

## CLASS III.—REPTILIA.\*

## TEGUMENTARY SYSTEM.

THE external coverings of Reptiles have not been so closely investigated, especially in an histological point of view, as those of Mammalia, Birds, and Fishes.

The naked Amphibia, such as the Frogs, have a smooth slippery skin covered by a tessellated epithelium, which is continually being shed in large irregular patches, or shreds. The nuclei of the epithelial cells are usually distinctly visible in the layers thus thrown off. Simple glandular follicles, closely aggregated, and more or less numerous, with frequently star-shaped or ramified pigmentary cells, are found beneath this epithelial layer. The skin surrounds but loosely the muscles of the body, and numerous spaces for lymphatic vessels are found beneath it. It is exceedingly vascular and richly supplied with nerves, and is therefore very sensitive, and capable of producing when irritated the most lively reflex phenomena. The small slightly-developed glandular follicles of the integument attain so large a size in the Toads, Frogs, and Newts, as to effect a transition to the more composite forms of glands. In some instances, as in *Salamandra*, *Triton cristatus*, &c., small pyriform follicles, either solitary or aggregated, extend over a great part of the back, or form, as in the Toads and Newts, a large warty protuberance behind the ear, from which an acrid milky fluid may be readily expressed, the excretory ducts of the several sacs being readily recognised during this operation.

## \* Class REPTILIA.

Sub-Class 1. Reptilia squamigera.

Order I. SAURIA.—Ex. *Crocodile*, *Lizard*, *Chameleon*.

II. CHELONIA.—Ex. *Tortoise*, *Turtle*.

III. OPHIDIA.—Ex. *Rattlesnake*, *Boa*, *Viper*.

Sub-Class 2. Reptilia nuda s. Amphibia.

Order IV. BATRACHIA.

{ B. Anoura.—Ex. *Toad*, *Frog*.  
B. Urodela.—Ex. *Salamander*.

V. ICHTHYODEA.—{ Derotremata.—Ex. *Amphiuma*, *Menopoma*.  
Perennibranchiata s. Proteidea.—Ex. *Proteus*, *Siren*,  
Azolotti.

The transition from the Naked to the Squamigerous Reptiles appears to be effected by those kinds of Reptiles, as the Chameleon, that are provided with a thin and delicate epidermis, having beneath it soft tubercles or excrescences, endowed with the power to expand and contract. These tubercles, which are continued also upon the circular eyelids, are separated from each other by strong annular layers of fibres, and consist of a bed of fibro-cellular tissue, within which a double layer of pigmentary cells may be detected. The most superficial pigmentary cells are black, either small and rounded, or of larger size and ramified, and beneath them are found some smaller nucleated cells or spots of a bright red color. The general appearance of these structures remind us very strikingly of the chromatophorous cells of the Cephalopoda, and it is probable that in the living Chameleon the same lively contraction of the walls of the cells may take place as in the Cuttle-fish; and to this property may be owing the well-known power of changing color which that animal possesses. In specimens preserved in spirits of wine, these cells may be rendered beautifully distinct by treating the skin with caustic potash.

The Squamigerous Reptiles exhibit various degrees in the development of their epidermic structures, giving rise to those numerous diversities of form which it is the special province of Zoology to depict. Frequently, as in the Snakes, in *Scincus* and other Saurians, scales are found that overlap each other like tiles, as in Fishes, or are disposed in a quincuncial order, or so as to form annular bands, as in *Ophisaurus*. Scutes, provided with tubercles and spines, are also commonly met with, or large plates containing bony matter, as in the Crocodiles and Chelonia; in the latter indeed they constitute true dermal bones, which coalesce with the skeleton, and form the dorsal and ventral shields, as will be described more minutely further on. The laminæ or scuta of the epidermis are formed by the coalescence of horny cells, which may be brought into view by submitting the scales of a tortoise to the action of caustic potash.

The scales of the Snakes exhibit under the microscope very delicate longitudinal and transverse striæ, which are probably caused by the coalescence of cells. In the parts of the epidermis situated between the scales, the cellular structure may be often more distinctly recognised. The epidermis is cast several times during the year, either piecemeal, or like the exuvia of the caterpillar, in one entire piece from off the whole surface of the body. A kind of



moult is thus performed, as by Birds, and something analogous occurs not only in many Saurians, but even in Emys among the Chelonia. The exuviation usually takes place in spring, but frequently upon the occurrence of a change of weather several times in the course of the year.

