2. Observations on the Development of the Rostrum in the Cetacean Genus *Mesoplodon*, with Remarks on some of the Species. By Henry O. Forbes, F.Z.S., F.R.G.S.

[Received January 17, 1893.]

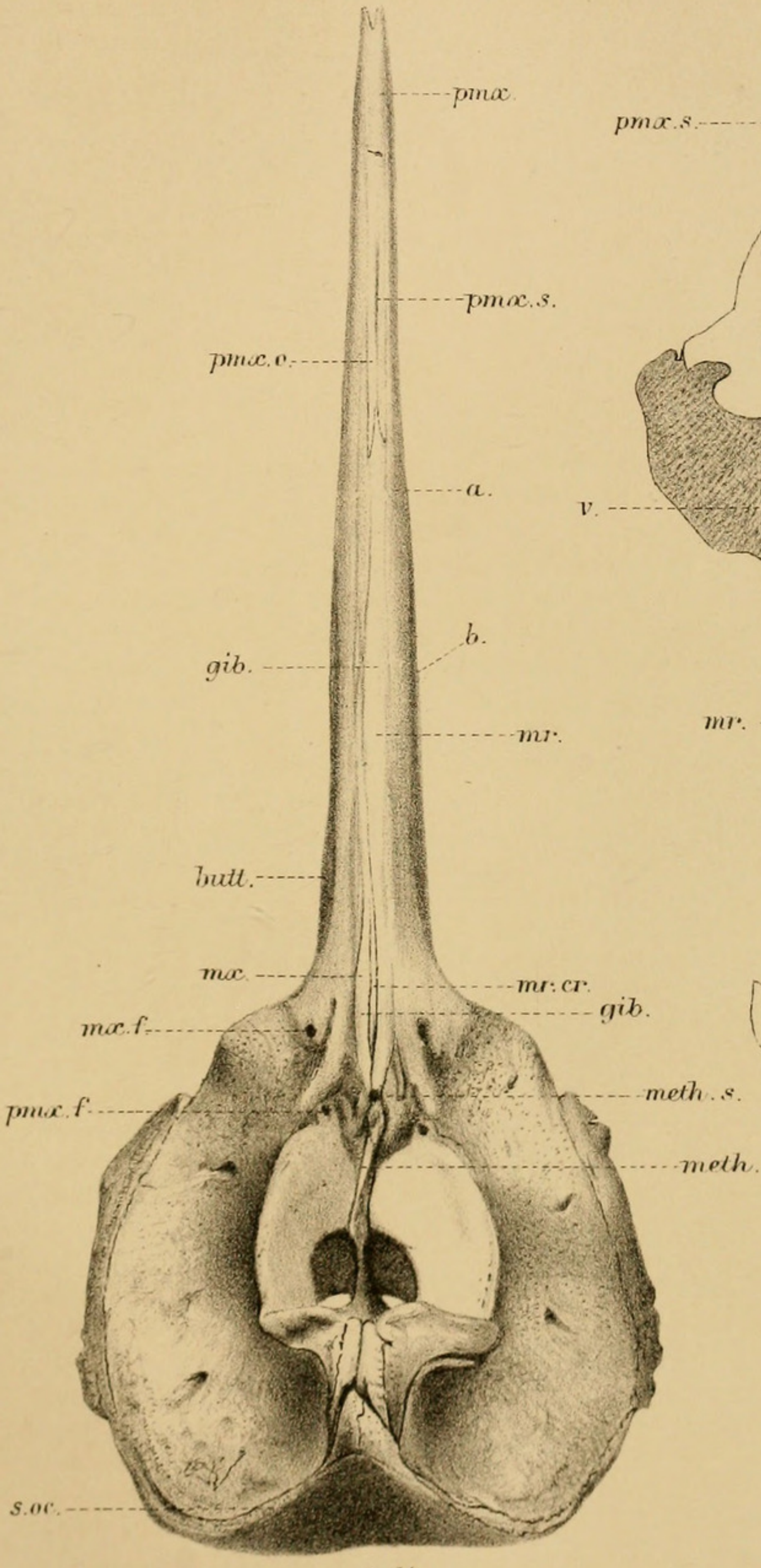
(Plates XII.–XV.)

In the course of my duties as Curator of the Canterbury Museum, Christchurch, N. Z., I had occasion to study the Cetacea in that collection. In my determination of the species of *Mesoplodon* I was necessarily guided by the authoritative papers on this group by Sir William Flower in the 'Transactions' of this Society, and by Sir William Turner in his Report on the Cetacea of the 'Challenger' Expedition. In his paper in volume x. of our 'Transactions,' page 422, Sir William Flower observes, in speaking of a form near to *Mesoplodon grayi*, Haast:—"Making every allowance for individual variation, it scarcely seems possible that a rostrum such as that shown in figure 2 [i. e. *Mesoplodon grayi*: Plate XIV. fig. 3] could change in the course of growth to that in figure 3 [i. e. *Mesoplodon haasti*, Flower: Plate XII. fig. 2]. If so, most of the determinations of the fossil species based solely on the form of the rostrum are quite valueless." The same author, on an earlier page (page 420) of the same paper, remarks:—"There is still much to be learned with regard to the mode of ossification of this cartilage. All the specimens which I have had an opportunity of examining are either so young that ossification has not commenced, and the trough of the vomer in the rostrum proper is completely empty in the dried skull, or so old that the consolidation of the cartilage and its union with the surrounding bone has been completed." In having lived for some time in the region in which this genus is not uncommon, I have been fortunate in having had an opportunity of examining several immature crania in which the relations of the bones which constitute the rostrum were such as to enable me to trace some unobserved stages in their development. These observations I have thought of sufficient interest to lay before the Society, especially as they bear on some of the characters by which the various forms of *Mesoplodon* and *Ziphius*, both recent and fossil, have been separated from each other.

The deductions I have arrived at in this paper are based on a personal examination and comparison of the following specimens:—

A. A very young (and, according to Haast, a male) skull, with its mandible,—one of three specimens sent from the Chatham Islands to Sir Julius von Haast in 1875. It is a co-type of *Mesoplodon* (*Oulodon*) *grayi*, Haast, described in vol. ix. of the 'Transactions' of the N.Z. Institute. In this specimen the vomerine trough is quite empty. It forms part of the collection in the Otago Museum, Dunedin, N.Z.

A*a*. A young specimen in the Otago Museum, Dunedin, in



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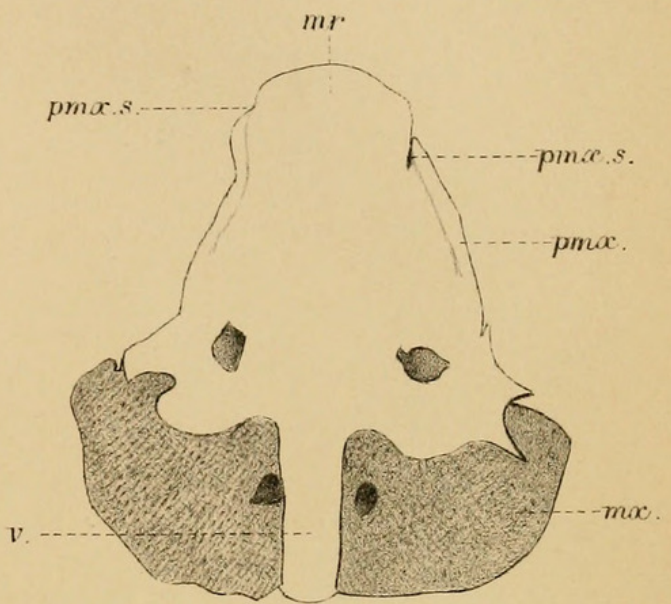

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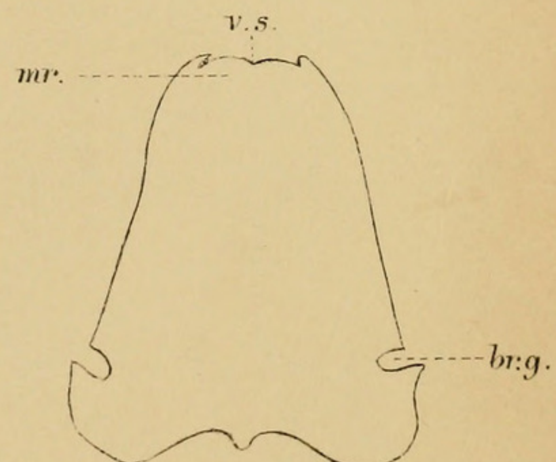

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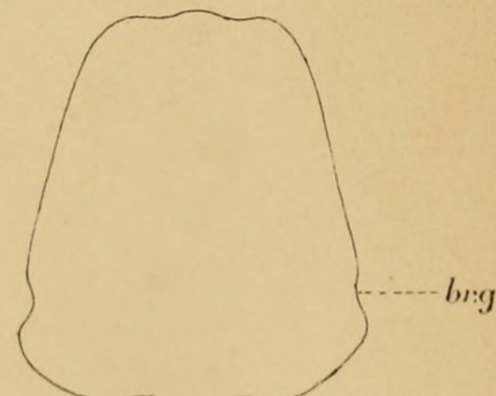

