricht, Holland.
- No. 523. [1015] *Proroporous complanatus*, Reuss.
Gault.
- No. 524. [1145] *Quinqueloculina Ferussaci*, d'Orb.
Eocene: Parnes, France.
- No. 525. [1036] *Siderolina calcitrapoides*, Lam.
Chalk: Maestricht, Holland.
- No. 526. [1039] *Siphonina reticulata*, Reuss.
Miocene: Germany.
- No. 527. [1150] *Spirolina cylindrica*, Lam.
Eocene: Paris, France.
- No. 528. [1043] *Textularia conulus*, Reuss.
Upper Chalk.
- No. 529. [1047] *Textularia pupoides*.
Upper Chalk: Meudon, France.
- No. 530. [1049] *Textularia spinulosa*, Reuss.
Miocene: Germany.
- No. 531. [1161] *Vertebralina nitida*, d'Orb.
Eocene: Grignon, France.

No. 523. (1015)

No. 519. (1094)

No. 516. (968)

No. 521. (1098)

No. 530. (1049)

PLANTÆ.

SERIES PHANEROGAMIA.

CLASS DICOTYLEDONS.

SUB-CLASS ANGIOSPERMÆ.

No. 532. *Sassafras
cretaceum*, Newb.

Angiospermous plants date from the Cretaceous, and many genera are identical with those now living. Our modern forest trees are largely represented in the fresh-water deposits of the interior region and in the cretaceous clays of the Atlantic border.

Dakota Group (Cretaceous), Ellsworth County, Kansas.

No. 533. *Betulites Vestii*, Lesq.

Dakota Group (Cretaceous), Ellsworth County, Kansas.

SUB-CLASS GYMNOSPERMÆ.

FAMILY CONIFERÆ.

No. 534. [1322, Cast]. *Pinites pseudo-stroboides*, Göp.

The genus *Pinites*—the ancient Pine Tree—was introduced upon the earth much earlier than the other members of our present forest trees, and has been persistent in its sojourn. This is attested by trunks, leaves and cones preserved

in strata of every age from the Devonian up through the Carboniferous, Trias, Jura, Cretaceous and Tertiary. In this latter period, and at the present day, the genus has had its maximum of development. This perfectly preserved cone is from the Lower Miocene Tertiary beds of Carbone, France.

Size, 6 x 3.

No. 535. [1206, Cast]. *Dammarites* ———, Sternb.

A conifer from the Inferior Oolite, Burton, Somerset, England.

Size, 6 x 6.

FAMILY CYCADACEÆ.

No. 536. [1204, Cast]. *Cycadoidea megalophylla*, Buckl.

Syn. *Mantellia nidiformis*. Brongn.

This short, spheroidal trunk probably belonged to a Cycad,—a tropical plant related to the Conifers in structure and fructification, but totally different in habit. It supported a tuft of large, pinnated, palm-like leaves; and the surface is covered with rhomboidal scars formed by the attachment of the leaf-stalks. Its shape has caused it to be named "*Crow's Nest*" by the quarrymen. Neither leaves nor fruit have been found. From the Purbeck beds (Wealden), Isle of Portland, England, and now in the Ward Collection, University of Rochester.

Size, 12 x 12.

No. 537. *Trigonocarpus Noeggerathi*, Brongt.

Genus of nut-like fruits, ovoid, 3-6 ribbed. This species is ovate and tricostrate. They are doubtfully referred to the Cycads. Carboniferous, Saarbrück, Rhenish Prussia.

No. 538. *Trigonocarpus tricuspидatus*, Newb.

Nut elliptical in outline. 3-costate, with a bottle-shaped nucleus. Coal Measures, Mahoning Co., Ohio.

No. 539. *Carpolithes Brandonensis*, Lesq.

A fruit of unknown affinity. Eocene, Brandon, Vermont.

No. 540. **Fruit.**

This fruit, or nut, is replaced by Marcasite, which radiates from the small, spherical nucleus in thin fan-shaped plates, whence the name "*Cupid's Wings*," by which they are commonly known. Lias, Lyme-Regis, England.

CLASS MONOCOTYLEDONS.

No. 541. [1207, Cast]. *Nipadites Burtini*, Brongt.

This fossil palm-nut is so called from its resemblance to the fruit of the existing *Nipa* of Bengal and the East Indies. The *Nipa* is allied to the coconut tribe on the one side, and on the other to the screw-pine. It is a low-growing plant, luxuriating in marshy tracts at the mouths of great rivers. From the Eocene clay, Schærbeck, Belgium, and now in the Ward Collection of the University of Rochester.

No. 542. *Phragmites cretaceous*, Lesq.

Dakota Group (Cretaceous), Ottawa Co., Kansas.

SERIES CRYPTOGRAMIA.

CLASS ACROGENS.

FAMILY LYCOPODIACEÆ.

No. 543. *Lepidodendron aculeatum*, Sterns.

The leaf-scars (bolsters) are rhomboidal, in quicunx order, making spiral rows. The inner scar ("cicatrice") bears three points (vascular scars), and beneath it are usually two oval "tubercles." A medial keeled line (cauda) runs from the cicatrice to the inferior point of the bolster. Other lines are variably present in different species.

No. 544. [1325, Cast]. *Lepidodendron Sternbergi*, Brongt.

This fine cast of a decorticated specimen shows the original cylindrical form of the stem. Coal Measures, Orange Co., Indiana. Size, 14 x 8.

No. 545. [1327, Cast]. *Sigillaria*.

The leaf-scars (cicatrices) are more variable in form than those of *Lepidodendron*, and are disposed in vertical rows upon bands or flutings of the trunk, but still with spiral arrangement. Coal Measures, Pittston, Pa.

No. 546. *Stigmaria ficoides*, Brngt.

This genus may represent the subterranean stems and roots of *Sigillaria* and other plants, or perhaps some forms may be the stems of floating plants. Coal Measures, Scranton, Pa.

No. 547. [1326, Cast]. *Stigmaria ficoides*, Brngt.

Coal Measures, South Joggins, Nova Scotia.

Size, 10 x 5.

FAMILY EQUISETACEÆ.

No. 548. *Ancylogonatum carbonacium*, Rom.

Lower Oolite, Whitby, England.

No. 549. *Annularia longifolia*, Brngt.

Coal Measures, Mazon Creek, Grundy Co., Ill.

No. 550. [1329, Cast]. *Calamites*.

The family—Equisetaceæ—is still represented by the common “Horse-tail” or scouring brush. *Asterophyllites* is only the foliage of *Calamites*.

Size, 12 x 4.

No. 551. *Equisetites arenaceus*.

Keuper, Stuttgart, Wurtemberg.

FAMILY FILICACEÆ.

No. 552. *Archæopteris Jacksoni*.

Catskill, Montrose, Penn.

No. 553. *Neuropteris hirsuta*, Lesq.

This beautiful fern, so characteristic of the Coal Measures, is from Mazon Creek, Grundy Co., Ills.

No. 554. *Pecopteris villosa*, Brngt.

Coal Measures, Mazon Creek, Grundy Co., Ills.

No. 555. *Sphenopteris communis*, Lesq.

Sub-Carboniferous, North Western, Arkansas.

CLASS THALASSOPHYTES.

No. 556. *Spirophyton caudi-galli*, Vanuxem.

This is generally regarded as a sea-weed, although thought by some geologists to be only the result of mechanical forces. Caudi-galli Grit, Rondout, N. Y.

GEOLOGICAL SUMMARY

OF THE

College Collection of Palæontology.

The palæontological material described in the body of the catalogue is in the following summary given a chronological arrangement. The species are broadly grouped zoologically, proceeding from lower to higher, under their respective Geologic Ages and Periods, beginning with the earliest, thus giving the classification which is most convenient and useful for a museum.

The number before each name is the list number of the catalogue.

The numbers in brackets are the numbers of casts, as recorded at our Museum, and as published in the old "Catalogue of Casts." These numbers will be plainly marked on both the specimens and the labels accompanying them.

Species of small size are usually represented by more than one specimen. The number may slightly vary, but will always be sufficient to fairly represent the species.

CAMBRIAN AND SILURIAN.

PROTOZOA.

- No. 506. *Eozoon Canadense*, Dawson.

PORIFERATA.

- No. 493. *Astræospongia meniscus*, Roem.
No. 495. [1164] *Brachiospongia digitata*, Owen.
No. 497. *Cryptozoon protiferum*, Hall.
No. 501. *Receptaculites Oweni*, Hall.

CCELEENTERATA.

- No. 490. *Graptolithus (Monoprion) clintonensis*, Hall.
No. 491. *Climocograptus typicalis*, Hall.
No. 492. *Diplograptus pristis*, Hall.

- No. 466. *Astrocerium pyriformis*, Hall. (2 specimens).
 No. 467. *Chætetes lycoperdon*, Say. (3 specimens).
 No. 469. *Favistella stellata*, Hall.
 No. 472. *Halysites catenulatus*, Linn.
 No. 474. *Monticulipora Dalei*, E. and H. (5 specimens).
 No. 475. *Monticulipora mammulata*, d'Orb. (2 specimens).
 No. 487. *Streptelasma corniculum*, Hall. (3 specimens).

ECHINODERMATA.

- No. 463. *Agelacrinus cincinnatiensis*, Roemer.
 No. 464. *Caryocrinus ornatus*, Say.
 No. 465. [936] *Lepadocrinus* (*Apiocystites*) *Gebhardi*.
 No. 443. [911] *Crotalocrinus rugosus*, Miller.
 No. 446. [932] *Ichthyocrinus lævis*, Conrad.
 No. 447. [938] *Mariacrinus nobilissimus*, Hall.

MOLLUSCA.

