XV.—*The Skull and Visceral Skeleton of the Greenland Shark,* Læmargus microcephalus.

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Some time ago, at the request of Professor EWART, I undertook an examination of the skull and visceral skeleton of the Greenland shark, *Læmargus microcephalus.* This I readily consented to do, not only because no attempt had yet been made to describe these structures in this shark, but because they claim careful consideration in view of the recent work by Professor EWART on the cranial nerves of Elasmobranchs.

In this paper I shall endeavour, without entering into too much detail, to point out some of the more salient features of the skull and visceral skeleton of Læmargus, and to compare them with those of other Elasmobranchs where that seems necessary.

I have made preparations of the above-named structures from the heads of several specimens of Læmargus. The sharks from which the heads were taken were of various sizes, the smallest being about six feet in length, and the largest twelve. As might have been expected, the skeletal parts of these heads are very similar to each other, but I have noticed among the few specimens I have examined points of difference, which make me wish I had a larger number of preparations at my disposal, to enable me to decide the more usual conditions.

THE SKULL (Plate I.).

Following the example of GEGENBAUR, I shall, for purposes of description, speak of the skull as consisting of four regions, viz., the occipital, the auditory,* the orbital, and the ethmoidal regions. The occipital region, which is in part continuous with the vertebral column, lies behind the canals for the pneumogastric nerves; the auditory extends from these canals forwards as far as the wide canals for the transmission of the trigeminal and other nerves; the orbital region, situated in front of the auditory, may be said to lie between the post-orbital and pre-orbital processes; the part of the skull in front of the orbital region forms the ethmoidal region.

The Occipital Region.

This region, which is small compared with the other cranial regions, is in part continuous with the vertebral column, and lies, as above stated, behind the canals for the

* GEGENBAUR terms this—Labyrinth-Region.

pneumogastric nerves. Owing to the oblique direction of these canals from within outwards and backwards, the region is marked out somewhat in the form of a V. The apex of this V is directed forwards, and its short backwardly-directed limbs receive the anterior portion of the first vertebra between them. The fore part of this vertebra, save at a point (Fig. 5, S3) on either side of its arch, is in contact with the occipital region. Mesially, its centrum (Figs. 3 and 5, V″) is continuous with the skull, but the lateral portions of its centrum (Fig. 3, V*p*), which present considerable expansions, are distinct therefrom, although firmly bound to it by connective tissue. These lateral vertebral expansions abut against the occipital processes (O*p*), which are thrown outwards and backwards from the occipital region. The surfaces of the vertebral expansions and occipital processes where they meet each other are smooth. Again, the anterior portion of the arch of the first vertebra (Fig. 5, V′) lies within the occipital foramen, and is in contact with its upper and lateral margins. A canal (Fig. 5, S3) for the transmission of the third spinal nerve lies on either side between the skull and the middle portion of the vertebral arch. The part of the arch below these canals rests on slanting surfaces on the lower lateral edge of the foramen magnum, and the part above them enters more freely within the foramen, and is overlapped by its dorso-lateral margin. In the smaller skulls of Læmargus examined I find that the neural arch, although bound to the margin of the foramen magnum by connective tissue, is distinct from it, and this connection permits of a little movement in a vertical direction; but in the largest skull at my disposal I noticed a much more intimate connection between the arch of the first vertebra and the skull. Especially is this the case with the portion of the arch below the canals for the third spinal nerves, where the arch and skull are continuous with each other.

In its cranio-vertebral connection Læmargus presents affinities to Hexanchus and such forms as Acanthias and Scymnus. In having the lower mesial portion of the first vertebra continuous with the cranium, and in having an intimate relation between the arch of this vertebra and the margin of the foramen magnum, Læmargus ranks with Hexanchus; in the connection of the expanded portions of the first vertebral centrum with the occipital processes it agrees with Acanthias, Scymnus, &c. I find no joint cavities existing between the lateral vertebral expansions and the occipital processes. It appears that GEGENBAUR finds such in Scymnus.

The dorsal portion of the occipital region slopes backwards towards the vertebral column, and at its hinder part is somewhat vertical. In a line with the spinous processes of the vertebræ, and extending from the back of the parietal fossa (Figs. 1 and 5, P) on the roof of the skull to the foramen magnum, is a crest, the occipital crest (C*o*), which is most prominent about the middle of its extent. Its development in Læmargus resembles that found in Acanthias and Centrophorus calceus, rather than that of Hexanchus or Heptanchus, in the latter of which the crest attains its greatest development among Selachians.

The ventral portion of the occipital region is continuous with, and assists in forming the hinder part of the large basilar plate (Fig. 3, B*p*) of cartilage which constitutes

the greater portion of the basal area for the posterior half of the skull. Sometimes the occipital part of this plate is irregular, and has processes standing out from it.

Pneumogastric Canals.—The outer opening of each canal (Fig. 1, V*g'*) is large and funnel-shaped, and is placed at the back of the skull, external to an occipital process. Each canal pursues a course from within backwards and outwards. Beside each pneumogastric canal are two canals, with a similar direction, for the first and second spinal nerves, and their outer orifices are placed near each other, internal to the pneumogastric foramina. In the skulls in which I followed up these canals I noticed that in part of their course they communicated with the pneumogastric passage.

GEGENBAUR describes in Hexanchus and in other Selachians a canal, the orifice of which is situated on each postero-lateral edge of the auditory region, near the foramen of exit for the glosso-pharyngeal and pneumogastric nerves. These canals he describes with the occipital region, since each opens into a pneumogastric canal. A vein which he considers to be the primitive jugular vein passes along each of these canals. In Læmargus I do not find this canal, but I notice that a vein which opens into the anterior cardinal sinus issues from the pneumogastric canal in company with the nerve. If this vein corresponds to that described by GEGENBAUR as passing along a separate canal for part of its extent, it may be concluded that in Læmargus this canal has blended with that for the pneumogastric nerve.

The Auditory Region.

This region is continuous with the occipital region behind, and with the orbital in front. The pneumogastric canals mark its limit behind, and at its fore part are the wide passages for transmitting the trigeminal and other nerves. The external configuration of this region is little affected by the organ of hearing which it contains, the semicircular canals and vestibules giving rise to no such elevations as are so characteristic of some Selachian skulls.

The dorsal aspect of this region presents on either side a crest, internal to which is a shallow groove on which are several foramina. These lateral crests, which project outwards and upwards, commence in front in a small eminence, and are continued from this point backwards to the hinder part of the auditory region. The central part of the dorsal surface is slightly raised, and the parietal fossa (Figs. 1 and 5, P) is situated here. This fossa is deepest posteriorly, and in this position the vestibular aqueducts open. The floor of the fossa slopes gently upwards towards the surface of the skull, and its lateral edges becoming more prominent as they pass backwards, meet at its hinder part in a small elevation (P*m*).

The ventral portion of the auditory region forms a considerable portion of the basilar plate (Fig. 3, B*p*) of the skull. A groove (C*g*), for a carotid artery, beginning on each side about the anterior third of the lateral edge of this plate, runs forwards

and inwards to a carotid canal (C*a'*). The grooves may be bridged over with cartilage in part of their extent.

On the lateral surface of the auditory region, at its lower and hinder part, is the depression (Fig. 4, *j j'*) which forms an articular surface for the two heads of the hyomandibular cartilage. The long axis of this depression is directed from above downwards and backwards, and for the most part it is distinctly demarcated from the surrounding parts. It exhibits two surfaces, an upper and a lower, incompletely separated from each other. The upper joint surface (*j*) is smaller than the lower (*j'*), and a small process, from which a distinct rim runs upwards and gradually fades away, is situated at its lower and anterior part. The larger articular surface is deep compared with the upper, and the basilar portion of the skull juts outwards under its lower part, while at its upper and hinder part a stout process stands out from the skull, and overhangs it.

In possessing a cranio-hyoid joint with two surfaces, the skull of Læmargus agrees with Zygæna.

A pyramidal process (Figs. 1, 3, and 4, A*p*) projects backwards from the auditory region behind the cranio-hyoid joint. The lower surface of this process (Fig. 3) is flattened, but its upper (Fig. 1) presents two grooved surfaces, an internal and an external, separated from each other by a ridge. The former of these leads up to the exit foramen (V*g'*) for the vagus, and the latter (G*p'*) to that for the glosso-pharyngeal nerve.

