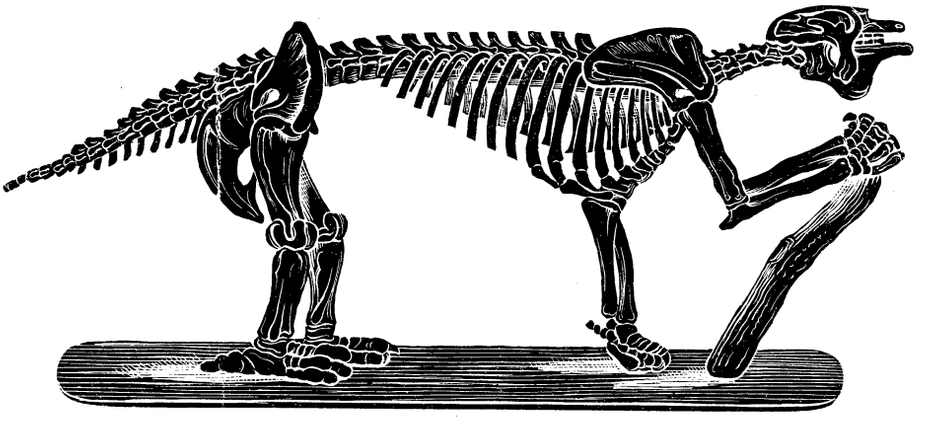
WARD SERIES OF CASTS

—OF—

FOSSILS.

(ACADEMY SERIES.)



ROCHESTER, N. Y.
1870.

GEOLOGICAL ILLUSTRATIONS.

WARD SERIES OF

CASTS OF FOSSILS.

Reduction of Price, Revision of the Series, Additions and New Catalogues.

Rochester, N. Y., November 1, 1870.

In the autumn of 1866, I issued a series of twelve hundred Casts of notable Fossils. These Casts I had moulded from actual specimens in the great royal and private Museums of Europe, with important additions from American sources. As this method was the only one by which these treasures illustrating the early Life on our planet might be brought within the reach of American students, studying on American soil, the enterprise was undertaken with a conviction of its utility to educational science, and with a confidence that the service would be appreciated. This confidence has not been disappointed. The call for these Casts has been large, and is steadily increasing. Our highest institutions of science have been the first to recognize their value and secure their aid. Among the scientific institutions which have most notably obtained this material are the following: New York State Geological Cabinet; the Buffalo Academy of Natural Sciences; the Philadelphia Academy; the Boston Natural History Society, and the Peabody Museum at Salem, Mass. Also the Cabinets of Williams, Amherst and Yale; of Columbia College, N.Y.; of Vassar College, Poughkeepsie, N.Y.; of Alleghany College, Meadville, Penn.; Madison University; University of Rochester; Ohio Wesleyan University; University of California, and the Wesleyan University of Middletown, Conn. (the last the donation of Orange Judd, Esq., of New York, editor of the *American Agriculturalist*), have each secured from $300 to $3,000 worth of these Casts. Considerable numbers have also been sent to the Museums of England, Austria, Bavaria, India and Australia.

The orders which have been received during the past four years have indicated the fact that certain forms in this large series are more constantly preferred.

This has decided the writer to make up two considerable suites or series of these Casts, including in them, severally, those forms which have proved to be of more particular attractiveness and interest for our lesser and our larger institutions. In this way two distinct Geological Cabinets have been compiled, each complete in itself, but of different magnitude and scope.

ACADEMY SERIES.

This Cabinet contains *one hundred and seventy* specimens, so chosen as to embrace forms in each of the divisions of Fossil animal life, from the highest to the lowest. Here are Casts, carefully formed and colored, of the various orders of Mammals which roamed the plains and valleys or dwelt in caves, in the Tertiary and Quarternary periods; of great extinct Birds; of huge uncouth Reptiles,—Ichthyosaurus, Plesiosaurus,

Iguanodon, and Pterodactyle—which lived in the Jurassic Age; of Fishes which swam in Cretaceous, Oolite, and Devonian seas—the latter so graphically described by Hugh Miller in his writings on the "Old Red Sandstone." Also Trilobites, and other Crustaceans, Insects, Ammonites and other Shells; Sea-Eggs, Star Fishes, Crinoids, Foramenifers and Sponges. Also, a few Fossil Plants suitable to be copied as Casts. This series is quite complete in its variety of forms, containing full material for illustration by the teacher of Geology in our Academies, Normal Schools and smaller Colleges. Its specimens vary in size from small shells to skulls and entire skeletons several feet in diameter. It will fill the shelves of a cabinet room twenty feet square. Each specimen is accompanied by a handsome printed label, and the display and graphic effect of the whole is very great.

To still further augment this display, there have been added three huge specimens, which are intended to stand independently on pedestals in the middle of the room. One of these—the Glyptodon, or great Fossil Armadillo—is nine feet long and about four feet high. These three specimens form a *Supplement* which may be taken with the cabinet, or may be omitted, as the purchaser elects.

The price of this entire Academy series, carefully boxed, and delivered at the Rochester freight office, is $500. The price without the supplement is $300.

COLLEGE SERIES.

This series consists of *three hundred and thirty* specimens, chosen like the preceding series, among the most noteworthy forms in the whole range of Fossil Organisms. The natural classes and orders are all here represented by copies of the most celebrated Fossils—the originals of which form the scientific treasures of Royal Museums, and are single and *unique*. The series commences with some rare human remains—including the famous Fossil human skeleton from Guadaloupe—and continues through all the classes of the Vertebrates, and then through the four sub-kingdoms of the Invertebrates, introducing every form and name of which the student in the highest course of geological teaching is ever likely to hear.

Besides the individual forms there are small suites of the Casts which illustrate particular families of Fossils, as among the Trilobites, Ammonites, Brachiopoda, Echinoidea, Crinoidea and Foramenifera. This series is so full and extensive that it may be arranged by itself in the Museum Hall, forming a complete Geological Cabinet, or it may be worked in in the classification with such actual Fossils as the College may possess. The series of itself will quite fill the shelves of a cabinet hall thirty by forty feet in size, some of the larger specimens—Glyptodon, Mastodon, Deinotherium and Diprotodon—standing on distinct pedestals in the central area.

A ***Supplement*** is also added to this College Series, containing four of the largest Fossils known to science, and the largest Casts which have ever been taken. These are the Megatherium; the Elephas Ganesa (Himmalaya Mammoth); the Colossochelys (colossal Himmalaya Tortoise), and the great Plesiosaurus Cramptoni, the latter *twenty-two feet long!*

The price of this College Series (boxed, &c.), is $1,000. Its price, together with the supplement is $1,600.

The two series above described have been chosen with much care and study that they shall meet the end for which they are intended, and be true compends of Geological science—complete illustrative cabinets.

The writer has just completed CATALOGUES of each of the series. These catalogues give a short descriptive notice of each specimen, stating its relation to modern forms, the locality where it was found, the geological bed in which it lay, its size, and the Museum in which the original is now preserved. There are also introductory notices of the Orders and other higher divisions, numerous illustrations, and a copious glossary-index. *The facts contained in these catalogues will be of much service to both teacher and student.*

The Academy Catalogue contains 80 pages, and 130 wood cuts. The College Catalogue contains 136 pages, and 230 wood cuts.

The writer, anticipating a large sale of these new series of Casts, or Geological Cabinets, has reduced

their price far below what has before been charged for the same material. An occasion is thus offered to the Trustees of our institutions to increase their scientific appliances. It is hoped, too, that *Patrons of Academies or Colleges* may see here a signal opportunity to endow them with a *beautiful, useful, attractive and valuable cabinet of Geology.*

For the advantage of those parties who choose to make their own selections, the writer has just issued a CHECK LIST of 64 pages, containing the name, locality, formation, size and price (but without further description), of his entire series of 833 Casts of Fossils, and 35 miscellaneous Casts, alike of Geological import. Parties desiring this pamphlet, or the Catalogues, should address the writer, who will send (post-paid) the

Check-List, - - - - - - - - - -	gratis,
Academy Catalogue, - - - - - - - -	30 cents,
College Catalogue, - - - - - - - -	60 "

A very few copies still remain of my "Illustrated Catalogue of Casts of Fossils," (pp. 228, wood cuts 284) which will be sent at the old price, viz. $1.25 for the bound edition, and $0.75 for the pamphlet form.

HENRY A. WARD, ROCHESTER, N. Y.,
P. O. Box, 297.

TESTIMONIALS.

From the American Journal of Science and Arts, for July, 1866.

Prof. Henry A. Ward's Collection of Casts of Fossils, at Rochester, N. Y.

Prof. Ward, in the course of his travels for the formation of his large Cabinet at Rochester, has had occasion to make casts of numerous fossils, large and small, from the skeletons of Elephants, Mastodons, and the Guadaloupe Man to shells of Rhizopods; and he is consequently enabled to furnish copies of them to other Cabinets. He is now issuing an illustrated catalogue of 200 pages or more, which gives some idea of the extent of his collections. His casts have already reached a number of scientific cabinets in the country, among them those of Yale, Amherst, Cambridge, Vassar College, Albany, etc.; and wherever they have gone they are admired for their excellence and perfection of finish. We would recommend to Colleges, Academies, and other institutions where science is taught in the land, to supply themselves, as far as they are able, with these casts. They enable the instructor to exhibit to students specimens of the rare fossil skeletons and other species from the rocks, many of which are seldom or never found in American collections. By means of them, series representing the principal types of different Families (as that of Trilobites, or of Ammonites, etc.) may be made complete or nearly so. The casts are light and strong, and thus are well fitted for class purposes. They have been copied from the best specimens to be found in any collections, and are colored to correspond with the originals. They give, at comparatively small expense, wonderful effectiveness to a cabinet as a means of instruction. *A gift of a collection of Mr. Ward's casts from any patron of learning to an academy or college would render great service to the instructor, the pupils, and the institution.*

From Prof. LOUIS AGASSIZ.

MUSEUM OF COMPARATIVE ZOOLOGY,
Cambridge, Jan. 21, 1869.

(*Extract from letter to Mr. Ward.*)

* * * I was surprised and delighted to find how greatly the perfection of the specimens selected for casting enhance the importance of your series of Casts of Fossils, and I truly congratulate you upon the success you have achieved, and hope that you may meet with all the approbation and support you so richly deserve. * * * I now write to ascertain for what price I can obtain a complete series of all those of your casts which were taken from original specimens. * * * I wish thus to testify to the value of your specimens for exhibition in a great Museum, and I would add, that for teaching they are admirably suited, and I would gladly recommend their purchase to all the larger institutions of learning.

Yours, very truly,
L. AGASSIZ.

From the late PRESIDENT HITCHCOCK, of Amherst College.

Amherst, Nov. 21st, 1863.

Prof. H. A. Ward,
My dear Sir,

I have just sent you four large boxes containing moulds of twelve of the more prominent slabs of tracks in our Ichnological Museum. The moulder whom you sent on copied these with *much* skill and truth; and the casts which you take from them will certainly be very close representations of the originals, and give their possessors an exact view of those wonders from the rocks of the Connecticut.

I am delighted to see the excellent work which you are accomplishing in the matter of the plaster copies of the larger and rarer fossils. It is no small thing thus to put into our hands, as it were, the wealth of the old European Museums,and to re-create for us, in actual, tangible forms, the huge and strange animals which walked our globe in the age of Reptiles and of Mammals, or swam and crawled through the muddy wastes of the Palæozoic seas. Hardly anything could be more fortunate to American students of Geology than the appearance of these casts. *They will be invaluable adjuncts to the scientific department in every Academy, College or University in our country; and it would be folly for any one pretending to teach Geology not to make use of them.*

Our College has obtained from you as many of these casts as our funds would permit, and we have much admired the care which you have expended in making their form and color exact copies of the original specimens. For the sake of Geological science, as well as for yourself, I wish you ample success in your enterprise, and expect that you will have it.

Truly yours,
EDWARD HITCHCOCK.

From PROF. J. S. NEWBERRY.

SCHOOL OF MINES,
COLUMBIA COLLEGE,
NEW YORK.

PROF. H. A. WARD,—

DEAR SIR: I take pleasure in expressing my judgment of the value of your series of casts, both to students of geology, and to the people at large. To the first class they serve an important purpose in giving a clearer and longer retained knowledge of the extinct forms of life than can be gained by any other means at their command. To the latter they arrest attention and excite interest, the first step, toward scientific education in the individual or community.

I have daily fresh evidence of the utility to my classes and the public of the series which I purchased of you. To most persons they are scarcely less interesting and impressive than the originals would be, and are equally instructive. I only regret in this connection that I have not space for more of them.

Yours very truly,
J. S. NEWBERRY,
Prof. of Geology.

From Prof. ALEXANDER WINCHELL.

UNIVERSITY OF MICHIGAN,
Oct. 14, 1870.

[*Extract from letter to Mr. Ward*]

* * * Your copies place within the reach of *all* classes, *fac-similes* of the best specimens extant, either in Europe or America. In the department of Vertebrate palæontology it is absolutely impossible to get together, in the actual state, one-third of the illustrations of which you furnish the casts, and I confidently assert *that any institution which undertakes to teach geology, can no more afford to dispense with the facilities which you provide than it can with blackboards and crayons and test-tubes and air-pumps.*

I am very familiar with the character of your casts—their finish, their *life-likeness*, their reproduction of the choicest specimens on either continent, and I can intelligently assert that nothing further is to be desired. I would earnestly recommend them to the attention of amateur geologists; to all persons connected with museums; to patrons of education waiting for the opportunity to perform a noble act, and to classes of students ambitious to leave a monument to themselves with *alma mater*, which shall be not only *aere perennius* but *aere utilius*.

Would that our people might learn like the Germans, to place less faith in brick and mortar, and more in books and the materials of science!

Very truly yours,
A. WINCHELL.

E. R. Andrews, Printer, 29 Buffalo Street, Rochester, N. Y.

[From the AMERICAN NATURALIST, for April, 1873, Vol. VII, No. 4.]

PROFESSOR WARD'S NATURAL SCIENCE ESTABLISHMENT AT ROCHESTER, N. Y.

WHEN Professor Agassiz gave his opening lecture in the Museum of Comparative Zoology at Cambridge in 1860, he said that American students had been forced to visit Europe, if they were desirous of making any extended study in the natural sciences, but that he intended to reverse this and compel European students to visit America; and by his judicious purchase of type collections abroad (thanks to the liberality of citizens and our State) he has made his promise good.

Professor Henry A. Ward of Rochester, New York, formerly a student of Professor Agassiz, and since Professor of Geology and Zoology in the Rochester University, has, under humbler auspices, long been working toward the same end. His large cabinet of geology and mineralogy at Rochester is well known to many of our readers. He long ago felt the necessity of bringing before the American student examples of those larger and rarer fossils known to geological science, of which only single specimens existed.

For this purpose he visited Europe, engaged accomplished workmen and commenced the foundation of a collection of casts. With untiring patience and sagacity he secured the moulds of nearly everything of importance, at enormous expense, carrying his workmen from one museum to the other, and taking moulds of the choicest specimens, for a period of three years.

The difficulties encountered in some of his experiences would form an interesting chapter. After many difficulties, he managed to secure moulds of the rare Megatherium, Glyptodon, Deinotherium, Diprotodon, Sivatherium, Colossochelys, Mosasaurus, Plesiosaurus, and many other unique specimens in European museums. Thorough and methodical in all his work, he felt that this collection of casts should be symmetrical and complete, as an educational collection, and so was commenced the famous Ward collection of casts. Thousands of dollars were spent in buying especially choice specimens of the obtainable forms solely for the

purpose of making casts from them, and the originals are still preserved in his museum at Rochester. Every educational institution in the country may now possess perfect casts of the rarest fossils, forming exact facsimiles of the unique originals in the British Museum, the Jardin des Plantes, and other foreign museums, besides a representative collection of all that is needed to illustrate geological history.

From this important beginning, Professor Ward has gone on enlarging the usefulness of his work by adding to his stock, skins and skeletons of animals, fossils and minerals, and alcoholic specimens, so that institutions may provide themselves with collections accurately labelled and arranged, without sending abroad for the purpose.

With the capital invested in so large an enterprise, rapid sales must be effected, and one not familiar with the scientific attainments of Professor Ward, and the sole desire that animates him, to spread far and wide the type collections so important for educational purposes, might confound his occupation with that of the ordinary dealer in natural history objects, such as one may find in any large city. While in the latter case, however, with some laudable exceptions, the dealers offer simply the fortuitous gatherings of sailors, comprising curiosities, shells, and detached portions of animals, like turtles' shields, sharks' jaws, and the like, of no intrinsic value, the work in which Prof. Ward is engaged is one of a solid scientific character. His outlays are immense, yet everything he does is done solely in reference to advancing science. He has the endorsement of every naturalist in the country, and already the leading museums in the country are indebted to him for some of their choicest material.

Every scientific man should visit Professor Ward's place at Rochester, New York, and see the bee-hive of industry he has built up around him. We visited Rochester in February, solely for the purpose of examining the new industry. Here one finds several large buildings, besides sheds and yards devoted to receiving, preparing and shipping specimens. There are twelve men constantly employed as taxidermists, osteologists, moulders and carpenters. Two of the osteologists he has brought from the Jardin des Plantes, Paris, where they had worked for a long time under the direction of eminent anatomists. The skeletons and skulls prepared here are beautiful in their whiteness and the elegance of their mounting. In the University building is Professor Ward's zoological cabinet, still his private property, containing type forms of the animal kingdom. This is carefully labelled and is strictly an educational collection.

In Cosmos Hall is a large room containing a large and valuable geological collection, particularly rich in Ammonites, fossil cuttle fishes, with the ink glands still preserved; beautiful fossil fishes from the Lias of England and Germany; fine Saurians in slabs; Icthyosaurus, Plesiosaurus, Teleosaurus; also the leg bones and other remains of the remarkable Dinornis from New Zealand; Mastodon and other mammal remains, and an almost perfect skeleton of the rare Glyptodon, the gigantic fossil armadillo.

Great interest attaches to this collection since it contains the original specimens of many of his casts, which have already a traditional value, now that so many institutions possess them. This series of *originals* is of intense interest, and will alone give tone and character to any geological cabinet in which they may be incorporated. In this room may also be seen relief maps and various models of geological import; many of these are familiar to College professors through the descriptions and figures given in Ward's "Illustrated Catalogue." At the time of our visit he was packing a series of casts for the Syracuse University, and a Megatherium was being cast for Dartmouth College. A cast of the skeleton of this latter huge animal may be seen in the Geological Hall of the Smithsonian Institution at Washington, where it was placed by Professor Ward, and copies of it are already in several other museums together with other of his specimens. The series of casts have been invaluable in advancing the study of geology, as their possession is just as important to the instructor in this department, as the possession of the manikin and skeleton is to the successful teaching of human anatomy.

The zoological portion of Professor Ward's establishment most interested us. Here all is on the same large scale. In bringing this collection together, Professor Ward has not only visited various portions of this country and Europe, Asia and Africa, but has his correspondents all over the world, and is constantly receiving from them most varied and rare material. While we were there he had just finished the preparation of a giraffe, thirteen feet in height, and was unpacking boxes containing a moose from Nova Scotia, a caribou from Maine, a bear from Pennsylvania, a huge basking-shark from the Atlantic coast; and, from Professor Agassiz, a walrus, a small whale, and the rare Rocky Mountain goat, to be mounted for the Cambridge museum.