- No. 411. *Gorgonia antiqua*, Hall.
 No. 412. *Ptilodictya Shafferi*, Meek.
 No. 407. *Lingula cuneata*, Conrad. (2 specimens).
 No. 408. *Lingula* (*Lingulepis*) *prima*, Con.
 No. 405. *Crania scabiosa*, Hall. (2 specimens).
 No. 391. *Strophomena alternata*, Con. (4 specimens).
 No. 392. *Strophomena planumbona*, Hall. (3 specimens).
 No. 393. *Leptæna sericea*, Sow. (5 specimens).
 No. 395. *Orthis laticostata*, James. (6 specimens).
 No. 396. *Orthis lynx*, Eichwald.
 No. 397. *Orthis occidentalis*, Hall. (6 specimens).
 No. 398. *Orthis plicatella*, Hall. (10 specimens).
 No. 399. *Orthis subquadrata*, Hall. (6 specimens).
 No. 400. *Orthis testudinaria*, Dalman. (10 specimens).
 No. 389. *Retzia evax*, Hall. (5 specimens).
 No. 376. *Zygospira modesta*, Say. (25 specimens).
 No. 365. *Rhynchonella dentata*, Hall. (10 specimens).
 No. 366. *Rhynchonella capax*, Con. (8 specimens).
 No. 370. *Pentamerus oblongus*, Sow.
 No. 371. *Pentamerus oblongus*, Sow. (2 specimens).
 No. 361. *Leptocœlia hemispherica*, Sow.
 No. 338. *Ambonychia radiata*, Hall. (2 specimens).
 No. 307. *Conularia trentonensis*, Hall.
 No. 308. *Tentaculites irregularis*, Hall.
 No. 301. *Maclurea Bigsbyi*, Hall. (2 specimens).

- No. 299. *Bellerophon bilobatus*, Sow. (3 specimens).
 No. 298. *Murchisonia bellicinati*, Hall. (4 specimens).
 No. 287. *Cyclonema bilix*, Con. (4 specimens).
 No. 281. *Raphistoma lenticulare*, Sow. (2 specimens).
 No. 253. [598] *Cyrtoceras macrostomum*, Hall.
 No. 251. *Endoceras proteiforme*, Hall.
 No. 250. [585] *Orthoceras amplicameratum*, Hall.
 No. 249. *Orthoceras Duseri*, H. & W. (2 specimens).
 No. 248. [580] *Lituities undatus*, Conrad.

ARTICULATA.

- No. 171. *Scolithus linearis*, Hall.
 No. 143. *Asaphus gigas*, De Kay.
 No. 144. [373] *Asaphus gigas*, De Kay.
 No. 142. [376] *Asaphus megistos*, Locke.
 No. 145. [386] *Acidaspis Buchii*, Barrande.
 No. 146. [390] *Bumastus (Illænus) Barriensis*, Murch.
 No. 147. *Calymene niagarensis*, Hall. (2 specimens).
 No. 148. *Calymene senaria*, Conrad. (2 specimens).
 No. 149. [394] *Calymene Blumenbachii*, Brongniart.
 No. 150. [398] *Ceraurus pleurexanthemus*, Green.
 No. 151. [407] *Dalmania (Phacops) limulurus*, Green.
 No. 153. [410] *Dalmania nasutus*, Conrad.
 No. 154. [412] *Dalmania nasutus*, Conrad.
 No. 156. [416] *Dikelocephalus minnesotensis*, Owen.
 No. 157. *Elipsocephalus Hoffi*, Schlotheim.
 No. 157. [421] *Harpes ungula*, Barrande.
 No. 158. [423] *Homalonotus delphinocephalus*.
 No. 159. [426] *Illænus giganteus*, Brong.
 No. 160. [428] *Lichas Boltoni*, Green.
 No. 161. [431] *Lichas pustulosus*, Hall.
 No. 163. [437] *Paradoxides bohemicus*, Bock.
 No. 166. [447] *Sphærexochus mirus*, Beyrich.
 No. 167. *Triarthrus Becki*, Green.
 No. 168. *Trinucleus ornatus*, Burm.
 No. 169. *Trinucleus concentricus*, Eaton. (2 specimens).
 No. 170. [1296] *Climactichnites Wilsoni*, Logan.
 No. 138. *Eurypterus remipes*, DeKay.
 No. 139. [1314] *Eusarchus scorpionis*, Grote and Pitt.
 No. 137. [370] *Pterygotus acuminatus*, Salter.

Cambrian and Silurian, 64 Genera, 81 Species, 103 Specimens;
 Value \$75.00

DEVONIAN.

PLANTÆ.

- No. 556. *Spirophyton caudi-galli*, Vauxem.
 No. 552. *Archæopteris Jacksoni*.

PORIFERATA.

- No. 498. *Dictyophyton nodosum*, Hall.
 No. 499. *Dictyophyton tuberosum*, Hall.
 No. 504. *Stromatopora*.

CŒLEENTERATA.

- No. 476. *Acervularia Davidsoni*, E. and H.
 No. 477. *Acervularia Davidsoni*, E. and H.
 No. 478. *Calciola sandalina*, Defrance. (3 specimens).
 No. 480. *Cyathophyllum helianthoides*, Goldf.
 No. 483. *Hadrophyllum d'Orbignyi*, E. and H. (10 specimens).
 No. 484. *Heliophyllum epigium*, Hall. (6 specimens).
 No. 485. *Heliophyllum Halli*, E. and H. (2 specimens).
 No. 488. *Zaphrentis corniculum*, E. and H. (4 specimens).
 No. 468. *Dendropora ornata*, Rom.
 No. 470. *Favosites Emmonsii*, Rom.
 No. 471. *Favosites*.
 No. 473. *Michelinia cylindrica*, E. and H.

ECHINODERMATA.

- No. 459. *Neucleocrinus Verneuli*, Troost. (2 specimens).
 No. 448. *Melocrinus (Ctenocrinus) typus*, Bronn.
 No. 435. [1320] *Renaster margaritatus*.

MOLLUSCA.

- No. 394. *Orthis Eifleensis*, Vern. (10 specimens).
 No. 384. *Athyris concentrica*, Buck. (3 specimens).
 No. 385. *Athyris spiriferoides*, Eaton. (3 specimens).
 No. 387. *Athyris vittata*, Hall. (4 specimens).
 No. 388. *Meristella barrisi*, Hall. (4 specimens).
 No. 390. *Uncites gryphus*, Defr.
 No. 377. *Spirifer micropter*. (8 specimens).
 No. 378. *Spirifer mucronata*, Con. (3 specimens).
 No. 379. *Spirifer Oweni*, Hall. (2 specimens).
 No. 381. *Spirifer speciosus*, Schloth. (3 specimens).
 No. 372. *Atrypa aspera*, Schloth. (8 specimens).

- No. 373. *Atrypa primipilaris*, d'Orb. (10 specimens).
 No. 374. *Atrypa reticularis*, Linn. (3 specimens).
 No. 375. *Atrypa reticularis*, Linn. (3 specimens).
 No. 364. *Rhynchonella alta*, Hall. (6 specimens).
 No. 363. [728] *Stringocephalus Burtini*. (2 specimens).
 No. 362. *Rensselaeria ovoides*, Eaton.
 No. 323. *Megalodon cuculatus*, Sow.
 No. 295. *Pleurotomaria sulcomarginata*, Con. (2 specimens).
 No. 254. [602] *Gyroceras trivolvis*, Hall.
 No. 252. [592] *Gomphoceras inflatum*, Quenst.
 No. 247. [595] *Nautilus maximus*, Conrad.

ARTICULATA.

- No. 152. [409] *Dalmania myrmecophora*.
 No. 155. [405] *Dalmania* (*Cryphæus*) *calliteles*.
 No. 164. *Phacops bufo* (Var. *rana*.), Green, (2 specimens).
 No. 165. [445] *Prætus longicaudus*, Hall.

VERTEBRATA.

- No. 105. [309] *Holoptychius nobilissimus*, Agassiz.
 No. 106. [313] *Cephalaspis Lyelli*, Agassiz.
 No. 107. [1303] *Cephalaspis Dawsoni*, Lankester.

Devonian, 34 Genera, 46 Species, 128 Specimens; Value \$39.30

CARBONIFEROUS.

PLANTÆ.

- No. 553. *Neuropteris hirsuta*, Lesq.
 No. 554. *Pecopteris villosa*, Brngt.
 No. 555. *Sphenopteris communis*, Lesq.
 No. 549. *Annularia longifolia*, Brngt.
 No. 550. [1329] *Calamites*.
 No. 543. *Lepidodendron aculeatum*, Sterns.
 No. 544. [1325] *Lepidodendron Sternbergi*, Brongt.
 No. 545. [1327] *Sigillaria*.
 No. 546. *Stigmaria ficoides*, Brngt.
 No. 547. [1326] *Stigmaria ficoides*, Brngt.
 No. 537. *Trigonocarpus Noeggerathi*, Brongt. (3 specimens)
 No. 538. *Trigonocarpus tricuspidatus*, Newb. (3 specimens).

PROTOZOA.

- No. 507. *Fusulina cylindrica*, Fischer.
 No. 516. [968] *Fusulina cylindrica*, Fischer.

CŒLEENTERATA.

- No. 481. *Cyathophyllum Murchisoni*.
 No. 486. *Lithostrotion canadense*, Castelnau.

ECHINODERMATA.

- No. 458. *Granatocrinus Norwoodi*, O. and S. (4 specimens).
 No. 460. *Pentremites cervinus*, Hall. (2 specimens).
 No. 461. *Pentremites Godonii*, DeFr. (5 specimens).
 No. 462. *Pentremites pyriformis*, Say. (5 specimens).
 No. 437. [864] *Actinocrinus proboscidealisis*, Hall.
 No. 438. *Actinocrinus Verneulianus*, Shum. (4 specimens).
 No. 441. *Batocrinus rotundus*, Y. and S. (3 specimens).
 No. 442. *Dorycrinus unicornis*, O. and S.
 No. 453. *Platycrinus planus*, O. and S. (3 specimens).
 No. 454. *Platycrinus*. (2 specimens).
 No. 455. *Crinoid*. (6 specimens).
 No. 456. *Crinoid*. (2 specimens).
 No. 457. *Crinoid*.
 No. 429. [781] *Palæchinus (Melonites) multipora*.