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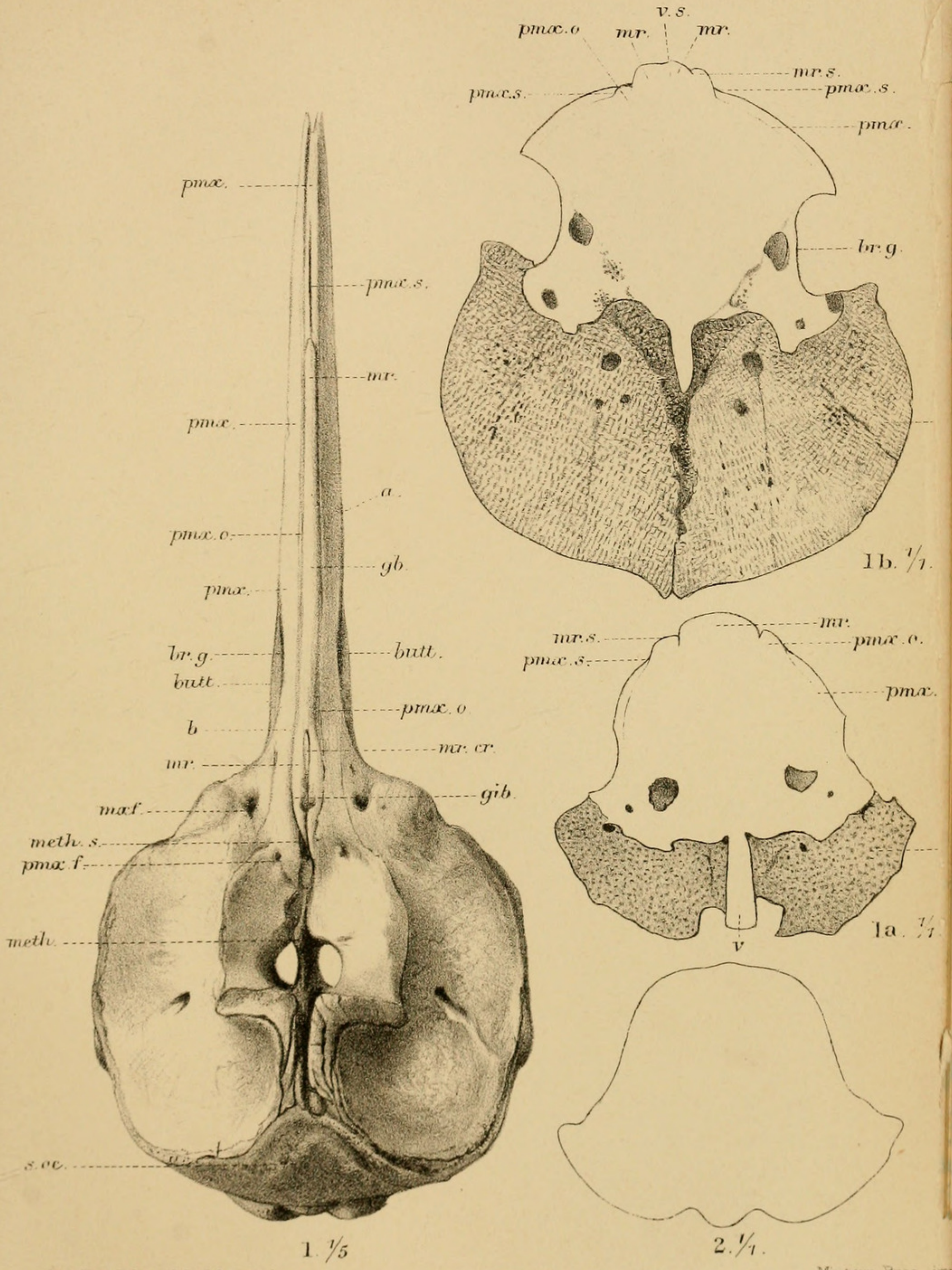
STRUCTURE OF MESOPLODON.



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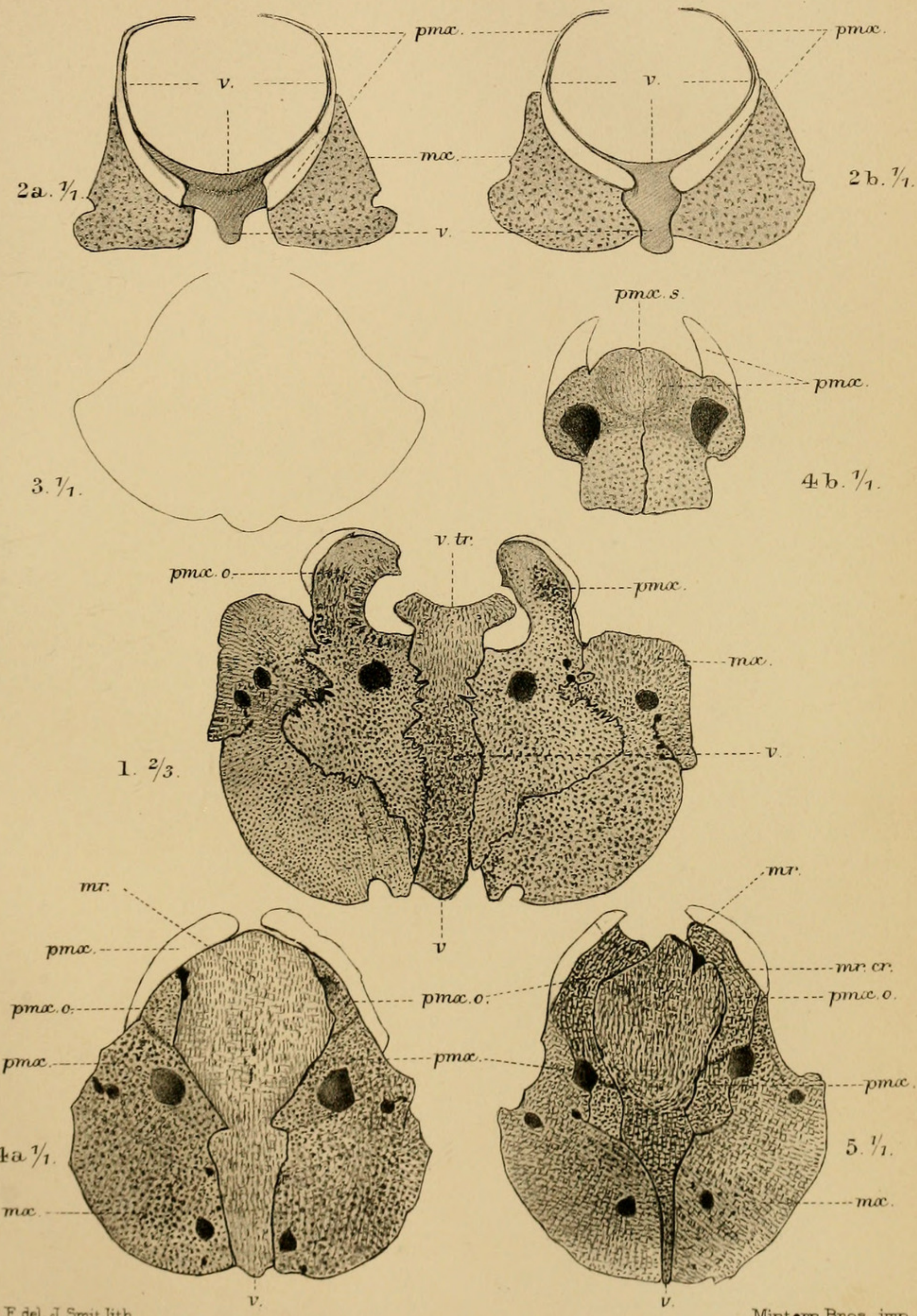

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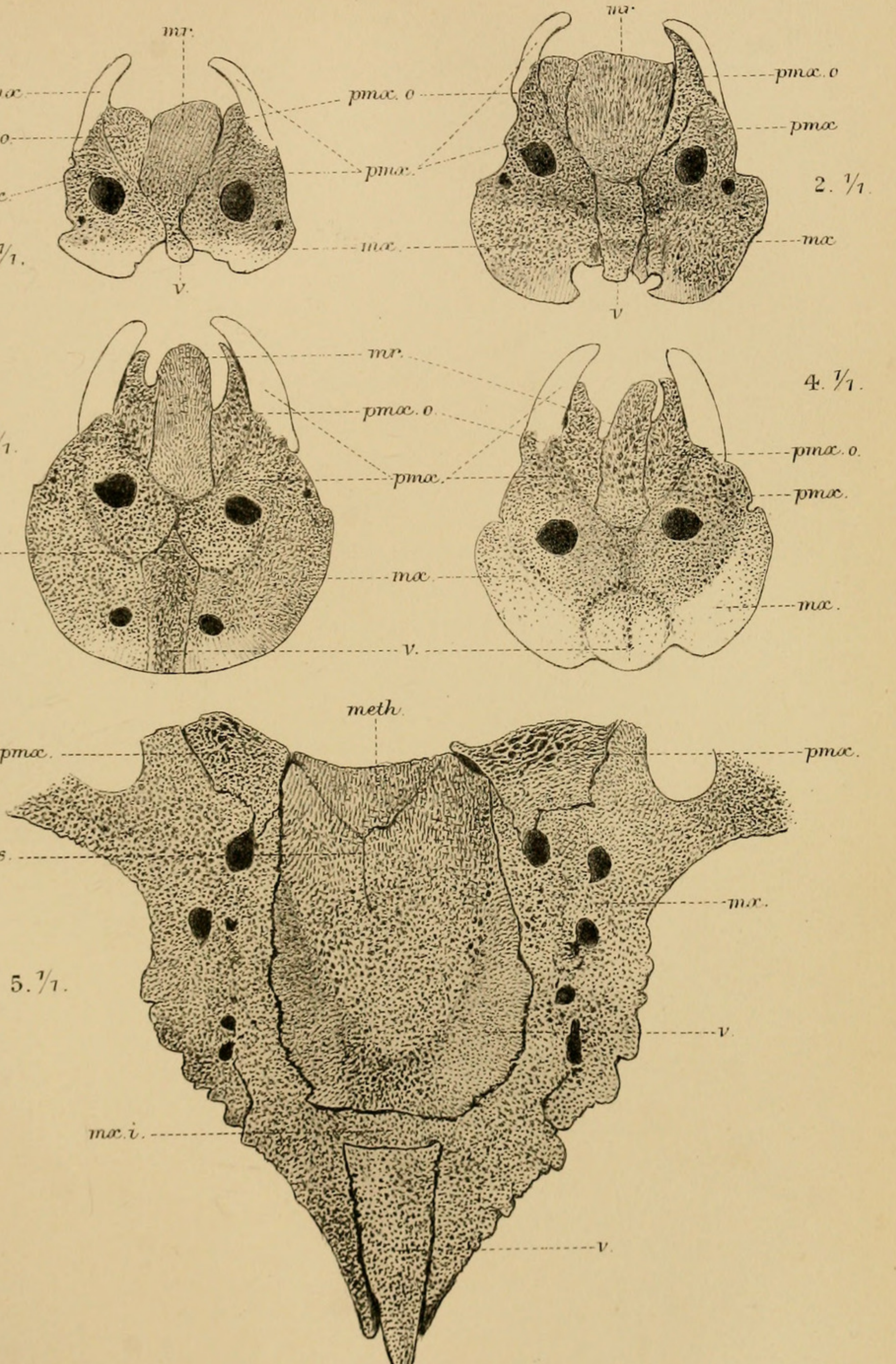

