VI. "On the Structure and Development of the Skull in the *Lacertilia*. Part I. On the Skull of the Common Lizards (*Lacerta agilis*, *L. viridis*, and *Zootoca vivipara*)." By W. K. PARKER, F.R.S. Received October 18, 1878.

(Abstract.)

The youngest, and therefore the most important, embryos that have been worked out in this present piece of research, were sent me, with those of the snake, by Dr. Max Braun, of Würzburg.

Other valuable specimens were the gifts of Professor T. Rupert Jones, F.R.S., and Professor Alfred H. Garrod, F.R.S.

The *three species* worked out are closely related, and two of them are native to this country: these familiar *Sand Lizards* are amongst the smallest, and yet the most highly specialized, types, to be found among the Reptilia.

This type may be taken as a sort of "norma," and by it all the other Lacertilia may be measured, as it were, when their height in the Reptilian scale is to be determined.

When such forms as *Hatteria* and the chamæleon are compared with a typical Lacertian, then we see how much there is that is generalized in those outlying species.

Putting together what I have learned as yet of the structure of the skull in the true Reptiles, and comparing what is seen in these cold-blooded Sauropsida with what is seen in the hot-blooded bird, I have come to the conclusion that the common lizard is a *culminating type*.

The snake, the tortoise, and the crocodile, notwithstanding their own peculiar specializations, are yet more *general* in their nature than the nobler and higher kinds of lizards: this is especially shown by the number of characters that are, in the latter, in conformity with those of the bird.

And, indeed, with the *high* or Carinate bird; for the skull of the Ratitæ (ostrich and cassowary) does not undergo, in several things, so much metamorphosis as the skull of the typical lizard; for, as I showed long ago, these birds are not devoid of a *Batrachian* strain.

Of all the lizards known to me the chamæleon is the lowest; in some respects the Chelonians come nearer the higher Lacertilia than that *bizarre* type does. I have carefully worked out the skull in the adult and the ripe embryo of the common kind, and in the adult of the *dwarf* species.

In several things the lizard's skull is but little modified from that of the snake; this is especially seen in the nasal structure, its glands, and the bones of its floor; so largely illustrated in my last paper.

These things are not repeated in the Chelonia and crocodiles, nor do they exist in the chamæleon; but in many birds, especially the

"songsters," these curious specializations reappear, but the parts are lessened and modified.

Even many of those metamorphoses of the skull, which when I worked out that of the chick seemed to me to be peculiarly *avian*, and indeed not to be found amongst the almost *reptilian* Ratitæ, now turn out to be *lacertian* also.

For instance, the separate cartilages that pad the "basi-pterygoid processes" of the skull and the pterygoid bones, at their articulation, these appear in the lizard; and even the division of the *septum nasi* from the ethmoidal wall begins in *Lacerta*, and other lizards.

That separation of the two regions has its explanation in the higher birds, whose fore face hinges on the skull; notably in the parrot.

In *Lacerta* it is a mere "fenestra," of no use to the creature; so it is in the semi-struthious Tinamou, and in some low, Southern passerine birds, *e.g.*, *Grallaria squamigera*.

But in the huge Ratitæ it is as absent, as in the Chelonia, and the low chamæleon.

This latter kind has no column-shaped bone on the pterygoid ("epipterygoid"); that bone exists but is small and modified in the Chelonia; in birds, especially the "*songsters*," it is manifestly a *process* of the pterygoid, but I have never seen it as a distinct bone.

These are some of the more striking characters in the skull of the adult lizard and its *sauropsidan* relatives, namely, snakes, tortoises, crocodiles, and birds: the latter, it may be remarked, differ less in their structure from a lizard than many an imago-insect does from its pupa.