MOLLUSCA.

- No. 409. *Archimedes laxa*, Hall. (6 specimens).
 No. 410. *Fenestella retiformis*, Schloth.
 No. 406. *Discina nitida*, Phil.
 No. 401. *Productus horridus*, Gein. (2 specimens).
 No. 402. *Productus longispinus*, Sow. (4 specimens).
 No. 403. *Productus Prattenianus*, Norwood. (2 specimens).
 No. 404. *Productus semireticulatus*, Mart. (2 specimens).
 No. 380. [690] *Spirifer pinguis*, Sow.
 No. 382. [698] *Spirifer striatus*, Martin.
 No. 383. *Athyris ambigua*, Sow. (4 specimens).
 No. 386. *Athyris subtilita*, Hall. (4 specimens).
 No. 367. *Rhynchonella pleurodon*, Phil. (6 specimens).
 No. 300. *Bellerophon hiulcus*, Sow. (4 specimens).
 No. 280. [622] *Euomphalus pentangulatus*, Sow.
 No. 306. *Gasteropod*, enlarged by silica.
 No. 182. *Goniatites ixion*, Hall.
 No. 183. *Goniatites Oweni*, Hall.

ARTICULATA.

- No. 141. [1316] *Euproops Danæ*, M. and W.

VERTEBRATA.

- No. 120. [1308, 1310] *Rhyssodus* (*Cochliodus*) *latus*.
(2 specimens).
No. 117. [343] *Edestes vorax*, Leidy.
No. 108. [311] *Rhizodus Hibberti*, Owen.
No. 96. [291] *Archegosaurus Decheni*, Goldf.
No. 95. [301] *Sauropus primævus*, Lea.

Carboniferous, 37 Genera, 51 Species, 109 Specimens; Value \$42.90.

TRIASSIC.**PLANTÆ.**

- No. 551. *Equisetites arenaceus*.

ECHINODERMATA.

- No. 444. [917] *Encrinus liliiformis*, Schloth.
No. 445. [920] *Encrinus liliiformis*, Schloth.
No. 415. *Cidaris dorsata*, Brown. (5 specimens).

MOLLUSCA.

- No. 341. *Gervillia socialis*, Lyc. and Mor. (2 specimens).
No. 336. *Modiola minuta*, Quenstedt. (2 specimens).
No. 334. *Nucula strigillata*, Goldf. (5 specimens).
No. 331. *Myophoria* (*Schizodus*) *Kefersteinii*. (2 specimens).
No. 229. [1203] *Ammonites tornatus*, Brown.
No. 184. *Ceratites nodosus*, De Hann.

ARTICULATA.

- No. 134. [358] *Pemphix Seurii*, Meyer.

VERTEBRATA.

- No. 104. [340] *Ceratodus*. (2 specimens).
No. 93. [293] *Labyrinthodon* (*Mastodonsaurus*) *Jægeri*.
No. 100. [305] *Labyrinthodon*.
No. 94. [294] *Cheirotherium Barthi*, Kaup.

- No. 87. [271] *Belodon* (*Phytosaurus*) *Kapffii*, Meyer.
 No. 79. [237] *Placodus gigas*, Agassiz.
 No. 76. [235] *Nothosaurus mirabilis*, Munst.
 No. 67. [278] *Dicynodon lacerticeps*, Owen.
 No. 61. [191] *Brontozoum giganteum*, Hitchcock.
 No. 62. [192] *Brontozoum Sillimanium*, Hitch.
 No. 63. [195] *Anomœpus major*, Hitch.

Triassic, 19 Genera, 21 Species, 34 Specimens; Value, \$69.50

JURASSIC.

PLANTÆ.

- No. 548. *Ancylogonatum carbonacium*, Rom.
 No. 536. [1204] *Cycadoidea megallophylla*, Buckl.
 No. 540. Fruit "(CUPIDS WINGS)."
 No. 535. [1206] *Dammarites*, Sternb.

CŒLEENTERATA.

- No. 489. [962] *Acalepha deperdita*, Bey. (2 specimens).

ECHINODERMATA.

- No. 439. [898] *Apiocrinus Parkinsoni*, Schloth.
 No. 440. [904] *Astrocoma cirini*.
 No. 451. *Pentacrinites cingulatus*, Munst. (20 specimens).
 No. 449. [945] *Pentacrinus* (*Extracrinus*) *Briareus*, Miller.
 No. 450. *Pentacrinus Briareus*, Miller.
 No. 452. [942] *Pentacrinus subangularis*, Miller.
 No. 436. [860] *Ophioderma Egertoni*, Broderip.
 No. 434. [863] *Solaster Moretonensis*, Forbes.
 No. 414. *Cidaris coronata*, Goldf. (6 specimens).
 No. 416. *Cidaris glandifera*, Goldf. (2 specimens).
 No. 417. [771] *Cidaris suevica*, Desor.
 No. 422. *Echinobrissus* (*Nucleolites*) *scutatus*. (3 specimens)
 No. 423. *Echinobrissus* (*Nucleolites*) *cunucularis*, Blainv. (3 specimens).
 No. 426. *Hemicidaris intermedia*, Fleming.
 No. 430. *Pygaster semisulcatus*, Phil.
 No. 431. [789] *Rhabdocidaris copeoides*, Desor. (3 specimens).

MOLLUSCA.

- No. 368. [737] *Rhynchonella speciosa*, Munst.
 No. 369. *Rhynchonella varians*, d'Orb. (10 specimens).
 No. 359. *Terebratella umbonella*, Lamk. (4 specimens).
 No. 358. *Terebratula sphæroidalis*, Sow. (3 specimens).

- No. 360. *Terebratula gregaria*, Suess. (8 specimens).
 No. 351. *Gryphea arcuata*, Lam. (*Gryphea incurva*, Sow.)
 No. 347. *Ostrea Marshii*, Sow.
 No. 343. *Lima rigida*, Deshayes. (2 specimens).
 No. 339. *Perna mytiloides*, Lam.
 No. 329. *Trigonia costata*, Park.
 No. 330. *Trigonia incurva*, Sow.
 No. 328. *Opis lunulata*, Sow. (3 specimens).
 No. 325. *Astarte obliqua*, Desh.
 No. 311. *Pholadomya Aequalis*, Sow. (2 specimens).
 No. 310. *Panopæa jurassi*, d'Orb. (2 specimens).
 No. 296. *Pleurotomaria ornata*, Defrance.
 No. 297. *Pleurotomaria conoidea*, Deshayes. (2 specimens).
 No. 246. *Nautilus semistriatus*, d'Orb.
 No. 232. *Trigonellites (aptychus) latus*, Park.
 No. 185. [467] *Ammonites armatus*, Sowerby.
 No. 186. [470] *Ammonites athletus*, Phillips.
 No. 188. *Ammonites bifrons*, Bruguiere.
 No. 189. [473] *Ammonites bisulcatus*, Brug.
 No. 190. [475] *Ammonites Blagdeni*, Sow.
 No. 191. [476] *Ammonites Birchii*, Sow.
 No. 192. [478] *Ammonites Brongniarti*, Sow.
 No. 193. [479] *Ammonites concavus*, Sow.
 No. 194. *Ammonites complanatus*, Brug. (4 specimens).
 No. 195. [481] *Ammonites Comptoni*, Pratt.
 No. 196. *Ammonites cordatus*, Sow. (2 specimens).
 No. 197. [484] *Ammonites cordatus*, Sow.
 No. 198. [486] *Ammonites coronatus*, Brug.
 No. 199. [488] *Ammonites cornucopiæ*, d'Orb.
 No. 200. *Ammonites communis*, Sow. (2 specimens).
 No. 201. [490] *Ammonites fimbriatus*, Sow.
 No. 202. [492] *Ammonites gigas*, Zieten.
 No. 203. [494] *Ammonites giganteus*, Sow.
 No. 204. [495] *Ammonites Goliathus*, d'Orb.
 No. 205. *Ammonites Henleyi*, Sow.
 No. 206. [499] *Ammonites heterophyllus*, Sow.
 No. 207. *Ammonites Humphriesianus*, Sow.
 No. 209. [505] *Ammonites Jason*, Reinecke.
 No. 210. *Ammonites Lamberti*, Sow. (3 specimens).
 No. 211. *Ammonites laticostatus*, Sow.
 No. 213. *Ammonites macrocephalus*, Schloth.
 No. 216. *Ammonites margaritatus*, Mumfort.
 No. 217. [521] *Ammonites obtusus*, Sow.

- No. 218. [519] *Ammonites modiolaris*, Luid.
 No. 219. *Ammonites Murchisonæ*, Sow.
 No. 221. [524] *Ammonites perarmatus*, Sow.
 No. 223. *Ammonites planicostatus*, Sow.
 No. 227. [531] *Ammonites serpentinus*, Schloth.
 No. 231. *Ammonites* (POLISHED SECTION).
 No. 173. [463] *Beloteuthis subcostata*, Munst.
 No. 174. [466] *Belemnosepia*, Agassiz.
 No. 175. [456] *Belemnites Owenii*, Pratt.
 No. 177. *Belemnites hastatus*, Blainv. (6 specimens).
 No. 178. *Belemnites densus*, M. and H. (3 specimens).
 No. 179. *Belemnites elongatus*, Miller. (3 specimens).
 No. 180. *Belemnite* (INK-BAG).

ARTICULATA.

