

NOTES ON THE FOETAL SKULL OF *MESOPLODON STEJNEGERI**

CHARLES McCANN

8 Kiwi Street, Heretaunga, Upper Hutt, New Zealand

ABSTRACT

The cranial anatomy in the skull of a foetal *Mesoplodon stejnegeri* True is described and illustrated. Some of the more important changes which take place in the structures in the course of their development from the foetal to the adult state are discussed.

INTRODUCTION

The Ziphioid skull is, perhaps, the most asymmetrically distorted of all mammalian crania. In the adult some of the elements are partially or completely overlaid, fused or so closely interdigitated that they defy separation and their relationship to one another is often most puzzling. In the advanced foetal stage the bones fall apart readily, on maceration, and allow of a greater understanding of the complex arrangement of the cranial components. However, it is seldom that a specimen, young enough, is available to study the intricate anatomy of such a skull.

On the 28th September, 1937, the late Dr. W.R.B. Oliver collected a specimen of *Mesoplodon stejnegeri* True which stranded on the Waiterere Beach, near the Manawatu Heads (*Dom. Mus.* 619). The specimen, a female, contained a full term foetus (*Dom. Mus.* 620, skeleton). The skeletons of both are preserved in the Dominion Museum, Wellington.

In the flesh, the adult measured 4,200 mm (14 ft) in total length and the foetus 1,550 mm (5ft 2 in). *Mesoplodon stejnegeri* is, perhaps, the smallest species in the genus. As the neonatals of *Mesoplodon* are approximately one third the length of the parent at birth, there seems little doubt that the adult presumably came inshore to calve, when she met her death. Three species of *Mesoplodon*, *M. grayi*, *M. layardi* and *M. stejnegeri*, are known to calve in New Zealand waters during the spring of the Southern Hemisphere.

Unfortunately, portions of the skull of the foetus have been lost or disintegrated during maceration; nevertheless, there is sufficient material available worthy of description and comment. As most of the cranial elements have fallen apart along their sutures, description of the various components and their relationship to each other is made comparatively simple. I draw attention to the main features of the skull below.

* This paper was compiled during my service with the National Museum, Wellington.

ANATOMICAL OBSERVATIONS

At this early age the axial base of the cranium (*basis crani*) is composed of three separate masses: anteriorly, the vomer-presphenoid mass; mesially, the basisphenoid mass; and, posteriorly, the basioccipital mass.

Vomer-presphenoid mass. (Pls. 3, fig. 1; Pl. 4, fig. 1)

Viewed dorsally, the rostral portion of the vomer (V) is a lanceolate channel or trough, deepest proximally (Pl. 3, figs. 1, 4). At the point of fusion with the presphenoid (PS), a portion of the vomer is obscured by the superimposition of the presphenoid (PS) and the ethmoid, but the vomer reappears posteriorly as a thin, horizontal, retuse, somewhat ligulate bone, the lateral lobes of which are slightly depressed on either side of the mid-line (Pl. 3, fig. 4). Viewed laterally, the vomer is somewhat canoe-shaped with a short 'drop-keel' (K) near the middle of its length. Ventrally, the vomer is strongly keeled except for the posterior, horizontal expansion. At the point of fusion between the internal, lateral walls of the vomer, and the presphenoid, there is an articular surface for union with the pterygoid bone. On the interior wall of the presphenoid are clearly seen the lines of fusion between it (presphenoid) and the ethmoid. The ethmoid fuses also with the adjacent walls of the vomer, but at this early age the base of the ethmoid is not in contact with the vomer below; at a later stage of development the union is completed.

The presphenoid rises in a steep curve from its almost horizontal floor to form the fore part of the cranial cavity. It lies across the axial base of the vomer, but it is free from the vomerine channel at this period of development. No foramina are apparent on the walls of the presphenoid, but a shallow sulcus is formed on the lateral edges which eventually contribute to the formation of the *optic foramen* and the *foramen lacerum*. The suture between the presphenoid and the basisphenoid is filled with cartilage. In the adult, although the suture narrows, the two bones never seem to fuse; there is always a gap between them.