I have a strong suspicion that the serpent is degraded as well as more ancient and generalized, as compared to the lizard: it has manifestly lost its limbs, and the correlate of that loss is an arrest of the cartilaginous cranium. The small rudiments of orbitosphenoids and alisphenoids, seen in the snake, are no longer an anomaly and unexplainable: they are patches of the large tracts in the lizard, which has, contrary to what I long believed, a large alisphenoid on each side.

This part is not a continuous flap of cartilage: in the bird it is, but it always has a great fenestra in its middle, even in them; in the lizard it is multi-fenestrate—a mere basket-work of cartilage, feebly and partially ossified.

In its auditory structures the high Lacertian corresponds very closely with the tortoise and the crocodile, and these three kinds differ only in non-essentials from the bird.

The snake and the chamæleon lie below them all, but the chamæleon is lower than the snake, and has a worse ear than most frogs and toads. The lower jaw of the lizard and the nestling bird agree very closely. The remains of the hyoid and branchial arches are far more ichthyic in the lizard than in the bird.

From familiar things I pass to things little known; that is, to the early stages of the lizard.

In the early stages I cannot confine myself to the nerve-supporting organs, but, of set purpose, let my work overlap that of my friend Mr. Balfour, who is, to me, the typical embryologist; Mr. Milnes Marshall's excellent papers, however, are not forgotten.

Much that is figured of the earlier stages is not described; my illustrations can, however, easily be compared with those of the *chick* in Foster and Balfour's work; and with the copious and exquisite illustrations given in Mr. Balfour's work on the "Elasmobranchs."

The reader is asked to refer to these works, especially the latter; that he may see how perfectly my observations on the embryo of the lizard correspond with what Mr. Balfour has discovered in other types.

Some of the most important of them relate to structures that must be well understood before we can gain even the most elementary conceptions of the morphology of the vertebrate skeleton.

These are—the brain and main nerves; the sense-capsules; the respiratory openings (clefts) through the wall of the throat; the "pituitary body," and its relation to the mouth and brain; and the extension into and subdivision of of the pleuro-peritoneal cavity in the head, even in front of the mouth.

The modification of the "segmental" muscular masses in the head; the difference between the axial structures of the head and the body; all these things have to be carefully attended to.

I will now propound my own theory of the skeleton of the head and throat, as compared with the skeleton of the body generally, namely, the spine and thoracico-abdominal cavity.

The undivided condition of the paired tracts, on each side of the notochord, which is so constant in the head, is the original state of things; the head is archaic, the trunk, with its vertebræ intercalating with the muscle-plates, is a much more modern result of evolutional metamorphosis than the undivided head; the limb-girdles and limbs are the newest of all.

Archaic entomocranial Vertebrates, had no vertebræ, properly speaking; they had a long head, composed of fourteen or fifteen segments; their throat was a large multiperforate bag; and instead of having one vagus nerve, they had seven or eight pairs of vagi, forking over all the respiratory passages, except those supplied by the glosso-pharyngeal and portio dura.

Some of them were like Cæcilians; they had long, vermiform bodies, and scarcely any tail behind their anal opening; they had no finished vertebræ, but a semi-solid, half-cartilaginous tube, surrounding the notochord.

Others were a sort of exaggerated tadpoles; they were the fathers

of all such as gradually improved into the larval condition (for a long while permanent) of the modern Batrachia, but they were *Ametabolous*, or arrested.

These ancient bull-heads had a huge pharynx, under which, more than behind, a very short abdomen was swung, with a snake-coiled intestine; their body was a mere lash, like the lash on the tail of the larva of the smooth newt and *Dactylethra*, and the lash of the tail of the adult *Chimæra*.

The forms from which the Marsipobranchii on the one hand, and the *Chimæra* on the other, sprung, were intermediate between the two extreme forms imagined; they were, however, close akin to the primordial tadpole.

What the pituitary body was, at that time, when the meso-cephalic flexure just appeared; how the vesiculation of the neural axis arose; and whether the sense-capsules were at first paired or unpaired; of these things I will speak when I have obtained more light upon this dark subject.

