smallest possible amount of material. Here also are the type specimens of the genera *Acanthaspis* and *Acantholepis*, which show a strange combination of plate and spine that is unknown in modern fishes. Another slab of limestone shows the head of an old Devonian fish that measures seven or eight inches in length. The head of this fish was completely incased with solid bony plates that were strongly united by sutures and highly ornamented on the exposed surfaces. This fish, which has received the long name of *Macropetalichthys*, seems to have had many features in common with the structure of the living sturgeon. One of the strangest fishes that ever swam in the Devonian seas, and which surpasses in interest even the *Pterichthys* and *Coccosteus* of the old world, is the *Onychodus*. Among the most unique specimens in the museum is a slab of limestone from the Corniferous rocks of Ohio, containing a nearly perfect mandible of this fish, which is fourteen inches in length and set with sharp conical teeth. At the junction of the two rami of the lower jaw there occurs a crest of seven large curved teeth which seem to have projected beyond the massive jaws, thus forming a terrible weapon, whose use seems to have been analogous to that of the sword in the living sword fish. Far more wonderful than any of these, and one of the strangest monsters ever exhumed from the cemeteries of the primeval world, is the *Dinichthys*, described by Prof. Newberry from the Huron shales of Ohio. The nearly perfect bony casing of this "terrible fish," which is exhibited, shows it to have been upwards of twenty feet in length; and judging from its formidable armament, it was by far the most destructive creature yet known from the Devonian rocks. The jaws are massive plates of dense bone, each two feet in length, and provided with sharp cutting and serrated edges. The anterior ends of the mandibles are upturned and united so as to form one immense tusk-like tooth, which shuts in between two equally massive premaxillaries on the upper jaw. The jaws of *Dinichthys* may be well represented by the arms of a man extended to their full length with the hands turned up and pressed together to represent the great tooth at the junction of the mandibles. One of the most curious and interesting features connected with this discovery, is the striking analogy that exists between the structure of the *Dinichthys* and the mud fish (*Lepidosiren*), now living in the rivers of Africa and South America. The number of these Devonian fishes is so great that we can but glance at a few of the more interesting ones that remain. Beside the dorsal shield of *Coccosteus* from the Old Red Sandstone of Scotland, is placed the only similar specimen known of *Coccosteus* from this country. Here too is the type specimen of the genus *Heliodus*, one of the most ancient of the Dipnoi. Specimens of *Rhynchodus* show us that the modern Chimæra belongs to a very ancient family.

We cannot linger over these ancient relics, which are but waiting the pen of a Hugh Miller to make them familiar to every reader in our land, but must pass on to other features of the Devonian, which are well exhibited in these cases. Our readers will remember that the shores of the Silurian ocean were barren solitudes. Not so was it in the Devonian. We have here before us the remains of a strange and luxuriant flora that shaded the land. Ferns grew luxuriantly: above these flourished the strange *Lepidodendrons*, with which we shall become more familiar in the age that follows. We have here the first appearance of the most beautiful of land plants, the tree ferns, which at the present day form such an attractive feature in the scenery of the tropics and of the islands of the South Pacific.

The next series of cases contains the remains of the fauna and flora that flourished in the carboniferous times—the age which witnessed the formation of the great coal fields of America. Here the scene again changes. The mollusks and crustaceans, the huge ganoids and the strange flora, of the Devonian age, have disappeared never to return again. Another cycle in the world's history has been completed. The fossils which we have now to examine are, as before, the remains of shells, fishes, plants, etc., but all very different from those of the Devonian. Fishes appear again in great numbers, but not the huge Placoganoids that we saw before, but the elegantly formed Lepidoganoids, covered with little plates of enameled bone. The most beautiful of these fossil fishes are from the cannel coal deposits of Linton, Ohio. The fossilization in these specimens is peculiar. Each little plate of mail and each delicately penciled fin seems wrought in gold leaf on a black ground. In reality, the substance which represents the fish is iron pyrites, on a surface of impure coal. These little fishes have received the generic title of *Eurylepis*, in reference to the breadth of their scales, and such specific names as *corrugata*, *insculpta*, *lineata*, *ornatissima*, etc., suggested by their delicate ornamentation. Specimens of *Cœlacanthus*, which occur with the *Eurylepis*, are even more highly ornamented, and have their scales and head plates so elegantly chased that the most skillful gem engraver could scarcely imitate their delicate tracery. The great fin spines which these cases contain show that the sharks were strongly represented in the Carboniferous waters. Here, too, are the teeth of the most gigantic ray ever discovered (*Archæobatis*), some of the flat crushing teeth of which were six inches in length, four inches wide, and an inch and a half thick.