J. Smit del. et lith.

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STRUCTURE OF MESOPLODON.

which the first appearance of change in the mesorostral groove is visible.

B. A damaged cranium, without its mandible, received from the Chatham Islands, and now exhibited; of unknown sex, and of a more advanced age than A. The vomerine trough is still empty and perfectly smooth. It would appear to be about the same age, being apparently about the same stage of development, as *Mesoplodon grayi*, Haast, figured by Van Beneden and Gervais in their 'Ostéographie des Cétacés.'

C. A skeleton in the Museum of the Royal College of Surgeons — that described and figured by Sir W. Flower as *M. grayi*, Haast, in his paper already cited. This is the second of the two Salt Water Creek skeletons prepared by Sir J. von Haast, and determined by him to be *Oulodon grayi*. Its sex is doubtful; but it is still quite young, as the interior of the vomerine spout (so far as unconcealed by the rostral integument on the anterior part of the snout and of the dried cartilage in the canal) is still smooth and free from ossification.

D. The rostrum of a specimen obtained for me from the Chatham Islands, and now exhibited. I have no doubt it belongs to the species *Mesoplodon grayi*, Haast. Its sex is unknown, but its age is somewhat greater than any of those already mentioned. The vomerine trough is partially filled with osseous tissue.

E. The rostrum of a third specimen from the Chatham Islands, and now on the table, of unknown sex and of a still more advanced age, but still immature. This specimen, along with B, D, and G, will be presented to the British Museum.

F. A skull, with its mandible, of an immature (according to Haast, female) specimen of *Mesoplodon* (*Oulodon*) *grayi*, Haast. This is the second of the three skulls described by him in the ninth volume of the 'Transactions' of the New Zealand Institute from the Chatham Islands, and now in the Otago Museum, Dunedin, N. Z. It is also a co-type of the genus and species *Oulodon grayi*.

G. The rostrum of a cranium obtained for me from the Chatham Islands. It is still immature, as the mesorostral furrow, though nearly full of ossified tissue, is not yet quite filled up, and the whole of the bones are still spongy. It belongs undoubtedly to the species *grayi*, Haast, of this genus.

H. A complete female skeleton of *Mesoplodon* (*Oulodon*) *grayi*, Haast, one of four individuals that in December 1876 ran on the beach near Salt Water Creek, north of Banks Peninsula, N. Z. It was identified and described as the co-type of *Oulodon grayi* by Sir J. von Haast. Of these four specimens two skeletons were prepared—one (C) being sent to the Royal College of Surgeons, London, and the present specimen retained in the Canterbury Museum, where it is now. Though described by Sir J. von Haast as "a full-grown animal," it still bears marks of immaturity in its incompletely filled-up vomerine spout and in the rostral bones exhibiting none of that petrosal density so characteristic of fully adult *Mesoplodonta*.

I. An aged skull, without the mandible (probably a male), from Kaiapoi beach, Canterbury, N. Z., labelled, under direction evidently of Sir J. von Haast, as *Mesoplodon knoxi*, Hector, and by another hand changed into *Mesoplodon hectori*, Gray. This is the specimen referred to by Sir James Hector, in the 'Transactions' of the N. Zealand Institute, vol. v. page 168, as being in the Canterbury Museum from Kaiapoi "without the lower jaw," which he considered the adult form of his young *Mesoplodon knoxi*. It appears also, with little doubt, to be the same specimen of which Sir J. von Haast, in volume ix. of the same publication, page 455, makes the following observation, which in the absence of the mandible I am at a loss to understand, as it seems to be and to have been, the only specimen from Kaiapoi, or of *M. hectori*, in the Museum :—" I wish to add that a comparison of these three skulls of *Oulodon* [A, F, I] with the skull of *Mesoplodon hectori*, Gray [= *M. knoxi*, Hector] in the Canterbury Museum, and which is derived from an aged specimen, shows at a glance the distinct specific character [*i. e.* teeth at the symphysis of the mandible], besides being much smaller in all its proportions."

The Canterbury Museum specimen, as will be seen from fig. 1, Plate XIII., differs from *Mesoplodon hectori*, Gray, as figured in Sir W. Flower's paper (Tr. Z. S. vol. x. pl. lxxi. fig. 4).

J. The skeleton of an adult from Lyall Bay, N. Z., in the British Museum, described and figured by Sir W. Flower, in volume x. of the Society's 'Transactions,' as *Mesoplodon australis*. It is probably of the male sex.

K. A mutilated skull, with its mandible, of an aged male *Mesoplodon* (*Oulodon*) *grayi*, Haast. This is the remaining one of the three Chatham Island crania referred to under specimen A. It is the type specimen of the genus and species, and is the individual figured by Von Haast in the 'Transactions' of the N. Z. Institute, vol. ix. plate xxvi. fig. 3 (not fig. 1, as erroneously marked on that plate). Along with its two companions (A and F) it had remained in the same condition as found and figured in 1875, enveloped in its integuments, till all three were partly dissected and partly macerated out by me in July 1890.

L. The specimen described and figured by Sir William Flower in the paper so often referred to, under the name of *Mesoplodon haasti*. This is an old—even aged—individual, nearly of the same age, in my opinion, as K. It is undoubtedly a male, and is now in the collection of the Royal College of Surgeons, London.

With these specimens I have compared the published descriptions of *Mesoplodon* (*Oulodon*) *grayi*, Haast, given by Van Beneden and Gervais on plate lxii. of their 'Ostéographie.'

All the above 13 specimens belong without any doubt to *Mesoplodon grayi*, Haast; indeed no fewer than six of them were recognized by Sir Julius von Haast as belonging to the species which he had himself established.

M. The skeleton of an aged male of *Mesoplodon layardi* in the Canterbury Museum, N. Z.—labelled *M. floweri*, Haast.

N. A cranium of an immature example of *M. layardi* in the Wellington Museum, N. Z.; sex unknown.

O. A cranium of a young individual of *M. layardi*, in the Napier Athenæum, N. Z., in which the vomerine trough is quite empty and smooth; sex unknown.

P. A cranium of an aged individual in the British Museum, evidently a male.

Q. For purposes of comparison with the species of *Mesoplodon*, I have examined the skeletons of *Ziphius cavirostris* (=*Epiodon chathamensis*) in the Canterbury Museum, N. Z.

R. A cranium of a very young individual of *Ziphius cavirostris*, collected by myself in the Chatham Islands in January last (1892), and now in the Canterbury Museum, in which the vomerine spout is quite empty and smooth, except on the bottom of the trough, where there is a small upgrowth.

S. A skeleton of *Ziphius* (*Epiodon*) *chathamensis* (=*Z. cavirostris*) in the British Museum collection.

T. A cranium of *Ziphius cavirostris* (the type) in the British Museum.

U. A younger cranium than T, of *Ziphius cavirostris*, in the same collection.

V. A skeleton and two crania of *Berardius arnuxii*, in the Canterbury Museum, N. Z.

With these I have also compared the various fossil species in the Geological Department of the British Museum, *Mesoplodon angustus*, *M. gibbus*, *Choneziphius planirostris*, and *C. planus*.

For the opportunity of examining one or more of the above enumerated specimens I am greatly indebted to the kindness of Dr. Günther, F.R.S., and Dr. Woodward, F.R.S., of the British Museum; to Professor Stewart, P.L.S., Royal College of Surgeons, Prof. T. J. Parker, F.R.S., Dunedin, N. Z., Sir James Hector, F.R.S., Wellington, N. Z., and to the authorities of the Hawke's Bay Philosophical Society in Napier, N. Z.

From an examination of these specimens I have come to the conclusion that the species of *Mesoplodon*, and certainly some of *Ziphius*, change very greatly in regard to the form of their rostra with age and sex; and from the transverse sections of various rostra that I exhibit it will be apparent that the contour of each varies with the amount of ossification and consolidation of the rostral bones in different sexes at different ages. It will then be seen, I think, that the species designated *Mesoplodon hectori*, Gray, by Hector and Haast, and *Mesoplodon australis* and *Mesoplodon haasti* by Sir W. Flower, are really more or less aged forms of *Mesoplodon grayi*, Haast. In his paper in the 'Transactions' of the Zoological Society already referred to, Sir W. Flower has been careful to remark :—"Under the circumstances it is somewhat difficult to know what course to pursue with reference to the names by which these specimens are to be respectively distinguished; but on the whole it will lead to less confusion if I designate them, provisionally at least, by specific appellations, bearing in mind that it is quite possible that further information and more abundant materials may cause a modification of this view"[1].