Tegumentary follicles of a particular kind are developed in several Sauria, as the true Lizards, *e. g.*, Lacerta, but also in Iguana, Cordylus, Gecko, though they are here fewer in number. In the above named genera a single row of them provided with from 12 to 20 orifices is found extending from the inguinal region to the knee-joint. These apertures are placed upon scales of a particular construction, forming tubercular or bulb-shaped elevations. Each opening conducts into a sac, the commencement of which is divided into small cœca.

## OSSEOUS SYSTEM.

THE remarkable diversities which the Osseous System of the Reptilia presents throughout the several orders and genera, render its description by no means easy without entering into very considerable detail.

As regards the *Cranial bones*, the best plan will be to consider them separately in each of the orders belonging to the two subclasses of Reptilia, commencing with the naked Amphibia. The Ichthyodea or Fish-like Amphibia and the Batrachia agree closely in the conditions of their skeleton, though that of the former approximates more closely to Fishes. This is exemplified in the structure of the occipital bone in the Proteus, where the two lateral occipital bones do not articulate by condyles with the vertebral column, but are united firmly by synchondrosis with the first cervical vertebra. In the Salamanders and Frogs, on the contrary, each of the two lateral occipitals has an elongated condyloid process, and both abut against each other superiorly and inferiorly, so as to circumscribe an interjacent foramen magnum. The body of the *sphenoid* bone is of considerable size, forming the basilar surface of the cranium, and is of a cruciform figure in the Anourous Batrachia, running to a narrow point anteriorly; it is broad, however, in the Pipa, and to a still greater degree in Siren and in Cœcilia. In the direction upward, it supports the alæ-majores, which are osseous only in the Tailed Batrachia, being in the Anoura membranous, and perforated by a large opening for the passage of the optic nerve. Each of the inferior wings or alæ (*processus sphenoides*) is provided

in the Frogs with two large processes, one in the direction forward and outward, uniting them with the supra-maxillary, palatal and nasal bone, and the other, or posterior process, with the os quadratum. In the Tailed Batrachia, as the Salamander, the sphenoidal wings are not united to the supra-maxillaries, but project forward into a free and pointed process; in Acholotes they unite with the vomer, but in the Siren are absent together with the palatal bones. The *temporal* bone has only the articulating portion of the petrous bone developed to form part of the cranium, and this is let in between the circumjacent bones. The articulating portion of the temporal, or what is called the *os quadratum* or *tympanicum*, is freely detached from the petrous, and consists mostly of one, more rarely as in Proteus, of two pieces. It is united above to the cranium by a suture, abuts inferiorly against the jugal bone, and articulates with the lower jaw. The pair of *parietal* bones are always distinctly present, but occasionally, as in Hyla and Bombinator, separated by an interval or membranous fontanelle. The two *frontals* of considerable size are very distinct in the Tailed and in the Fish-like Batrachia, but are either absent in the Frogs or anchylosed with the parietals. In front of the frontals, between them and the intermaxillaries, certain bones are found, the homologies of which it is by no means easy to determine. A pair of ossicles placed in this situation in the Frogs and Pipa have been regarded by some writers as the *nasal*, by others as *lateral ethmoidal* bones. In the Salamander, a pair of similarly placed, but smaller bones, separated from each other in the middle line by the principal frontals, have been regarded as particular bones under the name of the *anterior frontals*, if they be not upon the other hand viewed as ethmoids. A single azygos bone, which in many Batrachia and also in Cœcilia appears as a small plate in front of the parietal and frontal bones, and usually projects downward in the form of a septum, may be well considered as a *middle ethmoidal*. The *lacrymal* bones are generally absent. The analogue of the jugal bone is seldom met with, or is at all events not to be determined with certainty. In the Frog there lie in front of the apex of the body of the sphenoid a pair of narrow transversely directed bones, which are united to the superior maxillary, and by a small ascending ramus, with the nasal bones; they may be regarded as the *palatal* bones. In front of them is situated in the Frog a pair of bones of considerable size provided with minute teeth, and which are probably the representatives of the *vomerine*. On the contrary, in the



Tailed Batrachia, *e. g.*, Siren, only a single pair of ossicles is found provided with teeth, and which admit therefore of being taken either for palatal or vomerine bones. The *superior maxillaries* are usually of very large size, being rarely, as in the Siren, in a minute or rudimentary condition. The *intermaxillaries* are also considerably developed. The *inferior maxilla* generally consists of an anterior piece supporting teeth, and a posterior articular portion of nearly equal length. A small ossicle is occasionally placed upon its articulating surface, but is generally ankylosed thereto. A fourth piece is seldom found in the middle of the lower jaw, as is the case in the rest of the Amphibia.