Some of the slabs of stone from Linton, Ohio, upon being split open, showed the heads, limbs, scales, etc., of *Amphibians*, represented at the present time by the frogs and salamanders. It is at once apparent that this is the heading of a new chapter. In all the stony pages that we have glanced over, we have not seen characters like these. If we should follow out the records here begun, through all the following ages, we would find, indeed, that it is a chapter of wonders, containing the lives and struggles of the hugest and strangest monsters that have ever lived. We cannot pass on, however, without glancing at the flora of the Carboniferous, the relics of which these cases contain to overflowing. These forms, that are traced so delicately on the stones, were once living plants that millions of years ago bowed to the passing winds and drank in the sunshine as our most familiar trees and ferns do to-day. These fragments of trunks, branches, leaves, and cones give us a faint glimpse into the dark moist forests that clothed our land in the coal period. Many of the fossil plants we at once recognize as ferns, so nearly do they approach in form these beautiful plants which we meet in all our rambles. Others, after considerable study, have been shown to be closely related to the little ground pines or club mosses, which are also quite common in our woods. These ancient Lycopods, however, instead of being only a few inches in height, with cones an inch long, were gigantic trees, sometimes upward of seventy or eighty feet in length, with elegantly scarred trunks, and bearing large cones upon their gracefully pendent boughs. Another of our common plants, the Equisetum, also had giant representatives in the ancient flora. These, together with the Sigillarias, with their beautifully fluted columnar trunks, furnished the material from which our great stores of coal were formed. What at once appears as a remarkable fact upon looking over these fossils, is that they all belong to the lowest grade of vegetation, the cryptogamous or flowerless plants. Among all the hundreds of coal plants here assembled, we look in vain for so much as a single leaf of a broad-leaved plant like our maples and oaks. It was long supposed that there was a total lack of flowers in the Carboniferous forests, but a specimen in this collection shows a branch of some unknown plant with the remains of flowers clearly distinguishable.

As we pass on to the records of the next succeeding (Mesozoic) eras, the mediæval age of geology, we find no mention made of the luxuriant forests and the abundant animal life that passed before. Nearly all remembrance of these seems lost in antiquity. This age, in reference to the predominating forms of life, is called the reptilian age. The first indications that we have of these new rulers of the land and sea are their footprints, left along the muddy shores. Some of these from New Jersey and the Connecticut valley are shown in the case of Triassic fossils. These wonderful impressions are so well known through the writings of Prof. Hitchcock and others that we need do no more than mention them. The rocks in which these footprints were found have also furnished a great number of fossil fishes. Among hundreds of specimens of these Triassic fishes here assembled, there is one called *Ptycholepis*, with highly ornamented head plates and plicated scales, which is the only American specimen known of this genus, which occurs in the Lias of Europe; here, too, is the only specimen yet discovered of *Dipterus*; this was lately obtained from the Triassic rocks at Boonton, N. J. The rocks of this age have also yielded the oldest remains known of the Mammalia. This sub-kingdom makes its appearance in one of its humblest orders, the Marsupials, represented at the present day by the opossum and the kangaroo.

In the flora of the earlier portion of this age we find ferns, calamites, and conifers, with the addition of a new feature, the Cycads. As we pass on to the cases containing the fossil plants from the latest period of this age, the Cretaceous, we come suddenly to a splendid display of fossil leaves which have a wonderfully familiar appearance; they are the leaves of oaks, willows, maples, beeches, sycamores, etc., which the most casual observer would refer to the same genera that are living at the present day. There are differences which show that all these fossil leaves are specifically distinct from their modern representatives.

Among the most striking forms of animal life in the Mesozoic, were the Cephalopod shells, related to the living nautilus. Of these, the ammonites, which were foreshadowed by goniatites in the Devonian and Carboniferous and began to assume their characteristic elegance of outline in the Triassic, in the Cretaceous attain a degree of variety and beauty that could with difficulty be excelled. It is interesting to observe that after these mollusks had slowly attained this surpassing degree of elegance and ornamentation, the whole family became extinct. The collection contains many of these chambered shells from the Cretaceous of the Upper Missouri, which still retain their nacreous walls, that after the lapse of ages are as beautifully iridescent as any living shell. Here also are the bones of some of the great reptiles of the Cretaceous, the teeth of fishes, and a great variety of shells and plants from the same rocks. Many of these specimens are of great scientific value, as they are the type-specimens upon which many of the genera and species of Cretaceous fossils were founded.