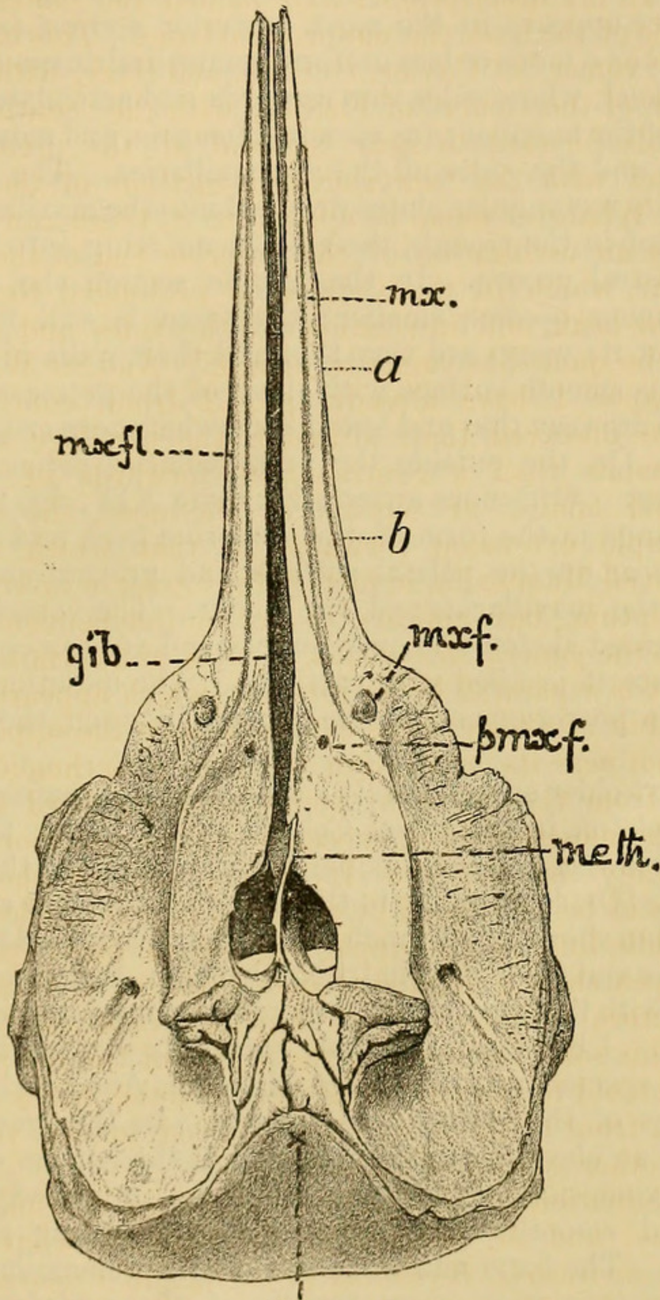
Sir William Turner, in his paper on *Ziphius cavirostris* and *Mesoplodon sowerbyi*, in the Trans. R. S. Edinburgh, vol. xxvi. p. 768, says:—"In my description I have named the dense solid bar in the middle of the beak the mesorostral bone. This bar corresponds with the 'vomer' of Cuvier, Gervais, and Gray, with the 'anterior tuberosity of the vomer' of Fischer, with the 'continuation of the pre-frontals forward to near the end of the premaxillaries' of Owen, and with the 'anterior prolongation of the ethmoid' of Flower. Whatever name be applied to it, there can be no doubt that it is an ossification of the anterior end of the long cartilaginous bar, which in the Cetacea is prolonged forwards to the end of the beak, and in relation to the sides and lower surface of which the spout-like vomer is formed." And Sir William Flower, in the paper I have already quoted from, continues:—"But it must be observed that, although the cartilage appears to be nothing more than a continuation forwards of the ordinary mesethmoid lamina or septum of the nose, the ossification is not a simple extension forwards of that which occurs in all Cetacea (in all Mammalia, in fact) in the hinder or internarial portion of the septum, but appears to be an independent production, peculiar to the genera *Mesoplodon*, *Ziphius*, and certain allied extinct forms. It is separated by an interval (which appears to diminish with age, but of which traces can be seen on the upper surface of the rostrum near its base) from the true mesethmoid ossification. It differs from the latter in being intensely hard and compact, whereas the mesethmoid is, especially at its anterior part, somewhat spongy in texture. It differs also in showing strong indications of being formed by a pair of lateral ossifications, united in the middle line, as the upper surface in many parts and the anterior apex show a marked median groove. I think it will be well therefore to adopt Prof. Turner's name of 'mesorostral' bone for this solid bar forming the centre of the rostrum, restricting mesethmoid to the part lying between the nares and a short distance in front of them, which is ossified in the young animal and in all other species of Cetacea"[2].

An examination of the sections of young specimens of *Mesoplodon grayi* and *M. layardi* in the light of what takes place in *Ziphius cavirostris*, *Berardius arnuxii*, and *Clymenia*, and perhaps in the fossil genus *Choneziphius*, will, I think, show satisfactorily that the mesorostral consolidation is not an ossification of the mesorhinal or mesorostral cartilage, but is an upgrowth in the rostral trough, formed by a proliferation of the osseous tissue of that part of the vomer itself, and perhaps partly of the premaxillaries, at all events not an ossification of the mesorostral cartilage pure and simple, as occurs in *Clymenia* and *Berardius*.

Before discussing the question of species, I shall trace from

[1] Tr. Z. S. vol. x. p. 419. [2] Tr. Z. S. vol. x. p. 420.

Fig. 1.



Upper surface (one fourth the natural size) of the cranium of a very young specimen (A in the list, p. 216) of *Mesoplodon grayi*, Haast.

Sections of this rostrum at *a* and *b* are represented on Plate XIV. figs. 2 *a*, 2 *b* respectively.

mxf. and *pmxf.*, the maxillary and premaxillary foramina; *gib.*, gibbosity of the premaxillaries; *s.oc.*, supraoccipital; *mxfl.*, maxillary flange; *meth.*, mesethmoid; *mx.*, maxillary bone.

their earliest appearance the changes that take place in the rostral bones.

Commencing with the youngest specimen I have yet examined, that lettered A above (see fig. 1, p. 221), sections of the rostrum taken at 11, $6\frac{1}{2}$, and $5\frac{1}{2}$ inches from its apex show the following appearances:—The vomer appears in the most posterior section (*i. e.* in that at 11 inches) as a more or less uniform semicylindric spout, with a thick rounded keel, whose sides thin upwards and articulate with a diverticulum of the maxillary (as seen in *Clymenia*, and more markedly in *Physeter*) and the sides of the premaxillaries. The premaxillaries are roughly rectangular plates dropped into the maxillaries, and they partly roof-in the trough, their sides entering into the formation of the rostral groove. In the middle section the upward arms of the vomer become smaller; the spout is still floored by the vomer, but its wings are very thin and their walls blend to form a continuous smooth surface with those of the premaxillaries, whose sides also are very thin and stand somewhat more erect (Plate XIV. fig. 2 *b*). On the outside the premaxillaries articulate with the maxillaries. Still more anteriorly (Plate XIV. fig. 2 *a*) there is a slight change in the form of the vomerine keel, and the premaxillaries appear on the palatal surface, and prevent any articulation between the maxillaries and the vomer. The vomerine trough in the macerated skeleton is quite empty and very smooth, and in the recent state it is filled with cartilage. The mesethmoid only just enters the posterior end of the groove, between the wings of the vomer.

The next older specimen (B) I take to be of greater age than that of the skeleton in the Royal College of Surgeons, figured by Sir William Flower, and about equal (judging alone by the figure, plate lxii., in his 'Ostéographie') to that of Van Beneden's specimen. Its examination showed how much the premaxillaries, and especially the maxillaries and the vomer in its basal region, had grown in massiveness, and with this growth the form of the vomerine canal had become narrowed. I have unfortunately seen only one specimen of *Mesoplodon* (a specimen in the Otago Museum, A*a*) in which the very beginnings of the change are present. In this young specimen there was an elevation in the mid-line of the bottom of the groove, but the vomerine trough was otherwise in no way different in shape and smoothness from that of the young forms already described. The form and thickness of the premaxillaries and their general contour were characteristic of the undeformed ziphioid snout. In a specimen of a very young cranium of *Ziphius cavirostris* (*Epiodon chathamensis*, Hector), which I was fortunate enough, during my visit to the Chatham Islands, to examine, changes had occurred in the rostrum very similar to those which take place in the genus *Mesoplodon*, but of a more pronounced character. If we follow the changes in *Ziphius* they will, I think, help to explain those that occur in *Mesoplodon*. The section (Plate XIV. fig. 1) taken from the specimen in the Canterbury Museum, "a very old female" according to Von Haast (Tr. N. Z. I. vol. ix. p. 430), will show more clearly than words that there has taken place a very great increase in the maxillaries and in the premaxillaries, which latter also (as in the young *M. grayi* just alluded to) come down and appear on the palatal surface of the rostrum, intervening between the vomer and the maxillaries. The vomer, it will be seen, has lost all its usual form by being squeezed; the trough is only indicated by a small depression between its two thickened arms (Plate XIV. fig. 1, *v.tr*). In the British Museum specimen of the same species, of which there is a complete skeleton, the vomer is in its upper aspect a sharp, triangular, ridged bar, very like that in *Mesoplodon angulatus*, one of the fossil forms from the Red Crag. There is an enormous thickening of the premaxillaries, as well as of the vomer. In the older specimens in which the great prenasal fossa is seen, the vomer forms the bottom of the fossa and the mesethmoid disappears. Into how extraordinary a feature this eventually grows up in the aged individual is well illustrated by the two crania in the British Museum collection. The species originally described by Sir James Hector as *Epiodon chathamensis* has now been united by Sir W. Turner to *Z. cavirostris*, a determination acquiesced in by Hector. The differences exhibited by the Chatham Island specimen and the other two crania in the British Museum are so very marked that it appears difficult for me to conceive how one form can ever grow into the other. If the identification be correct, and I have no reason to question it, it will be found that only in the one sex—probably the male—does this enormous development of the vomer take place, accompanied or preceded by the formation of the great prenasal cavity, from which the species derives its name. In New Zealand both forms occur; and I have examined specimens in which this prenasal cavity was already deep, but which were younger (*cf.* Tr. N. Z. I. vol. v. pl. iv.) than either of the specimens in the British or the Canterbury Museums, as indicated by the less advanced stage of the vomerine upgrowth. Sir W. Turner has remarked on the abrupt manner in which the posterior end of the mesorostral bone terminates and on the smoothness of the cavity. This is observable in all the New Zealand forms, and the appearance suggests that, through some cause or other, absorption takes place, or disease attacks these bones in the male and not in the female.