Proximally, the ethmoid is composed of rather spongy bone fusing with the presphenoid and the vomer; anteriorly, it continues in the trough of the vomer (mesorostral groove) as the *mesorostral cartilage*. With advancing age this cartilage ossifies and fuses with the adjacent bones and, in adult males completely fills the groove with dense, ivory-like bone; but in females the ossification is not so marked, the groove is only partially filled with bone of a more spongy nature (Pl. 1, OC). Some authorities hold that the filling of the mesorostral groove is effected by proliferation of the vomer itself (Forbes, 1893)*, but this view does not appear to be borne out by careful examination of transverse sections of the rostrum.

* Forbes, H. O., 1893. *Proc. Lool. Soc. Lond.* pp. 216-236, pls. 12-15.

Basisphenoid mass. (Pl. 3, figs. 2, 12; Pl. 4, fig. 2)

Viewed dorsally, the basisphenoid (BS) is somewhat butterfly-shaped (Pl. 3, figs. 2, 12), with great 'pedunculate' wings (alisphenoid) outspread obliquely forwards, the anterior margins of which articulate with the pterygoids. About the middle of the body of the basisphenoid is a shallow depression (*pituitary fossa*); on either side of this fossa is a large foramen (*foramen ovale*) (FO). The foramina pass obliquely backwards to the exterior.

As already observed, the anterior articulation is imperfect mesially, but the antero-lateral edges articulate with the presphenoid. The posterior articular surface of the basisphenoid is not markedly separated from the basioccipital. In the adult this suture fuses completely, and this union between the basisphenoid and the basioccipital becomes almost invisible. Ventrally, the basisphenoid is shallowly grooved, longitudinally (Pl. 3, fig. 12). Posteriorly, on either side of the median groove, are the elevated articular surfaces which articulate with the basioccipital crests or wings.

Basioccipital mass. (Pl. 3, fig. 3; Pl. 4, fig. 3)

Viewed dorsally, the surface of the basioccipital (BO) is somewhat triangular; the articular surface of the basioccipital with the basisphenoid is marked by four scollops (Pl. 3, fig. 3; Pl. 4, fig. 3); mesially there is a shallow fossa on either side of which there are articular surfaces for the adjacent bones. Posteriorly, a rounded projection forms the lower margin of the *foramen magnum* between the bases of the occipital condyles. Laterally, the basioccipital crests fall away obliquely with forwardly directed projections articulating beneath the basisphenoid. Postero-laterally, the basioccipital crests articulate with the exoccipitals.

With advancing age, the basisphenoid is 'crushed' between the presphenoid and the basioccipital, and, eventually, it (basisphenoid) fuses completely with the latter bone. The alisphenoids appear as irregularly shaped bones on the exterior of the skull, adjacent to the squamosal. The posterior horizontal portion of the vomer overlies the greater part of the basisphenoid and a portion of the basioccipital subsequently fusing with them.

Maxilla. (Pl. 3, figs. 5, 6; Pl. 4, fig. 14)

Addressed to the lateral portion of the vomer is the lanceolate projection of the maxilla (MX); posteriorly, the maxilla flattens out almost horizontally to form a broad supra-orbital expansion as in the adult (Pl. 3, fig. 6). Its posterior margin bends round towards the mid-line of the skull and contributes to the formation of the *vertex* and the lambdoidal ridge. In the foetus, a basirostral groove (DN) is present, extending from below the maxillary tubercle to the anterior extremity, just below the dorsal profile of the maxilla. This groove is believed to be homologous with the dentary groove of other mammals. This canal apparently houses the dentary branch of the superior maxillary nerve. In the adult of *Mesoplodon stejnegeri* the basirostral groove

(BG) is *absent*, being completely filled with secondary bone. In some species this groove is present throughout life (*M. grayi*) and forms a useful accessory character in diagnosis of the species.