A groove, the post-orbital groove (Fig. 4, P*g*), begins above the smaller articular surface of the cranio-hyoid joint, and is continued forwards and downwards to terminate at the inter-orbital foramen (I*o'*), which lies a short distance below the foramen (T*r'*), for the trigeminal and other nerves. About the middle of its course, the groove is bridged over by a band of cartilage (*x*). The space beneath this band, towards its fore part, is separated by a cartilaginous shelf into an upper and a lower chamber, the former of which lodges, in the recent state, part of the orbital sinus, while the latter contains part of the facial nerve, the palatine branch of which escapes in front (P*l*), while another portion of the nerve passes from beneath the band posteriorly. The lower part of the band may be perforated at several points for the passage of nerves. A ridge extends from about the middle of this band at its anterior part and forms the anterior and lower boundary of the post-orbital groove, and the upper border of a groove which lies below it. This second groove leads to a deep depression (*y*), at the bottom of which are two foramina. The hyoid artery rests in this groove, and the foramina, which are the orifices of canals opening internally on the lateral wall of the pituitary fossa, are for the branches of this artery. The band-like arrangement covering the exit foramen of part of the facial is interesting, as in Rhynchobatis, Trygon, Pristis, and Squatina a similar band covers the outer opening of the facial canal.

Glosso-pharyngeal Canal.—The inner opening (Fig. 5, G*p*) of this canal is placed at the lower and lateral part of the cranial cavity, in front of the pneumogastric

foramen (V*g*). From this point to its external orifice it pursues a course from within outwards and backwards, and passes through the cranial wall external to and at a lower level than the vagus canal. The canal in question is not continuous throughout, its continuity being broken a short distance after its commencement, as it here opens into the lower part of the vestibule of the ear. After a short interval, the canal is continued, and passes to its outer opening (Figs. 1 and 4, G*p'*). The first part of the canal is narrow, the second is wide. In communicating with the vestibular part of the auditory capsule, and consisting of a narrow and a wide part, the glosso-pharyngeal canal of Læmargus is similar to that of Centrophorus calceus, Acanthias, and the Rays.

The Facial Canal.—This canal, which is short, commences just inside a depression (Fig. 5, A*f*), which is common to part of the facial and the auditory nerve, and passes transversely outwards, to open in the space under the band of cartilage, already mentioned, on the lateral aspect of the auditory region.

The Orbital Region.

This region lies between the auditory region behind, and the ethmoidal in front. The post-orbital processes (Figs. 1, 3, and 4, P*o*), and the canals (T*r'*) for the trigeminal and other nerves mark its posterior boundary, while the pre-orbital processes (P*r*) and ridges running downwards from them serve as its anterior limitation. A capacious orbital cavity lies on either side of this region, and the supra-orbital crests, with their post- and pre-orbital processes, stand boldly out from the skull.

The dorsal portion of the orbital region (Fig. 1) forms the broadest part of the skull, and presents on each side a concavity between the pre- and post-orbital processes. Between the post-orbital processes there is a considerable median depression, in front of which are two smaller depressions also occupying the mid-dorsal line. Internal to each supra-orbital ridge there is a groove, the supra-orbital groove, continued forwards from a groove occupying a similar position in the auditory region, and on the floor of this the supra-orbital foramina (S*r*) are situated. There are six or seven of these foramina on each side, and one of the hindermost of them is always larger than the others. In this respect Læmargus agrees with Centrophorus calceus, Galeus, and Mustelus. The supra-orbital grooves are deepest anteriorly, and in this position each receives the upper opening of the pre-orbital canal (P*r''*). Two grooves, one of which runs along the inner and dorsal part of the nasal capsule, while the other turns outwards and leads to the hinder part (*em*) of the ethmoidal canal, commence at the point where the pre-orbital canal opens.

The ventral aspect (Fig. 3) of this region of the skull presents a comparatively narrow anterior and a broad posterior portion. The broad part forms the anterior portion of the basilar plate (B*p*) of the skull, and in front, on each side, it throws out a shoulder-like process. In front of each shoulder is a concavity, the palato-basal depression (P*d*), for lodging the palato-basal process (Pl. II. Fig. 1, P*p*) of the palato-

quadrate cartilage (*ppt*). The basal angle (Fig. 4, A) is not so marked in Læmargus as in the Notidanidæ or in Scymnus, but seems rather to resemble that of Acanthias. The narrower anterior basal portion of this region projects in the middle line, and forms the hinder part of a keel (K) which runs under the ethmoidal region. The outer openings (C*a'*) of the carotid canals, which will subsequently be described, are placed towards the anterior part of the basilar plate. A small mesial aperture (H*c*), which is the lower opening of a canal, evidently the hypophysis canal, is also found at the anterior part of the basilar plate.

The orbital cavity (Fig. 4).—Each cavity is overhung by a supra-orbital ridge with its pre- and post-orbital processes. Its anterior boundary is formed by a cartilaginous ridge, which, curving downwards from the pre-orbital process, gives rise to an antorbital process (A*n*) at the fore part of the orbit, and then curving backwards from this point fades away as it approaches the palato-basal depression (P*d*). Behind, the orbital cavity has no distinct boundary as the auditory region merely slopes forwards and inwards towards the orbital basin. A sort of floor is formed to the orbital cavity behind by an outward projection of the basilar plate, but in front of this the orbit is devoid of a floor.

The post-orbital process.—This process (Figs. 1, 3, and 4, P*o*), which is of considerable strength and size, is pyramidal in form, and has its apex directed outwards, downwards, and backwards. One surface is directed upwards, a second downwards and forwards, and a third downwards and backwards. The process resembles that found in Acanthias.

The pre-orbital process (Figs. 1, 3, and 4, P*r*).—This process, which is not so prominent as the post-orbital, is connected in front with the roof of the nasal capsule by a band of cartilage (*b*) which roofs in the ethmoidal canal. The base of the process is pierced by two canals, the upper and larger of which is the pre-orbital. The lower canal, which is also found in Scyllium and Galeus, opens on the roof of the skull just in front of the pre-orbital opening (P*r''*).

The palato-basal depressions (Figs. 3 and 4, P*d*), the position of which has already been indicated, are distinctly seen, one on each side of the inter-orbital septum. They have a direction upwards and backwards, and a prominent ridge runs upwards from the shoulders of the basilar plate and forms a hinder boundary for them. In front of the depressions there is a less pronounced ridge.

Canal for the trigeminal and abducens nerves and the ophthalmic and buccal branches of the facial.—This is a large canal, and its external orifice (Fig. 4, T*r'*) is situated at the back of the orbital cavity, considerably below the post-orbital process, and its position in Læmargus corresponds with that in Scymnus. The canal is short and wide, and has a direction from within outwards and forwards. Its anterior wall is less extensive than its posterior.

Canal for the oculi-motor nerve.—This canal passes almost directly outward through the cranial wall, and its outer opening (Fig. 4, O*m'*) is placed a short distance in

front of that for the trigeminal and other nerves. The part of the skull through which this canal runs is thick.

Canal for the optic nerve.—This is a wide canal, and like the former passes almost directly outwards through the skull wall. In a side view of the skull its outer orifice (Fig. 4, O′) is seen lying considerably in front of that of the canal for the trigeminal and other nerves.

Canal for the patheticus.—This is a narrow canal, having from within a direction outwards, downwards, and slightly forwards. Its outer opening (Fig. 4, P*a*′) is placed at the upper part of the orbital cavity, and lies either directly above the optic foramen or a little behind that point.

Pre-orbital canal.—The hinder opening (Fig. 3, P*r*′) of this canal is situated at the anterior and upper part of the orbit. The canal pierces the base of the pre-orbital process, and runs from the orbital cavity to open (Fig. 1, P*r*″) on the roof of the cranium. A second canal, which has already been noted, lies below it.

Orbito-nasal canal.—This canal, which has its hinder orifice (Fig. 3, O*n*) some distance below that for the pre-orbital, passes forwards and slightly inwards, to open (O*n*′) on the surface of the skull at the hinder and inner part of the nasal capsule.

Inter-orbital canal.—The outer aperture (Fig. 4, I*o*′) of this canal, the course of which will be followed later, lies a little below the foramen of exit for the trigeminal and other nerves.