It is to be noted that in many of the specimens of this species the accretion of material and the change of form are confined to the vomer, as is seen in the Canterbury Museum specimen and in that figured by Van Beneden—at least for some considerable time there is no deposit of osseous tissue in the premaxillary portion of the spout, to which the cartilage also extends. If the filling-up of this trough were the result of ossification alone of the rostral cartilage, it would proceed, it seems to me, uniformly over the whole surface of the trough. If we examine also, in connection with this, the anterior prolongation of the ethmoid as it occurs in *Berardius arnuxii*, it may be observed that the ossification proceeds in quite a different manner; it takes place inside the cartilage, and must, if it were to coalesce with the vomer and premaxillaries, grow downwards. In *Clymenia* the ossification in the ethmoidal cartilage takes place in the same way, from above downwards, so that it is apparent that in *Mesoplodon* the ossification of the rostral elements proceeds differently. They may obtain material from the mesorostral cartilage for a time, but at all events when the vomerine element has extended above the level of the premaxillaries the cartilage must have become too attenuated to be able to provide any longer the material necessary for such a mass of bone as is developed in the British Museum specimen of *Z. cavirostris*, in which the resulting mesorostral bone is far greater in all dimensions than the original cartilage. Sir W. Flower remarks[1] that this "ossification has not hitherto been found wanting in any thoroughly adult example of any species of *Mesoplodon* or *Ziphius*; on the other hand, it appears never to occur either in *Hyperoodon* or *Berardius*." This I have found to be true, for in the *Berardius arnuxii* which I brought from the Chatham Islands there is an unusually long mesorostral ossification extending to nearly three fourths of the length of the snout; but it is not an ossification [2] of the same character as that in *Mesoplodon*, though *Mesoplodon* and *Berardius* have such close affinities. The fossilization of such a specimen of *Berardius* as this might perhaps result in a form like *Choneziphius* [3], in which the ossification has apparently proceeded, as in *Berardius*, from above downwards.

To return to *Mesoplodon grayi*, it will be seen from the sections (Plate XV. figs. 1, 2, 4, *v*) that the premaxillaries, by growing in upon the keel of the vomer, have induced a considerable thickening in that region. It is not improbable that this pressure is the cause of the proliferation of the osseous tissue in other parts of the vomer. In some cases the maxillary ingrowth also in this region actually cuts the bone into two parts, leaving its lower portion,—that emerging as a bar on the palatal surface between the pterygoids,—as a loose fragment kept in place by the maxillaries (Plate XV. fig. 5, *mx.i* & *v*).

In the section it may be seen how shallow and compressed the outline of the original trough has become; that the sides of the premaxillaries are no longer horizontal, but perpendicular. The fragment (*meth*) seen in Plate XV. fig. 5, fitting into a depression in the vomerine groove, is exceedingly interesting. It represents the ossified anterior prolongation of the mesethmoid. It is complete in its anterior termination, it has never extended

[1] *L. c.* p. 419.

[2] It is an ossification of the ethmoidal cartilage.

[3] In describing *Choneziphius packardi* (Quart. Journ. Geol. Soc. xxvi. (1870) p. 503), Prof. Ray Lankester says :—"Below and posteriorly to this most anterior part of the rostrum is a cavity $\frac{3}{4}$ of an inch in diameter, extending axially to the rostrum (pl. xxxiii. figs. 1 & 3, *v. c.*), the remains of the primitive trough-like cavity of the vomer, as Prof. Huxley calls it in describing *Belemnoziphius*." This appears to me to imply that the ossification had been proceeding from above downwards at the time of the death of *C. packardi*.

further, and moreover it is not ossified to the other bones, and, as a matter of fact, it remains for a long time separate. It may become one with the mesorostral bone in very aged animals; even then the suture remains generally very distinct, wedged in between the upgrowths of the mesorostral.

A section of the same snout (Plate XV. fig. 3) taken more anteriorly is also of great interest, for there the thickening and ingrowth of the premaxillary bones are seen to bisect the vomer into two parts just below the spout; the growth of premaxillary ossifications (*pmx.o*) on both sides has compressed and folded together in the middle the vomerine walls, thickened already by proliferation of their tissue, the point of union being with some care observable in the median line.

In a still more anterior section (Plate XV. fig. 4, *v*) the keel portion of the vomer below the bisection has increased in growth and appears as a round rod, part of which shows on the palatal surface, and has begun to become implicated in the ivory-like ossification which has commenced.

In the Chatham Island specimen and in that in the Otago Museum (G and F respectively in above list) much the same changes occur. In some cases, as, for instance, in the female specimen (H in the above list) in the Canterbury Museum, the filling-up of the vomerine spout has proceeded more symmetrically, and we have then greater regularity in the form of the section of the snout (Plate XIV. fig. 4, *a*). Fig. 1 *b*, Plate XII., represents a section through the middle of the snout of the type (male) specimen of *M. grayi* in the Canterbury Museum, and how widely it differs from that of the female of the same species in the same Museum (Plate XIV. fig. 4 *a*) or of *M. australis* in the British Museum (Plate XIII. fig. 2) is at once apparent—yet not greater than the difference between the three forms of *Mesoplodon layardi* shown in the sections *a*, *b*, *c*, fig. 2, p. 228. Fig. 2, Plate XII., is a reproduction of the section of *M. haasti* from Sir W. Flower's paper in the Trans. Zool. Soc., so often referred to, and which, as he has pointed out, differs so much from the section of any other he has examined that he could not include it in any known species; while fig. 1 *a*, Plate XII., is a section made by me of the type specimen of *M. grayi* in the Canterbury Museum, somewhat more anterior than fig. 1 *b*, but still in the region where the vomer appears on the palatal surface, and their similarity will be at once admitted.

I have already quoted Sir W. Flower's remark that if so great a change can take place, due to individual variation, as exists between *M. grayi* and *M. haasti*, then most of the fossil species based solely on the form of the rostrum are quite valueless. If we take, for instance, the two forms *M. angulatus* and *M. medilineatus*, there exists far less difference between them than between some of the forms of *M. grayi* or of *M. layardi*.

The median lines or sutures on the surface of the mesorostral bone, which vary so much, and also the gibbosities of the premaxillaries, are, after studying the sections of immature forms, easy of explanation. The gibbosities, it will be observed, occur n the rostrum over those regions where the vomer does not reach the palatal surface. The removal of the wedge gives more space beneath, causing the premaxillaries to gape, while more anteriorly, in front of the place where the vomer vanishes, the premaxillaries stand still more apart. In the regions where the edges of the premaxillaries are closest the vomer is wedged in on the palatal surface between the bases of the maxillaries, and there the rostral bone, as a rule, grows densest and protrudes furthest above the level of the premaxillaries, and just there often shows no median line or suture. In the male *Z. cavirostris* the greatest growth of the mesorostral occurs where not only the vomer, but also the lower edges of the premaxillaries, protrude on the palatal surface.

The lines or sutures on the surface of the mesorostral are produced by various causes, sometimes (as in the specimen, Plate XIII. figs. 1, 1 *a*, *v.s*) by the two wings of the vomer meeting in the centre [1], when the suture may persist or may become lost, according to the amount of squeezing the mesorostral undergoes. Then on each side of the solidified vomer may appear the sutures of the premaxillaries (Plate XIII. fig. 1 *a*, *pmx.s*), and very often the thickenings of the interior surface of the premaxillaries (*pmx.o*) grow up between and shoot above the original petrous walls of these bones, forming another suture, so that there may be as many as five lines traceable on the surface. There may be more if, as sometimes occurs, one of these segments becomes crumpled (Plate XIII. fig. 1, Plate XIV. fig. 5, *mr.cr*) in the general squeeze of the parts. Hence, as diagnostic characters (cf. *M. medilineatus*), the lines on the mesorostral bone are also quite valueless. In the most anterior part of the rostrum there is only one median suture (*pmx.s*), often very well marked, especially in old individuals, where the osseous growths on the interior surfaces of the premaxillaries meet. As has been pointed out both by Sir W. Flower and Sir W. Turner, a suture, or often a deep depression, between the mesethmoid and the mesorostral is generally visible (Plate XII. fig. 1, Plate XIII. fig. 1, *meth.s*).

On comparing the different specimens which I have had an opportunity of examining personally, or by their various published descriptions, the species of the genus *Mesoplodon* seem to me to be reducible to six:—

1. Mesoplodon bidens (Sowerby).

Cf. Flower, Trans. Zool. Soc. x. p. 415 (1878).