The dorsal profile of the rostral portion of the maxilla slopes gently upwards towards the nares (NR); the lower is almost straight, rising abruptly (at an angle of about 45 degrees) at a vertical dropped at the maxillary tubercle (MT). The cranial portion of the maxilla is expanded laterally, as already indicated above, but does not margin the orbit. The inner face of the maxilla is sculptured to articulate with the premaxilla and the vomer. The outer face is sculptured posteriorly to articulate with the palatine bone (PL), (Pl. 3, figs. 5, 6). From above, on the inner side of the maxillary tubercle, the large maxillary foramen (MXF) is visible. Another large foramen (sometimes additional secondary foramina are present), the *post-maxillary foramen* (PMXF), is to be seen near the middle of the flattened expansion or 'maxillary plate'. The expanded portion of the maxilla over-rides the malar bone (jugal), the lachrymal bone and the frontal bone (F), except for its (frontal) lateral margin which forms the orbit.

Premaxilla. (Pl. 4, figs. 13)

The premaxilla (PMX) is a much elongated, compressed and twisted bone, anteriorly wedged between the vomer and the maxilla and posteriorly margining the anterior nares (NR) and forming part of the vertex. Its posterior extremity forms part of the 'hood' over the anterior nares (the hood is most pronounced in *M. stejnegeri*).

Dorsally, the premaxilla is perforated by the *premaxillary foramen* (PMF). In the foetus the premaxillary foramina are approximately on the same transverse level as the maxillary foramina, but with the elongation of the rostral bones, the premaxillary foramina moves a short distance behind the maxillary foramina as in the adult. A canal, carrying a branch of the trigeminal nerve and the associated blood vessels, enters the matrix of the premaxilla and travels to its anterior extremity. This canal is connected with the premaxillary foramen. The dorsal margin of the premaxilla, together with the wall of the vomer, encloses the mesorostal cartilage, but the premaxilla exceeds the vomer in length, and, anteriorly, the premaxillae alone constitute the groove. In the adult the bone of the premaxilla is much denser than that of the maxilla.

Palatine bone (PL). (Pl. 3, figs. 5, 6; Pl. 4, fig. 15)

The palatine bone is sandwiched between the maxilla and the pterygoid and when the latter bone is in place the major portion of the palatine is obstructed, with only a narrow margin of its anterior extremity and dorsal edge margining the pterygoid above. Anteriorly, the palatine bone is somewhat arrow-headed in shape (Pl. 3, fig. 5, 6 (PL)). Postero-dorsally, two short articular surfaces project, the upper in contact with the maxilla, frontal

and the lachrymal bones; the lower, with the lachrymal alone. Postero-ventrally, the palatine bends round the angle of the maxilla forming a small lobe compressed between the maxilla and the vomer. The external face of the palatine articulates with the pterygoid and eventually fuses with it completely. A portion of the palatine enters the anterior nares.

Pterygoid bone (PY). (Pl. 3, figs. 1, 8; Pl. 4, fig. 16)

The pterygoid bone is somewhat triangular in general shape. Postero-dorsally the pterygoid articulates with the vomer and the base of the presphenoid and, in time, fuses with them; its internal lateral face abuts the exterior of the palatine bone and eventually fuses with it. Externally, the pterygoid is concaved and forms what is known as the *mesial lamina* (PML); its lower margin turns outwards and posteriorly forms the pterygoid *hamulus* (H). Together the paired pterygoids form the posterior nares which contains the laryngeal mass. The pterygoids approximate each other along the axial line but, normally, do not fuse with each other, even in the adult.

Lachrymal bone (L). (Pl. 3, figs. 11a, 11b; Pl. 4, fig. 12)

The lachrymal bone is roughly oblong in shape. Viewed ventrally, the anterior half is flat, but the posterior half presents a strong keel. Dorsally, it is in contact with the maxilla and the anterior portion of the frontal, forming the orbital margin. Posteriorly, it is also in contact with the palatine and with the pterygoid. Anteriorly it is in contact with the malar bone. (Pl. 3, figs. 11a, 11b)

Malar bone (*jugal*).