One building is devoted to taxidermy. The upper room in this building is a wonder to behold; hanging from the ceiling are hundreds of skins, including Apes, Monkeys, Wolves, Bears, Hyænas, Lions, Tigers, Sloths, Ant-eaters, Armadillos, Buffaloes, Deer, Elk, Moose, Giraffe, Yak, Wild boar, Peccaries; besides an im-

mense collection of such animals as Kangaroos, Echidna, Wombat, Tasmanian devil, Ornithorynchus, Thylacinus and other rare skins. Some huge Alligators, Turtles, Iguanas and other reptiles completed the display. In an adjoining room are kept fishes, batrachians, and other specimens in alcohol; among these are Lepidosteus, Amia, Menopoma, Spatularia, Scaphiorynchus, Aspidonectes, and other American species of special anatomical interest. Still another building is devoted exclusively to the preparation of skeletons; these are received with the flesh dried upon them, and are subjected to a long process of maceration and bleaching; over fifty vats are ready to receive them. These vats are all systematically numbered, and the most painstaking care is manifested to secure every bone, so that each specimen may be perfect. Custom work is combined with all this; and hundreds of specimens are received from the museums of Cambridge, Boston, Salem, Philadelphia, Albany, and many of our colleges, for the purpose of being properly prepared and mounted.

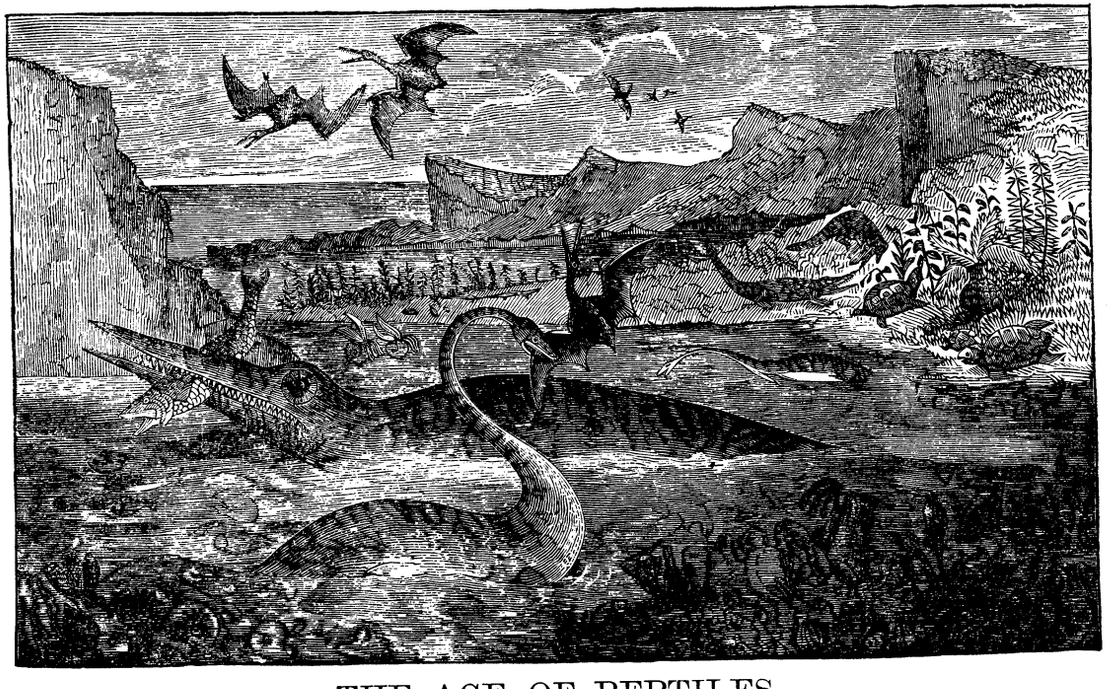
We have dealt thus in detail that the public may know the true character of the enterprise in which Professor Ward is engaged; and the duty of every one interested in science and education to cordially sustain him.

Professor Ward has by long study and by travel in foreign countries, as well as by his long experience as a professional teacher of zoology and geology, fitted himself for the important and arduous task before him.

He has received the unqualified endorsement of the leading naturalists, and his untiring devotion to the work, and the immense outlays he has made, should be widely known among those who desire to sustain in this country an institution where one may secure the material for the foundation of a museum, as well as examples for educational purposes.—E. S. Morse.

[We had the pleasure last summer of visiting Professor Ward's Rochester Establishment, and of seeing his important collections. One point which Professor Morse has failed to notice is the work done by Mr. Ward in the matter of blocks, labels, shields, and other appliances for the arrangement of cabinets. He has not only planned, but has gone on and constructed the cabinet cases in Vassar, Alleghany and Pittsburg colleges, in the Orange Judd Hall of Science at Wesleyan University in Middletown, Conn., and in the new Syracuse University. At the time of going to press we are informed that Mr. Ward has been engaged to construct the cabinet cases in the new Geological hall—two hundred feet long—of the Smithsonian Institution.—F. W. P.]

Printed at the Salem Press.



THE AGE OF REPTILES.

CATALOGUE

OF THE

ACADEMY SERIES

OF

CASTS OF FOSSILS,

FROM THE

PRINCIPAL MUSEUMS OF EUROPE AND AMERICA,

WITH SHORT DESCRIPTIONS AND ILLUSTRATIONS,

BY

HENRY A. WARD, A. M., F. G. S.,

Professor of the Natural Sciences, in the University of Rochester.

ROCHESTER, N. Y.
EZRA R. ANDREWS, BOOK AND JOB PRINTER.
1870.

"Geology, although it cannot prove that other planets are filled with appropriate races of living beings, has demonstrated the truth of conclusions scarcely less wonderful:—the existence on our own planet of so many habitable surfaces or worlds as they have been called, each distinct in time, and peopled with its peculiar races of aquatic and terrestrial beings."

SIR CHARLES LYELL.

INTRODUCTION.

The science of Geology is so profoundly practical and so intensely interesting, that it will never lack students. And it becomes a matter of first importance to provide them with the best avenue to the subject. The peculiar nature of the study, as well as the high place which it is taking in our Institutions of learning, demands for it better and increased appliances for illustration. For it is clear that in Geology, not less than in the other Natural Sciences, something more is needed than simple text-books or oral teaching. Visible, tangible objects can alone meet this necessity, and give the student clear and correct views. "I have satisfied myself long ago (says Agassiz), that the grand and most elementary principles of our science are better understood when illustrated from nature than when explained in a more abstract manner."

Museums of natural objeets are becoming more and more a recognized necessity. Geological cabinets are multiplying in numbers and increasing in size. In them the department of Palæontology is securing a prominent position, now that Geologists more fully appreciate the real value of fossil organisms, and regard them as portions of the great life-history of our globe — essential links in the chain of Zoölogical series — instead of mere "medals" for the identification of strata. Some of the greatest questions as to the past condition of the earth are to be answered only by the study of fossil in connection with living forms.

But a Palæontological cabinet, in order to serve its end, must possess a certain completeness. To illustrate certain forms of primeval life in undue proportion, accumulating species under some few genera, and leaving whole families, orders, and even classes of the fossil Zoölogical series entirely unrepresented, is to distort nature. This sort of exclusiveness is an unavoidable feature in the drawers of a Palæontologist who is working on a special fauna or some particular zoölogical division of fossils. But to accomplish the purposes of general instruction, a cabinet of fossils should be as

complete as possible, covering the whole ground, and giving an unbroken view of ancient life. What our Institutions must have as the primary condition of their success in the Natural Sciences,—and yet that which, it must be said, our Academies and many of our Colleges lack,— is a consistent and well-proportioned exhibition of all the classes in the several departments of nature.

It is not expected that Academies or even Universities should aim at representing every living thing in nature. It takes royal wealth and centuries of time to finish one British Museum. But a glance at what is called a "*Geological Cabinet*" in the great majority of our Institutions, reveals a gross caricature: there are heaps of specimens of the same species (because they chance to be abundant in the neighborhood), and Palæozoic Crinoids or Trilobites, Corals or Brachiopods preponderate, while the myriad forms which lived in the other great ages, as the gigantic vertebrates—so long the lords of creation, are utterly ignored. How is it possible for students to receive from such a collection any correct idea of ancient life?

It may be asked, how our Cabinets can be rounded out and systematized by suitable additions? Good fossils are rare and costly in proportion, and only single specimens have been discovered of the relics of many extinct animals. If we explore our own country for these "missing links," we meet with a difficulty in the general horizontality of the sedimentary strata, which renders them largely inaccessible, and in the great area of the ancient seas whose deeper portions away from the shores have sustained a fauna limited as to variety of kinds. For this cause and by reason of their general early age, we find here chiefly invertebrate species, and fewer of those higher and more important forms which enrich the strata of the Old World.

Months of diligent search from Maine to California might yield us a tooth, perchance the vertebra of a Mastodon or Mammoth; New Jersey and Alabama together might give us fragments of a Reptile and Whale, and Nebraska contribute a few mementoes of ancient Pachyderms and Ruminants. We may be fortunate in finding a few Cephalopods and Fishes, but certainly not enough to represent their gradation in structure; of Monkeys and Birds not a single bone shall we discover; not a scute or a paddle of those huge Saurians that floundered in the Jurassic seas, and whose names are familiar to us all, but of which unaided we have no definite idea, not one of the great Carnivores that swarmed over Europe, nor the greater Edentates—the wonderful Megatherium and Glyptodon of South America; nothing of the colossal Antelope and "King of the Tur-

tles," disinterred from the flanks of the Himalayas; nothing of the classic Tapirs which once fed by the inland sea where now stand the palaces of Paris, and whose bones in the hands of the immortal Cuvier made the foundation of Palæontology,— nothing in this long procession nor like them does this country furnish, and deeply instructive and intensely interesting as they must be, we are obliged to do without them, and give our students the name for the thing itself. We own there are wide chasms in the Geology we attempt to teach; but how is it possible to represent these forms when they are found only, if at all, this side of the Atlantic in University collections.

The author of these pages has had considerable experience of the difficulties above mentioned, in his efforts during the last ten years, to give completeness to the Palæontological Cabinet of the University of Rochester. He has found that the only possible way to give this collection its desired symmetry, was by the introduction of *Plaster Copies* of these fossils, the originals of which are either unique specimens or are so rare that it is quite impossible to obtain them. The series of extinct forms can by this plan be made substantially complete, and the Cabinet enriched by many specimens of high scientific value, of manifest educational utility, and of great attraction to the general visitor. The author has obtained these casts by the slow labor of years, seeking the best original wherever it could be found.

These casts are offered to the Institutions of our country, with the hope that their advantages in the illustration of the Science of Geology will be appreciated. As these casts are offered at a low figure, those strange yet representative forms described by Professor Dana in his model *Manual*, but which to the mass of American students are as mythical as the "Great Dragon" of Mediæval romance, are within the reach of the poorest Academy. Without these tangible illustrations, in vain will teachers explain and students comprehend; with them, Geology may be made a most enrapturing study, and what it should be — the science of the earth and not of a district.

The attention of Teachers and the Patrons of Education is called to the following selected series representing 170 fossil forms. 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. It will be observed that the series is a compend of Palæontological History, presenting in proper proportions the varied forms which life has assumed from the Silurian Radiate up to Man. The dullest student can detect in this selection zoölogical order and chronological sequence.

It will be observed that nearly every order in the Animal Kingdom is represented, and that too by some of the most important members, as by the lion-like Machairodus and Cave-Bear among Carnivores; the Megatherium and Glyptodon among Edentates; Deinotherium, Mastodon and Mammoth among Pachyderms; Dodo, Palapteryx and Connecticut Footprints among Birds; Iguanodon, Ichthyosaurus and Pterodactyle among the Saurians; the Holoptychius and Cephalaspis among Fishes, etc., etc. So that while the Teacher will find these capital illustrations where otherwise he must make barren statements, the student on the other hand, comprehending the great facts of Geology, will be attracted to the science, and pursue it in right earnest. None but those who have tried it, can fully understand the amazing difference between the fruitless effort at teaching Natural History without the *thing,* and in holding up before the pupil a visible, tangible illustration.

It will also be seen that this series is strikingly comprehensive, embracing all the representative forms of life, so that with these alone a Teacher can illustrate the sciences of Zoology, Palæontology and to a large extent Comparative Anatomy.

HENRY A. WARD.

University of Rochester, Oct. 20, 1870.

The entire series of casts described in this catalogue (exclusive of the Supplement), is furnished, securely packed in boxes, for the sum of $300.

It is intended to be a *complete cabinet* for the teaching purposes of our highest grade of Academies,—those in which Geology is taught *in reality.* The *display* of this large Geological collection,—arranged upon the shelves and arrayed upon the walls of the cabinet-hall,—is one of its most noticeable and excellent features. A handsome printed label accompanies each specimen; giving in full the name of the fossil, the author of the species, its zoölogical formation, the locality where it was found, and—in the case of the Vertebrates—the Museum in which the original specimen is now deposited. A number on the label (as also upon the specimen) accords with the number under which the specimen is described in this catalogue.

FIRST SUB-KINGDOM.

VERTEBRATES.

The four great Classes of Cuvier, comprising this Province of the Animal Kingdom, have in common a general type of structure, clearly recognizable in all the members of the series. The grand characteristic is an internal jointed skeleton, made up of vertebræ, which with their processes form two cavities — the upper enclosing the great nervous cord, the lower containing the viscera.

The history of Mammals, Birds, Reptiles and Fishes, *as a sub-kingdom,* reaches back to the Upper Silurian Period. Their fossil bones and teeth, usually in a fragmentary state, have been found in every stage of alteration, from their present gelatinous state to that of complete petrifaction, and demonstrate the existence of numerous tribes of highly organized beings in the primeval age of the world, and the continuance of the same type of organization to the present day. The earliest evidence of a vertebrate animal is of the cold-blooded, water-breathing class in the Upper Silurian. The type, however, did not start from the inferior Fishes, but from the higher forms — the Ganoids and Sharks; the species now swarming in river, lake and ocean, did not come into existence until the Cretaceous Period. Reptiles were introduced in the Carboniferous — first amphibian, then the typical forms. In the Reptilian Age came the first of Birds and the first of Marsupials. The true Birds and Mammals had their full expansion in the Tertiary.

CLASS I.—MAMMALS.

The fossil relics of this Class consist, for the most part, of single and displaced bones, or groups of bones, and teeth, and the durable portions 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 exceedingly rare.

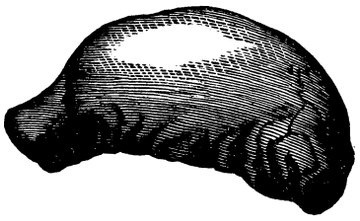
The earliest trace of a warm-blooded, air-breathing, viviparous animal, appears in the Upper Triassic—the *Microlestes*, a very small Insectivore, and probably a Marsupial, having been discovered in a bone-breccia at Diegerloch, Wirtemberg, and the kindred *Dromatherium* in North Carolina. From the Eocene Tertiary to the present day, an extensive and varied Mammalian fauna has existed, and left remains in the beds of ancient estuaries and rivers, in peat bogs, marl pits, and especially 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 1—BIMANA.

This Order, 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; and he is the only living Mammal having no vacant space in the dental series. In him the vertebrate type, which began during the Palæozoic age in the horizontal Fish, finally becomes erect.

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. The evidence that man existed in the fluviatile Drift Period, is derived solely from ossiferous caverns. Human implements, however, have been discovered in disturbed Alluvium, associated with the remains of extinct Post-Glacial Mammals.

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



SKULL, discovered in 1857, in a limestone cave in Neanderthal, near Dusseldorf. 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 braincase 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 Elberfield, Rhenish Prussia. Size, 8 x 6.

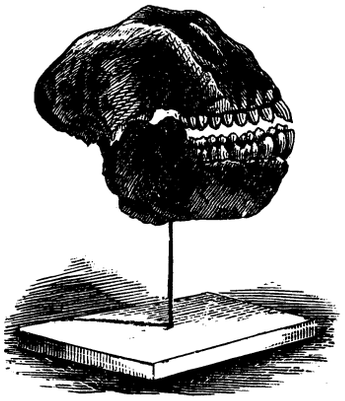
ORDER 2 — QUADRUMANA.

These Mammals, the most anthropoid of brutes, were so named by Cuvier, because they have prehensile feet as well as hands. But the term is strictly applicable only to the old-world Apes, as they alone have the opposable thumb on the hind foot. All those higher forms have the same number and kinds of teeth as Man — the deviation being the great size of the canines and a break in the series.

Cuvier held that the Quadrumana were scarcely, if at all, anterior to Man in order of creation. Lyell was the first (1830) to express a doubt of the total absence of fossil Monkeys. In 1839 fragments of the lower jaw of the *Eopithecus* were discovered by Owen in the London Clay, on the banks of the Deben, Eng. Since then remains have been found in the Sewalik Hills, India; in the Miocene strata of Southern France and of Greece, and in the Pliocene of France and Brazil. None of the Lemurs have been discovered fossil.

* The Nos. given in brackets are those under which the same specimen is described in the *Ward Catalogue of Casts, 1866*.

No. 2. **Mesopithecus Pentelici,** Wagner.



HEAD, on pedestal. This interesting fossil, lately discovered by M. Gaudry in the Upper Miocene deposit, near Pikermi, in Attica, tells us that Greece in Tertiary times was alive with curious Monkeys.—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. The original of this interesting specimen is in the Museum of of the University of Munich.

ORDER 3 — CARNIVORES.

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 *Cats* have 14 in all — true and false; the *Dogs* have 24; and the *Bears* 26.

The fossil bones of Carnivores are found principally in caves and fissures. The Digitigrades first appeared in the Eocene age; but the Plantigrades proper and the *Seals* have not been found below the Miocene. The earliest representative of the *Insectivores,* as far as known, is a Hedgehog discovered in the Auvergne beds, between the Eocene and Miocene in age. *Bats,* belonging to the family *Vespertilionidæ* first appeared in the Eocene, but they are not distinguishable from the species which now exist.

No. 3. **Machairodus cultridens,** Cuv.

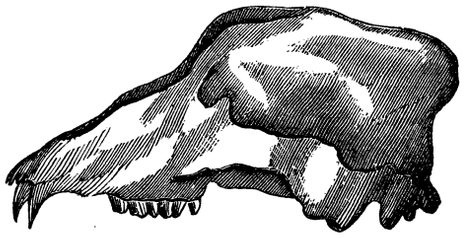
PORTION OF SKULL AND LOWER JAW. In the Middle and Later Tertiary times, South America, India and Europe, from England to Greece, were the abode of several species of a formidable and peculiarly destructive feline quadruped called the Machairodus or Sabre-toothed Lion. The canines, in fact, are the most remarkable of all fossil carnivorous teeth yet discovered, being long, curved and double-edged. This species equalled the Bengal Tiger in size; and its remains have been found in the Upper Miocene of Auvergne, France, and of Pikermi, Attica. This specimen, much compressed in the process of fossilization, was found at the latter place. Size, 9 x 6.

No. 4. [11] **Hyæna eximia,** Wagner.

LOWER JAW, LEFT RAMUS. 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 strewed over, like a dog-kennel, with hundreds of teeth and splintered bones, evidently the remains of prey dragged in and doomed by these ferocious Carnivores.

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. 5. [16] **Ursus spelæus,** Blumenbach.



SKULL. This "Great Cave Bear," as it is often called, according to Cuvier must have equalled a large Horse in size. Its bones, which abound in the caves of Germany, long ago attracted the attention of the curious, and were described in 1672 as fossil dragons. The illustrious Blumenbach was the first to recognize clearly a distinction of species. The *Ursus spelæus*, the oldest and most famous of all, and a cotemporary of man, is remarkable for its long, high pointed cranial crests, the prominence of the forehead and the wide interval between the formidable canine and the first 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. 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. 6. [17] **Ursus spelæus,** Blum.