But, even in the foggy illumination of the present, we can make out that even the term "the vertebral theory of the skull," is absurd; vertebræ, as such, are a late specialization of a segmented creature, whose mouth is opposite its nervous axis, and on the same aspect as its main circulating organ (hæmostomous).

For a long while there was no definite division into head and body; the Selachians show this to this day; their investing mass or parachordal tracts run on from the head into the body without division: the occipito-atlantal articulation is very late in its appearance.

Moreover, both the lamprey and *Heptanchus* show (or indicate) that the head of modern Vertebrates has been greatly shortened—much more than their throat; the cervical vertebræ are new segments of the axis, intercalated at that part, to bind the shortening head to the retreating body.

This view is curiously strengthened by an observation of Mr. Balfour's, with regard to the formation of "somatomes" in the cervical region of the chick; the foremost do not appear first, but the 4th, 5th, 6th, &c., are to be seen first, and then the three front segments.

Dr. Milnes Marshall's observations on the segmental nerves of the chick,* showing that the third, or *motor oculi*, is as good a segmental nerve as the great 5th, or trigeminal, and that the olfactory or first nerve is developed exactly in the same manner as the other cranial nerves, namely, from the dorsal region of the "epiblast;" these discoveries, I think, are of the greatest importance, and are very suggestive.

* See "Quarterly Journal of Microscopical Science," vol. xviii, New Series, Plates 2, 3, pp. 1—31.

Even those who are content to work at the development of the lowlier types, such as the worm and the cray-fish, are helping at this good work, for they are throwing light upon the evolution of the Vertebrates.

VII. "On the Chemical Composition of Aleurone Grains." By Sydney H. Vines, B.A., B.Sc., F.L.S., Fellow and Lecturer of Christ's College, Cambridge. Communicated by Dr. Michael Foster, Prælector of Physiology in Trinity College, Cambridge. Received October 22, 1878.

I. *The Aleurone Grains of the Blue Lupin.* (*Lupinus varius.*)

The proteids stored up in the seeds of certain plants, more especially of Leguminosæ, have been stated by various observers to exist in the form of the vegetable caseins such as Legumin and Conglutin, and this view has been advocated of late years more particularly by Ritthausen ("Die Eiweiss-Körper der Getreidearten, &c., 1872"). In 1877, Weyl published some observations ("Zeitschr. für Physiol. Chemie, Bd. I), which tend to show that the proteids exist in the seeds of these plants in the form of globulins, and that the caseins, extracted by Ritthausen and others, are the products of the alteration of the globulins effected by the reagents (alkaline solutions) used in their extraction.

In order to be in a position to form a decided opinion upon the subject, I first repeated Weyl's experiments, using the seeds of the blue lupin. I found that on treating the ground seeds with 10 per cent. NaCl solution, I obtained a fluid which gave all the reactions characteristic of fluids which hold globulins in solution. On dilution with water it gave a precipitate of a substance soluble in 10 per cent. NaCl solution (vitellin); and on saturating it with NaCl (rock-salt), a substance (myosin) was precipitated which was soluble in 10 per cent. NaCl solution.

With the view of ascertaining the value of Weyl's suggestion, that the casein (conglutin, Ritthausen) contained in the lupin was a product of the alteration of the globulin under the action of an alkaline solution, I made the following experiment: — About 50 grms. of the ground lupin-seeds were placed on a filter, and 250 cub. centims. 0·1 per cent. NaHO solution poured over them. The fluid ran through in a few minutes, and was found to give the reactions characteristic of alkaline solutions of vegetable casein (*see* "Sachsse, Chemie und Physiologie der Farbstoffe," &c., 1877, p. 267). The residue on the filter was then well washed with distilled water until the washings ceased to give an alkaline reaction. It was then treated with 250 cub. centims. 10 per cent. NaCl solution, and on testing the filtrate it was