

MESOZOIC MAMMALIA. XII. THE INTERNAL
MANDIBULAR GROOVE OF JURASSIC
MAMMALS.

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INTRODUCTION.

In three of the four known orders of Jurassic mammals there always occurs a definite longitudinal groove on the internal surface of the mandible. In view of the constancy of its occurrence, this groove must be due to an essential feature of mammalian anatomy at that time and it has given rise to much discussion. In studying Mesozoic mammals during the past few years, the writer has constantly had this groove and the various opinions concerning it in mind, and the present paper briefly sums up the results of this long observation. All the known Mesozoic mammal jaws, as well as some hundreds of Tertiary and recent ones, have been examined, and a few dissections of the overlying soft parts in representative recent mammals have also been made.

The first Mesozoic mammal to be described, *Amphitherium prevostii*, from the Stonesfield Slate of Oxfordshire, showed the groove, and it played its part in the attack on the interpretation of this jaw as mammalian. De Blainville, banner-bearer of the opposition, hailed it as a suture and as indicating the compound nature of the jaw. Owen, leader of the finally triumphant advocates of the reference of *Amphitherium* to the Mammalia, soon showed, however, that the groove has an entire bottom and hence cannot be a suture. At first calling it a "splenial harmonium," he eventually definitely homologized it with the mylohyoid groove. This view was adopted by Osborn in his classical memoir of 1888 and hence found its way into all the text and reference books. As early as 1883, however, Flower had somewhat ambiguously stated that the mylohyoid groove persisted in *Amphitherium* and was a remnant of that which originally lodged Meckel's cartilage. Bensley in 1902 published an authoritative study in which he more clearly pointed out that the Meckelian and mylohyoid grooves are not homologous, although sometimes confluent, and he gave excellent reasons for considering the groove of the Jurassic

mammals to be Meckelian. Based on wider knowledge and more detailed study of this particular point than any previous work, Bensley's view has naturally been almost universally accepted. It was based, however, more on a comparative study of recent mammals than on the actual Jurassic forms in question, and the latter demand reconsideration.

DESCRIPTION.

The internal groove occurs in the Triconodonta, Symmetrodonta, and Pantotheria. It is never present in the Multi-

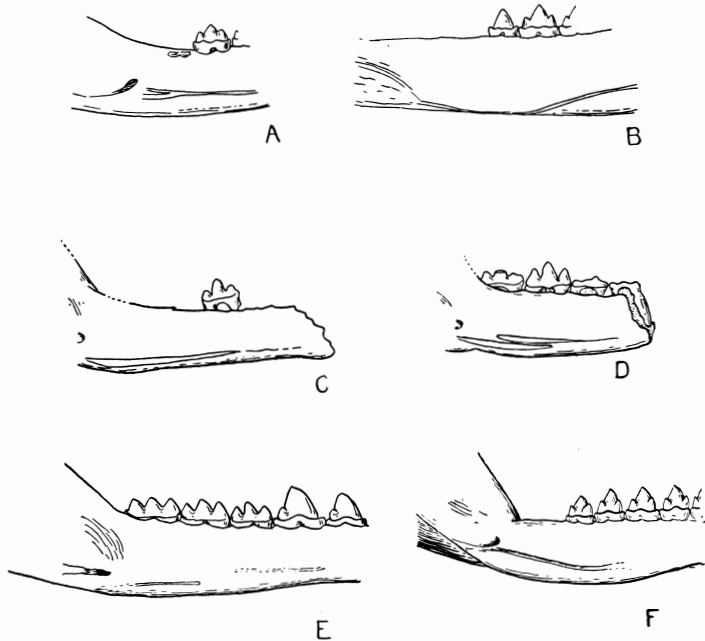


Fig. 1 The internal groove in triconodonts and symmetrodonts. A, *Phascolotherium bucklandi*. B, Same, another specimen. C, "*Triconodon*" *bisulcus*. D, Same, another specimen. E, "*Triconodon*" *ferox*. F, *Spalacotherium tricuspides*.