- No. 140. [364] *Limulus giganteus*, Munst.
 No. 136. [360] *Megachirus locusta*, Germar.
 No. 133. [354] *Eryon propinquus*, Germar.
 No. 129. [452] *Locusta speciosa*, Munst.
 No. 128. [451] *Æschna eximia*, Hagen.

VERTEBRATA.

- No. 123. [330] *Squatina acanthoderma*, Fraas.
 No. 121. [337] *Acrodus Anningiæ*, Agassiz.
 No. 118. [345] *Ichthyodorulite*—*Hybodus reticulatus*.
 No. 114. [326] *Gyrodus umbilicus*, Agassiz.
 No. 113. [324] *Gyrodus circularis*, Agassiz.
 No. 112. [320] *Microdon* (*Pycnodus*) *elegans*, Agassiz.
 No. 111. [319] *Aspidorhynchus speciosus*, Agassiz.
 No. 109. [1301] *Lepidotus Maximus*, Wagner.
 No. 110. [317] *Lepidotus minor*, Agassiz.
 No. 110½. *Lepidotus* (SCALES). (8 specimens).
 No. 92. [286] *Chelonemys ovata*.
 No. 91. [1289] *Platichelys Oberndorferi*, Wagner.
 No. 88. [276] *Saurophidium Thollieri*.
 No. 85. [254] *Teleosaurus minimus*, Quenst.
 No. 84. [253] *Teleosaurus Mandelslohi*, Bronn.
 No. 83. [249] *Crocodylus robustus*.
 No. 78. [233] *Pliosaurus grandis*, Owen.
 No. 77. [231] *Pliosaurus brachydeirus*, Owen.
 No. 75. [227] *Plesiosaurus macrocephalus*, Conyb.
 No. 74. [225] *Plesiosaurus dolichodeirus*, Conyb.
 No. 73. *Ichthyosaurus* (COPROLITE).
 No. 72. *Ichthyosaurus* (TOOTH).

- No. 71. *Ichthyosaurus* (VERTEBRA).
 No. 70. [214] *Ichthyosaurus communis*, Conyb.
 No. 69. [215] *Ichthyosaurus platyodon*, Conyb.
 No. 68. [207] *Ichthyosaurus intermedius*, Conyb.
 Nos. 101-103. [306-308] *Ichthyosaurus*, with *Plesiosaurs*.
 No. 98. [303] *Megalosaurus* (RESTORATION).
 No. 66. [1286] *Rhamphorhynchus phyllurus*, Marsh.
 No. 65. [241] *Pterodactylus crassirostris*, Goldfuss.
 No. 64. [1287] *Compsognathus longipes*, Wagner.
 No. 51. [1278] *Archæopteryx macrura*, Owen.

Jurassic, 61 Genera, 115 Species, 183 Specimens; Value \$324.70

CRETACEOUS.

PLANTÆ.

- No. 542. *Phragmites* cretaceous, Lesq.
 No. 533. *Betulites Vestii*, Lesq.
 No. 532. *Sassafras cretaceum*, Newb.

PROTOZOA.

- No. 510. *Orbitolites*. (10 specimens).
 No. 519. [1094] *Nodosaria inflata*, Reuss.
 No. 521. [1098] *Nodosaria radícula*, Lam.
 No. 522. [1138] *Orbitolites macropora*, Lam.
 No. 523. [1015] *Proroporous complanatus*, Reuss.
 No. 525. [1036] *Siderolina calcitrapoides*, Lam.
 No. 528. [1043] *Textularia conulus*, Reuss.
 No. 529. [1047] *Textularia pupoides*.

PORIFERATA.

- No. 494. *Chenendopora fungiformis*, Lamour.
 No. 496. [1165] *Cœloptychium agaricoides*, Goldf.
 No. 500. [1168] *Polypothecia dichotoma*, Benett.
 No. 502. [1174] *Siphonia (Hallirhoa) costata*, Lamor.
 No. 503. [1177] *Siphonia pyriformis*, Goldf.
 No. 505. [1185] *Ventriculites*.

CœLEENTERATA.

- No. 482. *Cyclolites elliptica*, Lam.

ECHINODERMATA.

- No. 413. *Ananchytes ovata*, Lam.
 No. 420. *Cyphosoma texana*. (2 specimens).
 No. 421. *Discoidea subuculus*, Leske. (4 specimens).

- No. 425. *Galerites albogalerus*, Lam.
 No. 427. [842] *Hemipneustes radiatus*, Agass.
 No. 428. *Micraster cor-anguinum*, Agass.
 No. 433. *Toxaster texana*. (2 specimens).

MOLLUSCA.

- No. 357. *Terebratula biplicata*, DeFr. (3 specimens).
 No. 356. *Terebratula semiglobosa*, Sow. (3 specimens).
 No. 353. *Exogyra arietina*, d'Orb. (3 specimens).
 No. 354. *Exogyra costata*, Say.
 No. 352. *Gryphea vesicularis*, Lam.
 No. 348. *Ostrea larva*, Lam. (3 specimens).
 No. 346. *Pecten* (*Neithea*) *quadricostata*, Sow. (2 specimens).
 No. 342. [667] *Gervillia anceps*, Deshayes.
 No. 340. *Inoceramus Sagensis*, Owen.
 No. 322. [659] *Radiolites* (*Sphœrulites*) *crateriformis*.
 No. 321. [655] *Hippurites radiosa*, Desmoulins.
 No. 320. *Corallochama Orcutti*, White.
 No. 319. [662] *Caprina adversa*, d'Orb.
 No. 317. *Cardium multistriatum*. (2 specimens).
 No. 312. *Tellina* (*Arcopagia*) *texana*.
 No. 309. *Teredo amphistœna*, Goldf.
 No. 291. *Pyrgulifera humerosa*, Meek. (5 specimens).
 No. 269. [608] *Rostellaria carinata*, Mant.
 No. 244. [570] *Nautilus elegans*, Sow.
 No. 245. [574] *Nautilus pseudo-elegans*, d'Orb.
 No. 242. [546] *Baculites anceps*, Lam.
 No. 243. *Baculites compressus*, Say.
 No. 241. [558] *Hamites* (*Hamulina*) *cinctus*, d'Orb.
 No. 240. [567] *Turrilites costatus*, Lam.
 No. 239. [560] *Helicoceras rotundum*, Sow.
 No. 238. *Scaphites nodosus*, Owen. (2 specimens).
 No. 237. *Scaphites æqualis*, Sow.
 No. 236. [563] *Scaphites Ivanii*, Puzos.
 No. 235. [541] *Ancyloceras gigas*, Sow.
 No. 234. [552] *Crioceras Duvalii*, Leveille.
 No. 233. [550] *Crioceras*, Leveille.
 No. 187. *Ammonites Batesii*, Thrash.
 No. 208. [503] *Ammonites interruptus*, Brug.
 No. 212. *Ammonites latus*, Park. (2 specimens).
 No. 214. *Ammonites mammilatus*, Schloth.
 Mo. 215. *Ammonites Mantelli*, Sow.
 No. 220. [523] *Ammonites peramplus*, Mant

- No. 222. *Ammonites placenta*, DeKay.
 No. 225. [530] *Ammonites rothomagensis*, Brong.
 No. 224. *Ammonites rothomagensis*, Brong.
 No. 226. *Ammonites semisulcatus*, d'Orb. (4 specimens).
 No. 228. *Ammonites splendens*, Sow. (2 specimens).
 No. 230. *Ammonites Woollgari*, Mant.
 No. 176. [460] *Belemnites dilatatus*, Blainv. (3 specimens).
 No. 181. *Belemnitella mucronata*, Schloth. (3 specimens).

ARTICULATA.

- No. 135. [1202] *Hoploparia (Astacus) longimana*, Sow.
 No. 132. *Palæcorystes Stokesii*, Mantell.

VERTEBRATA.

- No. 126. [346] *Beryx superbus*, Dixon.
 No. 122. *Ptychodus decurrens*, Agassiz. (2 specimens).
 No. 119. [1304] *Pelecopterus perniciosus*, Cope.
 No. 127. *Coprolite* (OF FISH), Buckl.
 No. 82. [248] *Thoracosaurus neocesariensis*, DeKay.
 No. 81. [1292] *Liodon*.
 No. 80. [263] *Mosasaurus Hoffmanni*, Mantell.
 No. 58. [200] *Iguanodon Mantelli*, Meyer.
 No. 59. [204] *Iguanodon Mantelli*, Meyer.
 No. 60. [1293] *Iguanodon Mantelli*, Meyer.
 No. 99. [302] *Pterodactyl*.

Cretaceous, 60 Genera, 80 Species, 122 Specimens; Value \$142.05

TERTIARY.

PLANTÆ.

- No. 541. [1207] *Nipadites Burtini*, Brongt.
 No. 539. *Carpolithes brandonensis*, Lesq. (2 specimens).
 No. 534. [1322] *Pinites pseudo-stroboides*, Göp.

PROTOZOA.

- No. 508. *Nummulites nummularia*, Brug. (3 specimens).
 No. 509. *Nummulites striata*, d'Orb. (20 specimens).
 No. 511. *Infusorial earth*.
 No. 512. [966] *Amphistegina vulgaris*, d'Orb.
 No. 513. [999] *Cassidulina serrata*.
 No. 514. [1003] *Clavulina communis*, d'Orb.
 No. 515. [1059] *Cristellaria cassis*, Ficht.
 No. 517. [1007] *Globigerina bulloides*, d'Orb.
 No. 518. [1077] *Globulina gibba*, d'Orb.
 No. 520. [1097] *Nodosaria oblonga*, Reuss.
 No. 524. [1145] *Quinqueloculina Ferussaci*, d'Orb.
 No. 526. [1039] *Siphonina reticulata*, Reuss.
 No. 527. [1150] *Spirolina cylindrica*, Lam.
 No. 530. [1049] *Textularia spinulosa*, Reuss.
 No. 531. [1161] *Vertebralina nitida*, d'Orb.