2. Mesoplodon europæus (Gervais).

Cf. Flower, Trans. Zool. Soc. x. p. 416 (1878).

[1] "It seems probable (as Duvernoy has already pointed out) that the 'central area' indicates the upper extent of the vomer, the only remains of the primitive trough-like cavity being the median slit above and the large fossa behind."—*Huxley*, Quart. Journ. Geol. Soc. vol. xx. p. 394 (1864).

3. Mesoplodon hectori (Gray).

Berardius arnuxii, Hector, Trans. N. Z. I. ii. p. 27 (1870).

Smaller Ziphioid Whale, Knox & Hector, Trans. N. Z. I. iii. p. 125, pls. xiii.–xv. (1871).

Berardius hectori, Gray, Ann. & Mag. Nat. Hist. ser. 4, vol. viii. p. 117 (1871).

Mesoplodon knoxi, Hector, Trans. N. Z. I. vol. v. p. 167 (1873).

Mesoplodon hectori, Turner, Trans. R. Soc. Edin. vol. xxvi. p. 778 (1872); Flower, Trans. Zool. Soc. vol. x. p. 416 (1878).

Since Sir William Flower's memoir on the genus *Mesoplodon*, no further information has been obtained as to this species, which differs so markedly from the others occurring in the same region, in the absence of a basirostral groove and in the position and form of its mandibular tooth.

The Kaiapoi specimen (I in the list, p. 218) (Plate XIII. fig. 1) in the Canterbury Museum, which bears the MS. name of *M. hectori* (and has been referred to by Hector as *M. hectori*), is undoubtedly at once distinguishable from this species by the presence of a most distinct basirostral groove. In this paper therefore I have placed it under *M. grayi*. It is just possible that the cranium and the mandible of *M. hectori*, Gray, figured by Sir W. Flower, may not belong to each other.

4. Mesoplodon layardi (Gray).

Ziphius layardi, Gray, P. Z. S. 1865, p. 358; Owen, Crag Cet. p. 12, pl. i. (1870).

Ziphius (*Dolichodon*) *layardi*, Gray, Cat. Seals & Whales B. M. p. 353 (1866).

Dolichodon layardii, Hector, Trans. N. Z. I. vol. v. p. 166, pl. iii. (1872).

Mesoplodon longirostris, Krefft, MS.; *M. guentheri*, Krefft, MS.

Calliodon guentheri, Gray, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. p. 368 (1871).

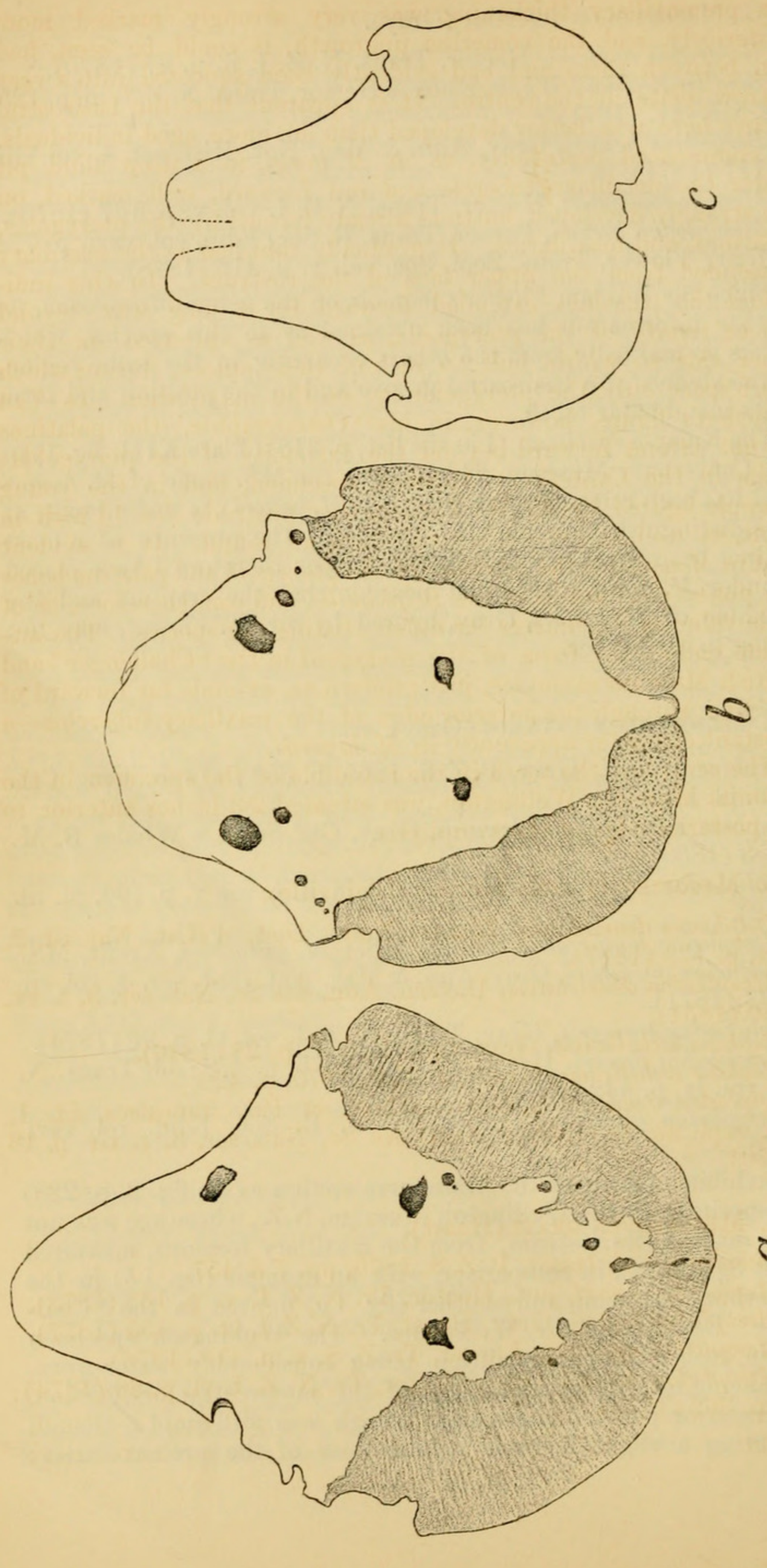
Dolichodon traversii, Gray, Trans. N. Z. I. vol. vi. p. 96 (1874).

Mesoplodon floweri, Haast, P. Z. S. 1876, p. 478; id. Trans. N. Z. I. vol. ix. p. 442 (1877).

Mesoplodon güntheri, Turner, Trans. R. Soc. Edin. vol. xxvi. p. 778.

I exhibit a figure of the transverse section *c* (see fig. 2, p. 228) of a specimen in the Wellington Museum, N.Z., whose age was not quite mature (its rostrum, from the maxillary foramen, measured 2 feet 3¼ inches), in comparison with an example (fig. 1 *b*) in the Canterbury Museum, and another (fig. 1 *a*) figured in the 'Challenger' Reports by Sir W. Turner. The Wellington specimen was in rather a poor condition, being considerably water-worn, and having lost by accident part of the mesorostral ossification. The anterior part of the rostral trough was still empty, though presenting a slight increase in the floor of the premaxillaries;

Fig. 2.



Transverse sections (reduced) of the rostrum of *Mesoplodon layardi*, Gray.

a, after a figure by Sir W. Turner in his 'Report on the Cetacea of the 'Challenger' Expedition'; *b*, from a male specimen in the Canterbury Museum, N.Z.; and *c*, from a not quite adult example in the Colonial Museum, Wellington, N.Z. (slightly diagrammatic).

the premaxillary thickening was very strongly marked more posteriorly, and the vomerine upgrowth, it could be seen, had lain between them and had evidently been squeezed into a very narrow plate in the centre. It is apparent that the basirostral groove here was better developed than in more aged individuals. It commenced posteriorly, as in *M. grayi*, in a deep blind pit under the maxillary tubercle and ran forward, well marked, on the strongly-developed buttress already formed by the pterygoids, palatines, and maxillaries. It gradually vanished as the maxillary descended from the upper face of the rostrum. In this individual the palatines extended forward for a long way beyond the extremity of the pterygoids, as well as appeared on their inner side to within half an inch of their apices, during which short space only the pterygoids lay on the maxillaries. In Van Beneden's figure, however, in his 'Ostéographie,' the palatines do not extend forward beyond the extremity of the pterygoids; while in the Canterbury Museum specimen, and in the young example figured by Sir W. Turner, they protrude for 1⅝ inch in front, as well as extend beyond them all round. It is evident that in *Mesoplodon* the relations of the pterygoid and palatine bones are not so constant as in the *Delphinidæ*, and can, therefore, be of little value as a character for differentiating the species. The anterior end of the fossa of the pterygoid in the 'Challenger' and British Museum examples, just referred to, extends far forward of the line through the anterior edge of the maxillary tubercles—a constant character apparently in *M. layardi*.

The centre of the tooth in the mandible of the specimen in the Colonial Museum, Wellington, was situated 2·3 inches anterior to the posterior edge of the symphysis.

5. Mesoplodon densirostris (Blainville).

Delphinus densirostris, Blainv. Nouv. Dict. d'Hist. Nat. éd. 2, t. ix. p. 178 (1817).

Mesodiodon densirostris, Duvern. Ann. des Sc. Nat. sér. 3, t. xv. p. 59 (1851).

Ziphius sechellensis, Gray, Zool. E. & T. p. 28 (1846).

Ziphius sechellensis, Krefft, P. Z. S. 1870, p. 426.

Diplodon densirostris, Gervais, Zool. et Pal. françaises, éd. 1, t. ii. expl. no. 40 (1850); Ann. des Sc. Nat. sér. 3, t. xiv. p. 16 (1850).

