REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL"*

II.

IT is well known that the eggs of sharks and rays, when deposited, are enclosed in a strong horny capsule or "purse" formed as a secretion from the oviduct. In both groups these curious appendages have the form of a pillow-case, the corners being pointed in the rays, and produced into long tendril-like processes in the shark and dog-fish. The embryo remains enclosed in the purse until about six months after oviposition, and it is during this period that all the most important metamorphoses are gone through.

The youngest embryo described was nearly an inch

Fig. 3

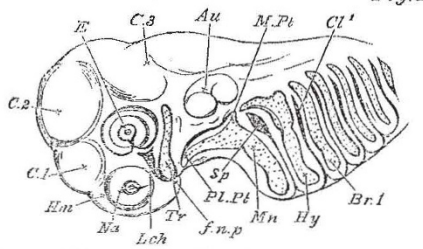

FIG. 3.—Head of Embryo Dog-fish, 11 lines long. Lch, lachrymal cleft; C 1, 2, 3, Cerebral vesicles; Hm, Cerebral hemispheres; fnp, fronto-nasal process; Sp, Spiracle. Other references as before. The visceral arches are dotted for distinction's sake.

long, an extremely active little creature, attached to a yolk-sac about $\frac{3}{4}$ of an inch in diameter. In this stage the head and branchial region are large and conspicuous, the body slender, and tapering off to a long thread-like tail. The dorsal laminæ have completely united, leaving, however, a very thin covering to the hinder division of the brain, which consists of the three primary cerebral vesicles (Fig. 3, C 1–3), bent over the end of the notochord in such a way that the second, or middle division, forms the anterior termination of the head; the "cerebral flexure" is, therefore, complete. The future hemispheres (Hm) have already appeared as small buds from the fore-

Fig. 4

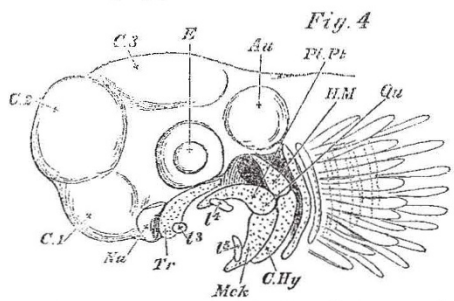

FIG. 4.—Head of Embryo Dog-fish, $1\frac{1}{6}$ in. long. References as before.

brain (C 1). The nasal, visual, and auditory organs are in an extremely rudimentary condition. On the under surface of the head is the large square mouth, bounded above by the fronto-nasal process (fnp), a shield-shaped elevation of the integument between the nasal sacs, found in the embryos of even the highest vertebrata, but persistent in the sharks and rays. Beneath the eye, and communicating by a slit running below the inferior boundary of the fronto-nasal process, is a cleft (Lch) answering to the lachrymal passage of the higher vertebrata, and formed by the shutting off of a portion of the original first visceral cleft by the growth of the pterygo-palatine arcade. This cleft, persistent in the higher animals, is a transient structure in the Elamobanchs. One of the most noticeable features in the embryo at this stage is the presence of a number of long filamentous external gills, each containing a single capillary loop; of these about ten spring from the hyoid and each of the branchial arches, while four much shorter ones project from the future spiracle, and are attached to the mandibular arch. The internal branchiæ are at present functionless, and form mere cog-like projections on the arches.

The embryo at this age is so transparent, that the visceral arches can be seen with sufficient distinctness through the skin without any dissection whatever. Even at such an early period, the anterior face-bars already begin to show signs of segmentation, there being constric-

Fig. 5.

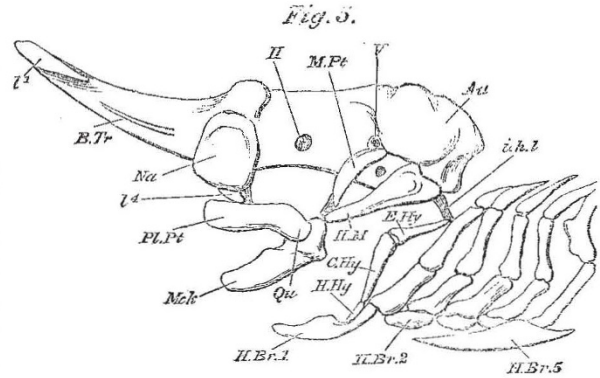

FIG. 5.—Skull of Ray. M Pt, Spiracular cartilage; ihl, inter-hyal ligament.

tions in the mandibular and hyoid arches, where division will afterwards take place. The upper part of these arches has assumed the pedate form which is taken on at a later period by the branchials. The pterygo-palatine arcade is already as large proportionally as in the adult, the true apex of the mandibular arch being reduced by its outgrowth to a mere tubercle (M Pt).