ECHINODERMATA.

- No. 418. *Clypeaster ghizehensis*.
 No. 419. [814] *Clypeaster umbrella*, Agass.
 No. 424. *Echinolampus affinis*, Desm.
 No. 432. *Scutella disca*, Mather.

MOLLUSCA.

- No. 355. *Terebratula grandis*, Blum.
 No. 350. *Ostrea*. (2 specimens).
 No. 345. *Pecten expansus*, Dall.
 No. 337. [685] *Dreissensia* (*Congeria*) *subglobosa*.
 No. 335. *Pectunculus pulvinatus*, Lam. (2 specimens).
 No. 333. *Arca diluvii*, Lam.
 No. 332. *Arca biangulata*, Lam. (3 specimens).
 No. 327. *Cardita Partschii*, Goldf. (4 specimens).
 No. 326. *Venericardia rotunda*, Lea. (4 specimens).
 No. 324. *Crassatella protexta*, Con. (2 specimens).
 No. 318. *Chama calcarata*, Lam. (3 specimens).
 No. 314. *Cytherea nitida*. (3 specimens).
 No. 313. *Venus lævigata*, Nyst. (4 specimens).
 No. 305. *Helix Tryonii*, New. (4 specimens).
 No. 304. *Helix turonensis*, Desh. (2 specimens).
 No. 303. *Dentalium hexagonum*, Sow. (10 specimens).
 No. 293. *Trochus podolicus*, Dubois. (4 specimens).
 No. 290. *Ampullaria vulcani*, Br.
 No. 289. *Cerithium Bronni*, Partsch. (5 specimens).
 No. 288. [618] *Cerithium giganteum*, Lam.
 No. 285. *Turritella Mortoni*, Con. (3 specimens).
 No. 284. *Turritella turris*, Bast. (4 specimens).
 No. 283. *Opalia anomala*, Stearns. (4 specimens).
 No. 282. *Opalia varicostata*, Stearns. (4 specimens).
 No. 278. *Crepidula cornu-arietes*. (3 specimens).
 No. 277. *Natica helicina*, Broc. (12 specimens).
 No. 275. *Natica sigaretina*, Desh. (3 specimens).
 No. 274. *Pyrula* (*Tudicea*) *rusticula*, Bast. (2 specimens).
 No. 273. *Pyrula bulbus*, d'Orb. (2 specimens).
 No. 270. *Rostellaria fissurella*, Lam. (4 specimens).
 No. 268. *Conus striatulus*, Broc. (3 specimens).
 No. 267. *Pleurotoma turricula*, Broc. (8 specimens).
 No. 266. *Pleurotoma demidiata*, Broc. (4 specimens).
 No. 265. *Columbella nassoides*, Bell. (5 specimens).
 No. 264. *Oliva Greenoughii*, Lea. (4 specimens).
 No. 263. *Voluta cithara*, Lam. (3 specimens).
 No. 262. *Nassa limata*, Chemn. (4 specimens).
 No. 261. *Nassa senilis*. (10 specimens).
 No. 260. *Pisania plicata*, Broc. (10 specimens).
 No. 259. *Buccinum stromboides*, Lam. (4 specimens).
 No. 257. *Fusus antiquus*, Müller.
 No. 256. *Fusus longævus*, Lam. (2 specimens).
 No. 255. *Murex caticulata*, Broc. (10 specimens).

ARTICULATA.

- No. 131. *Lobocarcinus Paulo-wurtembergensis*, Meyer.
 No. 130. Insects. (2 specimens).

VERTEBRATA.

- No. 124. *Diplomystus altus*, Leidy.
 No. 125. Fish.
 No. 116. *Lamna elegans*, Agassiz. (4 specimens)
 No. 115. *Carcharodon megalodon*.
 No. 97. [297] *Andrias Scheuchzeri*, Tschudi.
 No. 90. [283] *Emys hamiltonoides*, Falc. and Caut.
 No. 89. [281] *Testudo hemispherica*, Leidy.
 No. 86. [259] *Leptorhynchus giganteus*, Falc. and Caut.
 No. 52. [1277] *Odontopteryx toliapicus*, Owen.
 No. 43. [112] *Dinotherium giganteum*, Kaup.
 No. 44. [124] *Dinotherium giganteum*, Kaup.
 No. 42. [159] *Mastodon longirostris*, Kaup.
 No. 37. [59] *Anoplotherium commune*, Cuvier.
 No. 36. [57] *Oreodon Culbertsoni*, Leidy.
 No. 36½. *Oreodon Culbertsoni*.
 No. 36½. *Oreodon Culbertsoni*.
 No. 35. [74] *Hexaprotodon sivalensis*, Falc. and Caut.
 No. 34. [77] *Hippopotamus*.
 No. 33. [78] *Hippopotamus major*, Cuv.
 No. 32. [79] *Hippopotamus major*, Cuv.
 No. 28. [56] *Pœbrotherium Wilsonii*, Leidy.
 No. 26. [48] *Sivatherium giganteum*, Falc. and Caut.
 No. 25. [105] *Pliolophus vulpiceps*, Owen.
 No. 24. [1255] *Menodus (Titanotherium) Proutii*, Leidy.
 No. 23. [102] *Tapirus arvernensis*, Croiz. and Job.
 No. 21. [89] *Rhinoceros platyrhinus*, Falc. and Caut.
 No. 19. [106] *Palæotherium crassum*, Cuvier.
 No. 20. [111] *Palæotherium crassum*, Cuv.
 No. 18. [85] *Anchitherium Bairdii*, Leidy.
 No. 17. [83] *Hipparion elegans*, Christol.
 No. 15. [175] *Halitherium Schinzi*. (2 specimens).
 No. 14. [179] *Balænodon gibbosus*, Owen.
 Mo. 13. [176] *Zeuglodon cetoides*, Owen. (2 specimens).
 No. 12. [177] *Zeuglodon hydrarchus*, Carus.
 No. 8. [14] *Galecynus œningensis*, Owen.
 No. 5. [5] *Dryopithecus Fontani*, Lartet.
 No. 4. [1251] *Mesopithecus pentelici*, Wagner.

Tertiary, 84 Genera, 99 Species, 256 Specimens; Value \$223.60

QUATERNARY.**CœLENERATA.**

- No. 479. *Caryophyllia clavus*, Mch. (3 specimens).

MOLLUSCA.

- No. 249. *Ostrea*.
 No. 344. *Pecten opercularis*, Lam.

No. 316.	<i>Cardium echinatum</i> , Linn. Var. Desh.	(2 specimens)
No. 315.	<i>Artemis</i> (<i>Dosinia</i>) <i>exoleta</i> , Linn.	(2 specimens).
No. 302.	<i>Dentalium elephantum</i> , Linn.	(2 specimens).
No. 294.	<i>Trochus magus</i> , Linn.	(3 specimens).
No. 292.	<i>Turbo rugosus</i> , Linn.	(2 specimens).
No. 286.	<i>Turritella terebra</i> , Linn.	(5 specimens).
No. 279.	<i>Xenophora crispa</i> , Chem.	
No. 276.	<i>Natica millepunctata</i> , Lam.	(2 specimens).
No. 272.	<i>Cassidaria echinophora</i> , Lam.	(2 specimens).
No. 271.	<i>Aporrhais pes-pellicani</i> , Lam.	(3 specimens).
No. 258.	<i>Fusus antiquus</i> , Muller.	

ARTICULATA.

No. 172.	<i>Serpula</i> .	(2 specimens).
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VERTEBRATA.

No. 53.	<i>Dinornis</i> (<i>Meionornis</i>) <i>casuarinus</i> , Owen.	
No. 54.	[1276] <i>Dinornis</i> , Owen.	
No. 55.	[186] <i>Æpiornis maximus</i> , St. Hilaire.	
No. 56.	[184] <i>Didus ineptus</i> .	
No. 57.	[185] <i>Didus ineptus</i> .	
No. 50.	[181.] <i>Diprotodon australis</i> , Owen.	
No. 49.	[36] <i>Glyptodon</i> (<i>Schistopleurum</i>) <i>typus</i> , Nodot.	
No. 48.	[35] <i>Megalonyx Jeffersonii</i> , Harlan.	(2 specimens).
No. 47.	[32] <i>Megatherium Cuvieri</i> , Desm.	
No. 46.	[26] <i>Megatherium Cuvieri</i> , Desm.	
No. 45.	[21] <i>Castoroides ohioensis</i> , Foster.	
No. 41.	[155] <i>Mastodon giganteus</i> , Cuv.	
No. 40.	[1258] <i>Mastodon giganteus</i> , Cuv.	
No. 39.	[141] <i>Elephas primigenius</i> , Blum.	
No. 38.	[132] <i>Elephas primigenius</i> , Blum.	
No. 31.	[63] <i>Sus scrofa</i> , Meyer.	
Nos. 29 and 30.	<i>Tarandus Rangifer</i> (Reindeer).	(5 specimens).
No. 27.	[55] <i>Ovibos</i> (<i>Bootherium</i>) <i>bombifrons</i> , Leidy.	
No. 22.	[98] <i>Rhinoceros tichorhinus</i> , Cuv.	(2 specimens).
No. 16.	<i>Equus fossilis</i> .	
No. 9.	[16] <i>Ursus spelæus</i> , Blumenbach.	
No. 10.	<i>Ursus spelæus</i> , Blum.	(2 specimens).
No. 11.	<i>Ursus spelæus</i> , Blum.	
No. 7.	[11] <i>Hyæna eximia</i> , Wagner.	
No. 6.	[6] <i>Machairodus neogæus</i> , Kaup.	
No. 3.	[4] <i>Homo sapiens</i> .	
No. 2.	[2] <i>Homo sapiens</i> .	
No. 1.	[1] <i>Homo sapiens</i> .	