The Squamigerous Reptiles are characterized by the greater extent to which ossification is carried in the several bones composing their skull, many parts that in the naked Amphibia were only membranous having become in them converted into bone. The individual bones of the cranium are here also multiplied by division, as is especially exemplified in those that enter into the construction of the occipital, sphenoid and parietal. In this respect the present order of Reptiles seems to be most closely related to the Osseous Fishes.

In all the three orders composing this sub-class, namely, the Sauria, Ophidia, and Chelonia, the occipital bone is furnished with only a single condyle, which articulates with the first cervical vertebra, and is usually formed by the coalescence of three ossicles, namely, by the *body* of the *occipital* bone, which is always present, and the two *lateral occipitals*. Between the two last is interposed the *supra-occipital plate* completing the foramen magnum from above; it is of small size in the Ophidians, but mostly large in the Chelonia, where it projects backward into a pointed crest. In the last named order, and in the Crocodiles, a pair of *supra-lateral occipital* bones, as in Fishes, are intercalated between the others; they abut in the direction outward against the mastoid bone, internally against the petrous, and assist in forming the bony part of the organ of hearing. The body of the *sphenoid* is broad and short in the Chelonia, very elongated and narrow in the Ophidians, whereas in most Sauria it projects forward in the form of a style. The *alæ majores* of the sphenoid are in the Ophidians and Saurians perfectly membranous. There occurs here, however, a peculiar, narrow, long and style-shaped bone, usually called the *columella* (*os tympanicum* Bojanus, *os suspensorium* Nitzsch) which ascends perpendicularly like a small column from the inferior wings of the

sphenoid upon either side, and supports the parietal bone, which rests upon it like the capital upon a pillar. This *columella* corresponds according to some anatomists with the great wings of the sphenoid. The inferior wings of the sphenoid are very large in the Chelonia, and united with the body of the bone, and to each other in the middle line, by suture; they represent at the same time the great *alæ*, and unite in front with the palatal bones. In most of the Sauria they are narrow and elongated, frequently support teeth, and are connected by synchondrosis with the body of the sphenoid; they are separated from each other, and abut posteriorly against the *os quadratum*, and in front, generally by means of two processes, against the palatal and jugal bones. In the Crocodiles they are very broad, unite in the middle line by suture, and conceal the body of the sphenoid. In the Ophidia the two wings are widely separated, very elongated, frequently provided with teeth, and bifurcate into an internal piece united with the palatal bones, and which can be regarded as an internal pterygoid process, and an external corresponding with the external pterygoid, and connected to the superior maxilla. The first piece extends very far back posteriorly to the union of the *os quadratum* with the inferior maxilla. The last piece is considered by many anatomists as a particular bone under the name of *os transversum*. The *temporal* bone is divided upon an average in all three orders into four pieces. In the direction inward and backward is situated the *petrous* bone, posteriorly and externally the *mastoid*, which in the Ophidia is very much elongated and style-shaped, but shorter in the other orders; in front of and in contact with this is generally placed the *squamous* element, united in the Chelonia and Sauria by suture with the parietal and jugal bone, but being quite free in the Ophidia, and advanced further forward. This piece is however viewed by many anatomists as a peculiar bone, under the name of *anterior frontal*, and being divided in the Tortoise into two pieces; the posterior of them has been in like manner termed the *posterior frontal*. The right interpretation of these bones has, however, given rise to much contrariety of opinion, relative to which the reader must consult and compare the special treatises on the osteology of the Reptilia. The articulating portion of the temporal, called the *quadratal* or *tympanic* bone, is particularly broad and concave in the Chelonia so as to be adapted for the reception of the large tympanic membrane, and superiorly is united by suture with the squamous and mastoid elements, while inferiorly it always projects



into a rounded condyle for articulation with the inferior maxilla. This bone is similar in character, only narrower, in the Sauria, still more elongated in the Ophidia, and in both, especially the latter, moveably united to the mastoid bone. The *parietal* bone is double in the Tortoises, but throughout almost all the Ophidia and Sauria, as in the Crocodiles, and even the anomalous genus, *Amphisbæna*, it consists of a single usually insignificant bone. The two *frontals* are still smaller, and united by a suture in the Chelonia, Ophidia, and some Sauria; the Crocodiles and other Sauria have a single frontal. A pair of bones situated in front of the frontals, frequently separated, as in the Ophidia and Crocodiles, by the nasal bones, may be regarded as *ethmoidal*, or according to others *nasal* bones. They appear to be absent in other Reptilia.