6. Mesoplodon grayi (Haast).

Oulodon grayi, Haast, P. Z. S. 1876, pp. 7 & 457.

Mesoplodon knoxi, juv., Hector, Tr. N. Z. I. v. p. 168 (1873).

Mesoplodon hectori, Gray, Haast, Tr. N. Z. I. ix. p. 455 (1877).

Mesoplodon australis, Flower, Tr. Z. S. x. p. 419 (1878).

Mesoplodon hectori, Gray, Hector, Tr. N. Z. I. vi. p. 86 (1874); vii. p. 362 (1875).

Mesoplodon haasti, Flower, Tr. Z. S. x. p. 419 (1878).
Oulodon grayi, Haast, Van Beneden & Gervais, Ostéog. des Cét. p. 516, pl. lxii.

In examining the list of specimens of this species which I have enumerated above, they fall into three groups:—(1) The young forms in which the mesorostral groove is empty (A, A*a*, B); (2) those in which the groove is solidly filled up with porcellaneous ossification (I, J, K, L); and (3) the intermediate forms, in which what will become the mesorostral bone of Turner is in younger or more advanced stages of growth (C, D, E, F, G, H),—of these G and H are approaching maturity.

The table on the opposite page gives the principal dimensions of all the more complete specimens measured by me which I attribute to *Mesoplodon grayi*, Haast.

On comparing these measurements and the photographs of the crania which I exhibit, it is impossible not to be struck with the similarity of their general outlines—*Mesoplodon haasti* (L) with the type (K); *M. australis* (Flower) (J) with the Kaiapoi skull (I); and the skull from the skeleton of the co-type in the Canterbury Museum (H) with Van Beneden's figure of *M. grayi*, Haast. The skull of the younger Otago Museum specimen (A) graduates through the Chatham Island form (D) to the somewhat older representative in the Museum of the Royal College of Surgeons (C). The known female forms have more gracefully attenuated rostra, the males wanting in this respect somewhat owing to a greater development of the buttress formed by the maxillaries, palatines, and pterygoids. The female rostra are also longer than those of the males, as the measurements show where the sexes have been determined.

Seen from above.

The form of the rostrum may be observed (fig. 1, p. 221) in the younger specimens to be wider at the base and less slender throughout its length than in individuals of greater age. The maxillary tubercle has a more sloping and less acute-angled shoulder, and the maxillary bones (*mx*) are wider, and form, as they emerge on the rostrum, a more prominent flange (or upper border) to the basirostral groove on each side, than in older specimens. They run forward on the sides of the rostrum (well seen in Van Beneden's figure of *M. grayi*) along the premaxillaries as broad bands, one on each side, narrowing and descending towards the inferior surface as they proceed, while with the increasing age of the animal they become narrower and shorter on the sides of the rostrum, thus reducing the length and prominence of the basirostral grooves through the disappearance of their superior flanges. The inferior flanges of the groove are more prominent than the superior, extending in A for $1\frac{1}{2}$ inch more anteriorly than the superior. In the younger forms the supraoccipital (*s.oc*) is wide and flat behind, and its apex in the vertex expands more ante-

	Mesoplodon grayi, Haast. Otago Mus. (A). ♂.	*M. grayi*, Haast. Paris Mus. (Van Ben.) Sex?	*M. grayi*, Haast R. Coll. Surg. (C). Sex?	*M. grayi*, Haast. Otago Mus. (F). ♀ (Haast).	*M. grayi*, Haast. Cantb Mus. (H). ♀.	*M. grayi*, Haast. Cantb. Mus. (K). ♂. (Type.)	*M. grayi*, Haast. *australis*, Fl. B. M. (J)? ♂.	*M. grayi*, Haast. Cantb. Mus. (I)? ♂.	*M. grayi*, Haast. *haasti*, Fl. R. Coll. Surg. (L). ♂.
Extreme length of cranium	[18·60[1]]	26·60	30·30	[35·40[1]]	36·25	[34·00[1]]	30·30	30·30	
Length of rostrum from apex of premaxilla to middle of a line drawn between anteorbital notches	12·75	17·20	20·20	24·70	25·25	23·05	19·90	20·45	23·10
From middle of hinder edge of palate (formed by pterygoids) to apex of rostrum	13·75	19·20	24·50	26·30	26·85	23·40	23·80	21·00	
Greatest height of cranium from vertex to pterygoids	8·90	10·00	10·40	? 10·25[2]	? 10·75[2]	11·10	11·00	? 10·75[2]	
Breadth of cranium across middle of superior margin of orbits	8·45	9·00	10·50	11·25	11·75	11·25	11·20	11·25	11·20
Breadth of cranium between zygomatic processes of squamosals ...	8·95	10·40	11·10	11·85	12·00	12·00	11·70	12·00	
Breadth of cranium between anteorbital notches	5·75	7·00	7·20	7·00	7·50	7·50	7·40	7·40	7·50
Breadth of middle of rostrum	1·75	1·20–1·40	1·60	1·65–1·75	1·90–2·50	1·90	1·70	1·95	1·80–1·20
,, occipital condyles	......	3·30	3·70	......	4·10	......	3·90	4·35	
Premaxillæ, greatest width behind anterior nares	4·20	5·00	5·10	5·15	5·95	4·75	5·40	5·15	
Premaxillæ, least width opposite anterior nares	3·65	3·80	4·00	4·35	4·45	4·20	4·40	4·55	
Premaxillæ, greatest width in front of anterior nares	3·90	4·20	4·40	4·50	4·80	4·80	4·60	4·75	
Width through maxillary foramina .	5·25	6·00	6·80	6·85	7·10	6·60	7·00	6·50	6·80
Width of narrowest part of crest ...	2·00	1·30	1·22	1·40	2·25	1·75	1·40	1·50	
From crest of occipital to anterior end of pmx. crest	2·05	......	2·60	3·00	3·00	2·95	2·80	3·30	
Width of anterior nares	1·70	1·80	2·10	1·95	2·10	2·10	2·00	2·00	
Length of tympanic bone	2·00	2·10	2·00	2·05	......	2·75	1·90	......	
Greatest breadth of tympanic bone...	1·25	1·10	1·40	1·30	......	1·30	1·30	......	
Mandible, length of ramus	18·66	23·80	26·00	30·80	32·20	29·75	......	......	
,, length of symphysis	4·55	8·20	8·40	11·30	13·00	10·25	......	......	
,, greatest vertical height of ramus	3·55	4·00	4·10	4·40	5·10	4·35	......	......	
Centre of tooth from apex of mandible	4·55	8·20	7·60	10·50	10·90	10·20[3]	......	......	9·60

[1] Calculated. [2] Slightly broken. [3] Apex of tooth eccentric.

riorly. In A a line drawn through the *meatus auditorius* at right angles to the length of the rostrum transects it posteriorly to its crest, while in older specimens such a line falls anterior to the supraoccipito-frontal suture. The crest of the vertex is wider, and the bones which meet there (the nasals, frontals, supraoccipitals, maxillaries, and premaxillaries) articulate very loosely with each other. In the youngest form I have examined the nasals lie vertically between the ends of the premaxillaries, the right nasal being on, and the left beneath their level in the vertex; but as these whales advance in age the nasals sink more deeply between the crest of the premaxillaries, and with the frontals are tightly squeezed together between the premaxillary, maxillary, and supraoccipital bones. The nasal ends of the premaxillaries are less vertical, lower and less everted, and the asymmetry between their right and left portions in the younger individuals is but slightly marked, the right side, however, being always a little larger than the left. The inner borders of the maxillaries are parallel, presenting a gibbosity (*cf.* fig. 1, *gib*) opposite and extending anteriorly to the maxillary foramina. These gibbosities, which become more marked with age, are but slightly observable in Van Beneden's figure and in A, are already more prominent in the Royal College of Surgeons example, and still more so in the intermediate specimens. As I have remarked above, they occur over the intervals in which the vomer does not show on the palatal surface. The premaxillary foramina lie behind those of the maxillary, as usual in this species, and are situated—the right $\frac{1}{2}$ inch and the left $\frac{4}{5}$ of an inch—*anterior* to a line joining the anteorbital notches, and also anterior to the forward termination of the ethmoid bone. A line drawn thus in the Kaiapoi specimen (I) runs obliquely *between* the two pairs of foramina, but nearer to the premaxillary foramina than in the type. In the Canterbury Museum example (H) it touches the posterior margins of the right maxillary foramen, and the two pairs are situated nearer than in the type (which closely resembles Flower's *haasti* in this respect) or in the Kaiapoi specimen, being in the case of the nearest ·25 inch distant (as they are unsymmetrical, the right one of the two is slightly farther apart); in the type they are 1·90 and in the Kaiapoi specimen 1·25 inch apart. In the Royal College of Surgeons example of *M. grayi* such a line passes midway between the pairs, while in Flower's *M. australis* it traverses the left premaxillary foramen and comes very near the anterior margin of the right. In the older Otago Museum specimen (F) the right maxillary foramen is $\frac{1}{10}$ inch more posterior to the line than the left, and the pairs are distant, the right $1\frac{9}{20}$ inch and the left $1\frac{1}{2}$ inch. It is evident, therefore, that during growth there is a movement of the maxillaries and premaxillaries upon each other, which may not improbably have something to do with originating the proliferation of osseous tissue in the premaxillaries and vomer. In full-grown specimens these foramina are posterior to such a line and are more nearly opposite the anterior termination of the mesethmoid. The floor and sides of the mesorostral groove in the three specimens of the younger group are in their greater extent formed by the spout-shaped vomer, by a diverticulum of the maxillary bone (which appears superiorly for a short distance opposite the premaxillary foramina between the vomer and the premaxillary laminæ), and by the premaxillaries. As the vomer terminates at 3 inches from the tip of the rostrum, the anterior portion of the spout is entirely formed by the premaxillaries. The empty vomerine trough (in the macerated skeleton) shows no signs of the cartilage, which occupied it in the living state, having been attached at any point to any of the bones, except the anterior termination of the ethmoid, which is rough as is usual.