tuberculata, nor is an exactly similar or certainly homologous groove constantly present in any post-Jurassic mammals. Normally the groove begins near the dental foramen, usually just in front of and below the latter, and runs forward in a gentle curve, gradually converging toward the lower border

of the mandible. In many cases it reaches the symphysis, but it may become indefinite without reaching so far anteriorly. Union at the symphysis was loose, coössification of the mandibular rami never taking place in these orders. The groove may sometimes be seen to expand slightly and to pass into the irregular symphyseal surface (Fig. 2B, E). The grooves normally vary somewhat in course and in degree of

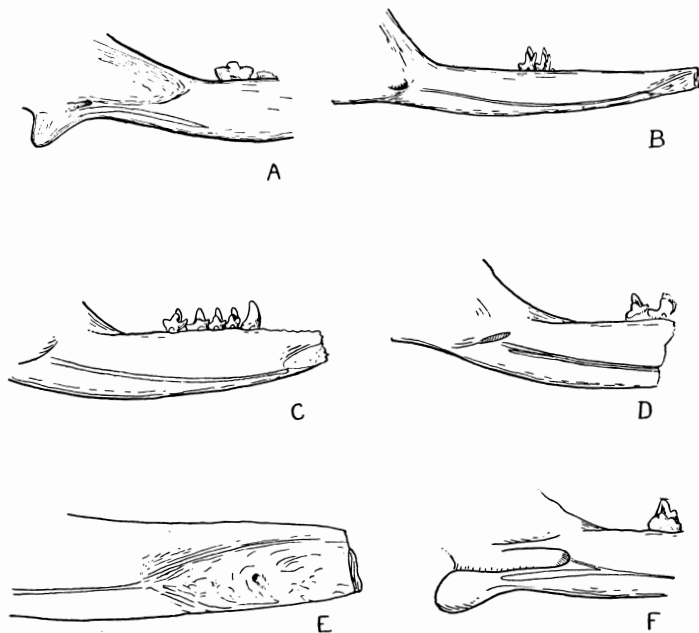


Fig. 2. The internal groove in pantotheres. A, *Peramus tenuirostris*. B, *Amblotherium* sp. C, *Laolestes emimens*. D, Same, another specimen. E, *Phascolestes* sp. F, *Docodon striatus*.

development but are always present and are usually well marked and with a rounded bottom.

Such are the normal conditions with which Bensley was exclusively concerned, but the numerous deviations from this type are even more important in any endeavor to assign a cause to this anatomical feature. In one case (Fig. 1D) there are two grooves, a lower, shorter, broader one extending farther posteriorly, and an upper, narrower, longer one extending farther anteriorly. In another specimen of the same

species there is only one groove (Fig. 1C) which combines the extent and to some degree the other characters of the two. In an English Purbeckian specimen, "*Triconodon*" *ferox*, there is a definite, straight posterior groove and a less definite, straight, more anterior one which is not in line with the first but higher on the mandible (Fig. 1E). In several cases the groove is double all along (Fig. 2D). In other cases the groove branches posteriorly (Fig. 1A). In the dicrocynodontids this branching seems to be the normal condition, a small branch passing to near the lip of the dental foramen and the main body of the groove continuing back of this and below it along the crest of the ridge above the angular process (Fig. 2F, 3).

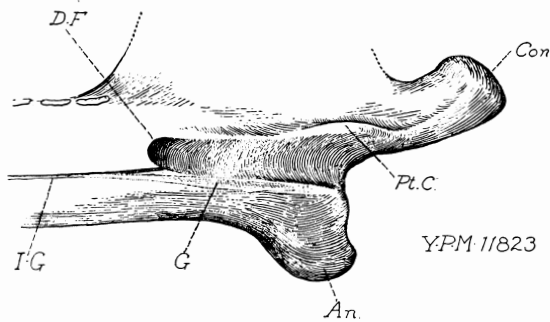


Fig. 3. *Docodon striatus*, internal view of posterior part or right ramus of mandible.