The last case at the southern end of the geological hall contains the fossils of the Tertiary period, the last period but one before the age of man. A glance at the contents of this case shows us that all the grand divisions of animals and plants which are living at the present day are represented. The shells of this period exhibit a very modern aspect, especially when compared with the older ones we have been studying; although many of them belong to living genera, yet nearly all the species are extinct. The Tertiary plants, which are shown in great abundance, prove that the flora was not very different in its general character from that clothing the Middle States at the present day. The higher vertebrates at this time appeared in such numbers and variety that this age is known as the age of mammals.

While lingering over the cases of Silurian fossils, we attempted briefly to retrace the picture of that age, with its small and barren land areas and its great oceans tenanted by the lowest forms of animals and plants. Let us contrast with the silent barren aspect of our continent in those primeval days, its appearance in Tertiary times. North America had then attained nearly its present outline, although extensive regions along the Atlantic and Gulf borders were yet beneath the ocean, and great lakes occupied the western interior. A flora of temperate or sub-tropical growth clothed the area of the United States, and the climate of Virginia reached as far northward as Greenland. The splendid collection of Tertiary plants from the region of the Upper Missouri, the Yellowstone, and other portions of the West, shows that the banks of the Tertiary lakes, which then existed at these localities but have since been filled, were fringed with a varied and beautiful vegetation. We find among these fossil plants the leaves of the maple, oak, hickory, conifers, etc., together with others that now grow far to the southward, as the palm, magnolia, cinnamon, and fig. Many of these fossil leaves are of double value, as they are the type specimens from which Prof. Newberry has described and figured this wonderful flora, rich both in species and individuals. When we inquire what animals lived in these luxuriant forests, a vast menagerie of strange forms passes before us. We can do no more than call a hasty muster-roll of names. Our country was then inhabited by great numbers of animals more or less related to our modern horse, tapir, wolf, panther, stag, musk, rhinoceros, camel, llama, etc. Besides these there were a large number whose modern representatives are not so well known—as the *Oreodon*, *Menodus*, *Uintatherium*, *Hyænodon*, and many others. This is but a meager list of the great number of Tertiary animals that have been discovered, but sufficient to show that a far richer and more wonderful assemblage of animals inhabited our land at that time than can now be found living on any continent; not even the jungles of India can produce such an array of gigantic pachyderms and carnivores as then lived in this country.

Again we are obliged to add, as with all the preceding ages, that both the luxuriant forests and these thousands of strange animals have become extinct, never again to appear on the earth. Dana remarks that "all the fishes, birds, reptiles, and mammals of the Tertiary are extinct species."

As we are writing sober facts and not attempting to trace an Arabian tale, we should hesitate to speak of the times that follow the Tertiary, so strange and wonderful are they, did we not have in the collection before us the unquestionable facts engraved upon tables of stone. As the climate of the Middle States in former ages extended to Greenland, so, on the other hand, there came a time, after all the fair picture of Tertiary days was blotted out, when the present climate of Greenland, with vast snow fields and continental glaciers, reached as far southward as New York and Cincinnati—a time when glaciers many thousands of feet in thickness moved southward over our Northern States, grinding down the country and exterminating nearly every form of life that before had found there a congenial home. This collection contains a large number of specimens of the bowlders, the bowlder-clay, and the polished and scratched surfaces, that the glaciers left behind them.

After the snow and ice of this great geological winter had passed away, and a climate very similar to that which we now enjoy had covered the land with its present flora and fauna, we find the first clearly acceptable evidence of the presence of man. The geological records before us are brought down to our own time by many relics of the stone-age of Europe and America, besides a collection illustrating the arts of the Egyptians and Etruscans. Here, too, is a cast of the celebrated fossil-man of Guadalupe, the original of which is in the British Museum.

One of the most interesting truths illustrated by the geological collections at the School of Mines, is the fact of the humble beginning of both plant and animal life on our globe, and their constant increase both in variety and specialization, as we follow their progress through the geological ages. Every one who is interested in the great question of our time—evolution—should make himself familiar with a collection of fossils arranged geologically, in order that he may see with his own eyes the facts written in the great stone book of the geologist, on which the man of science bases his theories and conclusions.—*American Naturalist.*

COLORING MATTER OF SANTAL AND CALLIATURA WOOD.