Quaternary, 34 Genera, 35 Species, 67 Specimens; Value \$397.60

TOTAL, 394 Genera, 529 Species, 1103 Specimens;
Value \$1,318.65

This whole collection will be furnished, packed and delivered at Depot in Rochester, for \$1,200.

INDEX AND GLOSSARY.

Not including Geological Summary, pages 170—184.

Acalepha (<i>sea nettle</i>) -----	154	obtus (blunt).	
deperdita (<i>lost</i>).		peramplius (<i>very full</i>).	
Acervularia (<i>a heap</i>) -----	152	perarmatus (<i>full-armed</i>).	
Davidsoni (<i>proper name</i>).		placenta (<i>placenta</i>).	
Acidaspis (<i>point-shield</i>) -----	83	planicostatus (<i>smooth-ribbed</i>).	
Buchii (<i>proper name</i>).		Rhotomagensis (<i>of Rouen, France</i>).	
Acrodus (<i>hump-tooth</i>) -----	72	semisulcatus (<i>half-furrowed</i>).	
Anningiæ (<i>proper name</i>).		serpentinus (<i>winding</i>).	
Actinocrinus (<i>ray-lily</i>) -----	144	splendens (<i>shining</i>).	
proboscideal (i) (<i>proboscis-like</i>).		tornatus (<i>turned</i>).	
Verneulianus (<i>proper name</i>).		Woollgari (<i>proper name</i>).	
Agelacrinus (<i>herd-lily</i>) -----	148	Amorphospongia (<i>formless sponge</i>)	
Cincinnatiensis (<i>of Cinn. Ohio</i>).		Amphistegina (<i>double-deck</i>) -----	163
Æpiornis (<i>lofty bird</i>) -----	38	vulgaris (<i>common</i>).	
maximus (<i>greatest</i>).		Ampullaria (<i>a globular flask</i>) ...	114
Æschna () -----	77	vulcani (<i>pertaining to Vulcan</i>).	
eximia (<i>extraordinary</i>).		Ananchytes (<i>not pressed</i>) -----	137
Ambonychia (<i>boss-claw</i>) -----	122	ovata (<i>egg-shaped</i>).	
radiata (<i>radiate</i>).		Anchitherium (<i>near to, beast</i>) ---	13
Ammonites (<i>horn of Ammon</i>) --	97	Bairdii (<i>proper name</i>).	
armatus (<i>armed</i>).		Ancycloceras (<i>curve-horn</i>) -----	105
athletus (<i>champion</i>).		gigas (<i>giant</i>).	
bifrons (<i>double-fronted</i>).		Ancylgonatum (<i>incurved angle</i>)	169
Batesii (<i>proper name</i>).		carbonaceum (<i>carbon</i>).	
Birchii (<i>proper name</i>).		Andrias (<i>image of man</i>) -----	63
bisulcatus (<i>double-furrowed</i>).		Scheuchzeri (<i>proper name</i>).	
Blagdeni (<i>proper name</i>).		Annularia (<i>circular</i>) -----	169
Brongniarti (<i>proper name</i>).		longifolia (<i>long-leaves</i>).	
complanatus (<i>smoothed</i>).		Anomæpus (<i>unlike foot</i>) -----	43
Comptoni (<i>proper name</i>).		major (<i>greater</i>).	
communis (<i>common</i>).		Anoplothorium (<i>weaponless beast</i>)	21
concavus (<i>concave</i>).		commune (<i>common</i>).	
cordatus (<i>heart-shaped</i>).		Apiocrinus (<i>pear-lily</i>) -----	144
cornucopiæ (<i>horn of plenty</i>).		Parkinsoni (<i>proper name</i>).	
coronatus (<i>crowned</i>).		Aporrhais ("spout shell") -----	112
fimbriatus (<i>fringed</i>).		pes-pellicani (<i>pelican-foot</i>).	
giganteus (<i>gigantic</i>).		Aptychus (<i>ridgeless</i>) -----	105
gigas (<i>giant</i>).		lamellosus (<i>of very thin plates</i>).	
Goliathus (<i>proper name</i>).		Arca (<i>a chest</i>) -----	122
Henleyi (<i>proper name</i>).		biangulata (<i>two angled</i>).	
heterophyllus (<i>irregular-leaved</i>).		diluvii (<i>of the Deluge</i>).	
Humphriesianus (<i>proper name</i>).		Archæopteris (<i>ancient fern</i>) ---	169
interruptus (<i>interrupted</i>).		Jacksoni (<i>proper name</i>).	
Jason (<i>mythological name</i>).		Archæopteryx (<i>ancient bird</i>) ---	36
Lamberti (<i>proper name</i>).		macrura (<i>long-tail</i>).	
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latus (<i>broad</i>).		Decheni (<i>proper name</i>).	
macrocephalus (<i>large-headed</i>).		Archimedes (<i>proper name</i>) -----	134
mammilatus (<i>mammilated</i>).		laxa (<i>loose</i>).	
Mantelli (<i>proper name</i>).		Artemis (<i>classical name</i>) -----	119
margaritatus (<i>pearly</i>).		exoleta (<i>defaced</i>).	
modiolaris (<i>bushel-shaped</i>).		Asaphus (<i>obscure</i>) -----	82
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- megistos (*very large*).
Aspidorhynchus (*shield-beak*)--- 69
 speciosus (*beautiful*).
Astarte (*classical name*)----- 121
 obliqua (*slanting*).
Astræospongia (*star-sponge*) --- 156
 meniscus (*concavo-convex*).
Astrocerium (*star-honeycomb*)--- 150
 pyriformis (*pear-shaped*).
Astrocoma (*star-hair*) ----- 144
 cirini (*of Cirini, France*).
Athyris (*without a door*)----- 131
 ambigua (*doubtful*).
 concentrica (*concentric*).
 spiriferoides (*Spirifer-like*).
 subtilita (*thin*).
 vittata (*banded*).
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 aspera (*rough*).
 primipilaris (*first captain*).
 reticularis (*reticulate*).
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Belemnites (*dart-stone*)----- 93
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 dilatatus (*expanded*).
 elongatus (*elongate*).
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 Owenii (*proper name*).
Belemnosepia (*dart-cuttle-fish*)-- 93
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 hiuleus (*gaping*).
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 Kapflli (*proper name*).
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Beryx (*proper name*)----- 74
 superbus (*magnificent*).
Betulites (*birch*)----- 166
 Vestii (*proper name*).
Bootherium (*bovine beast*)----- 18
 bombifrons (*bomb-fronted*).
Brachiospongia (*arm-sponge*)--- 157
 digitata (*finger-shaped*).
Brontozoum (*giant animal*)----- 42
 giganteum (*gigantic*).
 Sillimanium (*proper name*).
Buccinum (*trumpet*)----- 111
 stromboides (*top-like*).
Bumastus (*bunch of grapes*)----- 83
 Barriensis (*of Barr, England*).
Calamites (*a reed*)----- 169
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 sandalina (*slipper-like*).
Calymene (*obscure*)----- 83
 Blumenbachii (*proper name*).
 niagarensis (*of Niagara, N. Y.*).
 senaria (*six tubercles*).
Caprina (*goat*)----- 119
 adversa (*opposite*).
Carcharodon (*shark-tooth*)----- 71
 megalodon (*huge tooth*).
Cardita (*the heart*)----- 121
 Partschii (*proper name*).
Cardium (*the heart*)----- 119
 echinatum (*spiny*).
 multistriatum (*many lined*).
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 ornatus (*adorned*).
Caryophyllia (*clove-shaped*)----- 152
 clavus (*knob-like*).
Cassidaria (*a helmet*)----- 112
 echinophora (*spine-bearing*).
Cassidulina (*helmet*)----- 163
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 giganteum (*gigantic*).
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Crassatella (<i>thick</i>)----- 121	Discoidea (<i>quoit-like</i>)----- 138
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<i>cornu-arietes</i> (<i>horn of ram</i>).	<i>unicornis</i> (<i>one horn</i>).
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Crocodileimus (<i>crocodile</i>)----- 55	<i>clunicularis</i> (<i>haunch-like</i>).
<i>robustus</i> (<i>strong</i>).	<i>scutatus</i> (<i>shield-like</i>).
Crocodilus (<i>crocodile</i>)----- 55	Echinolampus (<i>lantern-urchin</i>)-- 139
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<i>Murchisoni</i> (<i>proper name</i>).	Emys (<i>tortoise</i>)----- 59
Cycadoidea (<i>cycas-like</i>)----- 167	<i>Hamiltonoides</i> (<i>Hamiltonia-like</i>).
<i>megalophylla</i> (<i>great-leaved</i>).	Encrinus (<i>in lily</i>)----- 145
Cyclolites (<i>circle-stone</i>)----- 152	<i>liliiiformis</i> (<i>lily-shaped</i>).
<i>elliptica</i> (<i>elliptical</i>).	Endoceras (<i>in horn</i>)----- 109
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<i>hexagonum</i> (<i>six-angled</i>).	<i>arietina</i> (<i>ram-like</i>).
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<i>tuberosum</i> (<i>tuber-like</i>).	Favistella (<i>a little honeycomb</i>)-- 151
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<i>lacerticeps</i> (<i>lizard-headed</i>).	Favosites (<i>a honeycomb</i>)----- 151
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<i>ineptus</i> (<i>silly</i>).	Fenestella (<i>a little window</i>)--- 134
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Fruit	167	radiatus (<i>radiated</i>).	
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<i>cylindrica</i> (<i>cylindrical</i>).		<i>sivalensis</i> (<i>of the Sivalik Hills, India</i>).	
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<i>antiquus</i> (<i>ancient</i>).		<i>elegans</i> (<i>elegant</i>).	
<i>longævus</i> (<i>aged</i>).		Hippopotamus (<i>river horse</i>)	20
Galecynus (<i>iceasel-dog</i>)	7	<i>major</i> (<i>greater</i>).	
<i>oeningensis</i> (<i>of Oeningen, Switz.</i>)		Hippurites (<i>horse-hoof-like</i>)	120
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Gervillia (<i>proper name</i>)	123	<i>dolphinocephalus</i> (<i>dolphin back</i>).	
<i>anceps</i> (<i>doubtful</i>).		Homo (<i>man</i>)	3
<i>socialis</i> (<i>social</i>).		<i>sapiens</i> (<i>wise</i>).	
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<i>nodosus</i> (<i>knotty</i>).		<i>intermedius</i> (<i>intermediate</i>).	
<i>Oweni</i> (<i>proper name</i>).		<i>platyodon</i> (<i>broad-toothed</i>).	
<i>ixion</i> (<i>mythological name</i>).		Iguanodon (<i>iguana-tooth</i>)	41
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<i>antiqua</i> (<i>ancient</i>).		Illænus (<i>look about</i>)	86
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<i>Norwoodi</i> (<i>proper name</i>).		Infusorial (<i>earth</i>)	164
Graptolithus (<i>stone-writing</i>)	155	Inoceramus (<i>fibrous shell</i>)	122
<i>clintonensis</i> (<i>of Clinton, N. Y.</i>)		<i>Sagensis</i> (<i>proper name</i>).	
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<i>arcuata</i> (<i>arched</i>).		Labyrinthodon (<i>labyrinth-tooth</i>) ..	61
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Halitherium (<i>sea-beast</i>)	10	Lepidotus (<i>scaled</i>)	69
<i>Schinz</i> (<i>proper name</i>).		<i>maximus</i> (<i>greatest</i>).	
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<i>catenulatus</i> (<i>made of links</i>).		Leptena (<i>thin</i>)	131
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Lithostrotion (*stone-rafter*) ---- 152
 canadense (*of Canada*).
Lituites (*trumpet*)----- 108
 undatus (*wavy*).
Lobocarcinus (*lobe-crab*)----- 79
 Paulo-wurtembergensis (*proper name*)
Locusta (*locust*)----- 77
 speciosa (*beautiful*).
Machairodus (*sabre-tooth*)----- 6
 neogæus (*of the New World*).
Maclurea (*proper name*)----- 115
 Bigsbyi (*proper name*)
Mariacrinus (*sea-lily*)----- 146
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Mastodon (*nipple-tooth*)----- 24
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 longirostris (*long-snouted*).
Megachirus (*long hand*)----- 80
 locusta (*locust*).
Megalodon (*great tooth*) ----- 121
 culcatus (*hooded*).
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 Jeffersoni (*proper name*).
Megalosaurus (*great lizard*)----- 64
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 Verneuili (*proper name*).
Nucula (*a little nut*)----- 122
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Nummulites (*coin-stone*)----- 163
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Odontopteryx (*toothed-bird*)----- 36
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 plicatella (*a little fold*).
 subquadrata (*quite four sided*).
 testudinaria (*with a test*).
Orthoceras (*straight horn*)----- 109
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 Duseri (*proper name*).
Ostrea (*oyster*)----- 123
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Palæotherium (*ancient beast*)--- 14
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Pelecopterus (*hatchet winged*)--- 72
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Pentacrinus (*five lily*)----- 146
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 Godoni (*proper name*).
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Phacops (*lens-eye*)----- 87
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Pholadomya (*Pholas-mussel*)--- 119
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Phragmites (*partitioned*)----- 168
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Pinites (*pine*)----- 166
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Pisania (*of Pisa*)----- 111
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Placodus (*plate-tooth*)----- 53
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Prætus (*mythological name*)----- 87
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Proroporus (*pro-w-pore*)----- 164
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Pterodactylus (*wing finger*)----- 45
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Pterygotus (*wing-ear*)----- 80
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Ptilodictya (*feather-net*)----- 134
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Ptychodus (*folded tooth*)----- 73
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Pygaster (*thick star*)----- 140
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Pyrgulifera (*tower bearing*)----- 114
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Pyrula (*a little pear*)----- 112
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Quinqueloculina (*five cells*)----- 164
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Raphistoma (*seam mouth*)----- 113
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Receptaculites (*receptacle-stone*)- 158
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Renaster (*Kidney-star*)----- 141
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 ovoides (*resembling an egg*).
Retzia (*proper name*)----- 130
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Rhamphorhynchus (*beak-snout*) 46
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Rhynchonella (*little beak*)----- 127
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 pleurodon (*side-tooth*).
 speciosa (*beautiful*).
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 Thollieri (*proper name*).
Sauropus (*lizard-foot*)----- 62
 primævus (*primæval*).
Scaphites (*boat*)----- 106
 æqualis (*symmetrical*).
 Ivanii (*proper name*).