The *Facial bones* exhibit fewer deviations from their normal type in the higher Vertebrata, and admit, therefore, for the most part, of being readily and consistently referred to their analogues in the human subject. In front of the frontals lie generally a pair of mostly elongated *nasal* bones, there being very rarely only a single bone in their place, as in *Moniter niloticus*. Between the squamous element of the temporal and the superior maxilla the *jugal* bone is intercalated; it is of very large size in all the Chelonia and Crocodiles, and is met with in the rest of the Sauria, but appears to be absent in the Ophidia, and its place to be supplied by the external wings of the sphenoid. The *palatal* bones are very generally present, situated between the pterygoid processes and the superior maxilla, and are broad in the Chelonia, very elongated and mostly furnished with teeth in the Ophidia. Between the superior maxillary, nasal, ethmoid, and jugal bones, there is introduced, as in the Crocodile, a bone of tolerably large size, which may be either regarded as a distinct bone by itself, or from the analogy of its position, as a *lacrymal* bone. It would appear to be absent in the remaining Reptilia. The *vomer* is in the majority of instances, as in the Ophidia and Sauria, of large size and double; in the Crocodile, however, it is absent. In the Chelonia this bone is single, and frequently concealed from beneath by the palatal bones. Those bony plates, called *ossa superciliaria* s. *squamæ supra-orbitales*, which are placed in the Lizards upon the edge of the frontal bones, and form the roof of the orbital cavity, are rather to be considered as pertaining to the tegumentary skeleton, than as true bones of the face. The *intermaxillary* bone is generally small and single in the Ophidia, Sauria and Matamata Turtle (*Chelys*); but double in the

rest of the Chelonia and Crocodiles. Externally and behind the intermaxillary is placed the *superior maxillary* bone. This bone is long, and beset with teeth of equal size in the ordinary Serpents, but very short and thick in the Venomous species, where it is hollowed out posteriorly, and supports the poison-tooth or fang. The *lower jaw* consists generally of two halves, which are completely anchylosed together to form a continuous arch of bone, without any trace of suture, in the Chelonia; in the Crocodiles and the rest of the Sauria, both halves are firmly connected by suture and synchondrosis; in the Ophidia, however, they are generally perfectly loose, being connected only by an intervening membranous symphysis, so that they can be separated widely from each other; indications of this separation may even be remarked externally in the groove upon the integument covering the chin. By means of this structure the mouth can be prodigiously expanded so that the Serpents can swallow living prey of much larger bulk than themselves. Each half of the lower jaw consists regularly in the Chelonia, Crocodilia, and most other Sauria, of six bony pieces. The Serpents have at least five, but the venomous kinds probably only three pieces. When, however, all six pieces are present, they are as follows: 1st. Most anteriorly, the large Dental piece (*pars alveolaris*) which, with the exception of the Chelonia, supports teeth. 2d. Posteriorly, the mostly small Articular piece (*p. angularis*) which, either alone, or in conjunction with No. 4, forms the concave joint for receiving the quadratal bone. Between these two terminal pieces, the following, united together by suture, and separable by maceration, are interposed, namely, 3d, the External accessory piece (*p. complementaris externa*) a bony plate, forming the greatest part of the external and posterior wall of the inferior maxilla. 4th. The Posterior accessory piece (*p. complementaris posterior*), which is situated beneath the former, and frequently concurs with the articular in forming the cavity for the os quadratum. 5th. The Anterior or Internal accessory piece (*p. complementaris anterior*), a plate of bone which assists in forming the inner wall of the lower jaw, and abuts anteriorly against the dental piece. 6th. The Coronoid piece (*p. coronioidea*), forming the highest part in the middle of the lower jaw, and which obviously corresponds to the coronoid process in Man and the Mammalia.

