

origin of the nerves to the extremities, but which are wanting in the Ophidia; the genus Bipes among the Sauria possesses only a posterior swelling upon the cord, and Chirotes only an anterior, in accordance with the position of the rudimentary extremities already described. The spinal cord is always traversed by a central canal. The *medulla oblongata* is flattened like that of Fishes in the naked Reptilia, and the rhomboidal sinus is broad and patulous; in the Squamigerous Reptilia this part is more dilated, especially in the proximity of the pyramidal tracts, and the pons is absent. The *cerebellum* arises by two crura, and consists in the naked Amphibia and Ophidia of a hollow medullary layer, which passes as a small narrow band transversely over the fourth ventricle, without covering it completely; in the Chelonia it forms a smooth spherical and hollow swelling, and in the Sauria, as in the Crocodiles, it is provided with one or several lateral transverse grooves. In front of the cerebellum are situated a pair of large oval ganglia, hollow internally, and partly coalescing in the middle line in the naked Amphibia, as the Ichthyic genera Proteus and Amphiuma, but which are of largest proportional size, and distinct from each other in the Frogs, and also in the Sauria; they represent the *corpora quadrigemina*, probably incorporated with the optic thalami. To these succeed the oval *cerebral hemispheres* of considerable size, and which, smooth and devoid of convolutions, give off the olfactory nerves. Within their lateral ventricles is placed, at least in the Crocodiles and Tortoises, an elongated ganglion, which corresponds perhaps to the corpus striatum; and by the side of this is a distinctly developed choroid plexus, while a system of commissures for uniting the double parts of the brain is always met with. The *pineal gland* is very large in the Chelonia, but smaller in the other orders, and lies uncovered by the hemispheres in front of the corpora quadrigemina. Although this gland is met with in all the Amphibia, it is difficult to determine whether it is really present in the Frog. The *pituitary appendage* is constantly present, and of noticeable size. The ventricles coalesce together; the aqueduct of Sylvius is a very wide canal, and the fourth ventricle is quite open and uncovered from above, especially in the Amphibia.

The *Cerebral nerves* admit of being very easily reduced to their analogues in the human subject and the rest of the Vertebrata, and have been traced with the most special care in the Frog, Tortoise, and Serpent.

In the brain of the Frog only eight separate nerves are found, the facial, glosso-pharyngeal, accessory of Willis, and hypoglossal, exhibiting no distinct roots; the facial is still supplied as a branch from the acoustic; the vagus, which arises behind the auditory nerve from the most posterior limits of the medulla oblongata, passes at a right angle through an opening lying to the outer side of the articulating tubercle of the occipital bone; some very delicate nervous radicles, arising from the inferior tracts of the medulla oblongata near to its anterior fissure, unite with it and appear to correspond with the glosso-pharyngeal. Some of the roots of the accessory nerve appear to be absent, and the hypoglossal is given off by the first pair of cervical nerves. In the Frogs, as in all the Reptilia, even the Ichthyodea, which live habitually in water, the olfactory nerves are of very considerable size, and proceed generally from some medullary ganglia situated in front of the hemispheres. The optic nerves are flat and form a chiasma, and at this seat of union there is found a partial decussation formed by the overlapping of several distinct laminiform fasciculi of nervous matter.

In the Tortoises, and probably all the Squamigerous Reptiles, all the twelve pairs of cerebral nerves are to be found, and their roots admit of being traced to the base of the encephalon.

As regards the *Spinal nerves*, their origin by two roots is always very distinct, and those of the Amphibia, especially of the Frogs, are particularly well adapted for the purposes of physiological experiment. Their number varies very much, ten pairs being found in the Frog, and several more in the Tortoise. In the Squamigerous Reptilia the last cervical and first dorsal nerves usually form the brachial plexus; from the lumbar nerves is given off the crural, and from it and the sacral nerves the ischiadic plexus.