PAIR OF MOLARS. Original in the Ward Museum, University of Rochester.

No. 7. [18] **Ursus spelæus,** Blum.

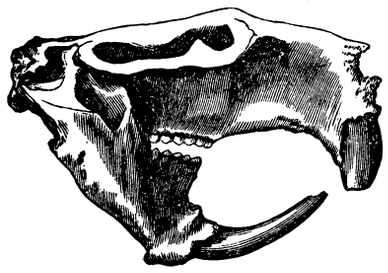
CANINE. Original in the Ward Museum, University of Rochester.

Order 4 — Rodents.

This Order contains the smallest of the Mammals, and the largest number of species. It is characterized by two long, incurved, rootless incisors in each jaw, enamelled only in front, and separated by a wide space from the molars. The molars have flat crowns with transverse enamelled ridges. 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 Mice are the typical family; but the Capybara and Beaver are now the giants of the Order, and the latter, in the duration of its distinctive type, is among the oldest of living Mammals.

No unequivocal evidence has been obtained of remains of Rodents in strata more ancient than the Eocene Tertiary. The fossils are chiefly found in lacustrine marls (Miocene), Pleistocene formations, and bone-caves.

No. 8. [21] **Castoroides Ohioensis**, Foster.



Skull and Lower Jaw, right ramus. This species is the most gigantic member of the order of Rodents hitherto discovered, whether recent or fossil. It differs slightly in anatomical structure from the living Beaver, which is considered by some to be its degenerate descendent. The incisors are fluted, and the molars consist of a series of elongated elliptical palates of enamel which include the dentine. All the processes and fossæ of the lower jaw are remarkably developed. This magnificent relic, supposed to have belonged to an animal nearly six feet in length, and contemporaneous with the mammoth, 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.

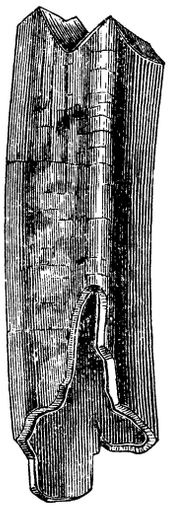
Size, 10 x 7.

Order 5 — Edentates.

The Edentates include two genera (*Myrmecophaga* and *Manis*) which are literally toothless; the rest (with one exception) have molars simply, which have no true enamel, are never displaced by a second series, and are rarely implanted in the premaxillary bones. The Order is limited in the number of species (forming only $\frac{1}{24}$th of living Mammals), but it is far from being so in the variety of its forms. In

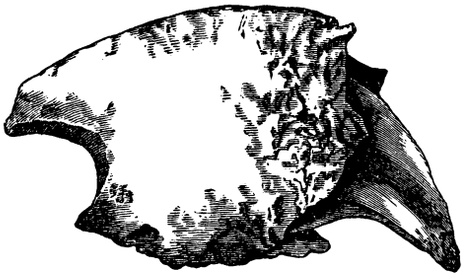
the Sloths, the zygoma is straight and trigonal; in the Armadillo and Orycterope, twisted; in the Pangolin, thin, deep, and exteriorly concave; and in the Anteater, very small. South America is now, and has always been, the natural home of this Order. The only extinct Edentate found in Europe, and at the same time the most ancient, is the gigantic Pangolin — *Macrotherium*. Edentates began with the Miocene Period and attained their maximum in the Pleistocene.

No. 9. [26] **Megatherium Cuvieri**, Desmarest.



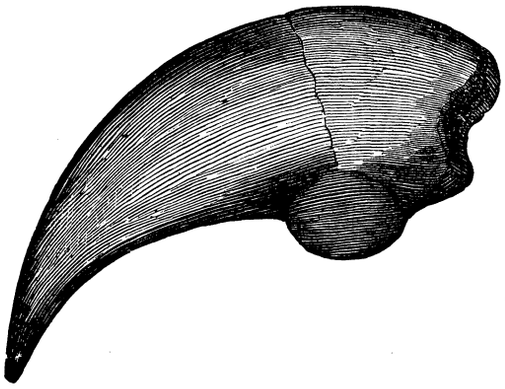
TOOTH. The gigantic fossil represented by this specimen was first made known to the scientific world in 1789. Its skeleton was discovered in the Pampean (Pleistocene) deposit, on the banks of the River Luxan, near the city of Buenos Ayres. Transmitted to Madrid, it was for more than half a century a 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 proves 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. 10. [32] **Megatherium Cuvieri**, Desm.



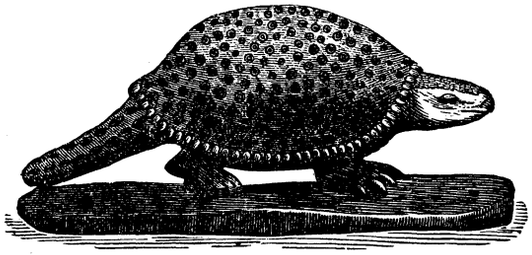
FORE-CLAW. In no other respect does the Megatherium differ more strikingly from existing quadrupeds of corresponding bulk than in the vast proportions of its fore-arms. They were furnished with prehensile feet having five toes—the 2d, 3d and 4th of which were armed with claws. This specimen, representing the last phalanx and the core of the claw, is from the same locality and Museum as the last. Size, 11 x 6.

No. 11. [35] **Megalonyx Jeffersonii,** Harlan.



TWO CLAWS. 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 Greenbriar county, West Virginia. Size, 7 x 4.

No. 12. [43] **Glyptodon clavipes,** Owen.



RESTORATION. The Glyptodon was the gigantic 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 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 tesselated bony casque. The tail possessed an independent dermal sheath or cuirass, and must have been a very formidable weapon. The bones of the leg and foot were perfectly adapted to bear the steady pressure of this enormous weight. 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 was derived from this fluting of the molars. The animal measured from snout to the end of the tail, following the curve of its back, eleven feet; the tesselated 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

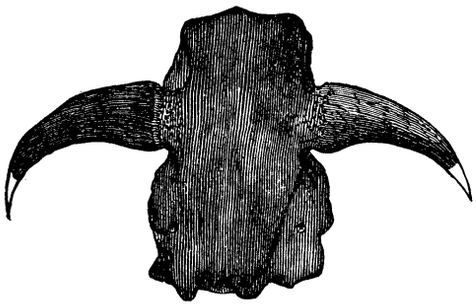
a local fauna of the highest interest, which is only faintly represented by the living Armadillos. The carapace of these Edentates probably weighed more than a thousand pounds. This cast is a restoration of the animal on a scale of about two inches to the foot. The original specimen is in the Museum of the Royal College of Surgeons in London. Size, 24 x 11.

Order 6 — Ruminants.

The Ruminants are herbivorous, even-toed, and hoofed. Excepting the Camel tribe and Musk-deer, the males, and sometimes the females, are provided with two horns attached to the os frontis. In the Deer tribe, these horns are of bone, solid and deciduous; the rest have hollow, corneous horns. The Camel only, has a pair of upper incisors; the hornless Ruminants have canines. The crowns of the molars are marked off by two double crescents, whose convexity is turned inwards in the upper and outwards in the lower.

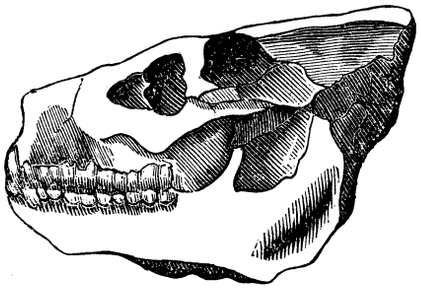
The specialized form of hoofed animal with cloven feet and ruminating stomach did not appear till the Miocene Epoch; but there existed in the Eocene certain even-toed Ungulates, *e. g. Anoplotherium*, which in several important characters (hornless foreheads, upper incisors and divided cannon bones) resembled the embryo of Ruminants, and were probably links connecting the true Ruminants with the Hippopotamus and Hog. They all disappeared during the Pliocene. Fossil species of the Camel, Camelopard, Deer and Antelope are found in the Miocene; the Bovine family first appeared along with the extinct Pachyderms of the older Pliocene; while the Sheep and Goat have been detected only in caverns and superficial deposits.

No. 13. [55] **Bootherium bombifrons**, Leidy.



Cranium with horn-cores. This ancient Bovine is closely allied to the Musk-ox, 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.

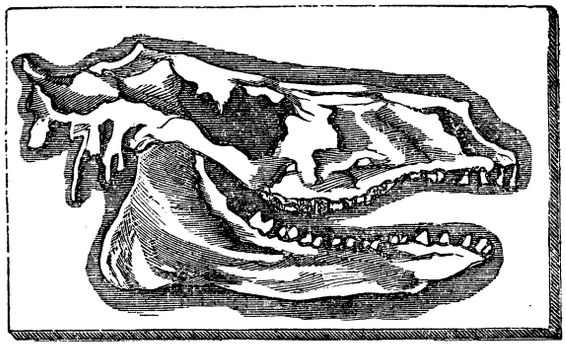
No. 14. [57] **Oreodon Culbertsonii**, Leidy.



HEAD. This remarkable 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. The molars have a ruminant character; while canines and incisors exist in both jaws and form with the molars almost unbroken rows, the dentition appears to characterize a ruminating Hog. This specimen was found in the Mauvaises Terres (Lower Miocene of Nebraska, and is in the Academy of Natural Sciences, Philadelphia.

Size, 8 x 5.

No. 17. [59] **Anoplotherium commune**, Cuvier.



HEAD ON SLAB. 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. 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 generic name (signifying *unarmed beast*) 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 7 — PACHYDERMS.

The Pachyderms are non-ruminant Herbivores. None have clavicles, nor more than forty-four teeth. All that are odd-toed behind have a third trochanter on the femur. Many of them by their size, cranial characters and life by the river and marsh, show an inter-

mediate position between the aquatic and terrestrial Mammalia. There are three groups, each tending towards some other Order. The *Proboscideans* approach the Rodents. They embrace the largest of all terrestrial creatures, and are characterized by a proboscis, tusks, the absence of canines, and a few large, transversely ridged molars. The only living species are the two Elephants, African and Indian. The total number of teeth they develop is twenty-eight; the two permanent incisors or tusks being preceded by two deciduous ones, and the number of molars (which succeed each other not vertically but from behind forwards) is finally reduced to one in each ramus. The Asiatic species most nearly approaches the Mammoth in the structure of its teeth and general proportions. The *true Pachyderms*, as the Tapir, approximate the Ruminants. They have two, three or four toes on the hind foot, and their dentition is still more various. The Hog is one of the few existing quadrupeds which retain the tpyical number and kinds of teeth, the formula being: $i\ \frac{3-3}{3-3}\ c\ \frac{1-1}{1-1}\ m\ \frac{7-7}{7-7}=44$. The *Solidungulates*, as the Horse, also approach the Ruminants. The canines are rudimentary or wanting in the females.

The Pachyderms were created at the dawn of the Tertiary Period. The earliest of elephantoid mammals was the *Mastodon*, which appeared in the Miocene. It was one of the first fossil animals by whose remains naturalists were convinced of the possibility of extinct species. But the earliest Pachyderm introduced upon our planet was a porcine beast — the *Chœropotamus*. The hoofed Herbivore, *Coryphodon*, if numbered with the Pachyderms, would dispute this honor. None of the Equine race appear to be older than the Miocene (Sewalik Hills.)

No. 16. [66] **Sus scrofa,** Meyer.

MOLAR. 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 other specimens very similar to or quite identical with the modern hog. This species was cotemporary with the Mammoth, and cannot be distinguished anatomically from the Wild Boar. The specimen shows the characteristic tuberculate surface formed by the wrinkled enamel. From a cave in Southern France.

No. 17. [77.] **Hippopotamus** ——

MOLAR. 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. The original is in the Museum at Darmstadt. 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. 18. [78.] **Hippopotamus major,** Cuv.

RIGHT TUSK. 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 H. of the present day. Size, following curve of tooth, 17 x 7.

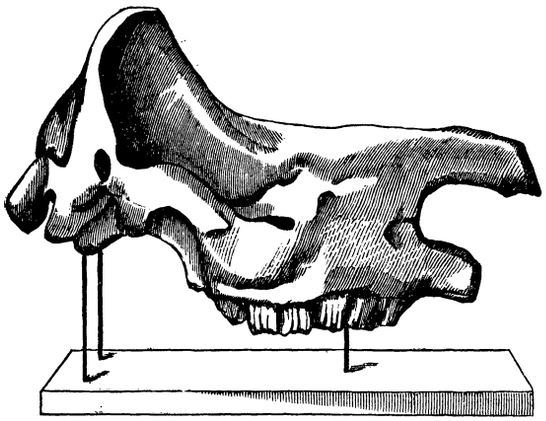
No. 19. (79.] **Hippopotamus major,** Cuv.

LEFT HIND-FOOT. From the Pliocene Tertiary beds of Auvergne. The H. major had peculiarities in its dentition which distinguished it from the modern species, and it was also nearly twice as large. This foot is quite perfect in preservation. Size, 1 ft. 9 in. x 11 in. On pedestal.

No. 20. [83.] **Hipparion elegans,** Christol.

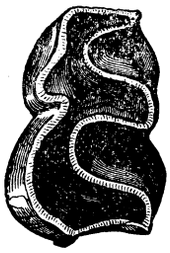
LEFT HIND-FOOT. This little equine quadruped was tridactyle; for while the two splint-bones alone are retained in the Horse, Zebra and Ass, in the H. they terminated in small digits and hoofs. Such a foot was better adapted for swampy soil, as it would not sink so deeply. The hoofs dangled behind like the spurious hoofs of the Ox. The H. was a transitional form between the Upper Eocene Palæotheres and the modern Horse, and its discovery supplied a powerful link in the 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. 21. [89.] **Rhinoceros platyrhinus**, Falc. and Caut.



SKULL. 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 Miocene deposits in the Sewalk Hills, India. This very perfectly preserved skull is now in the British Museum. Size, 30 x 18.

No. 22. [99.] **Rhinoceros Merkii**, Kaup.

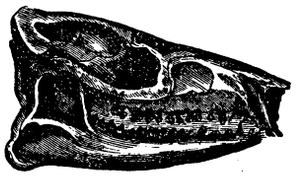


MOLAR. This specimen shows the folding of the enamel and the resultant figure of the crown-surface in molars from the lower jaw. From a lacustrine deposit (Miocene) at Steinheim, Wirtemberg. Original in Mr. Ward's private Geological Cabinet.

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

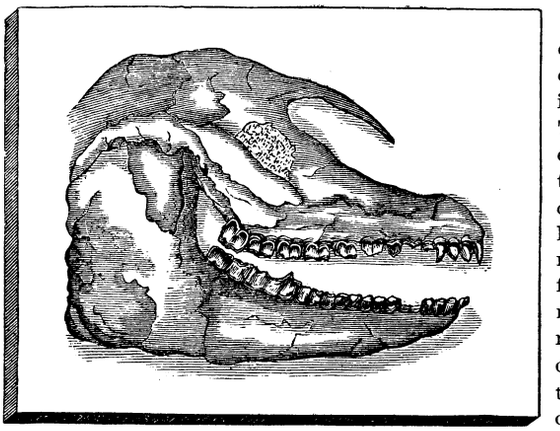
PALATE AND JAW. This extinct Pachyderm differed little from the Tapir of Sumatra. The upper jaw, when full, contains seven molars, one canine, and three incisors. This specimen was found in the Pliocene of Auvergne, Central France, and is in the Garden of Plants. Size, 9 x 12.

No. 24. [105.] **Pliolophus vulpiceps,** Owen.



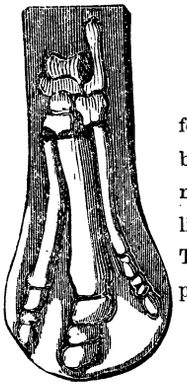
SKULL AND LOWER JAW. This odd-toed, hoofed Herbivore stood intermediate between the Tapir and Palæotherium, and has some affinities to the Hog and Horse. The dentition is like that of nearly all Eocene quadrupeds, a type not exhibited by any later or existing Mammal, namely: three incisors, one canine, four premolars, and three molars in each ramus. This interesting fossil was discovered in the London Clay (Eocene) of England, and is now in the British Museum.

No. 25. [106.] **Palæotherium crassum,** Cuv.



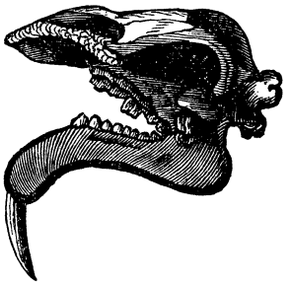
HEAD. The discovery of the P.—one of the most characteristic Mammals of the Tertiary world—formed an epoch in the history of fossils. It is one of those famous hoofed quadrupeds restored by Cuvier from their fossil remains in the quarries near Paris. The creature resembled the Tapir in the shape of the head and the possession of a short proboscis; and it frequented the banks of lakes and marshes. It had long canines, and molars resembling those of the Rhinoceros. This species is characterized by a long nasal bone and by short thick feet. The fossil head, now in the Garden of Plants, was discovered in the Eocene Gypsum of Montmartre, Paris. Size, 13 by 10.

No. 26. [111.] **Palæotherium crassum,** Cuv.



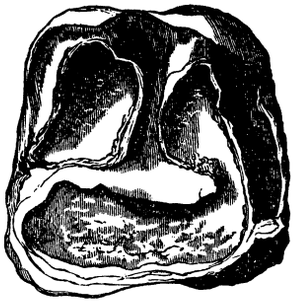
LEFT HIND-FOOT. The Palæotherium had three toes before and behind, each terminated by a hoof, the middle one being the largest. This species had short, thick feet, and may have stood about thirty inches in height. It had the limbs of the modern Tapir with one toe less on the fore-foot. This specimen is from the same locality and museum as the preceding. Size, 13 by 5.

No. 27. [112.] **Dinotherium giganteum,** Kaup.



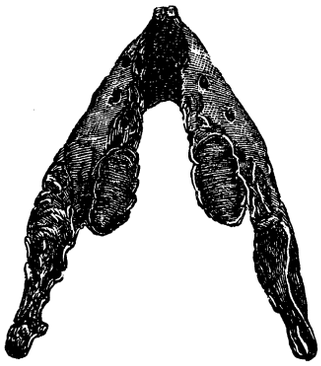
SKULL AND LOWER JAW REDUCED. This huge Pachyderm, though its teeth were discovered more than a century ago, has not yet found a resting-place in the classification of animals. Cuvier called it a gigantic Tapir; De Blainville and Pictet consider it an aquatic Herbivore, resembling the Dugong, and inhabiting the embouchures of great rivers; Kaup regards it as intermediate between the Tapir and Mastodon, and truly terres trial; while Owen says, that "in the general shape of the skull and aspect of the nostril, the D. most resembles the Manatee, but bones of the limb have been found so associated with teeth as to determine the D. to be a hoofed quadruped of probably aquatic habits, and transitional as it would seem between the large Lophiodons and the huge Proboscidians." The skull, which is characterized by a very flat occipital bone and large nasal aperture, seems to indicate the presence of a short proboscis. The enormous down-curving tusks are, in fact, two huge recurved incisors. "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 D. 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 deposits of Germany, France, Bavaria, Austria. America, and Perim Island, associated with the Hippopotamus, Horse, Ox, Antelope, Ape, Hog, Dog, Wolf, Cat, Lamantin, Mose, Sea-Calf and Dolphin—all of extinct species. The magnificent fossil, of which this is a reduced but faithful copy, was discovered by Dr. Klipstein, near Eppelsheim, Rhine Valley, in a bed of Miocene sand and marl, containing marine shells, and is now in the Museum at Darmstadt. Size, 16 by 16

No. 28. [124.] **Dinotherium giganteum,** Kaup.