The malar bone is missing in the specimen under discussion. In the adult, the malar is a flattish, triangular bone giving off, posteriorly, the slender zygomatic process; it is in contact with the maxilla internally and with the lachrymal externally. Anteriorly, it borders the antorbital notch.

Together with the lachrymal, and the anterior extremity of the frontal forming the orbit, the malar contributes to the formation of the antorbital tubercle.

Frontal bone (F). (Pl. 4, figs. 9, 11).

Dorsally, the frontal bone (F) is almost completely overlaid by the expansion of the maxilla, but, laterally, it borders the maxilla and contributes to the formation of the orbital—the lateral border of the frontal forms the superior border of the orbit. Anteriorly, its extremity interlocks between the maxilla and the lachrymal; posteriorly, the orbital ridge terminates in a free process above the squamosal. Posteriorly, the edge of the frontal can be followed, wedged between the maxilla and the supraoccipital, and thence twisting round into the vertex of which it forms part, under the maxillary 'plate'. Its posterior wall forms part of the brain case.

Nasal bone (N). (Pl. 4, fig. 10)

The nasal bone (N) are paired. Each bone is somewhat cuboidal in shape (Pl. 4, fig. 10) in the foetus; they are 'free'—they drop out of position on maceration. In the adult the nasals lose some of their shape and become welded to the adjacent bones posteriorly and laterally; anteriorly they are free, and contribute to the formation of the anterior nares. In the foetus the two nasals are in contact with each other mesially, but not fused; laterally the bones are adpressed to the internal faces of the premaxillae; ventrally they are in contact with the mesethmoid.

Narial passage (NR).

The narial passage is divided into two by a septum formed largely by the vomer and the ethmoid. The recurved walls of the vomer, together with a portion of the pterygoids, compose its posterior wall; the lateral walls are formed largely by the pterygoids and small segments of the maxillae and palatines; and, the anterior wall, partly by portions of the premaxillae, maxillae and pterygoids. The superior wall of the posterior passage is formed largely by the horizontal, posterior expansion of the vomer and a small segment of the frontals. The inferior walls are formed by the pterygoids.

A large foramen perforates each of the lateral walls of the anterior nares, carrying a branch of the trigeminal nerve and the associated blood vessels.

Interparietal (IP). (Pl. 3, figs. 9a, 8b, 9c, 10; Pl. 4, fig. 4)

The interparietal is a dense obovate bone with a ventral keel which fuses with the *falx cerebri*. Anteriorly, it is in contact with the frontals; laterally and posteriorly it fuses with the adjacent bones and with age loses its identity as a separate element. In the foetal specimen its sutures are still visible on its ventral aspect.

Parietals.

The parietals are damaged beyond recognition in the specimen.

Supra-occipital SO. (Pl. 4, fig. 4)

The supraoccipital at this early stage is very fragile. It is domed, with a median depression exteriorly; interiorly a deep flange forms part of the *falx cerebri*. At the posterior end of the *falx cerebri* is the internal occipital protuberance.

Exoccipital (EO). (Pl. 4, fig. 5)

The exoccipital is somewhat squarish. The superior margin fuses with the supraoccipital eventually; ventrally it articulates with the posterior margin of the basioccipital crest and, eventually, fuses with it; its lateral margin articulates with the squamosal and fuses with it; at its inner angle is the occipital condyle. Between the lateral margin and the condyle there is a deep notch along its ventral border; within this notch there is the exist leading

outward from the internal *condylar foramen*. The fusion of the exoccipital with the basioccipital is so complete in the adult that it appears as though the exit foramen was situated between the two bones.

Squamosal bone (SQ).

The squamosal bones (SQ) have been lost in the foetal specimen. A portion of one is preserved but is insufficient for description.