The Eye-stalk (Pl. I. Fig. 3, E.; Pl. II. Fig. 5).—This is an elongated rod, continuous at its proximal end (*m*) with the skull, and articulating at its distal extremity (*m*′) with the cartilaginous sclerotic of the eye-ball (Pl. II. Fig. 6). The stalk is slender at its proximal part, but increases in thickness towards its distal extremity, where it presents a somewhat triangular cupped surface on which, in the recent state, the eye-ball rests. The cartilage of which it is composed is similar to that composing the skull.

The Ethmoidal Region.

This region, which lies in front of the orbital, exhibits on either side the somewhat flattened nasal capsules (Figs. 1 and 2, N) which form its lateral expansions. These are separated from each other above by the deep pre-frontal fossa (Fig. 1, P*f*), and below by the inter-nasal septum. In front of the pre-frontal fossa the fore part of the region is produced forwards as a truncated rostrum (Figs. 1–5, R). The long axes of the nasal capsules have a direction forwards and slightly inwards. The ventro-lateral opening of each capsule is situated anteriorly, and its margin, which is very irregular, supports a ring-like nasal cartilage (Figs. 2, 3, and 4, N*a*). The ethmoidal canal (Fig. 4, *em*′) is found at the outer and lateral part of the dorsal surface of the capsule. A series of longitudinal ridges, with narrow grooves between them, pass forwards and gently outwards on the upper aspect of the capsule. These ridges and grooves are especially marked on the outer half of the roof of the capsule, and the latter lead to small canals which open anteriorly near the free margin of the structure.

Nasal-ring-cartilage (Figs. 2, 3, and 4, N*a*).—This is an incomplete ring of cartilage which surrounds the greater part of the nasal orifice. Externally it is in contact with the free margin of the nasal capsule, and the two ununited ends of the ring are directed inwards, the lower of these being very slender. Processes approach each other from opposite points of the ring and thus divide the nasal orifice into an inner and outer part, an arrangement which is not uncommon among Selachians.

The pre-frontal fossa (Figs. 1 and 5, P*f*).—This is an elongated deep fossa which lies between the nasal capsules, and assists in separating them from each other. The opening of the fossa on the roof of the cranium is somewhat elliptical, and its margins, which are irregular and sometimes perforated at parts, curve downwards and outwards to the upper surface of the nasal capsules, and terminate in front at the rostrum.

The inter-nasal septum.—This septum separates the nasal capsules from each other below. It is produced in front as a short truncated rostrum (Figs. 1–5, R), which is broader in front than behind. The ventral portion of the septum is laterally compressed and forms a keel (K), which runs forwards towards the rostrum. This keel is especially prominent at its hinder part, and in this respect Læmargus agrees with Scymnus and Acanthias.

The nasal fossa (Fig. 3, N*f*).—This is a deep fossa on the ventral surface, and lies between the inner border of the posterior half of each nasal capsule and the inter-nasal septum. These fossæ also occur in some other Elasmobranchs. A canal which communicates with the cranial cavity opens at the bottom of each fossa at its hinder part. A similar canal occurs in Heptanchus and some other forms, but not in Hexanchus. The presence of this canal, together with other evidence, gives a clue to the origin of the three-shanked rostrum found in some Selachians. A cartilaginous process (Fig. 3, P′), which may be loosely connected with the nasal capsule, projects inwards and backwards under each nasal fossa, and near the hinder part of the base of the process is the orifice (O*n*″) of a canal which runs upwards and forwards to open into the hinder part of the nasal cavity. The anterior opening of the orbito-nasal passage (O*n*′) lies a short distance behind the posterior opening of the canal just noted, and a short groove leads from one to the other.

Vertical longitudinal Section of the Skull in the mesial plane (Fig. 5).

This section shows,—the continuation of the cartilage of the first vertebral centrum with the skull, the thickness of the cranial roof and floor, the extent of the cranial cavity, as well as that of the parietal and pre-frontal fossæ.

The cranial cavity.—This cavity, which is considerably larger than the brain which it encloses, is open behind towards the neural canal, and is incompletely shut off from the pre-frontal fossa (P*f*) by a cartilaginous partition (D) in front. On each side this partition the cavity communicates with the nasal cavities through an olfactory passage.

For descriptive purposes the cranial cavity may be described as consisting of a posterior, middle, and anterior division. The posterior portion extends from the foramen magnum to the hinder wall (D*s*) of the pituitary fossa; the middle from this point forwards to the optic foramina (O); and the anterior division lies in front of these openings.

The posterior division.—This extends, as just stated, from the foramen magnum to the hinder wall or dorsum sellæ (D*s*) of the pituitary fossa. In some sharks, *e.g.* Hexanchus, the dorsum sellæ forms a considerable elevation on the cranial floor. Between this elevation and the foramen magnum there is a hollow, but in Læmargus, as the dorsum sellæ rises very slightly on the floor of the cavity, the hollow between it and the foramen magnum is very shallow. A distinct elevation passes from the dorsum sellæ for a short distance up the cranial wall, and behind it the large foramen (T*r*) for the trigeminal, abducens, and part of the facial nerve is situated, while the foramen (O*m*) for the oculimotor, which belongs, however, to the middle cranial region, is placed in front of it. There is a depression (A*f*) a short distance behind the foramen for the trigeminal and other nerves, at the bottom of which are two foramina, an anterior for the portion of the facial nerve which does not pass through the trigeminal canal, and a posterior for the auditory nerve. The foramen (G*p*) for the glosso-pharyngeal nerve is situated some distance behind the depression common to the two nerves just mentioned. The pneumogastric foramen (V*g*), which has a funnel-shaped depression leading up to it, is situated behind that for the glosso-pharyngeal, but at a higher level. A small foramen (S1) for the first spinal nerve lies below the pneumogastric opening, that for the second spinal (S2), which is larger, is placed behind it, while the third spinal nerve passes through a canal (S3) situated between the skull and the arch of the first vertebra. In having apertures and canals for the first and second spinal nerves in the cranial wall, Læmargus agrees with Scymnus, Acanthias, and some other sharks.

A downward projection from the roof of the cavity, caused by the sinking of the floor of the parietal fossa (P), presents itself in this part of the cranium. From this projection the roof passes forwards and upwards to its highest elevation.

The middle division.—This extends from the dorsum sellæ (D*s*) as far as the optic foramina (O), and its vertical diameter is greater than that of the division behind or before it.

The pituitary fossa.—This fossa occupies the floor of the division, and extends from the dorsum sellæ (D*s*) to (M) its interior limit. The hinder part of the fossa is deep, and its anterior wall slopes upwards and forwards and terminates in the slight sinking (M) on the cranial floor. The hinder and postero-lateral walls of the fossa are especially steep. Several canals open at various points on the walls of the fossa.

The carotid canals.—These two canals begin (Fig. 3, C*a'*), as already seen, at the inner ends of the grooves (C*g*) on the under surface of the basilar plate of the skull, and pass through the cranial floor, and meet each other a short distance behind the pituitary fossa. From their point of union a short wide canal passes forwards and slightly upwards to open (Fig. 5, C*a*) on the hinder wall of the fossa at its lower part.

A small shelf of cartilage (I*o*), with a transverse groove on its upper surface, lies over the carotid opening, and at either end of the groove the inner opening of the inter-orbital canal is placed. In the position of the shelf, the continuity of the inter-orbital canal as a cartilaginous tube is broken above, a condition which is found in Hexanchus and some other sharks. The portion of the canal on each side of the pituitary fossa, in Læmargus, pursues from without, a curved course inwards and slightly forwards.

The Hypophysis canal.—The internal opening of this canal (H*c*), already alluded to, and which is presumably the persistent hypophysis canal, is seen on the anterior wall of the pituitary fossa. The canal has an oblique course passing upwards and backwards from below. In one skull which I examined the canal had a vertical direction, and passed directly upwards to open at the lowest part of the fossa. Hexanchus and Heptanchus seem to have a canal which, while not so complete as in Læmargus, apparently represents it in these forms.

Two openings, a dorsal and a ventral, for the branches of the hyoid artery, are placed some distance apart on the postero-lateral walls of the fossa.

The foramen (O*m*) *for the oculi-motor nerve,* as already indicated, lies at the fore part of an elevation which passes outwards and upwards from the dorsum sellæ.

The optic foramen (O) is situated in a line with, but considerably in front of, that for the oculi-motor nerve.

The patheticus foramen (P*a*).—This is placed on the dorso-lateral wall of the cranial cavity, some distance above the optic foramen, and slightly posterior to it.