Granular subcutaneous thickenings have already appeared in relation with the face-bars; these are the extra-viscerals. In the same unchondrified condition are the parachordal and paraneural elements of the skull.

Embryos of $1\frac{1}{6}$ and $1\frac{1}{2}$ in. in length possess external gills

Fig. 6.

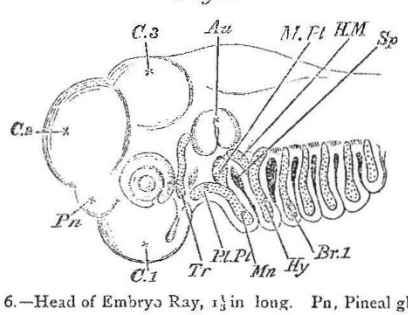

FIG. 6.—Head of Embryo Ray, $1\frac{1}{3}$ in long. Pn, Pineal gland.

two or three times as long as in the preceding stage those on the mandibular arch having already shrunk and begun to form the pseudo-branchia; the internal gills are still functionless. The eye is completely formed. The investing mass and the nose and ear capsules are chrondified, but the two halves of the former are still separate, and the roof and walls of the cranium membranous. To make out clearly the relations of the facial arches, it is now necessary to dissect away the skin (see Fig. 4); it is then seen that the process of segmentation has advanced greatly, the arches behind the mouth being split up as in the adult, and differing from those of the full-grown shark only in form. The trabeculæ have become flat-

* Continued from p. 426.

tened out from above downwards, but are still separate, and the lower-jaw arch, besides being divided into paleto-quadrate and Meckel's cartilage, has approached still more nearly to the adult character by the conversion into fibrous tissue of its apex (Figs. 2 and 3, M Pt).

The third stage described was a ripe embryo, about two inches long, having nearly the form of the adult. In this condition the external gills have entirely disappeared, the internal gills now performing the whole function of respiration. The skull has assumed all the characters of the adult, except as regards a few minor details, chondrification and segmentation being perfect. The investing mass has not only completely enclosed the notochord, but has formed an arch, like that of a vertebra, over the hinder part of the brain: in this way the occipital region of the skull is formed. The roof and walls of the brain-case, membranous in the last stage, have now become cartilaginous, and are fused with the nasal sacs in front, the trabeculæ below, and the auditory capsules and occipital region behind. The trabeculæ form the whole of the flat skull-floor in front of the ear capsules, where their original apices (pharyngo-trabeculars) are still to be seen as small rounded processes; they have completely coalesced behind, but are merely in apposition between the nasal sacs. The basi-trabecular (Fig. 2, B Tr) is small, and the first pair of labials (l^1), which together with it form the "cutwater," are flat, and widely separated; the snout is consequently much blunter than in the adult. The hypo-trabeculars (cornua trabeculæ of Rathke) occur as two inturned S-shaped filaments of cartilage on either side of the basi-trabecular: no trace of them is to be found in the adult.

III.—*Skull of the Ray or Thornback* (Raia clavata).—On the whole the skull of the ray resembles very closely that of the shark; in some respects, however, it approaches more nearly to the higher fishes, and in others, again, retains a lower or more embryonic character.

One of the chief points of difference between this type and the preceding is the much greater elongation of the skull, chiefly owing to the immense development of the basi-trabecular (Fig. 5, B Tr), which is produced to form the long, stout rostrum, the apex of which is strengthened by the first pair of labial cartilages (l^1). The region between the orbits is much pinched in, while the nasal and auditory regions are extremely broad, the nose capsules, especially, being as far apart as in the embryo shark. On the upper surface, the prominences (epiotic, pterotic, sphenotic) already described in the shark, are seen; but instead of one, there are two fontanelles, an oval one between the nasal sacs, and a second of an oblong shape, in the more normal position, between the orbits. On the under surface of the nasal capsules are seen the second, third, and fourth labials, forming a valvular apparatus for the nostrils; the fifth labial and the extra-branchials are absent.