In the previous part of this paper I have shown by sections what takes place in group 2; how, probably by the vigorous growth of the maxillary and premaxillary bones surrounding the vomer, a slight upgrowth, as a ridge-like elevation, appears in the bottom of the vomerine trough, and a thickening of the sides of the interior walls of the premaxillaries takes place, which gradually increases and eventually fills up the mesorostral groove. Where the gibbosities occur, over the regions where the vomer does not protrude on the palatal surface, this growth has more space and better resists the pressure, while in those parts where the premaxillaries approach closer together, the increasing vomerine growth indicates by its varied contortions the effect of the strains to which it has been subjected. The form, therefore, that the rostrum may eventually assume in the mature animal varies with the difference in the strains it undergoes, through the different rate of growth in the surrounding bones, and in the individual's vitality, sex, and age. The various sutures and lines which are seen on the surface of the solidified rostrum of aged crania have already also been explained.

In none of the three specimens of group 1 has the buttress (formed by the maxillaries, palatines, and pterygoids) extended sufficiently far forward or become prominent enough to appear externally to the flanges of the basirostral groove. In the oldest specimen I have examined, that from Kaiapoi (I) (Plate XIII. fig. 1), the buttress and the lower margin of the basirostral groove are very prominent, and resemble closely *M. australis* of Flower, which is also an adolescent individual. On comparing the whole series, it is to be seen that the younger the age, the less anteriorly does the buttress extend, and the less prominent are both it and the inferior flange of the basirostral groove.

Seen from the side.

The boundaries of the basimaxillary groove are formed by flanges of the maxillary. Their disposition as seen from the upperside has already been described. In the young specimen (A) (fig. 1, p. 221) in the Otago Museum and in Van Beneden's figure, the maxillaries run along the side of the rostrum, in the former to within 2·5 inches, and in the latter to within 3·5 inches of the apex; indeed, in the latter it appears to be, at 7 inches from the tip, still ⅛ of an inch wide (measured on the upper surface). In the older specimen (F) in the Otago Museum the maxillary ceases at 7·65 inches, and in the type (K) at 9¼ inches from the apex of the rostrum, so that the groove practically ceases there. The lower flange of this groove is generally traceable on the side of the rostrum much more clearly than the upper, and in older specimens is very pronounced at the base of the rostrum, decreasing in prominence as it runs forward, especially in the Kaiapoi specimen (I) and in *M. australis*, Flower. The depth of the groove and of its subtubercular pit, and the divergence of its flanges, appear to vary with age and sex, and would seem to be dependent on the individual growth of the bones in the neighbourhood, especially the increase forward of the palatines and pterygoids. In those forms in which the buttress is strongly developed, a shallow depression or groove separates the lower flange from the maxillo-pterygoid swelling.

Seen from the palatal surface.

From this aspect the relations of the palatine and pterygoid bones in the two Otago Museum specimens (A, F), in the three Canterbury Museum examples (H, I, K), and in *M. grayi* of Flower's paper in the Society's Transactions are identically the same. The palatines lie on the outside of the pterygoids, reaching forward as far as but not extending beyond their pointed ends; the pterygoids, therefore, articulate directly with the maxillaries. In the *M.* (*Oulodon*) *grayi* figured by Van Beneden the palatine bones completely surround the anterior ends of the pterygoids and extend anteriorly to them, preventing their coming into contact with the maxillaries. The same differences exist between the specimen in the Canterbury Museum of *Ziphius cavirostris*, in which the palatine bones surround the pterygoids, and the figure on plate xxi. *bis* in the 'Ostéographie' of Van Beneden, in which they do not. The same differences were also pointed out above in my remarks on specimens of *M. layardi*, and are therefore due solely to individual variation.

The relations of the premaxillaries, maxillaries, and vomer on this aspect of the cranium are the same in all these specimens, the amount which each contributes varying with the age, sex, or individual.

The number of teeth in the gum of the upper jaw in the examples I macerated, in one case exceeded by one, in the second case was less by one, and in the third equalled that given by Sir Julius von Haast in describing the type species.

The triangular pterygoid in all these examples has the usual everted lower border and deep fossa, as also the deep notch at the base of the pterygoid plate, and presents no essential feature by which the species can be separated one from another. The pterygoid fossæ in the three specimens I dissected contained each a large air-sac opening into the ear-cavity, and communicating with the mouth by the Eustachian passage. In *M. grayi* the pterygoid fossa never extends anterior to the level of the maxillary tubercle.

In the youngest Otago specimen the tympanic bone was $1\frac{3}{8}$ inch in length and 1 inch in breadth at its posterior end, and the older $1\frac{39}{40}$ inch in length by $1\frac{1}{8}$ in width, where it is divided by a deep groove, as in the species of *M. grayi* described by Sir W. Flower and Sir J. von Haast. Except for a slight difference in size these bones are almost indistinguishable in the different specimens in which they are present.

Mandible.

The table of measurements, p. 231, gives the data by which the mandible of the specimen A (the young Otago specimen) may be compared with that in the Museum of the Royal College of Surgeons specimen and with Van Beneden's figure—all immature; with that of F, the older example in the Otago Museum, H, the Canterbury Museum female, and the type K and other fully adult specimens. The teeth in the mandible of A are half opposite, half behind the posterior end of the symphysis. In the specimen H, the centre of the teeth is 2·1 inches anterior to the hinder end of the symphysis; in F it is 10·4 inches from the tip of the mandible, and ·80 inch in front of the hinder end of the symphysis, while their posterior margins are well anterior to the same point. The teeth are erect, equiangular, and slope outward, with the apex slightly incurved. The socket is large enough to allow of a slight play of the tooth in it. The dentary groove bulges out on both sides opposite the tooth from $\frac{7}{20}$–$\frac{11}{20}$ inch. In the type K the centres of the teeth are opposite to the posterior end of the symphysis.

Summary.

The above observations have, I think, shown that in the genus *Mesoplodon* the mesorostral bone is formed, not at all events by the sole and direct ossification of the mesorostral cartilage, but in great part by a proliferation of the osseous tissue in the floor and sides of the vomer, and in the walls of the premaxillaries, caused probably by the compression of these bones, as a result of the vigorous growth that seems to arise at an early age in the maxillary and premaxillary bones surrounding them, and originated perhaps also by the movement upon each other of the maxillaries and premaxillaries; that the form assumed by the rostrum when viewed in section varies very greatly with the age and sex of the individual; and that the outline of a transverse section of the rostrum can no longer be considered as a character for separating the species of the genus. It becomes necessary also to unite, ss I have done in this paper, the forms described under the names of *Mesoplodon australis*, Flower, *M. haasti*, Flower, *M. hectori*, Gray (of Hector, but not of Flower), under the same species *M. grayi*, Haast. It follows also that a great number of the Crag fossils of the genus *Mesoplodon* must be united together as forms of one species, of different sexes and ages.

EXPLANATION OF THE PLATES.

Plate XII.

Fig. 1. Upper surface of cranium of *Mesoplodon grayi*, Haast, type, ⅕ nat. size.
1 *a* & 1 *b*. Transverse sections of the rostrum of the same at *a* and *b* respectively, nat. size.
2. Outline transverse section of *M. haasti*, Flower, after Flower, for comparison with the sections 1 *a* and 1 *b*, nat. size.

Plate XIII.

Fig. 1. Upper surface of cranium of *Mesoplodon grayi*, Haast—the Kaiapoi skull (I), ⅕ nat. size.
1 *a* & 1 *b*. Transverse sections of the rostrum of the same at *a* and *b* respectively, nat. size.
2. Outline transverse section of *M. australis*, Flower, after Flower, for comparison with the sections 1 *a* and 1 *b*, nat. size.

Plate XIV.

Fig. 1. Transverse section of rostrum of *Ziphius cavirostris*, ♀.
2 *a* & 2 *b*. Transverse sections of the rostrum of a young individual of *Mesoplodon grayi*, Haast. *Cf.* fig. 1, page 221.
3. Outline transverse section of the rostrum of *M. grayi*, Haast, in the R. Coll Surgeons, after Flower.
4 *a* & 4 *b*. Transverse sections of the rostrum of *M. grayi*, Haast, ♀, in Canterbury Mus., Christchurch, N.Z.
5. Transverse section of the rostrum of *M. grayi*, Haast, ♀, in the Otago Univ. Museum, N.Z.

Fig. 1 is ⅔ nat. size; figs. 2–5 nat. size.

Plate XV.

Figs. 1, 2. Transverse sections of *Mesoplodon grayi*, Haast—Specimen E in list above, from the Chatham Islands, nat. size.
3–5. Transverse sections of *M. grayi*, Haast—G in the list above, from the Chatham Islands; fig. 4 is the most anterior and 5 the most posterior section, and all are of the nat. size.

Explanation of Abbreviations.

br.g. Basirostral groove.
butt. Maxillary buttress.
gib. Gibbosity.
mr. Mesorostral bone.
mr.s. ,, suture.
mr.cr. ,, crease.
mx. Maxillary bone.
mx.f. ,, foramen.
mx.i. ,, ingrowth.
meth. Mesethmoid bone.
meth.s. Anterior termination of mesethmoid bone.
pmx. Premaxillary bone.
pmx.s. ,, suture.
pmx.o. ,, ossification.
pmx.f. ,, foramen.
s.oc. Supraoccipital bone.
v. Vomer.
v.s. Vomerine suture.
v.tr. ,, trough.