The anterior division.—This division of the cranial cavity lies in front of the optic foramina. It is incompletely shut off from the pre-frontal fossa (P*f*) by the cartilaginous partition (D), and on either side of this partition the cavity is produced as a wide olfactory passage. Each olfactory passage, although it is wide throughout, becomes narrower as it passes forwards and outwards to open at the hinder part of the nasal cavity. A foramen (*z*) for a blood-vessel is placed at the dorso-lateral part of this cranial division, near the commencement of the olfactory passage.

The partition (D), which incompletely separates the cranial cavity from the pre-frontal fossa (P*f*), rises vertically from the cranial floor. In the skull figured, the partition is only connected at its lower part with the cranium by means of a narrow neck of cartilage, and as it does not touch the cranium at any other part, a space exists between it and the cranial wall, by means of which the cranial cavity and pre-frontal fossa communicate freely with each other. In another skull, the partition had three connections with the cranium. There was a broad connection at its base with the cranial floor, and its upper part was connected with the cranial roof by two narrow bands of cartilage, one on either side. In this case, therefore, instead of a single space existing between the cranial cavity and pre-frontal fossa, there were three,—one dorsal, and one on either side. In a third skull, the largest cranium which I examined, not only was there an extensive basal continuation of the partition with the cranial floor, but

the dorso-lateral connections were also extensive, and they largely encroached on the dorsal and lateral spaces, reducing them to wide canals.

In other Elasmobranchs, a membranous partition stretches across the space between the cranial cavity and the pre-frontal fossa.

The pre-frontal fossa (P*f*).—This is an elongated deep fossa, which, as already mentioned, is open above (Fig. 1), and communicates with the cranial cavity posteriorly. It is deeper behind than in front, its floor slopes upwards to the rostrum, and towards its upper part its margins curve inwards towards each other.

The parietal fossa (P).—This fossa has already been noticed (Figs. 1 and 5). In a longitudinal section of the skull, the opening of a vestibular aqueduct is seen posteriorly at the side of the floor of the fossa.

The Notochord (C).—In Læmargus, as in some other sharks, the notochord is persistent in the cranial floor. It passes forwards from the vertebral column to the vicinity of the pituitary fossa, and approaching the dorsum sellæ, curves rather abruptly upwards. Its anterior extremity in some cases is directed forwards, in others it curves backwards, but in all cases it terminates just below the perichondrium of the cranial floor. The direction of the cranial notochord of Læmargus bears a greater resemblance to that of Hexanchus or Heptanchus, than to that of such forms as Acanthias or Centrophorus calceus.

The Visceral Skeleton (Plates I. and II.).

The visceral skeleton consists (1) of the usual segmented hoops or arches, placed in succession one behind the other, and (2) of cartilages standing in relation to these. Of these arches there are seven. The first is the mandibular, the second the hyoid, and the remaining five are the branchial arches.

The Branchial Arches (Pl. I. Figs. 1 and 2, Pl. II. Figs. 2 and 3).—These arches gradually decrease in size from before backwards. A typical arch, *e.g.* the third (Pl. II. Fig. 2), consists on each side of the four segments which are usually found in Selachians. From above downwards, they are as follows,—(1) pharyngo-branchial (P*b*3), (2) epi-branchial (E3), (3) cerato-branchial (K*r*3), and (4) hypo-branchial (H3). A series of cartilages, the basi-branchials (Pl. II. Fig. 3, B1–B8), occupy a mid-ventral position between the lower ends of the lateral portions of the arches.

In several preparations of the visceral skeleton of Læmargus which I have examined, I found the typical number of segments in the first four arches, while in other preparations I noticed that only the first, third, and fourth arches possess the typical number, the hypo-branchials of the second arch having fused together to form a single transversely placed plate of cartilage (Pl. II. Fig. 3, H2). In some cases there is an intermediate condition in which this cartilaginous plate is incompletely divided.

In all my dissections I found that the fifth arch possessed only two segments on each

side, namely, an epi- and a cerato-branchial segment, the former of which has its upper extremity fused with the pharyngo-branchial of the fourth arch.

The pharyngo-branchials.—These are somewhat flattened rods, having their inner extremities free, and directed backwards and inwards (Pl. I. Fig. 1, P*b*1–4), while their outer extremities are thickened, and are connected with the upper ends of the epi-branchials (E1–E5). The upper surfaces of the pharyngo-branchials present grooves (Pl. II. Fig. 2, B*g*3) on which, in the recent state, the efferent branchial vessels rest. In the first three arches the grooves have a direction from before, backwards and inwards, while the grooves on the fourth pair of pharyngo-branchials have an almost transverse direction from without inwards. The position of these grooves varies in the different pairs of pharyngo-branchials. On the first pair the grooves lie over the outer extremities of the cartilages, but in the case of the other arches they become more internal in position and gradually deeper from before backwards. In Squatina there is a farther modification, because here, instead of grooves, we find canals perforating the pharyngo-branchials of the second, third, and fourth arches.

Each pharyngo-branchial of the fourth arch possesses a process (Pl. II. Fig. 3, P5) which, springing from about the middle of its hinder border, and having a direction outwards and slightly downwards, is continuous with the epi-branchial of the fifth arch. This process is regarded by some as the pharyngo-branchial of the fifth branchial arch. This process is absent in Hexanchus, and in Heptanchus it is only slightly developed. GEGENBAUR concludes from this that the process is developed from the pharyngo-branchial of the fourth arch, in order that a point of attachment may be given to the epi-branchial of the last arch, and that, therefore, it is not the representative of a pharyngo-branchial. In Læmargus, as I have already mentioned, this process and the epi-branchial of the fifth arch are fused together, a condition which occurs in other Elasmobranchs.

The epi-branchials (Pl. II. Figs. 2 and 3, E1–E5).—There are five pairs of these, and from the first to the fourth they diminish in size. The fifth epi-branchial of either side (E5), together with the pharyngo-branchial processes (P5) of the fourth arch, forms an elongated rod. The upper extremities of the four anterior epi-branchials are movably connected with the outer extremities of the pharyngo-branchials, while the fifth, as already seen, forms a cartilaginous union with the fifth pharyngo-branchial. The lower extremities of all are movably connected with the upper ends of the cerato-branchials. Processes jut forwards from the upper extremities of the epi-branchials, and fossæ, which increase in depth from behind forwards, are found on the inner surfaces of the four anterior cartilages.

The cerato-branchials (Pl. II. Figs. 2 and 3, K*r*1–K*r*5).—These are the longest segments in the branchial arches, and have their upper ends connected with the epi-branchials, but their lower extremities have various connections. The lower extremity of the cerato-branchial of the first gill arch, has lying in front of it, the small hypo-branchial (Fig. 3, H1) belonging to this arch, and it also touches the basal portion of the

hyoid arch, to which it is bound by connective tissue. The lower extremities of the cerato-branchials of the second, third, and fourth arches are connected with hypo-branchials (H2, H3, H4) respectively, while those of the fifth pair (K*r*5), which differ considerably from those of the other arches, are bound, one on either side, to a large basi-branchial plate (B5).

Processes project forwards from the lower ends of all the cerato-branchials, but those of the first arch are very feebly developed. Each process on the second, third, fourth, and fifth arches overlaps the portion of the cerato-branchial lying in front of it. Fossæ, for muscular attachments, similar to those on the inner faces of the epi-branchials, are also found in corresponding positions on the first four cerato-branchials, close to their upper extremities.

Hypo-branchials (Pl. II. Figs. 2 and 3, H1–H4).—There are four pairs of these cartilages, and they stand in relation to the first four branchial arches. The first pair (H1) are very small cartilages, lying, as is already mentioned, at the fore part of the lower extremities of the cerato-branchials of the first gill arch, to which, in the recent state, they are bound on the one hand, and on the other to the hyoid arch, by connective tissue. In some sharks, *e.g.* Hexanchus, these pair of hypo-branchials are absent. The second pair of hypo-branchials (H2) may be fused together, as in Scymnus, and form a transversely placed plate of cartilage which lies between the lower ends of the cerato-branchials of the second gill arch. A process projects backwards from this plate, and in some cases a small process projects forwards from the middle of its anterior border. In other cases the anterior border of this plate presents a straight edge, as is shown in Plate II. Fig. 3. In several preparations I found this plate consisting of two symmetrical pieces.