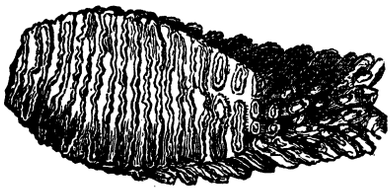
SECOND UPPER MOLAR, LEFT RAMUS.—The two incisors of lower jaw excepted, the teeth of the Dinotherium are all molars, numbering five in each ramus, and belong to the two ridged type, as in the Tapir, Megatherium, Kangaroos, and Manatee. This tooth, from the Upper Miocene at St. Jean le Vieux, France,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

No. 29. [132.] **Elephas primigenius,** Blum.



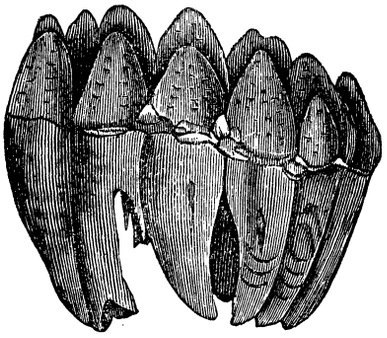
LOWER JAW, YOUNG. This is the latest form of true Elephant which lived in a temperate latitude, and is the best known of all the fossil species. These primeval Elephants, whose bones, teeth and tusks are distributed through the pleistocene accumulations of Europe, Asia and America, are specifically distinct from the living species. It was this fundamental fact which opened to Cuvier entirely new views of the theory of the earth, and determined him to consecrate the remnant of his life to palæontological science. Prior to his announcement in 1796 of their true nature, these colossal bones were supposed to belong to the antediluvian giants or to the elephants introduced by the Roman emperors. The most striking difference between these extinct Pachyderms and their modern representatives is in their size, the "Mammoth" or Russian species standing nearly a third taller than the largest African Elephant. They have also broader grinders and tusks with a greater curvature, and set in deeper sockets. This lower jaw, belonging to a young animal, was disinterred from a Pleistocene deposit at Lippe, Rhenish Prussia, and is in the University Museum at Bonn, Rhine Valley. It is a very perfect specimen, and retains the molar teeth in place. Size, 12 x 12.

No. 30. [136.] **Elephas intermedius.**



SIXTH UPPER MOLAR, LEFT RAMUS. This grinder was found in the Pleistocene on the banks of the Saône, France, and is in the Museum at Lyons. It shows well the distinctive structure of the Mammoth grinder, with its plates of enamel alternating with layers of "Cement." Size, 13 x 8.

No. 31. [155.] **Mastodon giganteus,** Cuv.



MOLAR. Mastodon remains were first discovered at Albany, N. Y., and described by Dr. Mather in the *Philosophical Transactions* for 1712. The first specimens 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 the rigors of an arctic winter. The remains occur chiefly in the United States, Europe and India. Mastodons

were the earliest of elephantoid mammals. 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.

The *M. giganteus* is the most common species in the United States. The transverse ridges of its grinders are in shape more like those of the *Dinotherium* than in any other Mastodon. The lower jaw has two tusks in the young of both sexes; these are soon shed in the female, but one of them (usually the right) is retained by the male. The upper tusks are retained in both sexes; they are elliptical, and are less obliquely curved than in the Elephant. This fine specimen was found at the celebrated locality of Big Bone Lick, Ky. (Pleistocene), and is now in the Ward Museum, 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. 32. [159.] **Mastodon longirostris,** Kaup.

LAST UPPER MOLAR, RIGHT RAMUS. This long-snouted, narrow-toothed Mastodon was the first of the great Elephants, 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.

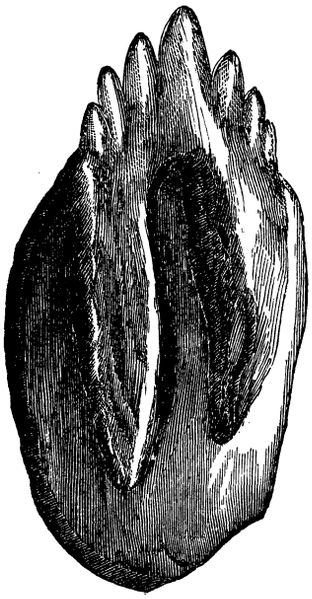
ORDER 8 — CETACEANS.

The members of this Order, formed for life in the ocean, have, in many respects, the external appearance of Fishes. They have lungs, a bald, smooth skin and a horizontal tail. By some authors they are called "Mutilates" because their hind limbs appear to have been amputated. The *Whalebone Whales* are characterized by the extremely long bones of the face, by the nasal bones forming the very highest part of the skull, by the absence of teeth in the adult, by horny plates crowning the palate, and two blowers. The *Sperm Whales* have a toothed lower jaw, smooth palate, and blowers united. The *Dolphins* have teeth in both jaws, smooth palate and united blowers. The *Manatees* (generally considered a sub-order of the Cetaceans) have

scattered hairs on the body, a whiskered muzzle, tubercular grinders and clawed limbs.

The earliest Cetacean remains discovered are three or four species from the New Jersey cretaceous, and the Upper Greensand of Ely, Eng. With these exceptions, the Order (according to our present knowledge) is confined to the Tertiary and Recent Periods. The most numerous fossil relics (teeth and ear-bones) have been found in the Red Crag, but evidently washed out of Eocene strata. In the Miocene Period, the Dugongs and Manatees were abundant and more widely distributed than now.

No. 33. [176.] **Zeuglodon cetoides**, Owen.



TWO TEETH. This carnivorous whale, once abounding in the Gulf of Mexico, typified a distinct family intermediate between Cetacea proper and Sirenia. Its teeth were first described by Scilla in 1747; in 1836 by Harlan under the name of *Basilosaurus*, or King of Lizards; 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. The jaws 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, conical, but with a more obtuse point, and with both front and hind borders deeply notched or serrated. These fossil teeth, one anterior, the other posterior, were discovered in a marl deposit of the "Jackson epoch" (Middle Eocene) in Claiborne, Alabama, and are now in the Anatomical Museum of Berlin. Size, 6 by 4.

No. 34. [179.] **Balænodon gibbosus**, Owen.

CETOLITES, two specimens. These fossil ear bones belong to a large, extinct Whale, which, probably like some cotemporary quadrupeds, retained fully developed characters which are embryonic and transitory in existing Cetaceans. They were found in the Red Crag (Pliocene) of Suffolk, England; but as they are water-worn and rolled, they were doubtless washed out of previous strata. The original specimens belong to the Ward Museum in the University of Rochester.

CLASS II.—BIRDS.

The earliest evidences of Birds are foot-prints on the tidal shore of the Liassic Sea. The fossil bones are much more rare than those of other Vertebrates, excepting, perhaps, in the favored locality of New Zealand. "The powers of flight possessed by most Birds (says Lyell) would ensure them against perishing by numerous casualties to which quadrupeds are exposed during floods." The length of time, also, during which the carcase of a Bird may float, exposes it the more to be devoured, and also to the wider dispersion of its remains. The greater part of ornithic remains yet found are those of land Birds.

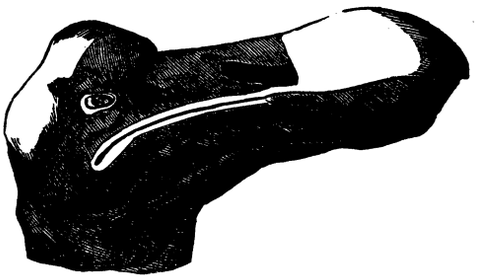
The oldest authentic ornitholites are the relics of a small Vulture (*Lithornis vulturinus*) found in the Eocene clay of the Isle of Sheppey.

Remains become more abundant as we approach the present era, especially in the Miocene strata, so richly developed in France. Indications of every Order, except the great *Cursores*, have been observed in that formation,—those of Waders being most numerous, as might be expected from their habits.

The Pliocene marls at Monte Bolca furnish impressions of feathers, and the Pleistocene clay of England has yielded a fossil humerus resembling that of the wild goose. But most of the ornitholites of the recent Tertiary are confined to bone-caverns. They belong to Birds resembling the falcon, wood-pigeon, lark, thrush and teal.

The most extraordinary additions to the palæontology of this Class have been obtained from New Zealand—an island remarkable for possessing but one indigenous land-mannal, and but a few diminutive reptiles. Colossal Birds, ranging from three to ten feet in height, akin to the Ostrich but tridactyle and tetradactyle, have left remains in the recent Alluvium.

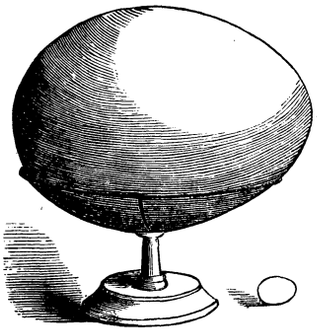
No. 35. [184.] **Didus ineptus.**



HEAD. The Dodo has been extirpated and become one of the extinct fossil forms, within the last 150 years. At the beginning of the sev enteenth 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, Ox-

ford, England, the leg of another in the British Museum, and a skull in the Royal Museum at Copenhagen. It was a monstrous aberrant form of the Pigeon family. 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 D. is the *Didunculus* of the Navigator's Islands. Size, 9 x 5.

No. 36. [186.] **Æpiornis maximus.** St. Hilaire.

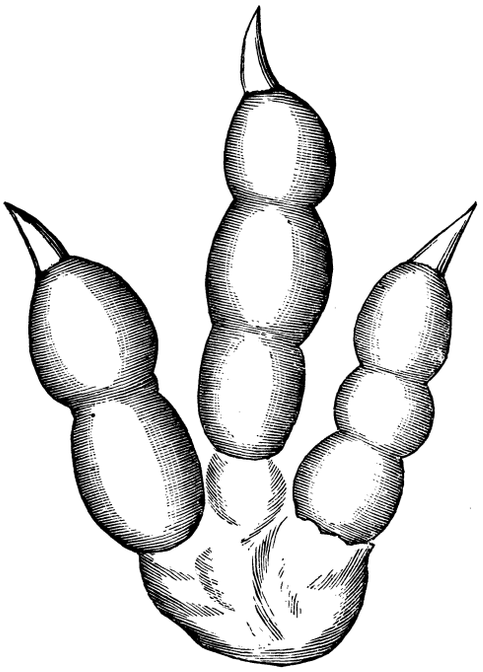


METATARSAL AND EGG. These remains indicate a three-toed, cursorial Bird, which must have stood twelve feet high. They were discovered in 1850, in Madagascar, in alluvial banks of streams, and belong to the Garden of Plants. Size of the metatarsal, 8 x 5; of the egg, 13 x 9. One of these eggs is equal to 148 hen's eggs, and will hold two gallons of water.

No. 37. [187.] **Palapteryx ingens,** Owen.

RIGHT FOOT. This gigantic struthious Bird, now extinct, was so called from its resemblance to the living *Apteryx* of New Zealand, although it is more nearly related to the *Emeu*. According to the calculations of Professor Owen, it stood nine feet high, rivalling in size the *Brontozoum* of the ancient Connnecticut Valley, whom it may have closely imitated in length of stride and size of step. It was four-toed, and well fitted for scratching and uprooting vegetable substances upon which it evidently fed. This relic of the P. was discovered in the menaccanite-sand deposit (Pleistocene) at Waingongoro, New Zealand, and is in the British Museum. Size, 21 x 16.

No. 38. [191.] **Brontozoum giganteum,** Hitch.



SINGLE TRACK, on slab. This is the largest tridactyle impression ever discovered. 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. It belonged to a bipedal animal (whether ornithic or reptilian is not yet decided) that lived by the shore of an estuary which deposited the sandstones of the Connecticut Valley. The stride was thirty-eight inches, so that the same limb carried out each step nearly seven feet. Hitchcock estimates that it was twelve feet high, and weighed from 400 to 800 lbs. If this be true, it far exceeded the Ostrich, which stands between seven and eight feet high, strides twenty-six inches, and sometimes weighs 100 lbs. This impression was discovered by Dexter Marsh in the Liassic (?) Sandstone at Northampton, Mass., and belongs to the Boston Society of Natural History. Size, 20 by 15.

CLASS III.—REPTILES.

The history of fossil Reptiles exhibits a degradation in type. The genera first created were of the most highly organized types; while the lower forms do not appear until the Tertiary Period. Reptilian life culminated during the deposition of the Wealden. The first osseous remains are those of the Carboniferous *Archegosaurus*. All the species of that Period were Amphibian. If the Labyrinthodonts (as Owen thinks) are Saurians arrested in their development on the level of the Batrachians, we then have proof that representatives of a permanent larva condition existed among the loricated Reptiles of the ancient world, in like manner as the Sirens among the recent Batrachians.

Order 1 — Saurians.

The Saurians are distinguished by an elongate, rounded body, densely covered with scales or plates; a long, tapering, usually scaly tail; four limbs (occasionally rudimentary); distinct ribs and sternum; one occipital condyle; teeth in both jaws, and a mouth not dilatable.

The *Deinosaurians* — the highest and most terrible of Reptiles — are distinguished by four well-developed, unguiculate limbs, so articulated to the body as to allow the animal to walk upright on all fours. They first appeared in the upper member of the Lower Lias, and are now extinct.

The *Enaliosaurians* were those marine, air-breathing, carnivorous Lizards that swarmed in such prodigious numbers during the Secondary epochs. In many respects they were intermediate between the Chelonia and Crocodilia; but the skin was probably naked.

The *Pterosaurians*, or "Pterodactyles," are among the strangest creatures brought to light by Geology They had the claws and teeth of a Reptile; the body and tail of a Mammal; beak, hollow bones, and keeled sternum of a Bird; and a development of the fore-limbs for wings like those of a Bat. The teeth are implanted in distinct sockets. The oldest Pterodactyles are from the Lower Lias; the largest occur in the Upper Greensand; but the best defined and most numerous specimens come from the Middle Oolite.

The *Crocodiles* are covered with a cuirass of square plates placed in longitudinal lines; the jaws are united into a solid mass; the teeth are set in sockets in a single row; the vertebræ of Cretaceous Tertiary and living species, are concavo-convex; of all others, either doubly flat, doubly concave or convexo-concave. Crocodiles have existed since the Lias Period.

The *True Lizards* have scales, lower jaws united by a suture teeth set in a groove (in certain extinct forms, in sockets), vertebræ concavo-convex. The earliest representative of the true lacertian type occurs in the Upper Oolite. But the Thecodont Reptiles, which agree in many respects with the amphicœlian Crocodiles, but combine a deinosaurian femur with lacertian teeth, and are usually reckoned among the "Lacertilia," are found as low as the Trias.

No. 39. **Iguanodon Mantelli,** Meyer.

LEFT HIND FOOT. This great Deinosaurian was discovered by Dr. Mantell in 1834. It was an oviparous, herbivorous, terrestrial quadruped, "a crocodile-lizard of the dry land." 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 Pachyderms. 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. It had large hollow limb-bones and unguiculate feet—the hind pair, at least, having only three well-developed toes. The huge tridactyle prints on Wealden strata referred by early observers to gigantic birds, have been considered to have been made by the thick-footed, three toed Iguanodon. 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, 34 x 12.

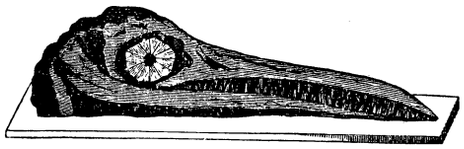
No. 40. [220] **Ichthyosaurus tenuirostris,** Conyb.

SKELETON on slab. The Ichthyosauri or "Fish-lizards" were the lords of creation during most of the Reptilian Age, and their bones now lie buried in great profusion in the liassic rocks of Europe. They are distinguished by a long head resembling that of the Dolphin, a very wide mouth armed with numerous teeth, short neck, large abdomen, polydactylous paddles and a powerful finned tail. They were probably naked like the whale, but carried a dorsal ridge like that of the Pond-Newt. When full grown, the larger species may have measured forty feet. They had a vertical caudal fin and four stout paddles, permitting them to crawl on the sea-shore.

This species is characterized by the great length and slenderness of the jaws. The cranium is flat and the orbits very large. The adult animal attained the length of fourteen feet. This complete skeleton was discovered in the Lias at Boll, Wirtemberg, and belongs to M. Defour-Walderode, of Prague.

Size, 4 ft. 4 in. x 13 in.

No. 41. [212] **Ichthyosaurus communis,** Conyb.

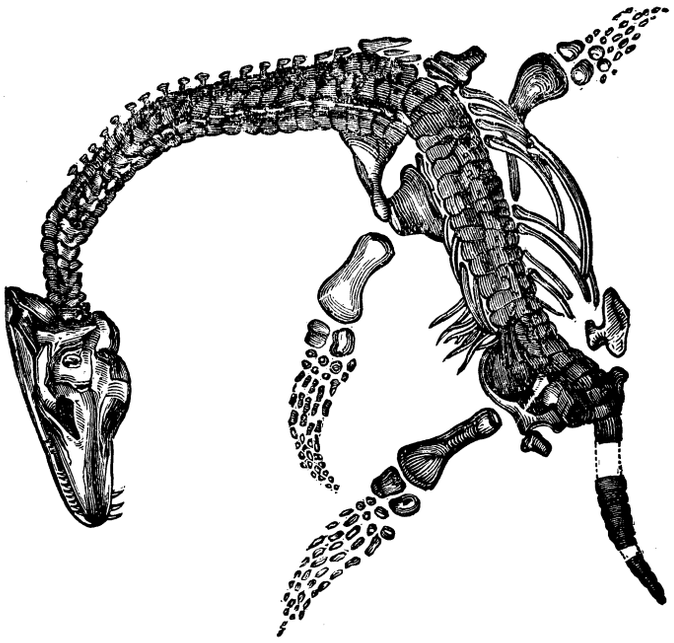


HEAD on pedestal. This species was the most "common" when first discovered in 1824, but has since been surpassed as to number of individuals, and it is second in size. This is a fine specimen, having all the bones and teeth complete and in true position, and showing well the sclerotic plates which defended the eye. Discovered in the Lias at Barrow-on-Soar, England, and now in the Cabinet of Alleghany College, Meadville, Pa. Size, 2 ft. 2 in. x 8 in.

No. 42. [214] **Ichthyosaurus communis,** Conyb.

PADDLE. The anterior paddles of this species were three times longer than the posterior, and were made up of 200 bones. This specimen is from the Lias in Boll, Wirtemberg, and belongs to the Krantz Museum, Bonn. Size, 11 x 5.

No. 43. [227] **Plesiosaurus macrocephalus,** Conyb.



SKELETON on slab. 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

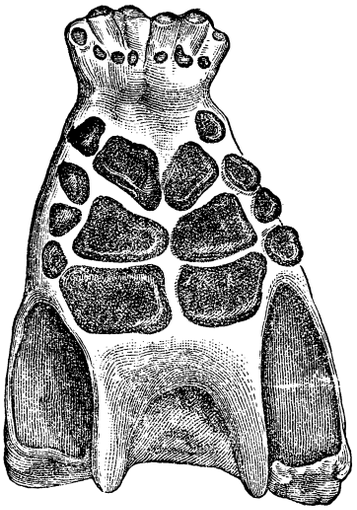
world." "To the head of a Lizard (wrote Buckland) it united the teeth of a Crocodile, a neck of enormous length, resembling the body of a Serpent, a trunk and tail having the proportions of an ordinary quadruped, the ribs of a Chameleon, and the paddles of a Whale" The neck consists of from twenty to forty vertebræ, while living Reptiles have not over nine. The Plesiosaurus differs from the Ichthyosaurus in having five toes, larger neck and paddles, and shorter tail. 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 the 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. 44. [233] **Pliosaurus grandis,** Owen.