- nodosus (*knobby*).
Scolithus (*tortuous*)----- 89
 linearis (*linear*).
Scutella (*little shield*)----- 140
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Serpula (*creeping*)----- 89
Siderolina (*constellation*)----- 164
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 pyriformis (*pear-shaped*).
Siphonina (*little siphon*)----- 164
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 mirus (*wonderful*).
Sphenopteris (*wedge-fern*)----- 169
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 speciosus (*beautiful*).
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Spirolina (*little spire*)----- 164
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 acanthoderma (*spine-skinned*).
Stigmara (*dotted*)----- 169
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Stringocephalus (*owl-head*)----- 127
 Burtini (*proper name*).
Stromatopora (*stratum-pores*)----- 158
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 irregularis (*irregular*).
Teredo (*borer*)----- 119
 amphistæna (*around-worm*).
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 biplicata (*two-folded*).
 grandis (*great*).
 gregaria (*in flocks*).
 semiglobosa (*half-globular*).
 spheroidalis (*spheroid*).
 umbonella (*little protuberance*).
Testudo (*tortoise*)----- 59
 hemispherica (*hemispherical*).
Textularia (*little weaver*)----- 164
 conulus (*little cone*).
 pupoides (*doll-like*).
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Thoracosaurus (*breast-plate lizard*) 55
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Toxaster (*bow-star*)----- 140
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Triarthrus (*three jointed*)----- 88
 Becki (*proper name*).
Trigonellites (*triangle-stone*)--- 105
 latus (*broad*).
Trigonia (*three-angled*)----- 121
 costata (*ribbed*).
 incurva (*bent in*).
Trinucleus (*three kernels*)----- 88
 concentricus (*concentric*).
 ornatus (*ornamented*).
Trigonocarpus (*triangle-fruit*)-- 167
 Noeggerathi (*proper name*).
 tricuspidatus (*three pointed*).
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 podolicus.
 magus (*magical*).
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 rugosus (*rough*).
Turrlites (*tower-stone*)----- 106
 costatus (*ribbed*).
Turritella (*a little tower*)----- 113
 Mortoni (*proper name*).
 terebra (*an auger*).
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Uncites (*hooked*)----- 130
 gryphus (*a griffin*).
Ursus (*bear*)----- 8
 spelæus (*cave*).

Venericardia (*Venus' heart*)----- 121
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Ventriculites (*little belly*)----- 158
Venus (*classical name*)----- 119
 lævigata (*polished*).
Vertebralina (*little vertebra*) --- 164
 nitida (*neat*).
Voluta (*rolled*)----- 111
 cithara (*lute*).

Xenophora (*guest-bearing*)----- 113
 crispa (*curled*).

Zaphrentis (*very ; diaphragm*) -- 153
 corniculum (*horned*).
Zeuglodon (*yoke-tooth*)----- 9
 cetoides (*whale-like*).
 hydrarchus (*water-chief*).
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SUPPLEMENT.

The series of 1103 Fossil Organisms, described in the preceding pages, represents well the prominent and important forms of life in the several Geological Periods. The range of the specimens—as will be seen by a glance at the geological and zoological summary given upon page 170—is very great, and is ample for the fullest purposes of illustration.

The great Glyptodon, Dinotherium, Mastodon and Diprotodon, illustrate the huge dimensions attained by animals in geologic times.

But there are instances where it is desired to make a still further display, and add an impressive feature in the central area of a large Museum Hall. To meet this requirement we propose the four monster specimens—the Megatherium, Elephas Ganesa (Himalaya Mammoth), Colossochelys and Plesiosaurus—which are described and figured in the following pages.

Their appearance is stately and imposing. These four specimens—two of them with pedestals as shown in the cuts—will be added to the previous series for an additional sum of \$800.* If ordered apart from the series (by institutions seeking to ornament their present Museum Halls), they will be furnished for the sum of \$840,—or they will be sold singly at the prices stated for each. The area occupied by these four monsters may be estimated by the dimensions appended to the description of each.

*If desired we will send a man to mount the latter three of these casts in the Museum Hall (and to give information about mounting the Megatherium) for his railroad fare and hotel expenses.

No. [23.] **Megatherium Cuvieri**, DESMAREST.

SKELETON. This gigantic fossil was first made known to the scientific world in 1789. It was discovered on the banks of the River Luxan, near the city of Buenos Ayres, and was subsequently transmitted to Madrid, where, for half a century, it excited the most lively speculations among all European naturalists, who were so fortunate as to see it. The original bones, of which this specimen is a copy, were found in the same Pampean deposit between the years 1831 and 1838, and belong partly to the Hunterian Museum of the Royal College of Surgeons, and partly to the British Museum. To give to the singular quadruped its proper position in the Animal Kingdom, was for many years a problem in comparative anatomy which the *savans* of Europe could not solve. Led astray by the huge carapace of the *Glyptodon*, found near it, the majority called it a mammoth Armadillo. CUVIER, who gave it its generic title, thought it combined the characteristics of the Sloth, Ant-eater and Armadillo. The merit of throwing a flood of light on the nature and structure of this most remarkable of all fossil mammals, was reserved for the celebrated English Geologist, Professor OWEN. He conclusively proves that the *Megatherium* was a "Ground Sloth," feeding on the foliage of trees which it uprooted by its great strength.