The third and fourth pairs of hypo-branchials (H3, H4), which have a slightly backward direction, much resemble each other. Their outer extremities are connected with cerato-branchials and their inner with basi-branchial cartilages.

Basi-branchial cartilages (Pl. I. Fig. 2, Pl. II. Figs. 2 and 3, B1–8).—These are a series of cartilages differing from each other in shape and size, varying slightly in number, and forming a broken line in the mid-ventral position. I found in most of the specimens of Læmargus which I examined a larger number of these cartilages than have been described in any other Elasmobranch. Heptanchus has five of these, but Læmargus has a number ranging from six to eight. The first basi-branchial (B1), when present, is a small nodule of cartilage which lies in the interval between the basi-hyal cartilage (B*h*) and the hypo-branchial plate (H2) of the first gill arch. Cestracion, so far as I am aware, is the only other Elasmobranch yet described which has a basi-branchial in this position. In two cases in which this cartilage was absent in Læmargus, I noticed that the hypo-branchial plate (H2) of the first gill arch had a process projecting forwards from the centre of its anterior border. This is interesting, as there may be a possibility that in these cases, the first basi-branchial is fused with the hypo-branchial plate. In some cases, however, I found that the first basi-branchial was altogether absent, and the hypo-branchial plate presented a straight anterior edge. The second basi-branchial cartilage (B2) is placed

behind the hypo-branchial plate of the second gill arch, and is fastened to it in this position. The third basi-branchial (B3), which is followed by the fourth basi-branchial (B4), lies immediately behind the second. The fourth is larger than the two which precede it. The second and third basi-branchials lie between the inner extremities of the third pair of hypo-branchials, and the fourth basi-branchial assists in separating the inner ends of the fourth pair. Behind the fourth basi-branchial, but separated from it by a short interval, is the large expanded breast-plate-shaped basi-branchial cartilage (B5), which is the fifth of the basi-branchial series. It is broad anteriorly, but becomes narrower as it passes backwards. The fourth pair of hypo-branchials (H4) are, on the one hand, connected with the fourth basi-branchial (B4), and on the other, with the anterior edge of the fifth, and their inner ends, as they pass from one basi-branchial to the other, close in a space which exists between them. The cerato-branchials (K*r*5) of the fifth gill arch are bound to the lateral edges of the fifth basi-branchial by connective tissue. The fifth basi-branchial is followed by three, it may be by two pieces of cartilage (B6, B7, B8), which are the sixth, seventh, and eighth basi-branchials. Narrow cartilages placed superficially are generally seen lying across the lines of contact of the fifth and sixth and the sixth and seventh basi-branchials.

The Gill rays (Pl. II. Figs. 2 and 4, R*y*, R*y*′, R*y*″, R*y*‴).—These are found in connection with all the branchial arches, and are for the most part elongated rods, but in some places are represented by mere nodules of cartilage. In the four anterior branchial arches the rays are connected with the epi-branchial and cerato-branchial segments, but most of the rays belong to the latter. The number of the rays in the various arches is small as compared with that of some other Elasmobranchs. In Læmargus I found eight rays to be the average number for either side of the first gill arch, and five to be that for either side of the fourth. One of the rays at or near the middle of each series is larger than the others, and may be known as the *central ray* (R*y*′). The gill rays of the fifth gill arch are much modified (Fig. 4). On the under surface of each cerato-branchial (K*r*5) of this arch there is an elongated piece of cartilage (R*y*″) which is firmly bound to it, and at the outer end of this elongated cartilage I have found in several cases, but not all, small nodules of cartilage (R*y*‴), which, as GEGENBAUR has pointed out, occur in some other Elasmobranchs, and are to be regarded as modified branchial rays.

Extra-branchial cartilages (Pl. I. Figs. 1 and 2, Pl. II. Fig. 2, *Ev*″, *Ev*‴).—From their position GEGENBAUR calls these the outer gill arches. There are, counting those belonging to the hyoid arch, five pairs on each side of the middle line, forming a dorsal and ventral series. They belong to the hyoid arch and first four branchial arches. The extra-branchials are elongated rods of cartilage, expanded at their inner ends and with their outer extremities pointed. Most of the gill rays are directed towards them (Pl. II. Fig. 2), and each of the upper extra-branchials is generally touched by one or more of them, but it is seldom that any ray reaches a lower extra-branchial. The outer end of each central branchial ray (R*y*′) lies midway between the outer extremities of a

dorsal and a ventral extra-branchial. The extra-branchials lie for the most part posterior to the arches to which they belong.

The gill rakers.—These, for the most part, are pointed or blunt processes of cartilage, lying chiefly on the inner surfaces of the cerato-branchials. Their bases rest on, and in some cases are continuous in this position with the cartilage of the arch to which they belong. Their free extremities project into the buccal cavity.

The Hyoid Arch (Pl. I. Figs. 1 and 2, Pl. II. Fig. 3).

This is a massive arch, and consists of a mesial and two lateral portions. Each of the lateral portions of the arch consists of the usual cartilaginous segments—an upper or hyo-mandibular (H*m*), and a lower or cerato-hyal (K*h*). The hyo-mandibular cartilage is short and broad, and when the parts are in apposition, stands out horizontally from the skull. The inner extremity of the cartilage presents an oblique surface with two heads (*g*,*g'*) which are separated from each other by a shallow groove. The heads, of which the posterior is the larger, articulate with the two surfaces which exist in the cranio-hyoid depression of the skull (Pl. I. Fig. 4, *j*,*j'*). At the outer extremity of the hyo-mandibular, a strong process, which may be called the suspensorial process, projects forwards towards a similar process arising from the hinder part of the lower jaw. The two processes are connected by a ligament, in which a cartilage corresponding to an interarticular cartilage is imbedded. Some other sharks also possess a cartilage in this position. There is a depression on the lower surface of the suspensorial process, for articulating with the upper extremity of the cerato-hyal.

Cerato-hyal (K*h*).—This is an elongated curved bar of cartilage, and has a direction from without downwards, forwards, and inwards. A rounded prominence, which articulates with the depression on the under surface of the suspensorial process of the hyo-mandibular, rises from its upper extremity. The lower extremity of the cerato-hyal passes below the outer part of the basi-hyal (B*h*), and rests in a depression which is there situated.

Basi-hyal (B*h*).—This is a block-like cartilage which lies between the lower ends of the cerato-hyals. Its anterior border is convex and its posterior is concave; its dorsal surface is flattened, while its ventral presents a concavity. Postero-laterally, it is produced into two cornua, to which the lower extremities of the cerato-branchial cartilages of the first gill arch are bound by connective tissue. The first pair of hypo-branchials (H1) lie at the hinder part of the cerato-basi-hyal joints, and they are also bound by connective tissue to the cartilages forming these joints.

Hypo-hyal (H*h*).—A nodule of cartilage is situated at the fore and upper part of each cerato-basi-hyal joint.* The cartilage occupies a position similar to that which the hypo-branchial (H1) of the first gill arch does in front of the first cerato-branchial cartilage. It does not appear that these nodules have been noticed before in any other shark. They are evidently hypo-hyal cartilages.

* These cartilages were absent in two of the sharks.

Hyoid gill rays.—These are either simple or branching rods of cartilage which project backwards and outwards from the hinder parts of the hyo-mandibular and cerato-hyal cartilages. As a rule, there are about eleven rays on each side, the majority of the rays springing from the cerato-hyal. The ray on either side of the joint, formed by the hyo-mandibular and cerato-hyal cartilages, is stouter than the others.

Extra-branchials.—There are two of these on each side, an upper and a lower, and they form the first of the series of extra-branchial cartilages (Pl. I. Figs. 1 and 2, *Ev*, *Ev'*). None of the hyoid gill rays touch the upper extra-branchials of this arch, but several are in contact with each of the lower extra-branchials.

The Mandibular Arch.

This consists of the palato-pterygoid and mandibular cartilages which constitute the upper and lower jaws (Pl. I. Figs. 1 and 2, Pl. II. Fig. 1).