TOOTH. 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 clay of Dorsetshire, Eng., and is now in the British Museum. Size, 12 x 3.

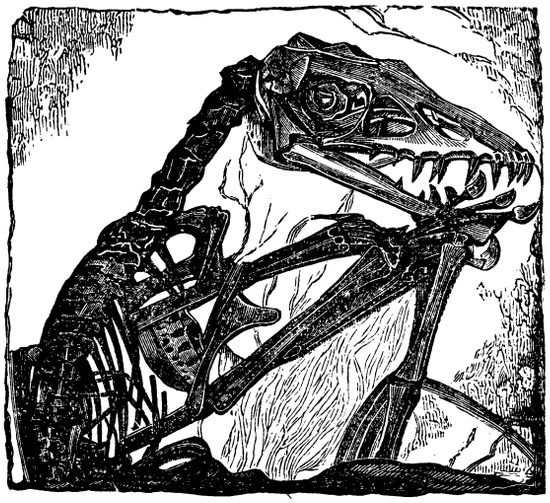
No. 45. [237] **Placodus gigas,** Agass.

SKULL. This Reptile (formerly called a Fish) was an Enaliosaurian, 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.—The teeth, which resemble paving stones, 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 much smaller; the premaxillary teeth, three in each ramus, are elongated and conical. This interesting relic was found in the Muschelkalk (Trias) at Laineck, Bavaria, and belongs to the University Museum of Munich.



Size, 7 x 5.

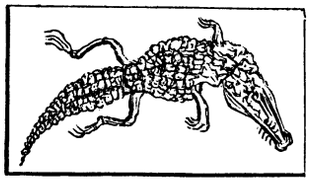
No. 46. [241] **Pterodactylus crassirostris,** Goldf.



SKELETON on slab. The Pterodactyle was one of the most extraordinary of all the creatures yet discovered in the ruins of a primeval world. 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; Sömmering, a Mammal; Spix, that it was intermediate between Monkeys and Bats; Macleay, a link between Mammals and Birds; and Agassiz thinks it a strictly marine Reptile. Cuvier, in 1800, determined the place and name it now holds.

The *P. crassirostris* is distinguished by a very large head, a comparatively short neck, a small trunk, bat-like wings and a tail. The only thing at all like it now living is the *Flying Dragon* of the East Indies. It has been estimated that some of these strange monsters, now happily extinct, had an expanse of wing surpassing that of the great Albatross; but this species did not measure over three feet from tip to tip of the wings. This specimen, which is the most perfect ever found, 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. 47. [249] **Crocodileimus robustus.**



SKELETON, on slab. 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

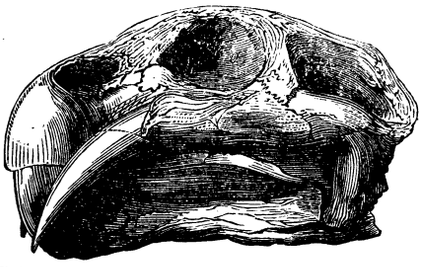
No. 48. [255] **Teleosaurus longipes,** Bronn.

SKELETON, on slab. 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, but was more strictly marine. Its name, given by St. Hilaire, has reference to his belief that it formed one extreme (the earliest) of the crocodilian series, as this series has been successively developed in the course of time on our planet. The jaws are armed with numerous long, slender, sharp-pointed, slightly curved teeth. This skeleton was found in the Upper Lias at Boll, Wirtemberg, and is in the Imperial Cabinet of Vienna. Size, 4 fet. 4 in. x 15 in.

No. 49. [270] **Saphæosaurus laticeps,** Meyer.

SKELETON, on slab. The most marked departure from the lacertian type in this Reptile is the more uniform length of the phalanges of the fore-limbs. It was a small scaly Lizard, with a long neck, short body and blunt teeth. This fossil was found in the lithographic slate at Kelheim, Bavaria, and belongs to the Tylerian Museum at Haarlem, Holland. Size, 15 x 7.

No. 50. [278] **Dicynodon lacerticeps,** Owen.



SKULL. 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. 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.

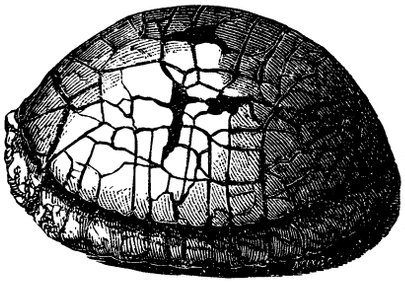
ORDER 2 — CHELONIANS.

These Reptiles, according to Agassiz, are the highest members of this Class,—approaching in some points of internal organization the lower families of aquatic Birds. The main ordinal characteristic is the solid, immovable armor encasing the greater part of the body. The dorsal shield or carapace is least complete in *marine* Turtles, and

this fact affords an important aid in the discrimination of fossil Chelonians. The sternum is broad in the land species, narrow in the marine. 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.

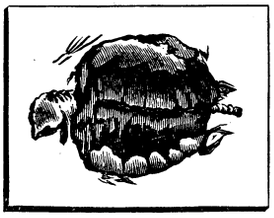
The two shields, usually in fragments, are the chief evidence of extinct Chelonians. The beaks are sometimes found solitary, in the Chalk. According to Agassiz, the first genuine Testudinata belong to the Oolitic series. The so-called Chelonian foot-prints on the Potsdam, Old Red, and Triassic Sand stones are very uncertain. The earliest species are Emydians from the Solenhofen quarries.

No. 51. [281] **Testudo hemispherica,** Leidy.



CARAPACE AND PLASTRON. This extinct land Tortoise was found in that celebrated burial-place of tertiary Mammals, the "Bad Lands" of Nebraska (Lower Miocene), and is in the Ward Museum of the University of Rochester. Size, 9 x 7.

No. 52. [286] **Chelonemys ovata.**



CARAPACE, ventral surface. 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.

ORDER 3 — OPHIDIANS.

The fossil remains of this Order, the most prolific at the present time, are vertebræ, eggs and fangs, but these are very rare. The earliest Serpent was a Constrictor, and appeared at the dawn of the Tertiary Period.

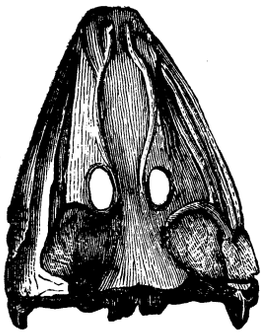
ORDER 4 — AMPHIBIANS.

Amphibians, the lowest members of the Class, are distinguished by a skull depressed at the expense of the cranium, two occipital condyles, if any, no distinct neck, ribs absent or rudimentary, and (in living species) the body naked or very rarely covered with very small embedded scales. They have no fixed type of external form. The size, shape and number of teeth vary much; sometimes the teeth are wanting. The snake-like *Cœcilians* have no legs; the tailless *Ranadæ* have four; and the tailed *Salamandridæ* two or four. All are subject to metamorphosis.

Of the Amphibious Reptiles, the scaly *Ganocephala* appeared first, the *Archegosaurus*, having been found in the Coal Measures. The *Labyrinthodonts* were introduced in the same period, but did not attain their full development till the Trias. These two extinct groups characterize the transitional period between the Palæo and Mezo-zoic epochs. They lived along with the Ganoid Fishes. The soft-skinned *Batrachians* belong to the age when most Fishes have the flexible cycloid or ctenoid scales — namely, the Tertiary and Post-Tertiary. Frogs and Salamanders have been discovered as low as the Miocene; and Toads in the Pliocene. Tailed Batrachians are now on the decline; the tailless forms are most numerous and various to day.

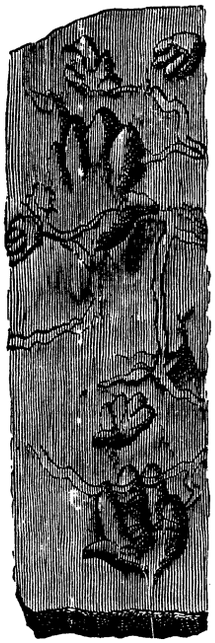
No. 53. [292] **Labyrinthodon (Mastodonsaurus) Jægeri,** Owen.

HEAD. This is the largest known Batrachian having labyrinthic teeth. The form of the animal was something between the Toad and Land-Salamander The body, estimated at nine feet in length, was covered with 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 Stuttgardt, Wirtemberg, and is in the Museum of that city.



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

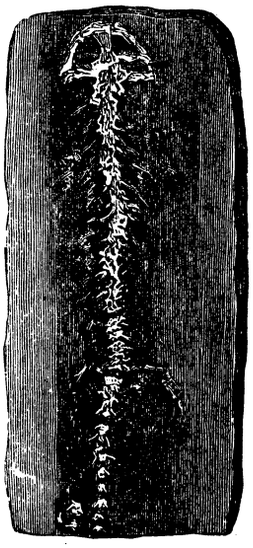
No. 54. [296] **Cheirotherium Barthi,** Kaup.



TRACK, on slab (relief). These remarkable foot-marks strikingly resemble the impression of the human hand, whence the generic title. 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. No certain remains of the the Cheirotherium have been found; but bones of *Labyrinthodon* have been found in the same locality as the footprints; and it is highly probable that the Cheirotherian tracks are those of Labyrinthodont Reptiles. The characters of the tracks, like those of the Labyrinthodon skull, suggest strongly a Batrachian of the Frog family. This specimen, discovered in the New Red Sandstone (Lower Trias) at Jena, Germany, belongs to the Ward Museum in the University of Rochester.

Size, 3 ft. 10 in. x 18 in.

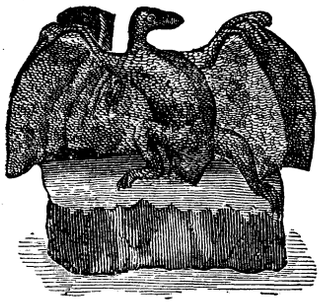
No. 55. [297] **Andrias Scheuchzeri,** Tschudi.



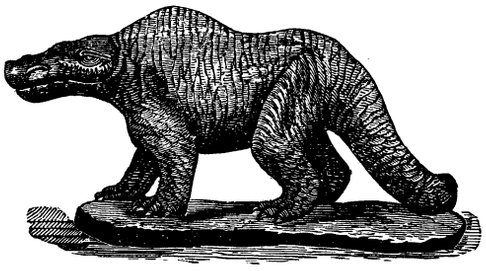
SKELETON, on slab. This noted fossil was a Batrachian of the Salamander family. It was a large specimen of this extinct animal, which was erroneously suppoed by Scheuchzer to be a human skeleton, and was described by him nearly a century and a half a ago as "*Homo diluvii testis.*" Cuvier demonstrated its near affinities to the Water-Salamander (*Menopoma*) of the United States. This specimen consists of the cranium, vertebral columns with ribs, the four extremities, and vestiges of the tail. It was obtained from the Miocene lacustrine deposits at Œningen, Switzerland, and is in the British Museum. Size, 3 ft. x 8 in.

Nos. 56–62. [302–308] **Restorations of Fossil Reptiles.**

Pterodactyle, Megalosaurus, Iguanodon, Labyrinthodon, Ichthyosaurus, Plesiosaurus dolichodeirus and *P. macrocephalus.* They are reduced (one inch to the foot) from the gigantic models in the Crystal Palace, London; constructed to

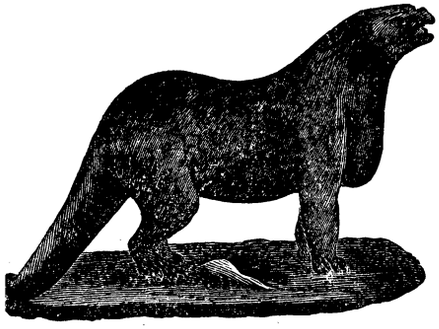


No. 56. [302] PTERODACTYLE.

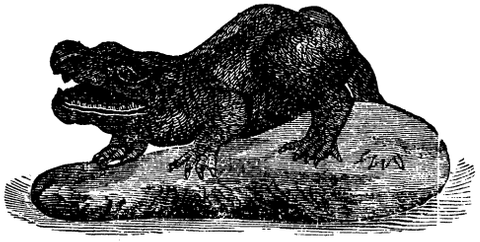


No. 57. [303] MEGALOSAURUS.

a scale by B. Waterhouse Hawkins, F. G. S., from the form and proportions of the fossil remains, and in strict accordance with the scientific deductions of

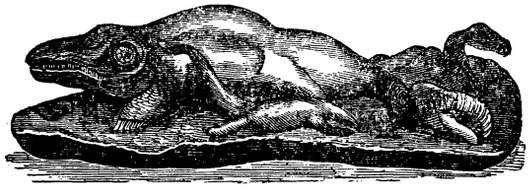


No 58. [304.[IGUANODON.



No. 59. [305] LABYRINTHODON.

Professor Owen. Preliminary drawings, with careful measurements of the originals in the Royal College of Surgeons, British Museum and Geological Society,



Nos. 60–62. [306–308] ICHTHYOSAURUS WITH PLESIOSAURI.

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.

To give an idea of these monster Saurians, Mr. Hawkins states that the Iguanodon, as it now stands in the Crystal Palace, is composed of four iron columns, 9 feet long by 7 inches in diameter, 600 bricks, 1550 tiles, 38 casks of cement, 90 casks of broken stone, with 100 feet of iron hooping and 20 feet of cubic inch bar. It was modelled after the great Horsham specimen; and the mold was afterward 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 five pieces:

ICHTHYOSAURUS WITH PLESIOSAURUS:	Size,	22 x 14.
MEGALOSAURUS: - - - - - -	"	23 x 12.
IGUANODON: - - - - - - -	"	19 x 14.
LABYRINTHODON: - - - - - -	"	13 x 8
PTERODACTYLE: - - - - . -	"	9 x 9.

CLASS IV.—FISHES.

This Class is the most heterogeneous among Vertebrates. No animals, indeed, exhibit such extraordinary aberration of form, or assume such peculiar shapes. They are every way inferior to the other members of the sub-kingdom,—falling behind in strength and compactness of structure, in intelligence and sensibility. They readily separate into the *Osseous* and *Cartilaginous*. The former include the common Fishes or *Teleosts*, and rank lower than the Cartilaginous; they are, nevertheless, the typical forms, and are the most numerous.

Over fifteen hundred fossil species have been described. Sedimentary strata, composed of fine detritus, have been most favorable for the preservation of entire forms; but in coarse limestone and conglomerate, the principal vestiges are detached teeth, scales and bones. The Fishes of the older formations differ most from existing species; the pectoral fins are smaller and invariably placed before the ventral. Above the Chalk, the ventrals approach nearer the head. The earliest evidences of a fossil vertebrate are the dorsal spine of a Shark and a buckler like that of a *Placoganoid*, both found in the Upper Ludlow by Murchison. We may infer the co-existence of some more powerful predatory Fish against whose attacks these primitive sharks were

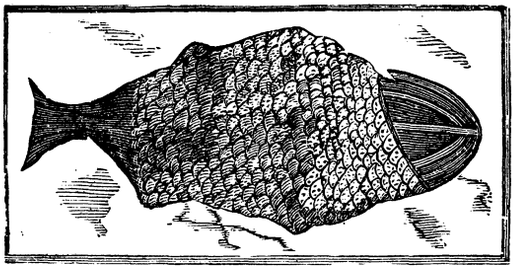
thus defended. According to Dana, the earliest fish remains in America occur in the Schoharie grit. As the Cartilaginous Fishes dwindled, the Teleosts took their place. They began in the Cretaceous, but abounded most in the Tertiary deposits. The "*Scomberoids*" (the Mackerel tribe), observes Owen, "seem now to be at the head of the piscine modification of the Vertebrate series."

Order 1 — Ganoids.

The Ganoids, represented now by the Sturgeon, Gar Pike and others, have a skeleton, cartilaginous or ossified, rhomboidal or angular scales, and labyrinthoid teeth. No living Ganoid has been observed in the Southern Hemisphere.

Of fossil Ganoids, 80 are found in the Devonian, 61 in the Carboniferous, 22 in the Magnesian Limestone, 23 in the Trias, 100 in the Lias, 154 in the Oolite, 36 in the Chalk, and 29 in the Tertiary. After the Triassic Period, they lost the Palæozoic feature of heterocercal tails; the Oolitic species were homocercal, but in the Sturgeons of the Tertiary and Modern times, the heterocercal form returned.

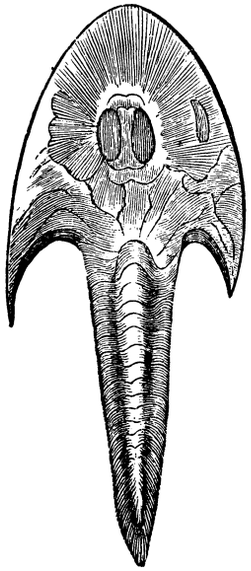
No. 63. [309.] **Holoptychius nobilissimus,** Agass.



Body and Head, on slab. The Holoptychians were Ganoid fishes, characterized by the large, deeply corrugated scales covering the body, and the sculptured and granulated plates defending the head. 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, who has written so graphically of this ancient fish) 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."

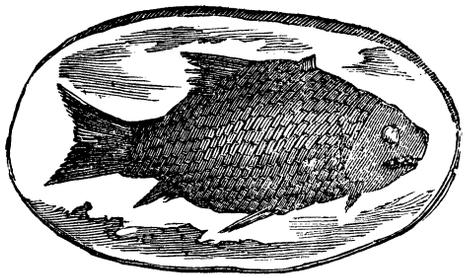
Size, 2 ft. 9 in. x 4 in.

No. 64. [313.] **Cephalaspis Lyelli,** Agass



BODY AND HEAD, on slab. This famous Devonian Fish is placed by Agassiz, Owen, and Pictet among the Placoganoids; but Huxley says it is uncertain whether the C. was a Ganoid or Teleost. 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.

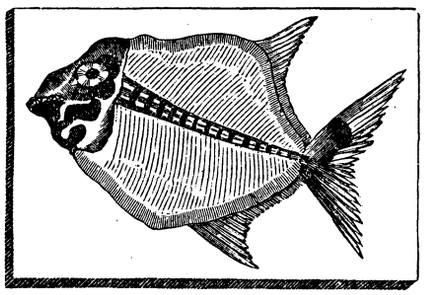
No. 65. [317.] **Lepidotus minor,** Agass.



BODY AND HEAD, on slab. This fine specimen of a homocercal lepidoid — 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 British Museum.

Size, 17 x 10.

No. 66. [320.] **Microdon (Pycnodus) elegans,** Agass.



SKELETON, on slab. 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. 67. [328.] **Megalurus lepidotus,** Agass.

SKELETON, on slab, This genus of homocercal Ganoids is distinguished by a large head with jaws armed with large and small teeth intermingled, and by a large, round tail. The scales resemble those of the Carp. This complete skeleton was found in the Lithographic slate (Upper Oolite) of Solenhofen, Bavaria, and is in the Museum of the University of Munich. Size, 17 x 8.

OREER 2.—PLACOIDS.