The upper and lower jaws or dentigerous arches closely resemble those of the shark; the opening of the mouth is, however more completely on the under surface of the head, as in the embryo Squaloid. In the front wall of the spiracle a semi-lunar cartilage (M Pt) is found, connected by ligament with the auditory capsule above, and with the angle of the lower jaw below, and having the same relations to the fifth and seventh nerves as the meta-pterygoid ligament of the shark (Fig. 2, M Pt), or the bone of the same name in the osseous fish; this, therefore, is the true apex of the mandibular or first post-oral arch.

There is no mistaking the hyo-mandibular (H M) a cartilage having precisely the same connection and relation to the hinder division of the *portio dura* as the part similarly named in the shark, but much more slender, pointed below, and inclined forwards. The remainder of the hyoid arch, however, has taken on an entirely new character, and shows a marked advance towards the Teleostian type, being attached, not to the lower part of the hyo-mandibular, but to its upper posterior angle, by means of a band of ligamentous fibre, answering to the small styliform bone (stylo-hyal of Cuvier) which in the osseous fish connects the free portion of the hyoid with the suspensory apparatus. The gill-bearing part of the hyoid is slenderer than in the shark, and more highly segmented, being divisible into epi- cerato-, and hypo-hyals (E Hy, C Hy, H Hy); the basi-hyal or keystone-piece is absent.

The branchial arches differ from those of the shark chiefly in the great development of the inferior segment or hypo-branchial. The first of these (H Br. 1) is much extended, and, uniting with its fellow of the opposite side, forms a transverse bar behind Meckel's cartilage. The second, third, and fourth hypo-branchials are broad adze-shaped plates, while the fifth is coalesced with its fellow in its hinder half, and extended forwards, so as nearly to meet the corresponding piece of the first arch.

The youngest ray described was an embryo of *R. maculata*, $1\frac{1}{8}$ inch long, taken from the purse at about the seventh week from oviposition. The body proper is not larger than that of the first stage of the dog-fish, the greater length being due to the immense development of the tail. The pectoral fins, which by their expansion and union in front with the head, give to the adult ray its peculiar depressed form, are at this age small semi-elliptical lobes, one on each side of the umbilicus or point of attachment of the large yolk-sac. Six or seven long branchial filaments, expanded or spatulate at the end, are attached to the hyoid and branchial arches, but none are apparent externally on the mandibular.

The facial arches are visible in a side view with perfect distinctness, and have already advanced considerably in segmentation, the apex of the mandibular being on the point of separation so as to form the spiracular cartilage, and the proximal end of the hyoid being cleft vertically, thus separating the hyo-mandibular from the epi-hyal.

Three months after oviposition, although the yolk-sac is still as large as a small walnut, the embryo has completely taken on the adult form, the pectoral fins having enlarged greatly, and brought the gill-slits to the ventral surface; from these the external branchiæ still project, being now in the form of long threads, almost like the hyphæ of a fungus; the first cleft behind the mouth (tympano-eustachian) remaining on the upper surface has taken on the form of the spiracular opening.

In the skull very few embryonic characteristics are left, the chief being that the brain-case is rounder, the rostrum shorter, and the two first labials separated from it by a slight interval, instead of being in perfect apposition.

METEOROLOGY OF THE WEST INDIES

THE hurricane season, here reckoned from July 25 to October 25, went by without damage so far as the Windward and Virgin Islands are concerned, though not without disastrous examples of the phenomenon from which it derives its name elsewhere. Two cyclones of the ordinary kind have in fact visited these seas during the above period; and although neither of them included the island of St. Thomas in its range, yet they passed sufficiently near to make us aware of their existence, and to create considerable alarm among the inhabitants.

The first of these appears to have originated about lat. 10° N. long. 55° W., on or near August 10. Taking a north-westerly direction it passed parallel with, but at a considerable distance from the Windward islands, where from August 11 to 13 the weather showed signs of great disturbance with violent squalls, that shifted to every part of the compass; while at Martinique in particular, where