The *Sympathetic nerve*, the existence of which was formerly overlooked in the Serpents, has now been proved of general occurrence throughout the present class. In the Frogs the ganglia admit of being very readily demonstrated lying upon the sides of the vertebral column; they are here situated near to those small white vesicles which protrude by becoming swollen chiefly during the spring of the year, and contain numerous microscopic calcareous crystals. The plexuses of the sympathetic nerve unite with the vagus, and by a ganglion with each of the spinal nerves. The sympathetic then enters the skull through the condyloid foramen, and unites with the ganglion of the fifth pair or trigeminus, and also with the other cerebral nerves. The cranial portion of the sympathetic in the Ser-



pent establishes at the base of the cranium communications with the n. trigeminus, vagus, glosso-pharyngeus, hypo-glossus, and also with the facial nerve. External to the cranium we meet with ganglia, which may be compared with the superior cervical and sphenopalatine ganglion. Upon the heart and the greatest portion of the trunk, and upon the internal processes of the vertebral bodies, the sympathetic nerves may be traced as extremely delicate streaks. The ganglia are also very small even in the largest Serpents. In the Crocodiles, the cervical portion of the sympathetic is situated deep within the canal formed by the transverse processes of the cervical vertebrae. The vagus is distributed in the Serpents as far as over a third of the cavity of the trunk.

The lateral branch, that arising chiefly from the nervus vagus, runs along the sides of the trunk as far as the tail, and is of general occurrence in the class of Fishes, is met with also in the Perennibranchiate Amphibia, the Proteidea, and the larvæ of Batrachia; but in the metamorphosis which the latter undergo, it disappears by degrees, and becomes finally reduced to the auricular branch of the nervus vagus, or some tegumentary offset corresponding to the former. In the Serpents and Lizards, no lateral nerve exists.

#### ORGANS OF THE SENSES.

##### *Organs of Vision.*

THE Eyeball with its several component parts, approximates in the naked Amphibia most in structure to that of Fishes, since they live in the same element as the latter, and the globe of the eye having to receive the rays of light through the water, is accordingly flatter in front, and the lens more spherical. In the Squamigerous Reptiles, the structure of the globe of the eye agrees more with that of Birds, yet even in them presents certain characteristic differences, as may be readily perceived, upon examining a longitudinal section of the eyeball. In *Proteus* the eye is very small, but provided with a lens, and the usual tunics; in the genus *Typhlops*, the eye is still more rudimentary. The sclerotic frequently contains a bony plate, or several bony scales united to form a ring, as in Birds. This is the case with the Tortoises, where ten bony pieces may be most usually counted, and in many

Sauria, as *Lacerta*, *Iguana*, *Monitor*. The cornea is more convex than in Fishes, and the anterior chambers of the eye of various dimensions. The choroid coat is very thick, frequently covered externally and internally with a dense layer of black pigment; the ciliary body usually gives off some projecting folds, or ciliary processes. The iris in the Batrachia is invested in front, with a gold-colored pigment. The pupil is capable of a slight degree of expansion; for the most part of a circular form, as in *Pipa*; it frequently, however, as in the Frog and Salamander, presents the figure of a transversely directed nearly rhombic oval; in the Crocodile, and many Ophidia, as the Viper, and Rattle-snake, but without bearing any reference to the poisonous qualities of the Serpent, the pupil forms a perpendicular slit. The optic nerve perforates the tunics of the eye in the direction externally and inferiorly, but usually enters the eye of a rounded shape. The papillary layer of the retina is very greatly developed. The vitreous humor is mostly small in proportion to the lens, which last is in those Reptiles that live in water, very spherical, or else compressed, and frequently, as in *Emys*, elliptical. In several Sauria, as in *Lacerta*, *Iguana*, *Chameleo*, *Monitor*, a feebly-developed process from the choroid, slightly plicated, and invested by a layer of pigment, is prolonged into the interior of the eye, from the point of entrance of the optic nerve, and appears to be analogous to the pecten in the eye of the Bird, though it never has so many folds, there being occasionally only two. The globe of the eye is usually moved by six muscles, four recti, and two oblique or rotator muscles. To those is superadded in the Frog an infundibuliform muscle (*suspensorius oculi*) divided into several fasciculi, which arises, in a manner perfectly similar to that described in the Mammalia, from the bottom of the orbital cavity, and is attached to the posterior part of the eyeball.