The Upper Jaw.—This is formed by the two palato-pterygoid cartilages (P*pt*), one on each side of the middle line. The anterior extremities of these cartilages are bound together by ligament, but they do not touch one another, while their posterior ends are widely separated. Each cartilage has a direction from before backwards and outwards. Immediately external to the maxillary symphysis there is a slight elevation of the cartilage, to the outer side of which lies the narrowest portion of the palato-quadrate. The elevation just noted is much more marked in Scymnus. Beyond its narrowest portion the palato-pterygoid becomes suddenly wide, and continues so to its posterior extremity. At the commencement of the wide portion a large somewhat conical process, the palato-basal process (P*p*), is placed on the upper part of the jaw. In the recent state this process rests on the palato-basal depression (Pl. I. Fig. 4, P*d*) of the skull. At the inner part of the base of the process there is a deep hollow, above which there is a considerable projection. Each palato-basal process is surmounted by a nodule of cartilage (n). The upper edge of the palato-pterygoid behind the palato-basal process becomes much everted, and the upper part of the inner surface of the cartilage, especially towards its hinder part, looks upwards and backwards. The outer surface of the palato-pterygoid in its posterior two-thirds presents a concavity. At the posterior extremity of the cartilage there is a faceted surface internally and an articular process externally, both of which are for articulating with the lower jaw.

Teeth are found on the lower and inner part of the anterior two-thirds of the palato-pterygoid cartilage. The younger teeth lie in a depression which is bounded above by a ridge.

The Pre-spiracular Cartilages (Pl. I. Fig. 1, P*s*).—These are two small flattened cartilages which rest on the surfaces of the palato-pterygoid cartilages, which are directed upwards and backwards. The cartilages are longer than they are broad, and have a direction upwards, forwards, and outwards.

The Lower Jaw.—The lower, like the upper, jaw consists of two cartilages, the mandibular cartilages (M*n*), one on either side of the mesial plane, and are bound together in

front, but widely separated behind. The anterior ends of the cartilages are only in contact with each other for a short distance, and below this point of contact an elliptical piece of cartilage, the *basi-mandibular* (Pl. I. Fig. 2, Bm), lies between them. The mandibular cartilages, which are wide at the symphysis, increase in width as they pass outwards and backwards. Internally, at the hinder part of each cartilage, a rounded process projects backwards and inwards. In the recent state, a ligament, in which an interarticular cartilage lies imbedded, connects this with the suspensorial process of the ceratohyal cartilage. On the upper surface of the rounded process just described there is an articular process which abuts against a similar surface on the upper jaw. External to the process there is a concavity on which the articular process at the posterior end of the palato-pterygoid rests.

Teeth are found along the upper edge and inner surface of each mandibular cartilage in its anterior two-thirds. A narrow shelf of cartilage lies along the lower part of the dentigerous surface, and above this shelf the youngest teeth are situated.

Labial Cartilages (Pl. I. Fig. 2, Pl. II. Fig. 1, L L′ L″).—These stand in relation to the upper and lower jaws. There are three cartilages on each side, and of the three, two (L L′) stand in relation to a palato-pterygoid cartilage, while the third (L″) lies in relation to a mandibular cartilage. The two upper cartilages lie across the palato-quadrate cartilage about the middle of its extent. One of them (L′) is an elongated, curved, cylindrical rod, which has a direction from above downwards and backwards, and its lower extremity is connected with a similar rod of cartilage (L″) which is connected with the mandibular cartilage. The other upper labial cartilage (L), which is flattened, is shorter than the one just described, and lies across its upper extremity, and is superficial to it. The labial (L″) of the lower mandibular cartilage resembles the rod-like cartilage of the palato-pterygoid. It has a direction from below upwards and backwards. Its upper extremity is bound to the upper rod-like cartilage by connective tissue, and the two meet each other at the angle of the mouth.

The Cartilage of the Skull and Visceral Skeleton.

The cartilage of which these are composed is soft as in Hexanchus, and yields readily to the scalpel. Only in a few parts does it show any indication of becoming calcified.

Points of Special Interest.

The points which I consider of special interest in the skull and visceral skeleton are the following:—(1) the cranio-vertebral connection; (2) the presence of an hypophysis canal; (3) the presence of a basi-mandibular cartilage; (4) the presence of a hypo-hyal cartilage at the fore and upper part of each cerato-basi-hyal joint; (5) the large number of basi-branchial cartilages, Læmargus possessing more of these than are found in any other Elasmobranch yet described; (6) the soft nature of the cartilage of the cranium and visceral skeleton.

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Plate I.

Fig. 1. Dorsal view of the skull and visceral skeleton.
Fig. 2. Ventral view of the skull and visceral skeleton.
Fig. 3. Ventral view of the skull.
Fig. 4. Side view of the skull.
Fig. 5. Vertical longitudinal section of the skull in the mesial plane.

Plate II.

Fig. 1. Upper and lower jaws.
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Fig. 3. Hyoid and branchial arches laid out.
Fig. 4. Cerato-branchial of the fifth branchial arch and rudimentary gill rays.
Fig. 5. Eye-stalk.
Fig. 6. Cartilaginous sclerotic.

Note.—All the figures, with the exception of Figs. 4, 5, and 6, Pl. II., which are natural size, are one-third of the natural size.

Figs. 5 and 6, Pl. II., are from a shark twelve feet long, and all the other figures are taken from specimens from six to seven feet in length.

A. Basal angle.
A*f*. Foramen common to facial and auditory nerves.
A*n*. Antorbital process.
A*p*. Auditory process.
Bl–8. Basi-branchial cartilages.
b. Strap of cartilage covering ethmoidal canal.
B*g*3, B*g*4. Grooves on third and fourth pharyngo-branchial cartilages.
B*h*. Basi-hyal cartilage.
B*m*. Basi-mandibular cartilage.
B*p*. Basilar plate.
C. Notochord.
C*a*. Inner opening of carotid canal.
C*a'*. Outer opening of carotid canal.
C*g*. Carotid groove.
C*o*. Occipital crest.

D. Cartilaginous partition (incomplete) between cranial cavity and pre-frontal fossa.
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E. Eye-stalk.
E1–5. Epi-branchial cartilages.
e. Cut extremity of eye-stalk on skull.
em. Ethmoidal foramen (upper).
em'. Ethmoidal foramen (lower).
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F. Prominence at hinder part of sclerotic for articulating with cup of eye-stalk.
g, g'. Heads of hyo-mandibular cartilage.
Gp. Glosso-pharyngeal foramen (inner).
Gp'. Glosso-pharyngeal foramen (outer).
H1–4. Hypo-branchial cartilages.
Hc. Hypophysis canal.
Hh. Hypo-hyal cartilage.
Hm. Hyomandibular cartilage.
Io. Inner opening of inter-orbital canal.
Io'. Outer opening of inter-orbital canal.
J. Point of articulation of upper and lower jaws.
j, j'. Cranio-hyoid depression.
K. Keel at lower part of internasal septum.
Kh. Cerato-hyal cartilage.
Kr1–5. Cerato-branchial cartilages.
L L' L''. Labial cartilages.
M. Anterior limit of pituitary fossa.
m. Proximal (cut) extremity of eye-stalk.
m'. Distal extremity of eye-stalk.
Mn. Lower jaw.
N. Nasal capsule.
n. Nodule of cartilage surmounting palato-basal process.
Na. Nasal-ring cartilage.
Nf. Nasal fossa.
O. Optic foramen (inner).
O'. Optic foramen (outer).
O''. Optic foramen in sclerotic.
Om. Oculi-motor foramen (inner).
Om'. Oculi-motor foramen (outer).
On. Posterior opening of orbito-nasal canal.
On'. Anterior opening of orbito-nasal canal.
On''. Orifice of canal in front of orbito-nasal canal.
Op. Occipital process.
P. Parietal fossa.
P'. Cartilaginous process underlying nasal fossa.
Pa. Patheticus foramen (inner).
Pa'. Patheticus foramen (outer).
Pb1–5. Pharyngo-branchial cartilages.
Pd. Palato-basal depression.
Pf. Pre-frontal fossa.
Pg. Post-orbital groove.
Pl. Foramen of exit for palatine branch of facial nerve.
Pm. Parietal eminence.
Po. Post-orbital process.
Pp. Palato-basal process.

Ppt. Palato-pterygoid cartilage.
Pr. Pre-orbital process.
Pr''. Pre-orbital foramen (upper).
Pr'. Pre-orbital foramen (lower).
Ps. Pre-spiracular cartilage.
R. Rostrum.
Ry, Ry', Ry'', Ry'''. Branchial rays.
S1, S2, S3. Foramina for 1st, 2nd, and 3rd spinal nerves.
Sr. Supra-orbital foramina.
Tr. Foramen (inner) for trigeminal and abducens nerves and part of facial complex.
Tr'. Foramen (outer) for trigeminal and abducens nerves and part of facial complex.
V. Vertebral column.
V'. Arch of first vertebra.
V''. Centrum of first vertebra.
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X. Strap of cartilage covering facial canal.
Y. Foramen for hyoid artery.
Z. Foramen for blood-vessel.