The Placoids (or *Selachians* as they are now more generally termed) have a purely cartilaginous skeleton and a rough skin, often composed of rhombic or angular plates, each rising into a point at the centre.

The Placoids, being Cartilaginous, have left little behind save spines, teeth, and a few scales. The fossil spines are called *Ichthyodorolites*, and abound in the Secondary deposits. Agassiz enumerates in his "*Poissons fossiles*" about 70 species. The *Squalodonts*, or True Sharks, began in the Jurassic and culminated in the Miocene.

No. 68. [333.] **Carcharodon.**

TWO TEETH. These teeth of a fossil Shark were found in the Miocene of the Isle of Malta, and belong to the Ward Museum in the University of Rochester.

No. 69. [345.] **Ichthyodorulite.**

FOSSIL DORSAL SPINE, on slab. From the Lias of Lyme-Regis, Eng., and now in the Ward Museum of the University of Rochester.

No. 70. [1201.] **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 fæcal remains to be composed chiefly of phosphate of lime. This coprolite was found in the Lower Chalk, Kent, England.

SECOND SUB-KINGDOM.

ARTICULATES.

The Articulates—incomparably the most numerous division of the Animal Kingdom—include all the Invertebrates having jointed bodies. Their Palæontological history 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 a former world. Their manifold, complex 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 catalogued forms but a small proportion of those which have probably existed. Bronn enumerates 1551 fossil Insects, 131 Arachnoids, 894 Crustaceans, and 292 Annelids. 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 I.—CRUSTACEANS.

In this class the skeleton has the form of an external crust or shell, which covers even the antennæ, hairs, jaws and teeth. The normal number of segments is 21, for the head, thorax, and abdomen, seven each. But most frequently the anterior segments form one piece called the cephalothorax, leaving the abdomen joined, terminated

by a compound tail-piece, *pygidium.* All Crustaceans are organized for life in the water, though many live chiefly on land. The earliest forms were trilobites. In general we may say that the Palæozoic Trilobites are followed by Lobsters in the Jurassic Period, and by Crabs in the Tertiary. The Upper Oolite of Solenhofen opens like a book filled with compressed and wonderfully preserved Shrimps and Lobsters, while the London Clay of the Isle of Sheppey is a rich repository of short-tailed Crustaceans. The Articulates which came latest are the *Barnacles.*

No. 71. [354.] **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 Eichstadt, Bavaria. Size, 6 x 5.

No. 72. [358.] **Pemphix Sueurii,** 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 (Macroura) that the Decapod Crustaceans were at first represented in the Geological series. The specimen is from the Muschelkalk (Middle Trias), Crailsheim, Wirtemberg. Original in the Ward Museum of the University of Rochester. Size, 6 x 3.

No. 73. [365.] **Limulus Walchii,** Desm.

This ancient "King-Crab," like those of the present day, was covered by a cephalothorax shield; 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 which are now worked at Eichstadt, Bavaria. The original of this fine slab, which shows both impression and relief of the specimen, is now in the private Geological Cabinet of Mr. Ward, Rochester. Size, 10 x 6.

No. 74. [367.] **Eurypterus lacustris,** Harlan.

The genus Eurypterus was established by De Kay 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. 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), Williamsville, Erie Co., New York. Size, 9 x 9.

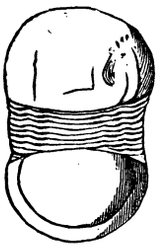
Trilobites.

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 do not belong to any modern group. For more than a century after these curious fossils were first noticed, they were objects of wonder, and by the early naturalists were referred to fishes, molluscs and insects, before their real character was discovered. The common type is an oblong body divided transversely into three principal parts—the head, covered by a "buckler," the thorax, and the "pygidium" or abdominal shield, and longitudinally into three lobes by two parallel furrows. No antennæ have been detected, nor any feet (save in one specimen of *Calymene*): the latter are supposed to have been rudimentary or membranous. They probably lived gregariously in the shallow waters of bays and coasts, swimming on their backs; and from the form of the mouth, it is inferred that they were carnivorous. More than 400 species of Trilobites are known, grouped in about 50 genera.

No. 75. [382.] **Asaphus tyrannus,** Murchison.

This species, one of the largest known, is peculiarly British, and is even restricted to Wales and the border counties. It is readily distinguished from the *A. gigas* by its more expanded form and strongly furrowed pygidium. The tail is longer and more convex than the head. It is the most highly ornamented of the *Asaphidæ*. This specimen (with parts of the cephalic and caudal shields restored) was found in the Llandeilo Flags (Lower Silurian), at Bishop's Castle, Wales. Size, 10 x 6.

No. 76. [390.] **Bumastus (Illænus) Barriensis,** Murch.

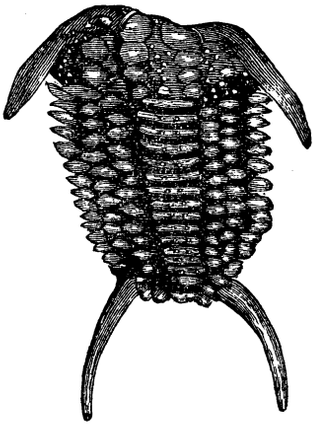


This genus of Trilobites is characterized by the great breadth and convexity of the cephalic and caudal plates, and the faintness of the longitudinal, trilobate markings. The genus closely resembles Illænus, and this species is only distinguished from *I. crassicauda* by the fact that the broad axis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

No. 77. [394.] **Calymene Blumenbachii,** Brongniart.

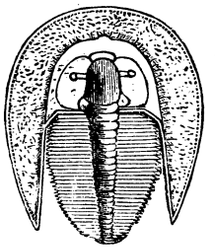
This well known genus derives its name from the obscurity which long hung over the real nature of these crustaceans. In this species, the cephalic shield is large, convex, rounded in front with a well-marked border, boldly three-lobed, and having prominent, but not very large eyes, set widely apart; 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 Museum in the University of Rochester.

No. 78. [398.] **Ceraurus pleurexanthemus,** Green.



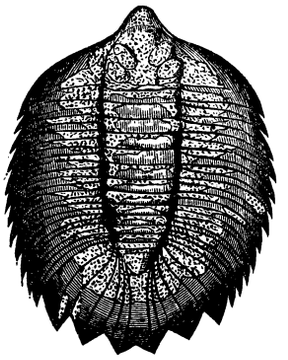
This genus is closely allied to the *Acidaspis* of Murchison. In this species the buckler is crescent form; the eyes small, distinct, and granulated; the glabella deeply furrowed on each side; the thorax has eleven articulations, and the caudal shield four. This specimen is a restoration by adjustment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

No. 79. [421.] **Harpes ungula,** Barr.



HEAD. From the Upper Silurian limestone at Kronieprus, Bohemia. In this genus the head, which occupies more than a third the 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 Museum in the University of Rochester.

No. 80. [428.] **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. 81. [437.] **Paradoxides Bohemicus,** Bock.

Two specimens. This genus is distinguished by a broad club-shaped glabella, large head-spines, oblong eyes, from 16 to 20 flat body-rings, and a very small gypidium. 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.

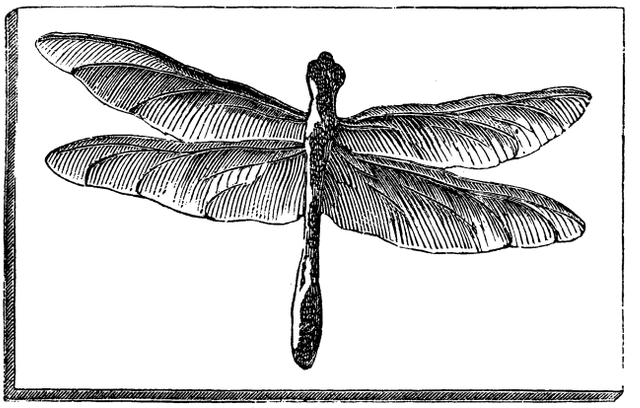
CLASS II.—INSECTS.

Insects are the most prolific of animals, and are essentially terrestrial or ærial. They are divided into *Arachnidans* or Spiders, *Insects proper*, and *Myriapods*.

The class is represented in the Palæozoic age. Of Arachnidans, the earliest is the fossil Scorpion from the Bohemian Coal-Measures. Spiders are found in the Solenhofen-slates and in the Tertiary gypseous marls of Aix. The Carboniferous forests were not uncheered by the hum of Insects; for in the Lower Coal Measures are discovered

fossils resembling the living Locust and Curculio. The *Blattina venusta* from Arkansas is the only Carboniferous Insect found in America, excepting perhaps the articulated fragments found by Dawson in the trunk of a Sigillaria. The principal European sources of fossil Insects are the slates of Solenhofen, the Tertiary deposits of Aix and Œningen, and the masses of amber from the northern coast of Prussia. About 100 Tertiary species of Ants are known; and these are either male or female; neuters are rare. Bees and Wasps are comparatively few.

No. 82. [451.] **Æschna 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 *Æschna*, 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 the state of repose. In this specimen, the wings, both pairs of which are finely preserved, spread six inches. The original is in the private Geological Cabinet of Mr. Ward. This insect was, in all likelihood, blown out to sea, and, sinking to the bottom, was there imbedded in the very fine mud, which alone could have so perfectly preserved its fine, delicate markings and the contour of its tender, perishable body. Size, 7 x 5.

THIRD SUB-KINGDOM.

MOLLUSCS.

This sub-kingdom ranks side by side with the preceding. The highest Molluscs are superior to the highest Articulates; while in both, the lowest are inferior to many Radiates. 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 appropriate 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. As a general rule, the land Molluscs are biennial; the aquatic species, annual.

Three-fourths of living species of Molluscs are univalves; the others are mostly bivalves. The bivalves are all aquatic. With rare exceptions, land, fresh water and littoral univalves have entire mouths and are vegetarians; while in marine shells, the mouth is interrupted by a notch or prolonged into a canal, and the animal is carnivorous.

Great changes have occurred in this sub-kingdom since its creation. The *Ammonites*, *Belemnites* and *Orthoceratites*, once so numerous, have become utterly extinct, and the *Nautili* have nearly past away. Bivalves have superseded the old fashioned Brachiopods, and Univalves vastly outnumber Cephalopods.

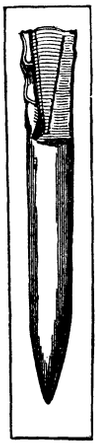
The remains of shell-bearing Molluscs are the most common of all fossils, and afford the most complete series of "medals" for the identification of strata. The sub-kingdom started an unfolded type. All its grand divisions, even to the highest, are represented in the lowest rocks. Both the highest and lowest groups were most abundant in the Palæozoic age; the ordinary bivalves and univalves attain their climax in existing seas. Fossil shells number about three-fourths of living species—15,000; of these 500 are land, 800 fresh-water, and over 13,000 marines. They passed their culmination in

the latter half of the Mesozoic age; but the largest number of species occur in the Miocene. The average duration of the marine species is one-third the length of a geological period. The life of land and fresh-water shells is of longer average extent. Tertiary fresh-water shells are Old World forms; while Tertiary land-shells are American in character.

CLASS I.—CEPHALOPODS.

The Cephalopods are the most highly organized of Molluscs. They 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. Unlike most other Molluscs, they are symmetrical; and the shell is usually straight or coiled in a vertical plane, instead of being spiral as in the unsymmetrical Gastropods. The Nautilus and Argonaut alone of living tribes have external shells; the rest are naked.

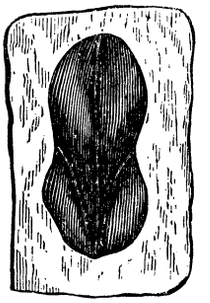
No. 83. [456.] **Belemnites Owenii,** Pratt.



GUARD. Among the innumerable relics of an earlier world, few fossils have excited more curiosity and given rise to so many fruitless conjectures as to their nature and origin as *Belemnites*, generally known in England as "thunderbolts." They are long, cylindrical, calcareous stones of a radiated structure, pointed at one end, and having at the other a cavity occupied by a chambered shell resembling a pile of watch-glasses. The exterior has usually a longitudinal groove. Besides these fossil parts, which were the osselets or guards of ancient Cephalopods allied to the Squid, there have been found remains of the ink-bag, pen, mantle, pens, mandibles, arms, and hooks. This specimen, now in the Ward Museum of the University of Rochester, is from the Oxford Clay (Upper Oolite) at Christian Malford, England.

Size, 6 by 2.

No. 84. [463.] **Beloteuthis subcostata,** Munst.



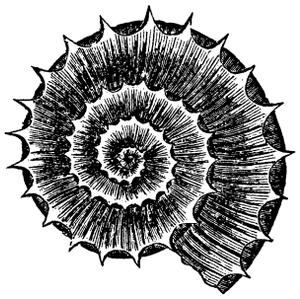
This flattened Calamary receives its generic name from its supposed affinity to the living Squid. The osselet or rudimental shell, represented in this specimen, is broad and rounded at each end, and in its form approaches nearly to the osselet of the living Sepia of the Mediterranean. It was found in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

Size, 6 x 3.

Ammonites.

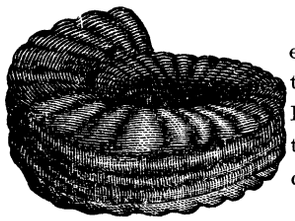
This is the most remarkable family of Secondary Molluscs. Some twenty or more genera, and nearly 1000 species, have been identified. They range from the Devonian to the Chalk inclusive, becoming totally extinct at the close of the Reptilian Period. They inhabited involute shells, having undulating septa, lobed and foliated sutures, a dorsal siphuncle (ventral as regards the animal), and a small nucleus, the whorl being compact from the first. The pattern is constant in each species. The shells are most beautiful when of middle growth, the ornamental characters being less developed in the young and lost in the adult. According to D'Orbigny, the compressed specimens are males, and the inflated, females. Their fossil beaks (Rhyncholites) are claimed to have been lately discovered. The shell of the Ammonite 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 comparatively rare in America, but abound in Europe, and they have been seen in Oolitic deposits on the Himalayas, 16,200 feet above the sea.

No. 85. [467.] **Ammonites armatus,** Sowerby.



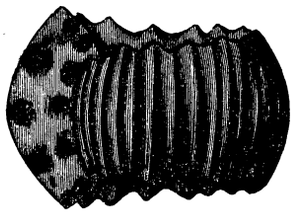
This species is typical of Von Buch's Group *"Armati."* From the Lower Lias, Charmouth, England, and now in the private Geological Cabinet of Mr. Ward, Rochester.

No, 86. [473.] **Ammonites bisulcatus,** Brug.



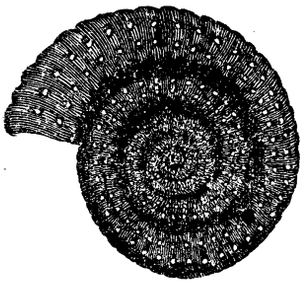
This Ammonite is frequently known by Sowerby's name of *A. Bucklandi.* It is the type of the group, *"Arietes"* of Von Buch. From the Lower Lias, Rautenberg, Brunswick, and now in the private Geological Cabinet of Mr. Ward, Rochester. Diameter, 13.

No. 87. [475.] **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 Museum, University of Rochester. Diameter, 7.

No. 88. [476.] **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 Museum, University of Rochester.

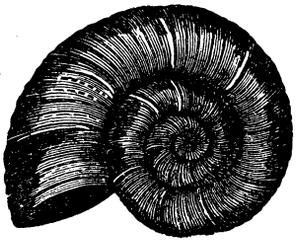
Diameter, 8.

No. 89. [484.] **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 Museum, University of Rochester.

Diameter, 7.

No. 90. [490.] **Ammonites fimbriatus,** Sow.

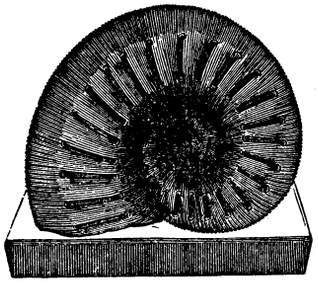


This species is characteristic of the group "*Fimbriati.*" The specimen shows the ornamental characters of the external shell. The lines of periodical enlargement or growth are very marked on this shell. From the Middle Lias, Charmouth, England, and now in the private Geological Cabinet of Mr. Ward, Rochester.

No. 91. [495.] **Ammonites Goliathus,** D'Orb.

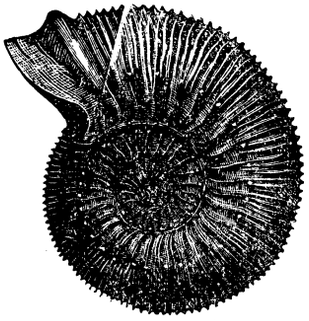
On pedestal. This specimen, an inner cast of a species allied to the *A. modiolaris,* shows well the outer markings of the lobes, and the floor of one of the septa. The original, from the Middle Oolite of Dives, France, is in the private Geological Cabinet of Mr. Ward, Rochester.

No. 92. [497.] **Ammonites Henlcyi,** Sow.



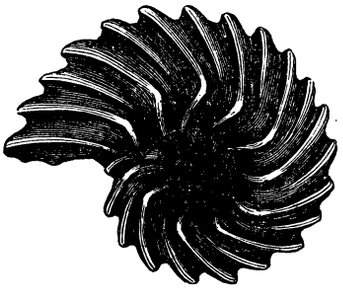
Pictet refers this to the group "*Macrocephali.*" This is one of the most symmetrically ornate of Ammonites. From the Middle Lias, Charmouth, England, and now in the Ward Museum, University of Rochester. Diameter, 6.

No. 93. [501.] **Ammonites Humphriesianus,** Sow.



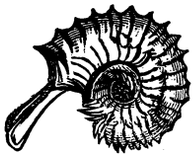
This species belongs to the group "*Coronati.*" It is one of the few Ammonites which have preserved the full contour of the front aperture or "mouth" of the shell. From the Lower Oolite, Yeovil, England, and now in the private Geological Cabinet of Mr. Ward, Rochester. Diameter, 9.

No. 94. [503] **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. Benettianus,* Sow., *A. serratus,* Sow., etc. From the Lower Cretaceous, St. Florentin, France, and now in the Ward Museum, University of Rochester.

No. 95. [505] **Ammonites Jason,** Reinecke.



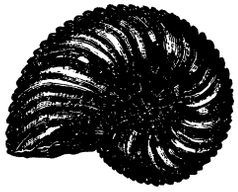
This beautiful species belongs to the group "*Ornati*" of Von Buch. The specimens from the Oxford Clay of Christian Malford, England, where this was found, are compressed in the marl, but show well two lateral shelly processes developed on each side of the aperture. This feature is found in the young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

No. 96. [511] **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, Wiltshire, England, and now in the private Geological Cabinet of Mr. Ward, Rochester.

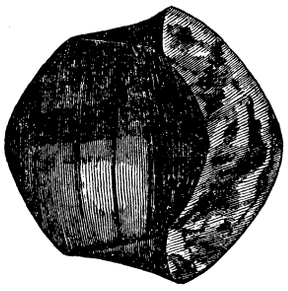
Diameter, 7.

No. 97. [515] **Ammonites magaritatus,** 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, and now in the private Geological Cabinet of Mr. Ward, Rochester. Diameter, 7.

No. 98. [519] **Ammonites modiolaris,** Luid.