Associated with the diversified forms of the several classes of Reptilia, are many peculiar modifications in the structure of the



cranium, which will not admit of being included under the general description already given. Thus, in the Chameleón, long processes invariably project backward from the temporal and parietal bones, and unite to form an arch, thereby occasioning a most singular form of skull. The serpent-like apodal Saurians, as *Pseudopus*, *Anguis*, have the head constructed completely upon the Saurian type, presenting as in them the same style-shaped bone or columella which occupies the place of the large *ala* of the sphenoid. Still more abnormal are the conditions of the cranium in the Saurian genera, *Amphisbæna* and *Trogonophis*, in which, however, the halves of the lower jaw are firmly consolidated; and also in those genera of Serpents, which depart most from the Ophidian type, as *Rhinophis*, *Tortrix*, and particularly *Typhlops*, where the maxillary and nasal bones form in front a hollow bony bladder, the pterygoid bones are represented by long squamoid bones, and the lower jaw, which in the Rattlesnakes consists of three pieces, appears to be formed of one piece, and to be edentulous.

The *Vertebral Column* exhibits remarkable diversities in the several orders of Reptilia.

The vertebræ of the Ichthyic Reptiles (*Proteus*, *Siren*, &c.) have their bodies conically excavated at either end, and the intervals between them filled up by a gelatinous substance, as in Fishes. The number of the vertebræ is remarkable in the elongated bodies of the animals belonging to this order, for 60 are to be counted in the *Proteus*, 80 in the *Siren*, and above 100 in the *Amphiuma*. The vertebræ are divided into those of the trunk and tail; the first of these presenting distinct and often strongly developed transverse processes, and for the most part spinous processes also, which entirely disappear at the extremity of the caudal series. The number of the vertebræ is also very great in the Tailed Batrachia, as in the spotted Salamander and Tritons, where there are 15—16 in the trunk, 20—30 in the tail, the numbers varying somewhat in different individuals. The bodies are concave anteriorly, and convex posteriorly; the reverse of this is, however, the case in the Tailless Batrachia, as the Frogs. These, as well as the Tree-frogs, have but very few vertebræ, there being from 8—9; in *Pipa* there are only 7, with stout transverse processes, which are especially long upon the second and third lumbar vertebræ, to which succeeds the single though large sacral vertebra, the transverse processes of which are particularly broad. A long style or sabre-shaped bone

forming the terminal portion of the vertebral column, and extending nearly to the pubic symphysis, is to be regarded as a caudal vertebra.

In the Ichthyic Reptiles, as also in the Batrachia, with the exception of *Pipa*, the first cervical vertebra or atlas is distinguished by the absence of transverse processes. It never supports any costal appendages in the true Frogs, though these are present in the Ichthyic and Tailed Batrachia under the form of small, pointed, bony processes. The *Pipa*, among the Anoura, has only upon two of its vertebræ a pair of cartilagino-membranous appendages. In *Proteus*, *Amphiuma*, and *Siren*, only from 7 to 8 vertebræ of the trunk, while in Salamander and Triton, nearly all of them support ribs. The *Sternum* is very rudimentary in the Sirens and Tailed Batrachia, being here reduced to some cartilaginous lines and laminae. The Toads exhibit the first traces of a distinct sternum, which, as a short bony piece, projects in them posteriorly into a cartilaginous plate, and abuts against the posterior clavicle. In *Pipa*, this cartilaginous plate is very broad. Besides the posterior, the Frogs have an anterior osseous piece which rests in front upon the anterior clavicular bone. The Serpentine genus, *Cæcilia*, which from its having a scaleless integument, and gills at an early period of its existence, has been referred by systematists to the Batrachia, presents a perfect anomaly in the fact that all the vertebræ, with the exception of the atlas and some few caudal vertebræ, bear short ribs. The number of its vertebræ is also very great, amounting in *Cæcilia lumbricoidea* to upward of 200.

The vertebræ of the Ophidia are short and strong, the bodies concave anteriorly, and provided behind with a spherical head, articulating in a ball and socket fashion with the vertebra next succeeding. The vertebræ are united moreover by means of the anterior and posterior oblique processes, which present eight articulating surfaces invested by cartilage, and surrounded by capsular ligaments, sufficiently loose to admit of a great degree of mobility, but at the same time of an adequately firm union between the several bones. Superior spinous processes, short and broad, are generally met with, and frequently also, inferior spinous processes. The first vertebra, or usually the first two vertebræ, belong to the neck, being destitute of ribs. The succeeding vertebræ, support large, strong, cylindrical and arched ribs, with short appended costal cartilages; they are very moveably attached by concave articulating heads to the corresponding, smooth, rounded transverse processes of