M^r P. J. White on the Greenland Shark — Plate I.

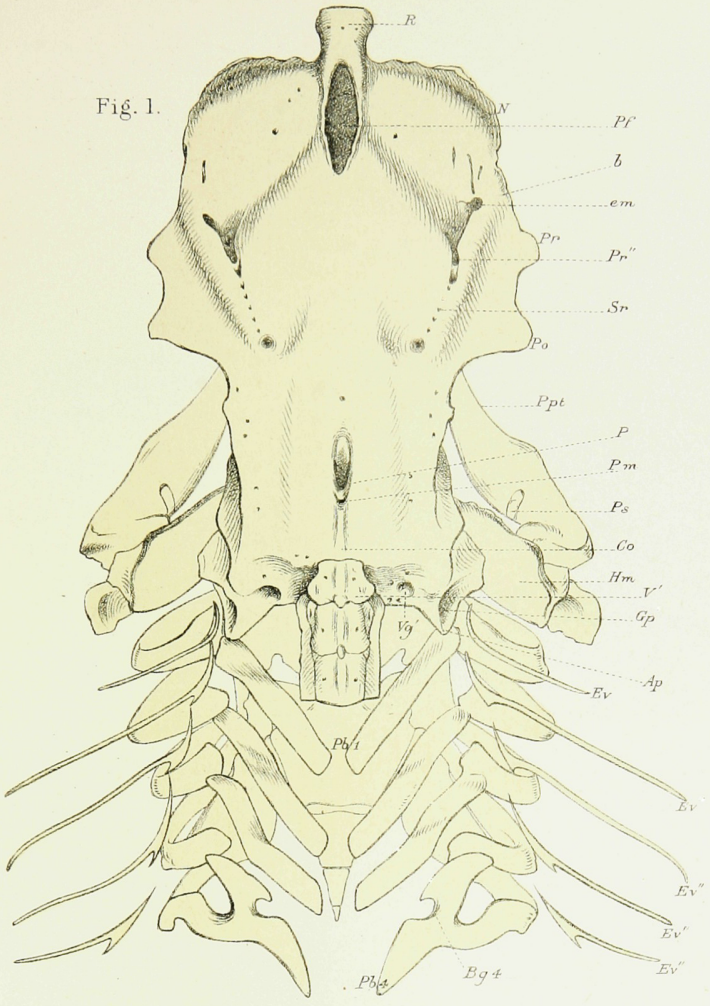


Fig. 1.

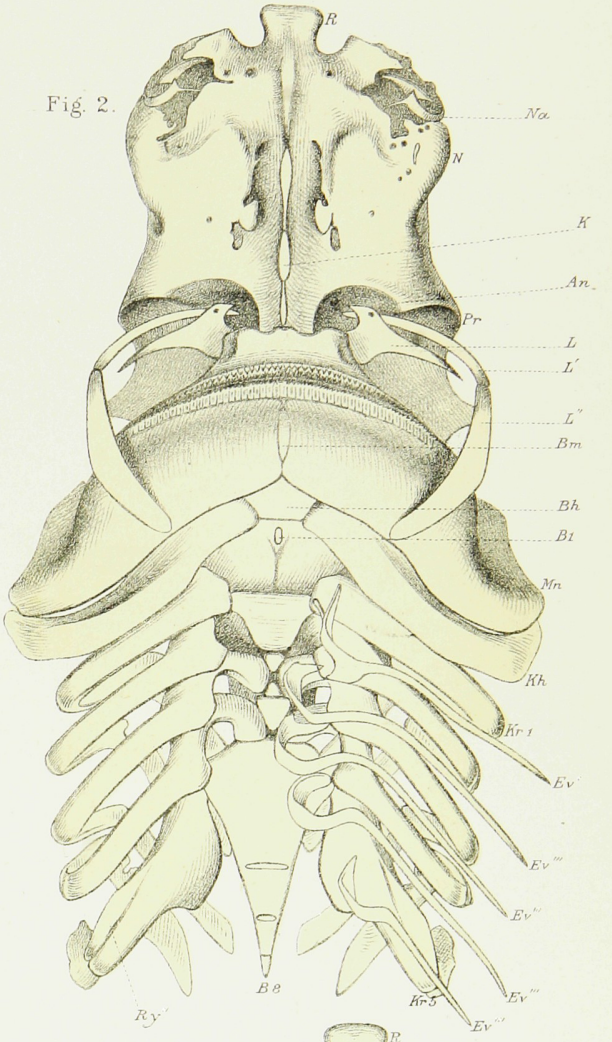
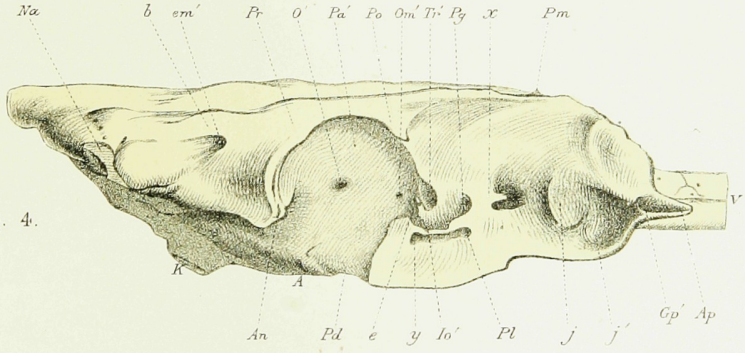


Fig. 2.



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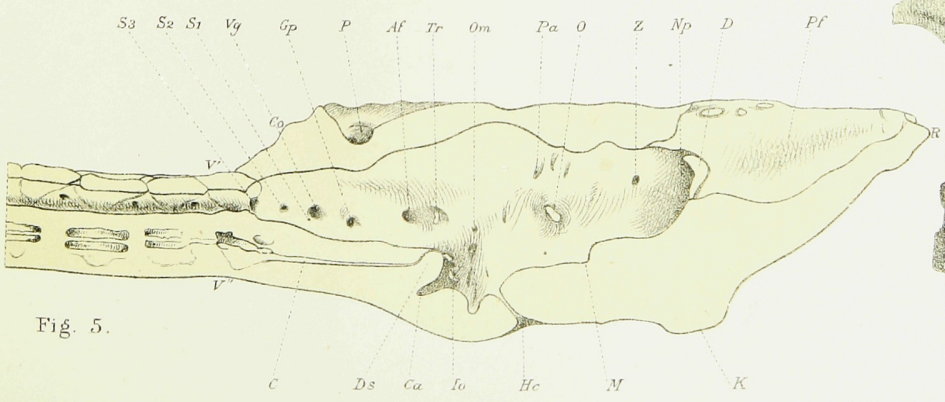

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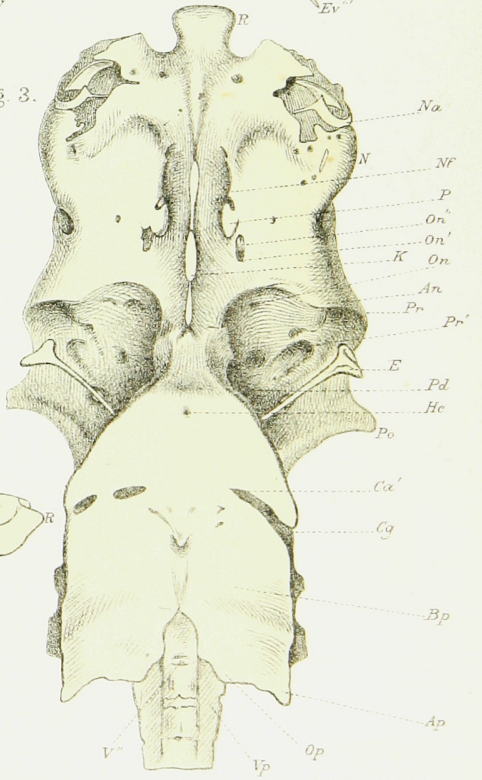

Fig. 3.

M^r P. J. White on the Greenland Shark — Plate II.