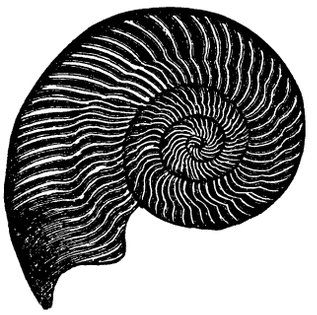


Also known as *A. sublævis,* Sow. This is one of the most inflated, yet deeply umbilicated, of all Ammonite forms. From the Kelloway Rock, Wiltshire, England, and now in the Ward Museum, University of Rochester.

No. 99. [525] **Ammonites planicostatus,** Sow.

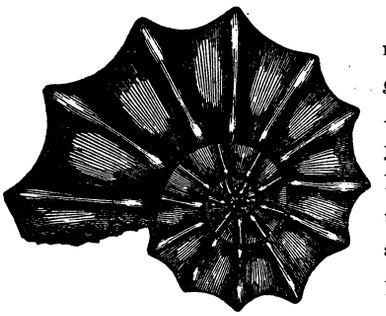
This small form would appear to belong to the group "*Capricorni,*" but as it increases in age, it assumes a single row of spines, in some instances very largely developed, and thus puts on the character of the group "*Armati,*" and becomes the *A. Dudressieri,* D'Orb. This sperimen is a slab covered with numerous shells, and is from the Lower Lias, Dorset. It is now in the private Geological Cabinet of Mr. Ward, Rochester. Diameter, 12.

No. 100. [531] **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, and now in the private Geological Cabinet of Mr. Ward, Rochester. Diameter, 7.

No. 101. [536] **Ammonites Woollgari,** Mant.



This species is one of the most marked forms in the group "*Rhotomagenses.*" It has much resemblance to *A. Rhotomagenses,* 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. Diameter, 9.

No. 102. [539] **Ancyloceras Andouli** Astier.

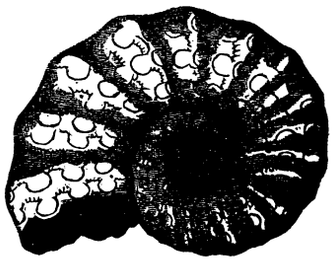
The Ancyloceras was like an Ammonite partly unrolled, having inner whorls not touching, and the outer one produced at a tangent and bent back again. From the Lower Greensand, Cheiron, France. Size, 13 x 6.

No. 103. [546] **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 Museum of the University of Rochester.

Size, 19 x 3.

No. 104. [547] **Ceratites nodosus,** De Haan.



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), Luneville, France, and now in the Ward Museum, University of Rochester.

Size, 7 x 5.

No. 105. [552] **Crioceras Duvalii,** Lêveillê.

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), Escragnolles, France, and now in the private Geological Cabinet of Mr .Ward, Rochester. Size, 11 x 8.

No. 106. [554] **Goniatites Ixion,** Hall.

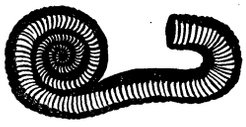
From the Lower Carboniferous, Rockford, Indiana, where it is a very characteristic fossil. The original of this fine, well-marked specimen is in the Ward Museum in the University of Rochester.

No. 107. [558] **Hamites (Hamulina) cinctus,** D'Orb.

From the Upper Neocomian (Cretaceous) Barrême, Basses Alpes, France, and now in the private Geological Cabinet of Mr. Ward, Rochester.

Size, 14 v 4.

No. 108. [563] **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. 109. [567] **Turrilites costatus,** Lamarck.

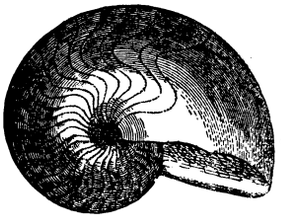
The eccentric, spiral coiling of the shell in this genus is a feature peculiar to it among all the many and varied cephalopod forms, and gives it in external appearance not a little the look of a Gasteropod. From the Chalk Marl, Lower Cretaceous, Rouen, France, and now in the Ward Museum in the University of Rochester. Size, 6 x 3.

Nautili.

This family includes those chambered-shells having simple, concave septa, smooth sutures, and an internal, simple siphuncle.

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 Pompilius* is one of the few representatives in the existing seas of that vast assemblage of chambered siphoniferous shells, which swarmed in the Secondary and Palæozoic oceans.

No. 110. [574] **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 Museum, University of Rochester. Size, 6 x 5.

No. 111. [580] **Lituites 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. From the Black River limestone (Lower Silurian), Middleville, N. Y.

Orthoceratidæ.

These Cephalopods were the princes of Molluscs in the Palæozoic times, being more abundant and attaining a larger size than any other fossil shell. They resemble in general uncoiled *Nautili*, 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 compactly coiled as in the *Nautili;* and the animal was probably unable to withdraw itself into the shell — the body-chamber being relatively smaller than that of the *Nautili.* The shell, however, was essentially external.

No. 112. [585] **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 Museum, University of Rochester. Size, 9 x 4.

No. 113. [592] **Gomphoceras inflatum,** Quenst.

This genus is characterized 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 Museum of the University of Rochester.

No. 114. [598] **Cyrtoceras macrostomum,** Hall.

The Cyrtocerus differs from the subsequent genus (Gyroceras) only in the direction of its shell, which is simply arched or bowed like a horn, and never rolls up in a spiral. This specimen is from the Trenton limestone (Lower Silurian), Mineral Point, Wisconsin.

No. 115. [602] **Gyroceras trivolvis,** Hall.

This shell is nautiloid; whorls separate, and the siphuncle eccentric and radiated. From the Upper Helderberg (Devonian) of Schoharie Co., N. Y.

Diameter, 6.

CLASS II.—GASTEROPODS.

These "belly-footed" Molluscs are the types of the Sub-kingdom. They make less approach to the Fishes than the Cephalopods, and less to the Crustaceans and Zoöphytes than Bivalves. The characteristic mode of locomotion is exemplified by the common Snail, which crawls by the alternate expansion and contraction of its foot. Gasteropods are terrestrial or aquatic; bisexual or hermaphrodite; oviparous or ovo-viviparous.

The Class is divided into four Orders, distinguished chiefly by the form and position of the lungs. The living species have world-wide range, inhabiting the bottom and surface of the sea, sea shore, fresh water and dry land; 8,000 are vegetable-feeders; 5,000, animal-feeders. The fossil species number over 9,000. They are found in every fossiliferous rock, except the "Lingula flags." Those which appear in the Palæozoic strata have entire mouths; the siphonated species are not found lower than the Lias, and they go on increasing in number in and from the Tertiary series to actual sea shores. The remains of Gasteropods are highly important to the Geologist, as they afford him unequivocal evidence of the terrestrial, fluviatile, lacustrine or marine condition under which strata were formed.

No. 116. [608] **Rostellaria carinata,** Mant.

This genus, nearly twenty times more abundant in former geological times than in our own, was represented during the Cretaceous period by some very extreme forms, of which the present specimen is one. From the Gault, Folkstone, England, and now in the private Geological Cabinet of Mr. Ward, Rochester.

No. 117. [619] **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. This magnificent specimen—the largest of all fossil Gasteropods—is from the Eocene Tertiary at Damery, France, and now in the private Geological Cabinet of Mr. Ward, Rochester. Size, 13 x 4.

CLASS III.—PTEROPODS.

These small Cephalous Molluscs are so called 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. 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.

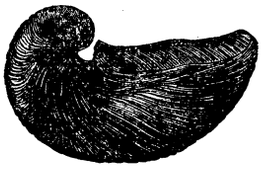
There are 32 fossil species,—all from the Tertiary, excepting the gigantic *Theca*, and *Conularia*, which are Silurian.

CLASS IV.—LAMELLIBRANCHS.

These ordinary, leaf-gilled bivalves are generally free and locomotive; a few, as the Oyster, are fixed. They are mostly equivalve, and always unequilateral. Each valve is a cone,—of every grade from a flat plate to a spiral; and the valves are articulated by teeth and a ligament, and also attached to each other by one or two muscles. The animal lives by filtering water through its gills, which are distinct from the mantle. Nearly all have a muscular foot developed from the ventral surface. The *Veneridæ* are the typical and most highly organized Lamellibranchs.

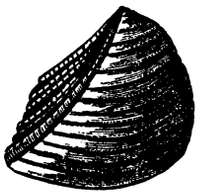
These bivalves, though less numerous now specifically, are far more abundant, individually, than the Gasteropods. They are all marine, excepting a few widely dispersed fresh-water genera (10 out of 90), and are found on every coast and in every climate, and from low water to the depth of 200 fathoms. The fossil forms constitute a third part of fossil shells.

No. 118. [650]• **Gryphea arcuata,** Lam.



From the Lias, Semur, France, and now in the Ward Museum, University of Rochester. Two specimens.

No. 119. [679] **Trigonia costata,** Park.



This belongs to the *Trigoniadæ,* the shell of which is equivalve and trigonal, with the umbones directed posteriorly. From the Lower Oolite, Œschingen, Wirtemberg, and now in the Ward Museum, Universy of Rochester.

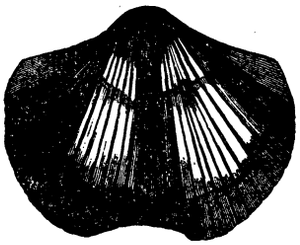
CLASS V.—BRACHIOPODS.

These headless Molluscs are enclosed in bivalved shells, which are symmetrical in form, and equal on either side of a vertical line let fall from the beak, while the valves are almost always unequal. 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, in most, a pedicle or byssus passes to attach the animal to some foreign body, for Brachiopods are deprived of the power of locomotion. The one or two accessory pieces occupying a triangnlar 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 shell structure is so peculiar that a Brachiopod may be determined by the smallest fragment; it consists of flattened prisms arranged parallel to each other with great regularity. The animal has usually two long spiral prehensile arms developed from the sides of the mouth, and respires solely by the mantle. Brachiopods, of all the Molluscs, enjoy the greatest range in climate, depth and time. They mostly

inhabit the deep sea; so that only 75 living speeies are known. They are among the oldest of existing forms of animal life. Over 1,200 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 developments) in the Devonian age, and minimum in the Upper Oolite. They are the most numerous fossils of the Silurian deposits. The hingeless genera (as *Lingula*) are most highly developed in the Palæozoic age. Of the articulated genera, those having spiral arms appeared first; those with calcareous spires disappeared with the Lias period. Of the 77 Lower Silurian New York species, 51 are restricted to the Trenton Limestone. Brachiopods furnish the most numerous instances of recurrence, owing to their tenacity of life.

No. 120. [690] **Spirifer pinguis,** Sow.

This Brachiopod belongs to the *Spiriferidæ*, a family characterized by the possession of internal calcareous spires (the mineralization of their coiled arms) extending from the center of the shell outwards. From the Carboniferous limestone of Kildare, near Dublin, Ireland, and now in the Ward Museum of the University of Rochester.



No. 121. [706] **Terebratula grandis,** Blum.

This Brachiopod belongs to the *Terebratulidæ*—a family of minutely punctuate shells, usually round or oval, smooth or striated, the ventral valve having a prominent beak with a foramen, and two curved hinge-teeth, and the arm-supports having the form of a loop. From the Miocene Tertiary of Bunde, Westphalia.

FOURTH SUB-KINGDOM.

RADIATES.

This division includes all those animals whose plan of structure is radiation from a centre. There are three natural Classes, exhibiting the three different ways in which the radiation is carried out; and they all show the radiation in the distribution of both external and internal organs. In the first class five is the typical number,—nearly all the varied forms repeating it in their arms, jaws, ambulacræ, eyes, etc. No branch of the Animal Kingdom presents so great a diversity of attitudes as the Radiates. Nor do we elsewhere find an entire group of animals so captivating by the exquisite geometry of their forms, or of such delicate, fascinating colors. The living Radiates number about 10,000 species, and are found in all seas, although they increase rapidly in numbers toward the tropics, and offer more forms in the southern than in the northern hemisphere. A single genus, *Hydra*, inhabit fresh-water. This sub-kingdom has been represented with great richness of forms throughout all periods of geological time, and with a steady increase in numbers from the Palæozoic to the present.

CLASS I.—ECHINODERMS.

This Class is the true type of the Sub-kingdom, and no Class of the Animal Kingdom more clearly exhibits a graduation of structure. For while some are rooted to the sea-bottom and thus resemble the Polyps, others have true rayed forms clothed in prickly armor, and these conduct us to soft, elongated organisms that mimic the Molluscs,

or seem to stand on the lowest step of the Articulate division. In the Crinoids, the anus is near the mouth upon the ventral surface; in the Star-fishes and regular Sea-urchins, it is exactly opposite the mouth; in the Sea-cucumbers, it is at the posterior end of the body. All are marine.

The Class has been represented in all geological periods, but reached its maximum development in the Mesozoic Age. "More difficult of study than shells (says Professor Owen), and less uniformly present in all strata, the enduring remains of Echinoderms and Corals are unsurpassed in beauty of form and structure, and in the value of the evidence they afford."

Order 1. — Holothurioids.

These vermiform Echinoderms, vulgarly called "Sea-cucmbers," constitute the highest Order of the Class. The body is either cylindrical or pentagonal, with scattered patches of calcareous deposit.

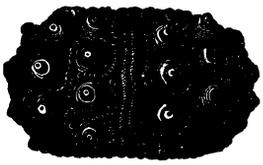
The only examples of fossilization are small fragments from the Upper Oolite of Bavaria, the Chalk of Warminster, and the northern Drift of Bute, Scotland.

Order 2. — Echinoids.

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. Ten broad bands (interambulacral) alternate with ten narrow bands (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 exsertion of tubular feet or suckers, which are used for locomotion. The mouth has five sharp angular teeth, tipped with enamel. In the regular forms the eyes and anus are situated at the summit opposite the mouth.

The fossils of this Order are usually divided into three groups: the Turban-shaped, Buckler-shaped and Heart-shaped. They include 71 genera and about 700 species. They are rare in the Palæozoic, and attained their maximum in the Oolite and Cretaceous strata. The regular forms appeared first; the elongated forms are more recent. In geological history the Echini succeed the Crinoids and Star-fishes.

No. 122. [762.] **Cidaris coronata,** Goldf.



Two specimens. 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, Wirtemberg, and belong to the Ward Museum, Univresity of Rochester.

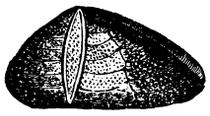
No. 123. [776.] **Hemicidaris intermedia,** Fleming.

This large, depressed genus belongs to the *Cidaridæ* 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, and now in the private Geological Cabinet of Mr. Ward, Rochester.

No. 124. [781.] **Palæechinus (Melonites) multipora,** Nor. & Owen

Group, on slab. This gigantic Echinoderm—some specimens measuring five and a half inches in vertical diameter and four transversely—has an ovoid form, central mouth and anus, ten areas, interambulacral plates mostly hexagonal, and the ambulacral plates hexagonal and rhomboidal. The ranges of plates number 65; and each plate is perforated by two holes. From the St. Louis limestone (Sub-carboniferous), St. Louis, Mo. Size, 12 x 12.

No. 125. [802.] **Echinobrissus (Nucleolites) clunicularis,** Blainv.

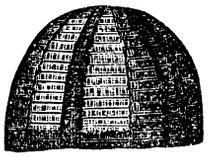


Two specimens. This genus is a section made at the expense of *Nucleolites,* to include those shortened and square forms with united poriferous zones. From the Lower Oolite of Stroud, England, and now in the Ward Museum of the University of Rochester. Price, $0.30

No. 126. [814.] **Clypeaster umbrella,** Agass.

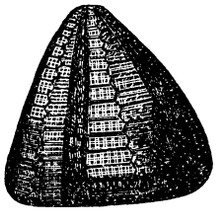
This inflated form, with interambulacra rising into ribs, is from the Miocene Tertiary, Sardinia, and belongs to the Ward Museum, University of Rochester. This genus of the Buckler-shaped group includes the largest of sea-urchins. The mouth is armed with well-developed teeth.

No. 126. [821.] **Discoidea cylindrica,** Agass.



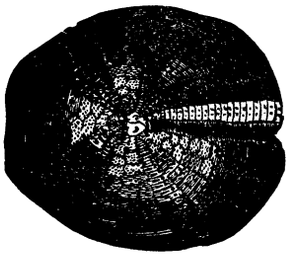
This Echinus has a hemispherical test, the height sometimes exceeding its diameter, and very small tubercles arranged in concentric series. From the Chalk-marl (Cretaceous) of Rouen, France, and now in the Ward Museum of the University of Rochester.

No. 127. [825.] **Galerites albogalerus,** Lam.



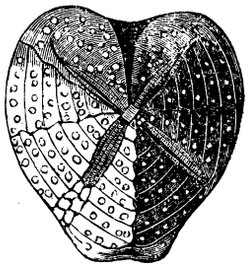
Pyramidal variety. This lofty, almost turreted form, with marginal anus, is from the Upper Chalk, Kent, England, and now in the Ward Museum, University of Rochester.

No. 128. [842.] **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 Museum, University of Rochester.

No. 129. [847.] **Micraster cor-anguinum,** 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 Chalk, Kent, England, and now in the Ward Museum, University of Rochester.

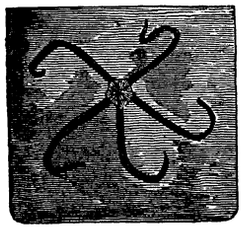
Order 3.—Asteroids.

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. The dorsal and lateral surfaces of the animal are covered by a coriaceous skin, strengthened by a net work of calcareous plates. In the centre 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, attaining their maximum in the present seas. No family of Star-fishes has become extinct.

No 130. [860.] **Ophioderma Egertoni,** Broderip.



This extinct Star-fish resembles the living "Snake-tails" or "Brittle-stars," ranked by some naturalists as a distincto rder, called "Ophinroides." This specimen is from the Lias of Lyme-Regis, England, and now in the Ward Museum of the University of Rochester.

No. 131. [863.] **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.

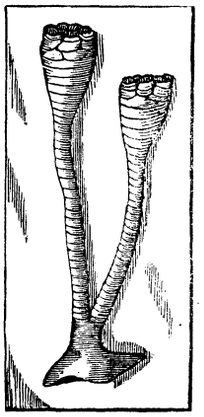
Order 4.—Crinoids.

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 "Encrinus." 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 some sub-marine rock; a hollow jointed stem; and a corolla-shaped body provided with five solid arms, independent of the visceral cavity and adapted to prehension. The mouth is central and placed upwards; the vent is situated on its 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 *Encrinus liliiformis;*

others were free, yet clinging to different bodies at the bottom of the ocean, as the young *Comatula;* 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. They are among the earliest relics of animal organization; and after the microscopic organisms and Polyps, they have taken the largest share in modifying the composition of the earth's crust. 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 Lower Silurian (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. The *Comatula* (Alecto) and *Pentacrinus Caput-medusæ* are the only living representatives of the Order.

No. 132. [898.] **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. In this species, the stem is comparatively short. This specimen is from the Great Oolite, Bradford, England, and now in the private Geological Cabinet of Mr. Ward, Rochester. Size, 6 x 3.

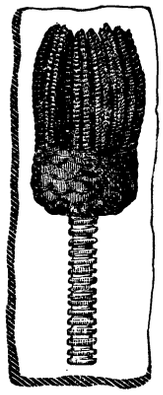
No. 133. [904.] **Astrocoma Cirini.**

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. 134. [911.] **Crotalocrinus rugosus,** Miller.

Body, stem and root, on pedestal. This ancient Crinoid is so called from its peculiar shape and structure. The sub-divisions 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 2.

No. 135. [917.] **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 Museum of the University of Rochester. Size, 8 x 2.

No. 136. [942.] **Pentacrinus subangularis,** Miller.