The *Protective* and *Glandular appendages* of the eye exhibit very diversified degrees of development in the Reptilia. In the Ichthyodea, the external integument is partly continued over the eye, as a transparent lamella. The Squamigerous Reptiles have for the most part a superior, and larger inferior eyelid provided with a cartilaginous plate, and usually very moveable, and in addition to these, a third internal eyelid, or nictitating membrane. Numerous varieties however occur; thus in *Scincus*, and *Gecko*, both eyelids are small and immoveable; the Salamanders possess only two short eyelids, but the Frog the additional third



one, which is very moveable; in the Chameleon the eyelids form a thick cushion, furnished with a dense muscular layer, and having a small central aperture opposite the pupil. The nictitating membrane of the Frog slides underneath the upper eyelid, and is moved by a mechanism, that reminds us of that already described in Birds. There are found a detractor and an elevator of the nictitating membrane; the latter muscle arises superiorly and in front from the nictitating membrane, and gives off a tendon, which passes through a pulley to beneath the eyeball, perforates the infundibuliform muscle, and terminates by a small muscular belly attached to the posterior angle of the eye. In the Ophidia the eye is covered by a transparent lamella of epidermis, which is shed along with what is called the exuvia or cast skin. Beneath it lies the conjunctiva which is reflected over the sclerotic coat, invests the cornea, and so forms a completely closed sac, which receives the excretory ducts of the lacrymal gland, and conducts the secretion from the latter through a duct between the maxillary and palatal bones into the cavity of the mouth. The *Lacrymal gland* is situated behind the eyeball, and is particularly large in the non-venomous Serpents, as the genus *Coluber*, but also in the Vipers, *e. g. V. berus*, where it was formerly falsely taken from the poison-gland. The Sauria and Chelonia have for the most part two lacrymal glands, an external, the largest, and an internal, smaller; one of these is destined for the nictitating membrane, and corresponds to the Harderian gland. The naked Amphibia do not appear to be furnished with a lacrymal apparatus.

#### *Organs of Hearing.*

THE naked Reptiles completely approximate the Fishes in the structure of their organ of hearing, while the Squamigerous subclass exhibit a higher grade of organization, by the appearance of a true cochlea. The tympanic cavity is absent in the Ichthyodea, and Tailed Batrachia, and both integument and muscles are continued over the external ear; the oval fenestra is closed by a cartilaginous operculum, into which is inserted a horizontal, elongated, style-shaped ossicle, like that in Birds, and called the *columella*; the Eustachian tube is wanting. The tympanic cavity is also absent in the Ophidia, but they have for the most part a columella and operculum. The Anourous Batrachia have in general a membranous tympanic cavity, which commences by an infundibuliform

cartilaginous ring, upon which the *membrana tympani*, uncovered from without, is stretched. The fenestra ovalis is closed by a cartilaginous, slightly concave operculum, upon which the broad end of the columella rests, while to its outer extremity a small cartilage is united, the swollen head of which is fixed upon the *membrana tympani*; the two Eustachian tubes open into the cavity of the pharynx, and occasionally in the middle of the latter by a common aperture. In the Chelonia and Sauria the tympanic cavity receives a partly bony, partly membranous Eustachian tube, which is mostly very short and broad in the Sauria; several of the latter have also the *membrana tympani* covered by skin and muscle. The fenestra ovalis is closed by an operculum, upon which rests the columella, and is united to the *membrana tympani* by a small cartilaginous frequently divided body, that presents a discoidal form in the Chelonia. If we compare this chain of auditory ossicles with those of the Mammalia, the small cartilage united to the tympanic membrane will be found to agree with the malleus, the columella with the incus, and the operculum with the stapes, if not in form, at least in function. Two muscles are found in the internal ear of Reptiles, namely, a *tensor tympani*, and a *stapedius*.

A variety of specialities belonging to the auditory apparatus occur in this diversely constructed class; of these the following are perhaps the most important to be mentioned. The operculum is found in *Cœcilia*, *Amphiuma*, *Siren*, and *Tortrix*, and a small columella, such as occurs also in the true Serpents, in *Amphisbœna*. *Typhlops* and *Rhinophis* have no auditory ossicles. In the Salamander there is situated a membrane upon the fenestra ovalis, beneath the operculum, and a short canal conducts to the vestibule. The *Bufo igneus*, and *Rana cultripes* Cuv., perfectly resemble the Salamanders, in the absence of a tympanic cavity, and they have also, like *Pipa*, only a single opening within the pharynx for the two Eustachian tubes. In the Tortoises, the incomplete canal of the Eustachian tubes is seen at the base of the sphenoid bone, made up inferiorly by membrane; in several, as in the genus *Chelonia*, the columella is lodged in a posterior excavation of the *os quadratum*, which receives the *membrana tympani*, and in *Emys expansa* is in the form of a foramen. The columella is moved by a single muscle. In *Chameleo*, *Anguis*, *Acontias* (in which last the columella even is wanting), and partly in *Pseudopus*, the *membrana tympani* is covered by muscles and integument, but is freely exposed on the contrary in *Ophisaurus*, while in *Chirotes* the whole