Mastoid process.

A mastoid process arises from the posterior of the auditory bulla and interdigitates with the posterior protuberance of the squamosal; it is connected to the bulla by a narrow neck. On its latero-ventral surface is an articular face which articulates with a corresponding surface on the posterior lobe of the periotic bone. (Pl. 4, fig. 8).

Tympanics.

Viewed ventrally, it will be seen that the bulla (B) (Pl. 4, fig. 6) obscures much, if not all (all in adult) of the periotic bone (Pl. 4, fig. 7) lying beneath it. The two bones are connected to one another by a thin, fragile piece of bone. The eustachian canal opening is directed forward. Externally, the ventral surface of the bulla is divided into two lobes, an internal lobe running parallel with the basioccipital crest and an outer, smaller lobe.

The periotic bone (Pl. 4, fig. 4), perhaps, the most solid in the whole skeleton (of cetacea), fits closely into a hollow formed in the squamosal. Anteriorly, the periotic is margined by a thin *falciform process*, arising from the squamosal. The periotic bone may be divided into three regions; an anterior lobe with an articular face for the margin of the eustachian tube, a central lobe perforated by several foramina and a posterior lobe with an articular surface to receive the counter part of the bulla already referred to.

Mandibles (MN). (Pl. 4, fig. 17)

The mandibles at this early age are very fragile. Along the superior margin the dentary groove is completely open. Near the posterior union of the symphysis a single mandibular tooth is present in each ramus. The tooth is just a hollow triangular shell with an acute tip. (Pl. 4, fig. 17). On the exterior face of each ramus, in the vicinity of the tooth, there are the mental foramina. The posterior blade of the ramus is about twice as deep as the anterior; the coronoid is slightly anterior to the articular condyle and, the angular slightly posterior to it.

Course of the 5th cranial nerve (trifacial). (Pl. 5)

The course of the 5th cranial nerve in *Mesoplodon* calls for some comment because of the great departure of the cranial elements from the more familiar mammalian type of skull. Because of the distortion that takes place, it is difficult to correlate the various branches with the ramifications of the

corresponding nerves observed in other mammals, including Man. The exit foramina of some of the major branches play an important role in taxonomic description.

The courses of the nerves and the associated blood vessels are represented in the skull by canals and these have been traced by means of wire tracers.

In the foetus of *Mesoplodon stejnegeri*, as with other mammals, the 5th cranial nerve leaves the brain case through the *foramen lacerum* and enters a large cavity (homologous to Meckel's cavity in Man) situated just below the *maxillary foramen* (MF). Within the cavity lies a large ganglion, *Gasserian Ganglion*, which gives off several branches to the facial region. Postero-ventrally, a short branch perforates the lateral wall of the anterior nares (NR) through the maxilla ('Nasal' branch). Postero-dorsally, another large branch is given off which courses backwards, partly through the maxilla and partly between the maxillary and frontal 'plates', and emerges to the exterior of the skull through the *post-maxillary foramen* (PMXF). This branch probably corresponds to the *frontal branch* (of human anatomy).

Antero-dorsally, two closely associated branches are given off, the larger emerging to the surface through the maxillary foramen (MF) the smaller, passing under a bony ridge, crosses the suture between the maxilla and premaxilla and, finally emerges through the premaxillary foramen to the dorsal surface of the skull.

Below the maxillary foramen a large branch from the ganglion courses forwards the full length of the maxilla, just below its superior margin, in an open channel. This branch is the homologue of the *dentary nerve* (DN) in other mammals. The bony channel is referred to, in cetacean parlance, as the *basirostral groove*. The presence (in *M. grayi* and *M. bidens*) or absence (in *M. layardi* and others) of the basirostral groove in *Mesoplodon* is of some diagnostic value when describing or determining adult skulls and it has been made use of. In the adult skull of *M. stejnegeri* the basirostral groove (BG) is absent but in the foetal skull the groove is present. (Reference to the disappearance of the groove in the adult will be discussed below).