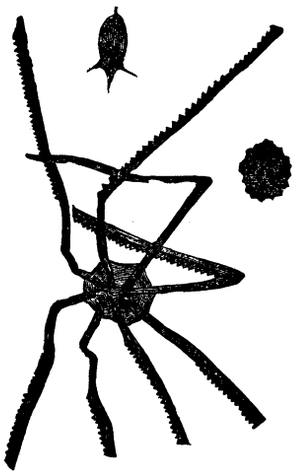
Body and stem, on slab. This genus of five-sided Crinoids is still represented by a solitary species in the West Indian Seas. The number of little bones in a single skeleton has been computed at 100,000. The body-plates are firmly articulated together; the rays of the disc are fixed immediately to the 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, Wirtemberg. Size, 4 ft. 5 in. x 1 ft. 6 in.

CLASS II.—ACALEPHS.

These soft, gelatinous Radiates, 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 observed 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. According to Agassiz, *Favosites* and *Chætetes* belong to this class; and it is quite possible, says Dana, that most of the so-called *Graptolites* are Acalephs.

No. 137. [963] **Graptolithus octobrachiatus**, Hall.



The Graptolites were first considered of vegetable origin; subsequently they were regarded as extremely slender Orthoceratites; but Portlock has pointed out their analogy with the lowest forms of Acalephs. They consist of sessile polype cells arranged in one or two rows on flexible, tubular stems, which radiate from a central disc. 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 Silurian fossils, and prevail in argillaceous deposits. This specimen is an artificial representation (it being quite impossible to take a cast of the delicate original) of an eight armed Graptolite from the Quebec group, as figured by Hall. The two smallest figures represent the germs of two distinct species of Graptolites. Size, 7 x 6.

FIFTH SUB-KINGDOM.

PROTOZOANS.

This division of Protozoa, created by Von Siebold in 1845, has been extensively adopted by naturalists as a convenient receptacle for many forms of animal life, which do not fall readily into any one of the four great Sub-kingdoms established by Cuvier. A large proportion of these organisms consist simply of cells, single or compound.

Naturalists entertain many and widely diverse views as to the legitimacy of the group, or its value, if allowed. Agassiz does not recognize the Protoza as a distinct branch of the Animal Kingdom; while Owen takes the bold step of creating for their reception a third primary division of the organic world, intermediate between animals and plants. With the majority of comparative zoölogists, however, the group is gaining ground, although much has yet to be done towards the attaining of a perfect knowledge of their structure and development, before their limits can well be defined, or a good classification can be attempted.

CLASS I.—INFUSORIA.

Infusoria inhabit both fresh and salt waters, and are all recent,—the fossil organisms often called Infusorial being Foraminifers, Polycystines and Diatoms.

CLASS II.—RHIZOPODS.

These Protozoans are mostly microscopic, and consist of one or more cells,—the compound kinds taking fanciful shapes. Each cell is generally occupied by a separate animal, though they are organically connected. The animal is of the simplest form possible, having no permanent mouth, stomach or members. From its gelatinous body are thrown out at will long, delicate, contractile filaments, resembling roots (whence the name Rhizopod), which 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 spicula.

The Protozoans enclosed in calcareous shells, constitute the interesting group of *Foraminifers*. These are marine animals, dwelling in shells of extreme beauty, sometimes simple, but usually consisting of an aggregate of chambers which intercommunicate by minute apertures, whence the name.

Upwards of 700 fossil species of Foraminifers have been described. They commence in the Palæozoic age, 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 of the Atlantic Telegraph Company show that the bed of the Ocean is composed of little else than shells and shields of microscopic organisms.

Below (138–156) is a series of 19 Foraminifers, enlarged after views under the microscope, each mounted with a brass standard on a block:

No. 138. [968] **Fusulina cylindrica**, D'Orb.
Carboniferous: Russia, Belgium, Ohio, Nebraska.

No. 139. [999] **Cassidulina serrata.**
Miocene: Austria.

No. 140. [1002] **Clavulina communis**, D'Orb.
Pliocene: Nussdorf, Austria.

No. 141. [1007] **Globigerina bulloides,** D'Orb.
Miocene: Austria. Pliocene: Italy. Living: Adriatic.

No. 142. [1015] **Proroporus complanatus,** Reuss.
Gault.

No. 143. [1036] **Siderolina calcitrapoides,** Lam.
Chalk: Maestricht, Holland.

No. 144. [1039] **Siphonia reticulata,** Reuss.
Miocene: Germany.

No. 145. [1043] **Textularia conulus,** Reuss.
Upper Chalk.

No. 146. [1047] **Textularia pupoides.**
Upper Chalk: Meudon, France.

No. 147. [1049] **Textularia spinulosa,** Reuss.
Miocene: Germany.

No. 148. [1059] **Cristellaria cassis,** Ficht.
(Young.) Pliocene: Sienna, Italy.

No. 149. [1077] **Globulina gibba,** D'Orb.
Eocene: Grignon, France. Miocene: Bordeaux, France. Pliocene: Castel-Arquato, Italy. Living: Adriatic.

No. 150. [1094] **Nodosaria inflata,** Reuss.
Upper Chalk.

No. 151. [1097] **Nodosaria oblonga,** Reuss.
Eocene.

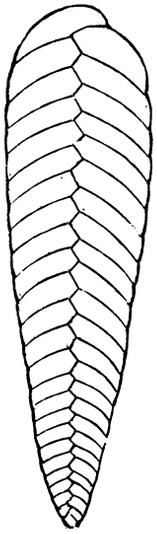
No. 152. [1098] **Nodosaria radicula,** Lam.
Gault.

No. 153. [1138] **Orbitolites macropora,** Lam.
Chalk: Maestricht, Holland.

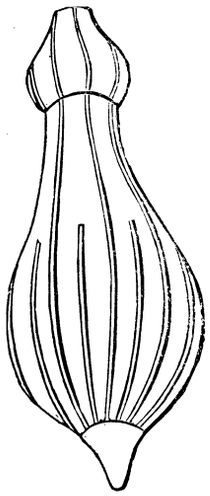
No. 154. [1145] **Quinqueloculina Ferussaci,** D'Orb.
Eocene: Parnes, France.

No. 155. [1150] **Spirolina cylindrica,** Lam.
Eocene: Paris, France.

No. 156. [1161] **Vertebralina nitida,** D'Orb.
Eocene; Grignon, France.



No. 142. (1015)



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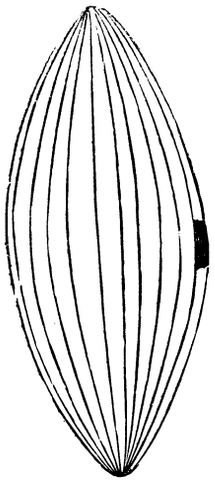
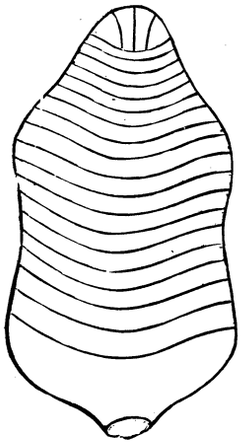
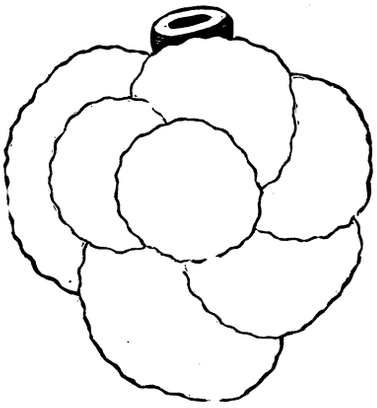


No. 138. (968)

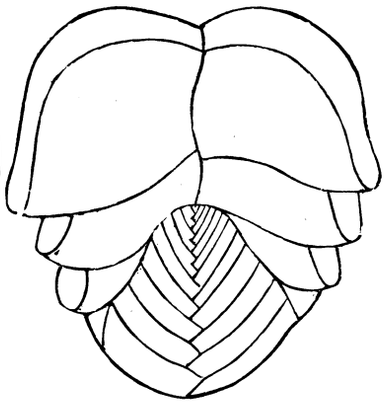


No. 151. (1097)

No. 147. (1049)



No. 144. (1039)



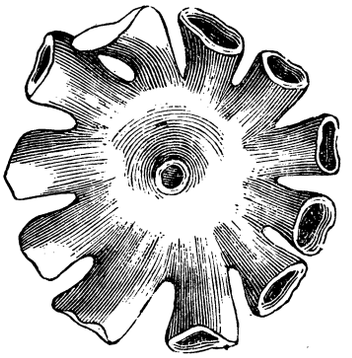
No. 139. (999)

CLASS III.—SPONGES.

The Porifera or Sponges have a structure which is a union of transparent pulpy matter (sarcode) with tough horny fibre. This latter forms a branching net-work or skeleton throughout the entire organism. In most Sponges the skeleton is further strengthened by calcareous or siliceous spicula. The only evidence of life are its growth and the constant circulation of water—flowing through the larger tubes. Excepting the fresh-water *Spongilla*, Sponges are natives of the sea.

Pictet enumerates over 400 species of fossil Sponges. They abounded in the seas of all geological periods, but especially the Cretaceous. The flint of the Chalk formation consists largely of the remains of Sponges.

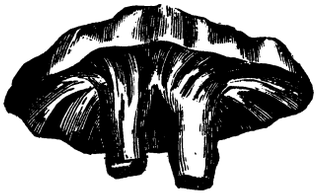
No. 157. [1164] **Amorphospongia ——.**



This undescribed specimen of a large and remarkable fossil sponge, with eleven beautifully radiating and recurved hollow branches, is from the Lower Silurian, Franklin County, N. Y.

Size, 11 x 11

No. 158. [1165] **Cœloptychium agaricoides,** Goldf.



Two specimens. 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 Museum of the University of Rochester.

No. 159. [1172] **Scyphia polyommata (?)** Goldf.

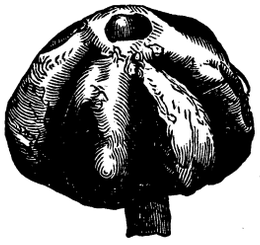
This species is closely allied to *S. clathatra.* From the Middle Oolite, Streitberg, Wirtemberg, and now in the Ward Museum of the University of Rochester. Size, 9 x 8.

No. 160. [1168] **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, and now in the private Geological Cabinet of Mr. Ward, Rochester.

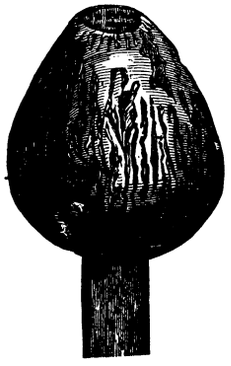
Size, 7 x 4.

No. 161. [1174] **Siphonia (Hallirhoa) costata,** Lamouroux.



(Syn. *Polypothecia septemloba*, Benett.) Two specimens. The fossil Porifera, 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 surface of the central cavity. The base of the stem was fixed by root-like processes. From the Upper Greensand, Westminster, England, and now in the private Geological Cabinet of Mr. Ward, Rochester.

No. 162. [1177] **Siphonia pyriformis,** Goldf.



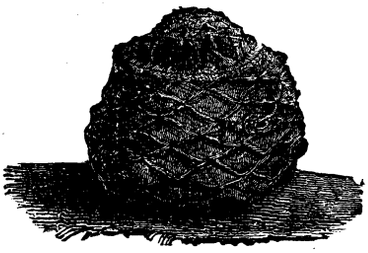
Two specimens. These pear-shaped Sponges are from the Upper Greensand, Blackdown, England (a locality which has furnished many very interesting and peculiar forms of Sponges), and are now in the Ward Museum of the University of Rochester.

No. 163. [1185] **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! From the Upper Chalk of Bridlington, England, and now in the Ward Museum of the University of Rochester. Size, 10 x 3.

PLANTS.

No. 164 [1204] **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 Museum, University of Rochester. Size, 12 x 12.

No. 165. [1206] **Dammarites ——,** Sternb.

A Conifer from the Inferior Oolite, Burton, Somerset, England.
Size, 6 x 2.

No. 166. [1207] **Nipadites Burtini,** Brong.

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 cocoa-nut 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 Museum of the University of Rochester.

No. 167. **Dictyophyton tuberosum,** Hall.

This interesting specimen is a portion of one of the marine Algæ or Fucoids which represented vegetable life in the waters of a later Devonian sea. The genus—known by eight or ten species—is characterized by an expanding, flabellate frond, sustained below by a hollow, cylindrical stem. This stem is marked externally by cross striæ, which divide the surface into minute rectangular spaces. In the present species (as also in *D. nodosum*) this stem expands at intervals, and is protruded into tubercles or nodes, with a longitudinal axis and moderate elevation. The original specimen, now in the Ward Museum of the University of Rochester, is from the Chemung group (Upper Devonian), of Steuben County, N. Y. Size, 7 x 5.

ZOOLOGICAL SUMMARY.

Vertebrates,	52 genera;	60 species.		
Articulates,	12	"	12	"
Molluscs,	23	"	39	"
Radiates,	17	"	17	"
Protozoans,	21	"	27	"
TOTAL,	125 genera.	155 species.		

PLANTS, 4 genera; 4 species.

GEOLOGICAL SUMMARY.

Post-Tertiary,	16	specimens.
Tertiary,	39	"
Cretaceous,	32	"
Jurassic,	51	"
Trias,	8	"
Carboniferous,	4	"
Devonian,	5	"
Silurian,	15	"
TOTAL,	170	specimens.

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Blagdeni (*proper name*).
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fimbriatus (*fringed*).
Goliathus (*proper name*).
Henleyi (*proper name*).
Humphriesianus (*proper name*).
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margaritatus (*pearly*).
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SUPPLEMENT.

The series of 170 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 zoölogical summary given upon page 71,—is very great, and is ample for the fullest purposes of illustration.

But the wish is often expressed for a few of the largest fossil animals, which shall impress the spectator by their colossal size, and render their array still more graphic and impressive to the student and to visitors.

To meet this requirement Mr. Ward has added the three large and notable specimens — Glyptodon, Diprotodon, and Mastodon,— which are described and figured in the following pages. They are intended to stand on pedestals in the central area of the Cabinet Hall, in which position they will reveal their huge dimensions, and will be a most effective accompaniment and complement to the preceding series as arranged on shelves around the wall.

These three specimens — each mounted on a distinct pedestal, as shown in the cut — will be added to the previous series for an additional sum of $200*, making a total of $500.

If ordered apart from the series (by institutions seeking to add a feature of imposing display to their present cabinet), they will be furnished for the sum of $225.

The area occupied by these three monsters may be estimated by the dimensions appended to the description of each.

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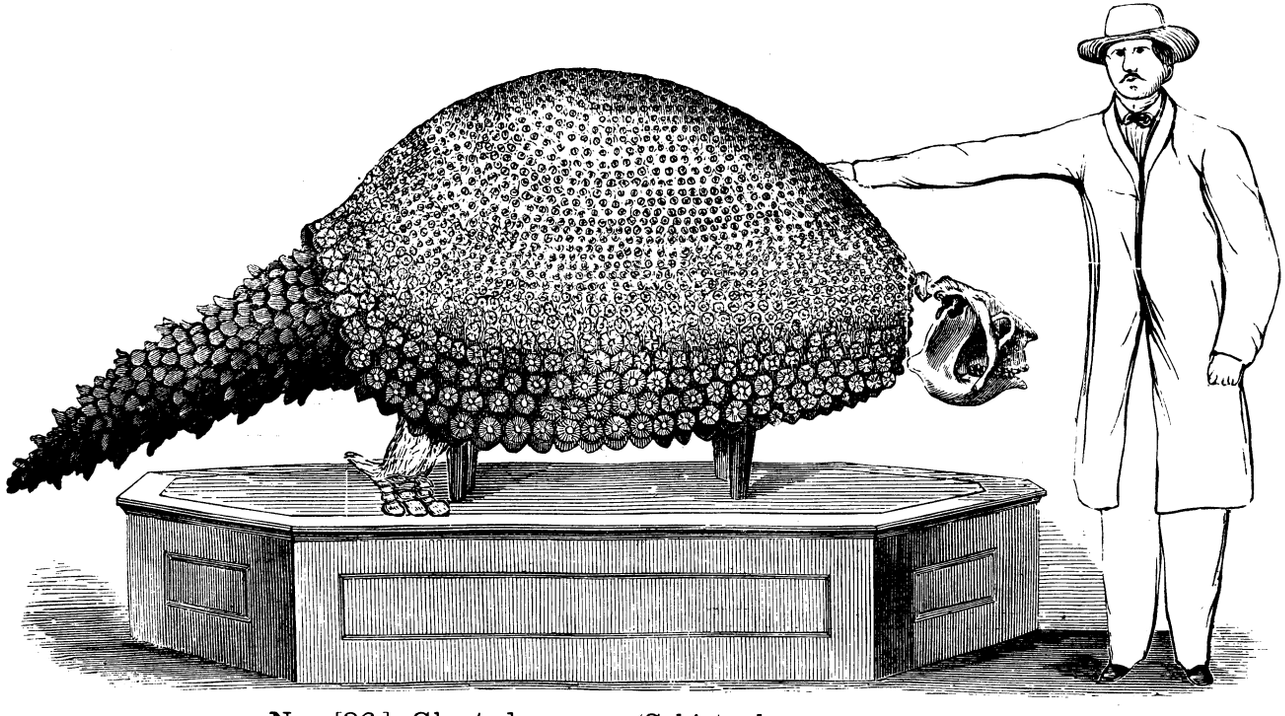
* In such case, No. 12 [43] of the series would become superfluous, and would not be sent.

No. [36.] **Glyptodon** ——. (Schistopleurum typus, NODOT.)

CARAPACE, HEAD, TAIL AND HIND LEG. 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 to 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 the body. The head was defended by a tessellated bony casque. The tail possessed an independent dermal 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 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 was derived from this 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 tesselated 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 (Pleistocene). 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, and forms the crowning glory of the Cabinet.

Length, 11 ft. Breadth, 4 ft. 2 in. Height, 3 ft. 8.



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

From the late PRESIDENT HITCHCOCK, of Amherst College.

Amherst, Nov. 21st. 1863.

Prof. H. A. Ward,

My dear Sir,

I have just sent you four large boxes containing moulds of twelve of the more prominent slabs of tracks in our Ichnological Museum. The moulder whom you sent on, copied these with *much* skill and truth; and the casts which you take from them will certainly be very close representations of the originals, and give their possessors an exact view of those wonders from the rocks of the Connecticut.

I am delighted to see the excellent work which you are accomplishing in the matter of the plaster copies of the larger and rarer fossils. It is no small thing thus to put into our hands, as it were, the wealth of the old European Museums, and to re-create for us, in actual, tangible forms, the huge and strange animals which walked our globe in the age of Reptiles and of Mammals, or swam and crawled through the muddy wastes of the Palæozoic seas. Hardly anything could be more fortunate to American students of Geology than the appearance of these casts, of which you say that your Catalogue will enumerate over 1000. *They will be invaluable adjuncts to the scientific department in every Academy, College or University in our country; and it would be folly for any one pretending to teach Geology not to make use of them.* I believe that our men of science in America will fully appreciate, and be glad to profit by, your undertaking, and that you will have the satisfaction of seeing that your labor has not been in vain.

Our College has obtained from you as many of these casts as our funds would permit, and we have much admired the care which you have expended in making their form and color exact copies of the original specimens. For the sake of Geological science, as well as for yourself, I wish you ample success in your enterprise, and expect that you will have it.

Truly yours,

EDWARD HITCHCOCK.