tympanic cavity is absent. The malleal cartilage is tripartite in the Crocodile, and round in the Chelonia. No external ear is present in Reptiles, and it is only the highest form of them, the Crocodile, that possesses a rudiment of this structure, under the condition of a double tegumentary fold or flap, the superior portion of which contains in its interior a bony plate, and can be shut down by a muscle like a valve.

All Reptiles have a bony labyrinth lined by a membrane, and completely separated from the cranial cavity, with which it is merely associated by the openings for the passage of nerves; it is situated within the temporal bone, and partly within the latero-inferior pieces of the occipital bone. The vestibule is of varied form and size, and receives the semicircular canals by four or five openings; the external canal is placed horizontally, and the anterior and posterior stand perpendicularly, and have one of the crura common to them both. Two grooves are usually found in the vestibule, and the sac lying within it encloses a friable crystalline cretaceous mass, and in rare instances harder lithic bodies; the membranous canals expand into ampullæ. The cochlea appears to be entirely absent in the naked Amphibia, but on the contrary to be found in all the Squamigera. It is found in its simplest condition, as a rounded cavity with a sac in the interior containing a watery fluid, in the Chelonia. Yet even in them, a round or cochlear fenestra, separated from the fenestra ovalis by a thin septum, is found placed in the direction backward, and closed by a second tympanic membrane. In the Sauria and Ophidia the cochlea is a hollow cone, blunt and somewhat dilated at the apex; it includes a pair of cartilages, which turned toward each other, are clothed by a plicated membrane, upon which, as upon the spiral plate of the higher animals, the auditory nerve expands into delicate filaments; at the extremity of the bony sphere is situated a peculiar retort-shaped sac (*lagena*) which contains the fluid of the labyrinth, and receives, like the vestibular sac, a twig from the acoustic nerve. The branches of the portia dura pass only through the tympanic cavity, and there appears to be a true chorda tympani present. Hollow cells are frequently found in the tympanic and mastoid bones, and stand in communication with the internal ear.

### *Organs of Smell.*

It is a very general character of the Reptilia, and is in relation to their peculiar mode of pulmonic respiration, that the posterior nasal apertures perforate the palatal bones internally, this being the case even in the Ichthyodea, though, however, some genera occur among these, in which, as in some Fishes, the nostrils merely open as small slits behind the lips, as in *Proteus* and *Siren*, while in *Amphiuma*, *Menopoma*, *Acholotes*, &c., the openings of the choanæ or posterior nares are found in the palate. The nasal cavities are frequently lined by a plicated pituitary membrane, e. g. in *Proteus*, as in Fishes. It is rarely, as in *Trionyx* among the Chelonia, that the nose is lengthened out into a small membrano-cartilaginous snout. The nasal canals are in other respects very simple in the Naked and in the Squamigerous Reptilia; in the Batrachia the nostrils are contractile externally. A cartilaginous partition separates the two nasal passages, and cartilaginous plates, invested by mucous membrane, and which correspond to the turbinated bones, clothe the rest of the nasal parietes, and project slightly beyond the bones, as cartilaginous external nasal organs. The nasal passages are of greatest length in the Sauria, as the Crocodile, and are frequently expanded in front, in the form of a pouch, and, as in the Cetacea, can be closed by valves; feebly developed cartilaginous, or bony turbinated organs are also present. Besides the olfactory nerves which pass through small ethmoidal plates, and divide and ramify in a simple manner, a twig also from the fifth pair of nerves is distributed chiefly to the external part of the nose. A special nasal gland is found in many Serpents, constantly situated between the superior maxillary, lacrymal, and nasal bones, and having a proper excretory duct, that opens into the palate. The *Cœcilia* and many Serpents have also an orifice between the nose and eye, which leads into a small blind sac, from which arises a small tentacle; the function of this organ is unknown.