By N. FRANCHIMONT.

THE coloring matter of these dyewoods is identical, and may be represented by the formula $C_{17}H_{16}O_6$. Calliatura wood is the richer in this compound. The pure color, on fusion with caustic potash, yielded acetic acid, resorcin, and probably proto-catechuic acid, and pyro-catechin.

DEPREZ'S ELECTRO-MAGNETIC ENGINE.

By the COUNT DU MONCEL.

ACCORDING to Count du Moncel (writing in *La Lumière Electrique*) M. Marcel Deprez has succeeded in solving the problem of making an electro-magnetic motor capable of doing useful work in many industrial applications. We venture to doubt whether the new motor can compete with even a water motor as regards economy, to say nothing of gas and steam engines; but according to Du Moncel, Deprez's apparatus is barely 8 in. long by less than 6 in. in breadth; it weighs about 6½ lb., and can supply a power of nearly 8 foot pounds per second with five Bunsen elements. This (says Du Moncel) is really an extraordinary result, and one which could scarcely have been anticipated a few years ago. Under these conditions sewing machines may with perfect ease be worked by electricity without any cumbrous apparatus. This ingenious system consists of a horseshoe magnet of eight plates 5⅞ in. in length, between the poles of which is introduced a Siemens armature, acted upon by the magnet over a length of 2¾ in. Up to the present time no one has ever thought of causing magnets or electro-magnets to act otherwise than by their polar extremities; and all the engines devised hitherto have been arranged on this principle; but M. Marcel Deprez, thinking that under these conditions the whole of the magnetism that can produce a magnet was not utilized, endeavored to cause the whole of the sufficiently magnetized portions of the magnet engine to act upon the mobile system to be influenced; that is to say, in the present case, the branches of the magnet nearly up to the neutral line. The electro-magnetic armature, instead of being placed transversely to the magnet, is arranged longitudinally and parallel to it. Under these conditions the magnetic power exerted on the armature is found to be considerably augmented, as is perceptible from the difficulty experienced in producing rotation; and this increase of force may give an idea of the considerable advantages presented by this system of motor, which works by the effect of successive reversals of the current. Everybody knows the Siemens armature; it is a kind of galvanometer frame, of which two sides constitute the two poles of a straight electro-magnet with a flat core, broader than it is long, upon which the wire is wound. The axis of this electro-magnet is parallel to the coils of wire in the magnetizing helix, and, consequently, to the arms of the magnet. At one end it carries a reversing commutator, and at the other end it is provided with a pinion which gears into a wheel of which the diameter is 30 times greater. When the apparatus is properly regulated, the armature makes 90 revolutions per sound, and, consequently, the wheel which it acts upon makes three revolutions. It is upon the axis of this wheel that are fixed the pulleys transmitting the movement, and by which the engine is caused to work either a sewing machine or any other apparatus which is to be set in movement. In order to render the working of this apparatus perfectly uniform, M. Marcel Deprez has adapted to it an extremely ingenious regulator, the action of which is extremely efficacious. It is a sort of spring fixed by one of its extremities to one of the ends of the armature. By means of a screw, a tension suitable for any given velocity of the engine is given to the spring. The transmission of the current from the commutator to the wire of the armature is effected without difficulty by this spring, as in the case of all frictional contacts; but, when the velocity is greater than that which is requisite, centrifugal force is brought into action, and the mass of the spring causes it to fly off and to break the circuit, whence results a slackening of the speed, and then the completion of the circuit, which is again broken when the velocity again becomes too great. The alternations are so rapid when the electric power is somewhat higher than is strictly necessary, that a continuous spark is seen at the commutator where the regulating spring is in contact with it. Nothing can be simpler than this little apparatus, which, as at present constructed, may be of great service. Its force may be estimated by trying to stop the pulley, the diameter of which is nearly 4 in. With five Bunsen elements at work this stoppage can be effected only with great difficulty; whereas with the ordinary electro-magnetic engines it is easy to produce a stoppage by pressing a little upon the axis of rotation. Count du Moncel does not say what is the cost of five Bunsen elements, nor where they are to be placed when employed in working a sewing machine in a lady's boudoir.