

II.—*On the Form and Use of the Facial Arches.*

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PLATE CII.—C.

HAVING had an unusual amount of leisure this summer, I have been able to work with the microscope once more, and thus be the recipient of no little pleasure and profit; but, as my time is very swift-winged, it is not proper that I should run from one pretty thing to another. I have had, this time, one subject—the Salmon's Skull.

Those who consider the salmon from merely a dietetic point of view will be shocked to hear that my friends, Messrs. Waterhouse Hawkins, F. Buckland, and Henry Lee, have, together, supplied me with some two hundred specimens. These, however, were not full-grown individuals, but fry and embryos, as yet unhatched. These last have lost their chance of living as salmon, but I hope that they, many of them, will live for ever in the Transactions of the Royal Society; their portraits and descriptions of their personal appearance will be offered to that great good mother of all our Scientific Societies.

It occurred to me, however, that a sketch of the face of one of these water-babies might be acceptable to this pleasant daughter-society.

And here let me say that, when once we know all about the face of infantile salmon, we shall be well prepared to discuss the form of the first foundation of our own face and features. I have not made many alterations in my mode of working this time, but one or two "wrinkles" have been developed.

Firstly, it is better to preserve the eggs and fry in strong spirit, and then to place them in a solution of chromic acid for a week or two before they are dissected; except in some instances, when I want to use high power on thin slices as transparencies, I eschew glycerine. It is better to keep the little preparations in a watch-glass, still preserved in a solution of the acid. This saves them from losing their good yellow colour; in glycerine they become bluish-white, and are bad for examining as opaque objects.

Another thing is the comfort of using only clean water; great irritation of the nerves, to say nothing of the temper, is apt to be produced by the discomfort of feeling one's fingers sticky when working with the glycerine. This is no little matter to a worker with the microscope, for the eyes and brain become intensely weary in such sharp-sighted researches, and the least interruption is apt to injure the calmness of the observer when he is highly strung. One most excellent effect of the chromic acid is, that it preserves, and even increases the lilac tint of hyaline cartilage; that it makes

the soft brain substance as solid as cheese without shrinking it ; and that it gives a rich umbre tint to thin laminae of bone, so that in opaque sections the finest layer—the merest trace of a membrane-bone—can be seen. I have tried a solution of chromate of potassæ with a little sulphate of soda added, as recommended in ‘Stricker’s Histology,’ but I have not found any particular advantage in its use above that possessed by the acid.

Now for the facial arches. The young salmon has one more arch in front of the mouth, and one more behind, than the frog, that is to say, the larval frog: it has, under the head, nine arches in all, two in front of the great mouth-slit, and seven behind it. The first arch, or pair of rods, is the trabecular arch formed by the “rafters of the cranium”; the second is the pterygopalatine; the third, the mandibular; the fourth, the hyoid; and the remaining five are the branchial. The last arch is imperfect and functionless as to respiration.

Speaking of the science of “form,” or morphology, let me say, in passing, that it would be a very simple matter if the primary form were fixed; but this is seldom the case, and the original parts undergo a large series, in many cases, of changes, both in form and tissue. This is the case most remarkably in the facial arches of the osseous fish, especially in the two in front and the two behind the mouth. Yet the primary form of these nine arches is the same, as my simple diagram will show (Plate CII., Fig. C).

My earliest observations on these have been made upon very young, thin, unsymmetrical embryos, with a rudimentary solid heart, and with the head flat at the top, and just projecting free from the yolk-membrane. The arches were distinguishable by being granular, but hollow, lying in the midst of, and enclosing, nearly liquid protoplasm. The foremost point most forwards, below, and the hindermost are placed almost transversely across the rudimentary throat; but they all have one shape, *viz.* that of the letter S, the upper part being most hooked inwards.

The first pair, the “rafters,” together, have a lyre-shaped appearance as they diverge a little in front, and are strongly bowed behind. The next, or palatine pair, are at first merely semicircular, but they become S-shaped afterwards. All those behind the mouth have a remarkable similarity of form, although the two first of these are larger than those that follow; they all gradually decrease in size, from before, backwards. In the vertebrate animals, generally, these arches have the same form, that is, as far as our researches go; the amount of modification possible is therefore something marvellous. I was not at all surprised to find this S-shaped hooked form of arch in the gill-apparatus of the fish, because there it is persistent, and the inturned tops of the bars are bare of *gills* and carry teeth, which are antagonized by the teeth of

the fifth or gill-less arrested arch. Here the primordial form serves throughout life, and is very gently specialized for life-function. But it was the first pair which most struck me with the beautiful *prospective harmony* between morphology and final purpose, for the same curve inwards at the top, which is so apt for the formation of the crushing apparatus of the fish's throat, here serves to wall-in the pituitary body, and thus form the primordial "Sella turcica" or *Turkish Saddle*. Again, the next arch, which crescent-like, forms an elegant ledge for the huge eye-ball to rest upon—this arch must needs, as soon as it is freed from the pressure of the precocious visual organ, curve itself inwards at the top. By doing this, it exactly applies itself to the front edge of the succeeding arch, to which it is soldered in a week or two after hatching. The arch of the lower jaw and the arch of the tongue have the same advantage in the upper hook, and all the secondary attachments and delicately beautiful adaptations, as they become specialized, all these, I say, give voice to the morphological importance of the primary curve. It would be endless to go into the use of the facial arches in the various tribes, for, when there are no gills developed, as in reptiles, birds, and mammals, the two pairs of horns attached to the bone of the tongue (hyoid), the arch of the lower jaw, the arch of the palate, and all the base of the nasal septum, and of the skull itself, as far backwards as to the exit of the optic nerves—all these parts are derived from the simple S-shaped facial rods. But there is an exquisite instance of special use which I cannot pass over; it is in the class of birds. In these, as in all vertebrates above the amphibia (newts and frogs), the only gill-arch developed is the first, and this is gill-less, but is made to subserve other functions. In most birds, this arch reaches as far as the occipital plane, but in humming-birds and woodpeckers these horns are of extreme length and slenderness, and reach as far as to the fore-end of the cranial roof. These elongated rods form the skeleton of the long worm-like protrusible tongue, and enable it to be shot out without a moment's notice, so that the nimblest of insects are caught "or ever they are aware." A function so new in a gill-arch would seem to ask for a large amount of metamorphic change of form. It is not so; this arch in those birds retains exactly its primordial curve. We must still study *form* free from all final purpose, bias, and preconception; but a new and delightful phase of teleology will set in when the laws of *form* have been mastered. A man may run whilst he is reading the large plain characters in which final purpose is written, but he must be as good a *sitter* as the best hen in a farmyard if he would add anything of value to the science of *form*.