From below the premaxillary foramen, a branch leaves the ganglion and courses forwards, at first through the matrix of the premaxilla and then along the suture between the premaxilla and the maxilla, to the extremity of the rostrum. The canal for this nerve is readily seen in a cross section of the rostrum (PN).

Below the dentary branch (DN) another large division leaves the ganglion, at first descending between the maxilla and the palatine bone, then, entering the matrix of the maxilla at about the middle of its depth, it descends gradually to the inferior margin of the maxilla where it emerges by a foramen some distance short of the extremity of the maxilla (median maxillary nerve-MMN). Yet another large nerve leaves the ganglion and after coursing forwards through the matrix of the maxilla emerges by a foramen close to the exit of the median maxillary nerve (MMN). This lower nerve I refer to as

the *inferior maxillary nerve* (IMN). The last two mentioned nerves probably correspond to the sphenopalatine nerves.

The presence of the basirostral groove in the foetal skull and its absence in the adult skull, already referred to above, calls for some explanation. As already observed, the dentary branch enters the so-called basirostral groove below the maxillary tubercle (MT). Apparently, at an early period of development, the dentary nerve (DN) is intact from the point of emergence from the ganglion to the extremity of the rostrum. As growth proceeds secondary bone develops at its proximal end and gradually strangles the nerve and blood supply, eventually cutting off both the neural and vascular supply completely. This severance of the nerve in *M. stejnegeri* appears to commence some time before birth, the groove itself gradually filling up, subsequently, with secondary bone, leaving little or no trace of the basirostral groove; however, its erstwhile position is sometimes demarcated by narrow, fragile planges on either side—its position is often visible throughout the length of the rostrum. Hence, *M. stejnegeri* is described as having “no basirostral groove”. In the adult of *M. grayi*, although the channel is closed off proximally under the maxillary tubercle (MT), leaving the so-called ‘pit’, the rest of the channel remains open permanently.

It is remarkable that, in *M. grayi*, in which the basirostral groove is always present, rudimentary teeth frequently occur in the upper jaw, but such teeth are not socketed in the maxilla, whereas in species devoid of the basirostral groove in the adult, rudimentary teeth have not been observed. This observation seems to suggest that, in *M. grayi*, the dentary nerve is strangled at a later period of development than in those species in which the dentary channel (basirostral groove) is obliterated by the growth of secondary bone.

This suppression of the dentary nerve and blood supply at an early period of development possibly accounts, at least in part, for the absence of teeth in upper jaws of most *Mesoplodon* and in other ziphioid whales. However, it is interesting to observe that, in addition to the functional teeth (in males), vestigial teeth do sometimes occur in some members of the Ziphiidae and their presence may be dependent on the extent to which the dentary nerve has been ‘strangled’.

The course of the mandibular branch of the 5th nerve is obviously not traceable in the foetal specimen. The inferior dental groove is however, open along its entire length and the functional mandibular teeth are present in the rami (one in each). As far as I am aware, rudimentary mandibular teeth have rarely been observed in *Mesoplodon*. Fraser (1953) illustrated the presence of such vestigial teeth in *M. bidens*. Rudimentary mandibular teeth have been more frequently reported in *Hyperoodon* (Boschma, 1950) and in *Ziphius*. In *Tasmacetus*, the rarest of the family, teeth are present in both upper and lower jaws. The presence of teeth in both jaws of *Tasmacetus* suggests, perhaps, that it is less specialised than the other ziphioids and retains part of its more ‘primitive’ characters.