The extreme length of the mounted skeleton is seventeen feet and nine inches ; its height when mounted as shown in the cut, 13 feet. No other fossil so exceeds its modern representative, as the lordly *Megatherium* surpasses the pigmy remnant of the *Tardigrade* race ; for the largest living Sloth does not exceed two feet in length. One is tempted to join the Spanish naturalist who objected to the place assigned to the *Megatherium*, because "all

other Edentates could dance in his carcass." But that there is the closest affinity between it and the diminutive arboreal Sloth, is now undeniable. The number of the teeth, their deep insertion, equable breadth and thickness, deeply excavated base, inner structure and unlimited growth, and the absence of canines, are characters common to both. The part in which the *Megatherium* least resembles the Sloth, is the tail; and, as a general rule, in those modifications of structure in which it differs from its living analogue, it approximates to the *Anteater*; e. g. in the number and structure of the true vertebræ.

The head of the *Megatherium* is remarkable for its relatively small size, for the extraordinary depth of the lower jaw, and for the great size of the zygomatic processes. The length of the skull is thirty inches; three inches less than that of the Asiatic Elephant. The formation of the muzzle indicates the possession of a short proboscis.

The spinal column consists of seven cervical, sixteen dorsal, three lumbar, five sacral and eighteen caudal vertebræ, and measures fifteen feet in length, or three feet more than the Elephant's. The circumference of the skeleton, at the eighth rib is eleven feet.

The *Megatherium* differs strikingly from existing quadrupeds of corresponding bulk, in the vast proportions of its anterior extremities. Its clavicle, fifteen inches long, is the longest known. The fore-leg bespeaks enormous strength; with the foot, it is seven feet and four inches in length.

The posterior extremities are shorter than the anterior. The pelvis is the largest bone in any land mammal, living or extinct; it is upwards of five feet broad. The rugged ilium and spinal crest show that it was the centre of muscular bundles of enormous power, which diverged to act upon the trunk, the tail and the hind legs. These muscles, judging from the size of the spinal cord, which in this region is four inches in diameter, must have been characterized by the extreme energy of their vital contractibility. The acetabulum is excavated in a very exceptional manner, its concavity facing directly downward. This gave increased strength for sustaining vertical pressure at the expense of rapid motion.

The hind legs appear more like columns for support than organs for locomotion, and, with the hind feet, are models of massive organic masonry. The heel-bone alone has the extraordinary length of seventeen inches, and a circumference of twenty-eight inches. The monster walked, like the *Anteater*, on the outside edge of its foot, on a marginal hoof-like callosity. The middle toe of the hind foot, and likewise the second, third and fourth digits of the fore-foot, were armed with powerful claws. The magnitude of the tail fills the observer with wonder; when clothed with flesh, it must have been more than six feet around at the greater end. With the hind legs, it formed a tripod upon which the animal rested when obtaining its food.

It would be interesting to know something of the daily life of the animal whose colossal size was united to such strange anatomy. As the brain of the *Megatherium* was less by nearly one-half than that of the Elephant, we infer that he was a creature of fewer instincts. Nevertheless, his cotemporary quadrupeds must have acknowledged him as the head of the Animal Kingdom. To the tongue of a Giraffe and the proboscis of a Tapir, there was added the power of rotating the bones of the fore-arm. These prehensile organs were suited to a leaf-feeder. That the animal was not carnivorous, is settled by the structure of its molar teeth; it lacks incisors; therefore it was

No. [128.] *Elephas Ganesa.*

not a Ruminant. But if the great animal fed on foliage, how did it obtain it? The Elephant gathers its food with a long proboscis. The Giraffe, standing on stilt-like fore-legs, and reaching out its attenuated neck, plucks the high branches with long flexible lips and muscular tongue. The Megatherium could imitate neither. Did it climb like the Sloth? Such was the conjecture of the Danish Naturalist, Dr. LUND; but the clumsy make and the immense bulk and weight of the creature forbid it. The structure of the fore-feet, moreover, militates against the theory; for the outer digit is hoof-like, as if made for terrestrial progression. The hind-legs, too, are much shorter than the fore-legs; and the tail is too short and thick for prehensile purposes.

The fossorial hypothesis, too, has no better foundation than the scansorial. In burrowing animals, as the Mole, the pelvis is remarkably slender, and the claws form a continuous plane with the palm of the foot; while in the Megatherium the pelvis is remarkably large, and not one of the claws can be brought into a line with the metacarpus. The fore arms are plainly formed for grasping, not climbing or digging; they were instruments of tremendous strength, evidence of which is furnished by the deep groves and sharp ridges on the radius and ulna, the starting points of stout tendons and muscles. The moment we estimate this force, the colossal proportions of the hind-extremities lose their anomaly and harmonize with the front. The application of the fore-arms to the work of tearing down a tree would demand a corresponding fulcrum, such as we find in the heavy pelvis, the ponderous tail and massive hind-legs.

The Megatherium needed not agility for securing prey, for it was not carnivorous; nor for flight, for its size alone must have been a protection against any living foe. Had we beheld it living on its native plains, its slow movement would have excited our wonder as well as its bulk. It was doubtless a solitary animal. The gathering together in herds was not required for self-defence; indeed the necessities of the creature to obtain an enormous daily supply of food would not have allowed it, unless the vegetation of that day was far more dense than is the modern vegetation of the same region. When stripping the trees it has prostrated, its position was probably a reclining one; and Professor AGASSIZ has ventured the opinion that this crouching attitude was constant to the animal, and that it crept along with the full length of its fore-arm resting upon the ground.

The Pampas, where the remains of the great fossils have been chiefly found, are vast plains stretching from the mountains of Brazil to Terra del Fuego. Palms grow at one end, while snow covers the other almost the entire year. The soil is chiefly a dull-reddish, slightly indurated, argillaceous earth, with here and there calcareous concretions; underneath are beds of stratified gravel and conglomerate. These deposits constitute the Pampean formation, which varies in depth from twenty to one hundred feet. It was in this recent formation—referable to the Quaternary period, because most of its shells are still living in the ocean—that the Megatherium was entombed. Like the Aborigines of our own continent, like the Dodo of Mauritius, the Edentate giants perished one after another, in the lapse of infinite ages, by those changes of circumstances in the organic and inorganic world which are always in progress.

Price of bones packed but not painted \$250.

No. [128.] **Elephas Ganesa**, FALC. and CAUT.

SKULL WITH TUSKS. This remarkable Asiatic Elephant, long ago extinct,

No. [279.] *Colossochelys atlas*.

is distinguished by a pair of tusks ten and a half feet in length, and twenty-six inches in circumference at the base. In consequence of their slight curvature, they project eight feet five inches in front of the head. The length of the skull is four feet two inches; width, twenty-nine inches. The apparent disproportion of the tusks to the size of the skull is truly extraordinary, and exemplifies the maximization of dental development. By their great leverage they must have added to the skull of the living animal a weight of nearly two thousand pounds. The molars present seven or eight ridges, and the valleys between are filled with a large quantity of cement. The original, preserved in the British Museum, was discovered in that classical palæontological ground—the Sewalik Hills of India—in a Pliocene deposit, consisting of concretionary grit, conglomerate, sandstone and loam, and containing lignite, trunks of dicotyledonous trees, and land and fresh-water shells.

This cast is in five pieces.

Price, with mounting and pedestal, \$95.

No. [279.] **Colossochelys Atlas**, FALC. and CAUT.

This gigantic Tortoise—the King of the Chelonians—was a contemporary of the *Sivatherium*. This cast is a restoration from fragments discovered in the Pliocene strata of the Sewalik Hills, India, and now in the Museum of the Asiatic Society of Bengal.

Size, 12 ft. x 5 ft. 10 in.

Price of all the parts, with pedestal, \$350.

No. [228.] **Plesiosaurus Cramptoni**, CARTE and BAILY.

SKELETON, on slab. This splendid Plesiosaurus—the largest ever discovered—was found in 1848 in the Lias, near Whitby, England, and adorns the Natural History Museum of the Royal Dublin Society. It lies in a prone position, resting upon the ventral surface with the head and neck slightly inclined to the right. The skull is almost entirely free from the matrix, and is very perfect, excepting the zygomas. In contour it is crocodilo-lacertian; it is somewhat flattened in proportion to its length and width, tapering from the parietal crest to the snout. The orbits are obliquely placed and subtriangular in shape; the greatest diameter is five and a half inches. The nasal apertures are ovoid, and are situated just in front of the orbits. The anterior portion of the cranium is elongated and rounded at the muzzle. The lower jaw is extremely massive, its greatest length being three feet six inches, and its greatest depth, six inches. The teeth number over a hundred. They resemble those of the Crocodile in their irregular arrangement, and in being implanted in distinct cavities. The large teeth are situated in front. The length of the head is to that of the neck as five to eight, and to that of the whole skeleton as one to six. The vertebral column throughout has fallen over towards the right side, presenting a slightly irregular curve, thus exposing in the cervical series a side of the centrums with their large neuropophyses. The cervical vertebræ number twenty-seven. There are thirty dorsals, having a united length of eight feet. The caudal portion is somewhat dislocated; the centrums with their spines and processes are, however, well exhibited. The vertebræ of this region number thirty-four. The ribs are well shown, being nearly in their original position. Excepting the left hind-paddle which is imperfect, the extremities are remarkably preserved. The carpal and tarsal bones are each six in number; the metacarpals and metatarsals, four. The humerus and femur are each twenty inches long.

This cast is in eight pieces. Size, 22 ft. 8 in. x 12 ft. 6 in.

Price, painted and packed, \$150.

No. [228.] *Plesiosaurus Cramptoni*. [Size, 23 ft. 8 in. x 12 ft. 6 in.]

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