### *Organs of Taste and Touch.*

Although it is doubtful whether the members of the present class are endowed with a distinct sense of taste, this is certainly not the case with the Land Tortoises. Reptiles swallow their food nearly



whole, and the *Tongue*, though frequently developed to a very great degree, seldom exhibits an organization adapted for the exercise of the gustatory function. The tongue is very variously formed, being but slightly developed in many genera, and in some instances scarcely projects from the bottom of the mouth; it is for the most part however freely moveable, frequently more or less deeply divided, and surrounded at the root by a membranous sheath.

The tongue is developed in the most imperfect manner in the lowest order, or that which comes next to the Fishes, and is actually wanting entirely in the Proteus and Siren, though this is the case in some other Batrachia, as Pipa. In the Tailed Batrachia, as the Salamanders, the tongue is attached to the floor of the mouth. In the Frogs and Toads the tongue, which is soft, and lubricated by a viscid secretion, is free and bifurcated posteriorly, but on the contrary, is broad where it is attached in front behind the symphysis of the lower jaw, and under this form is admirably adapted for being flung out of the mouth with rapidity, to seize the prey that adheres when touched to its apex.

Among the Tortoises the tongue in the Marine species, at least in Chelonia, is small and hard, slightly moveable in Emys, and provided with depressions. In Testudo, on the contrary, it is more manifestly constructed as an instrument of taste, being beset all over with small soft papillæ.

In the Serpents the tongue is soft and smooth, generally long, highly moveable and protrusile, slit at the apex, and surrounded at the base by a sheath. The tongue is exactly similar in many Sauria, as in the true Lizards, where it is very deeply slit, especially in the genus Monitor; it is entire, though at the same time retractile, in most Apodal Sauria, as Anguis, Pseudopus. The smooth apapillary tongue of the Crocodile is very flat, depressed, and united by its whole extent to the floor of the mouth.

The Chameleon is remarkable for the peculiar structure of its lingual organ. It is very large and protractile, can be stretched out to a great length like a worm, is traversed by a central canal, and terminates in front by a kind of fleshy disc, which is concave, and covered by a viscous secretion. The creature is able to dart out the tongue suddenly to seize the prey that adheres the instant it is touched to the tip of the organ, which is so extended during the act as to appear even longer than the entire body; the exercise of this function depends upon the peculiar structure and arrangement of the lingual muscles. During rest the tongue lies retracted

within the mouth, lodged in a deep groove of the palate, and enclosed within a long sheath.

The *Lingual bone* of the Reptilia, which supports the tongue, exhibits great diversities, and in the Ichthyodea it resembles most that of Fishes. It consists in them of one or two middle azygos pieces lying behind each other, and supporting in front a broad cartilaginous plate. A pair of lateral pieces represent the anterior cornua, and serve to attach the lingual bone, through the intervention of ligaments, to the skull. Posteriorly, the single piece coalesces with the superior pieces of the branchial arches, which represent in some respects the posterior cornua. In the Batrachia, *e. g.*, the Frog, a similar structure is met with in their tadpole or larval state. At a later period of existence, after the disappearance of their branchiæ, the parts blend more together, and there remain a middle piece or body, a pair of anterior flattened, and a pair of lesser posterior, cornua. In the Chelonia, the lingual bone is very different, and consists frequently of a great number of pieces, amounting even to 20 in Trionyx. A single median body is however invariably present, and two pairs of cornua, the posterior of which usually consist of several pieces; occasionally a very small third pair of cornua is appended to the body in front, as in Emys. The lingual bone of the Ophidia is very simple, for here the body is entirely wanting, and there are present only the anterior cornua, as a pair of long cartilaginous filaments, connected in front by ligaments. In the Lizards a very delicate cartilaginous filament (*appendix styloidea* Losana) unites the small body of the lingual bone to the skull. The structure of the body of the bone in the Crocodile is directly the reverse, being flat, very large and broad, with only the posterior pair of cornua occurring as appendages. In the rest of the Sauria the middle portion or body is prolonged into a fine cartilage which penetrates the substance of the tongue; two pairs of cornua are found, whereof the anterior are by far the longest, and frequently present several curves; the posterior pair are more simple, regular in form, and always consist of bone. Occasionally, as in the Lizards proper, the body is slit posteriorly into two crura, or processes, which correspond to the single process in Birds. In Ophisaurus and Anguis the anterior cornua are entirely cartilaginous, and the body is very small in Amphisbæna, so that these structures conduct at once to those already described as existing in the Serpents.

As regards the *Muscles*, the tongue is furnished with a protract-