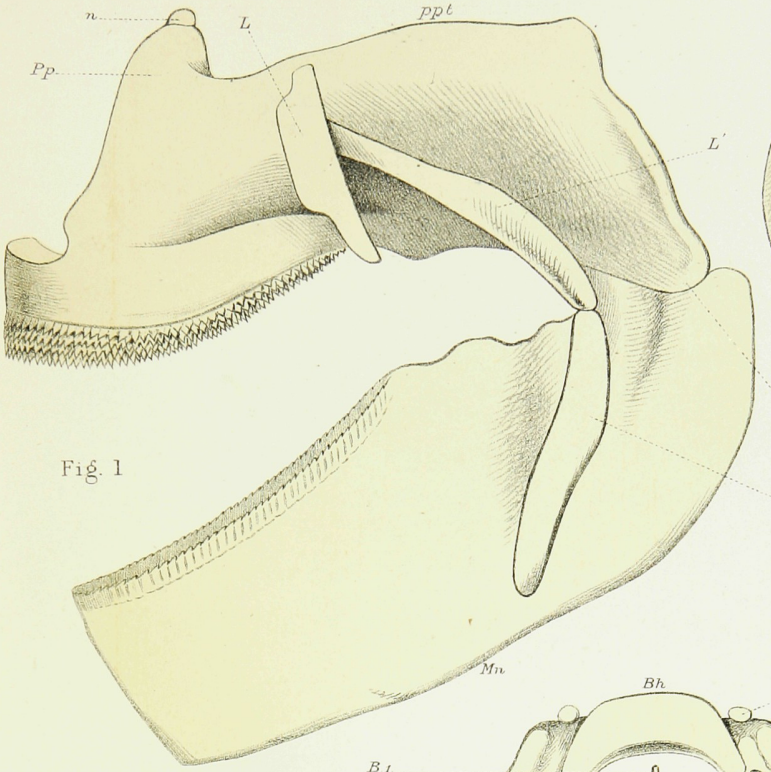

Fig. 1

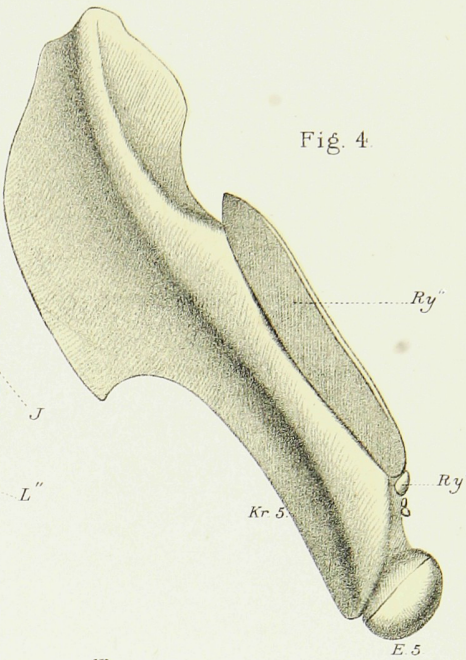

Fig. 4

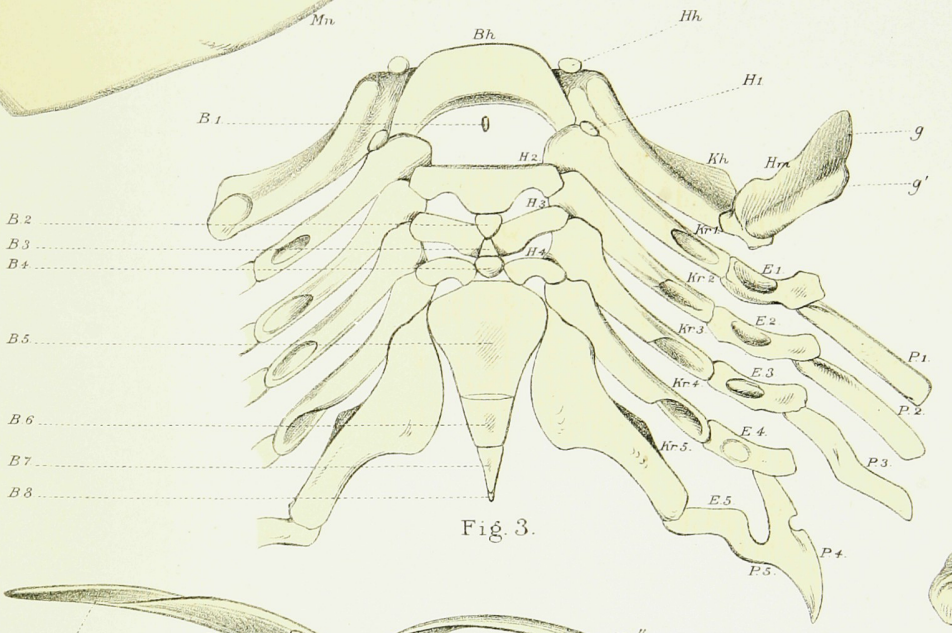

Fig. 3

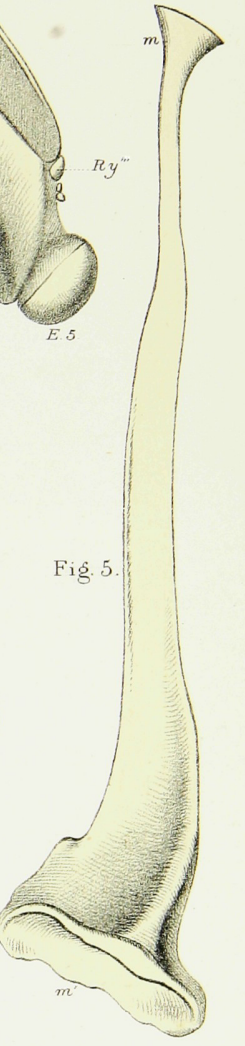

Fig. 5.

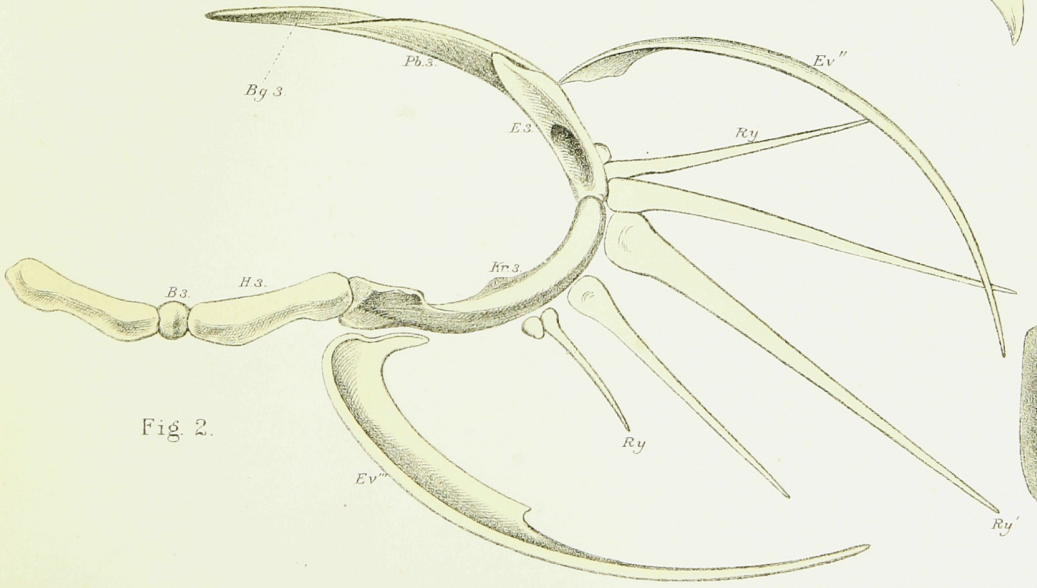

Fig. 2.

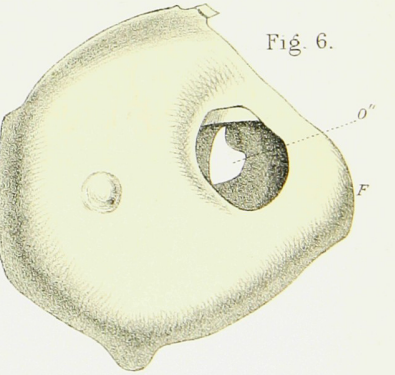

Fig. 6.

J. T Murray, Edin^r, del.

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