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EXPLANATION OF PLATES

PLATE I

Stejneger's Beaked Whale: *Mesoplodon stejnegeri* True. Lateral aspect of cranium of adult female showing arrangement of elements.
Courtesy Nat. Mus. Wellington, N.Z. Photo P. M. Hedgland
 (For explanation of lettering see end of paper)

PLATE II

Stejneger's Beaked Whale: *Mesoplodon stejnegeri* True. Dorsal aspect of cranium of adult female showing arrangement of elements.
Courtesy Nat. Mus. Wellington, N.Z. Photo P. M. Hedgland
 (For explanation of lettering see end of paper)

PLATE III

Stejneger's Beaked Whale: *Mesoplodon stejnegeri* True. Disarticulated elements of the foetal cranium.
 1. Vomer-presphenoid mass (dorsal aspect); 2. Basisphenoid (dorsal aspect); 3. Basisoccipital (dorsal aspect); 4. Vomer-presphenoid mass (lateral aspect); 5. Maxilla (internal face); 6. Maxilla and palatine bone (external face); 7. Pterygoid bone (external face); 8. Pterygoid bone (internal face); 9a. Interparietal (anterior face); 9b. Interparietal (lateral face); 9c. Interparietal (ventral face); 10. Interparietal with adjacent frontals (dorsal aspect); 11a. Lachrymal bone (ventral aspect); 11b. Lachrymal bone (dorsal aspect); 12. Basisphenoid (ventral aspect).

del. C. McCann

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PLATE IV

Stejneger's Beaked Whale: *Mesoplodon stejnegeri* True. Disarticulated elements of foetal cranium.

1. Vomer-presphenoid mass; 2. Basisphenoid; 3. Basioccipital; 4. Supraoccipital; 5. Exoccipitals; 6. Bulla; 7. Pariotic bone; 8. Portion of squamosal; 9. Posterior portion of frontal (damaged); 10. Nasal bone; 11. Orbital portion of frontal (damaged); 12. Lachrymal bone; 13. Premaxilla; 14. Maxilla (posterior portion incomplete); 15. Palatine bone; 16. Pterygoid bone; 17. Mandible (with tooth). (Excepting nos. 5, 9, paired bones show opposite faces; all other bones show the dorsal aspect only.)

Courtesy Nat. Mus. Wellington, N. Z.

Photo F. O'Leary

PLATE V

Stejneger's Beaked Whale: *Mesoplodon stejnegeri* True. Showing courses of the main nerves and vascular supply traced in the rostrum of a foetal specimen (*Semidiagrammatic*).

1. Outer aspect of left rostral portion of maxilla. 2. Transverse section on maxilla. 3. Proximal portion of right maxilla showing maxillary foramen and passage of premaxillary branch to premaxillary foramen. 4. Divisions of the 5th cranial nerve (*Diagrammatic*).

(For explanation of lettering see end of paper.)

del. C. McCann

EXPLANATION OF LETTERING ON PLATES

AN—Antorbital notch.	MT—Maxillary tubercle.
AT—Antorbital tubercle.	MX—Maxilla.
B—Bulla.	MXC—Maxillary crest.
BG—Basirostral groove.	MXF (MF)—Maxillary foramen.
BO—Basioccipital.	N—Nasal bone.
BOC—Basioccipital crest.	NF—'Nasal' nerve foramen.
BS.—Basisphenoid.	NR—Anterior nares.
C—Occipital condyle.	OC—Ossified mesethmoid cartilage.
DN—Dentary nerve.	OG—Optic groove.
EO—Exoccipital.	OT—Antorbital tubercle.
F—Frontal.	PL—Palatine bone.
FO—Foramen ovale.	PMF—Post maxillary foramen.
FP—Falsiform process.	PML—Pterygoid median lamina.
GG—Gasserian ganglion.	PMX—Premaxilla.
H—Hamulus.	PMXF—Premaxillary foramen.
IMN—Inferior maxillary nerve.	PS—Presphenoid.
IP—Interparietal.	PY—Pterygoid bone.
K—Keel of vomer.	SO—Supraoccipital.
L—Lachrymal.	SQ—Squamosal.
MC—Meckel's cavity.	TF—Temporal fossa.
ME—Mesethmoid.	V—Vomer.
MMN—Median maxillary nerve.	VN—Fifth cranial nerve.
MN—Maxillary notch.	