Nor is the groove always on the internal mandibular surface. In one case (Fig. 1B) it lies along the lower border for part of its course, and in another case nearly the whole extent of the groove is along the ventral, not medial, aspect of the jaw.

In résumé, the following are its chief features of importance:

1. The groove or one of its branches has a fairly constant relationship to the dental foramen.
2. It frequently runs forward to the symphyseal surface, where in some cases it seems to open out onto the irregular surface for the intermandibular cartilage. This surface is sometimes pierced by small vascular foramina.
3. The groove is always nearly or quite horizontal.
4. There are frequent indications that it has a dual cause;

it may be double and it may branch posteriorly but has not been observed to branch anteriorly. There may rarely be two quite separate grooves.

5. The groove occasionally runs for much of its course along the lower border of the mandible.

6. It has no certain relationship with the squamosodentary articulation, always being directed posteriorly, either toward the dental foramen or below it.

7. The groove is usually quite regular in width and depth and with a well-rounded bottom, but there is much variation. In different jaws of the same species it may be deep throughout, or deep in some places and shallow elsewhere, or very shallow and irregular throughout, but it is never wholly absent. This sort of irregularity has no relationship to taxonomy nor to individual age.

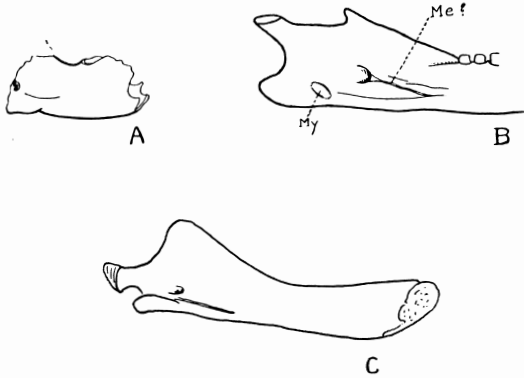


Fig. 4. A. *Thlaeodon* sp., Cretaceous didelphid, showing groove possibly Meckelian. B. *Priodontes gigas*, recent edentate, showing mylohyoid groove, possible Meckelian groove, and other groove-like markings. C. *Callorhinus* sp., recent pinniped, showing vascular groove such as frequently occurs in this suborder and may extend much farther anteriorly.

INTERPRETATION.

By analogy with later mammals and with earlier pre-mammals, the following seem to exhaust the possibilities:

1. The groove lodged a reduced splenial bone, like the broad groove in the same position in the cynodonts.
2. It was more or less fortuitous, due to irregular ossification, or other cause, like some very inconstant groove-like markings in later mammals.

3. It lodged the Meckelian cartilage or was a vestige of the embryonic groove for this cartilage. (Bensley.)

4. It was for muscle attachment, like the groove on the lower border of the *Ornithorhynchus* mandible.

5. It lodged a nerve or artery or both, like the mylohyoid groove of later mammals. (Owen, Osborn.)

6. It always or sometimes involved two of the above causes.

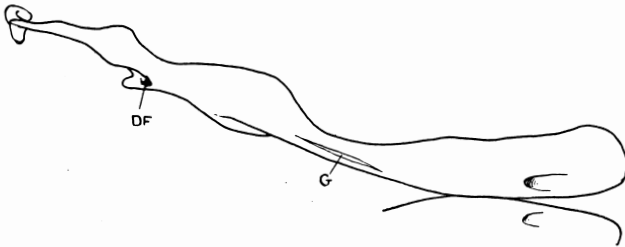


Fig. 5. *Ornithorhynchus paradoxus*. Lower aspect of mandible. DF, dental foramen. G, muscle attachment.

These may be discussed in sequence:

1. The extreme narrowness of the groove, its occasional branched or double character, its relation to the posterior part of the mandible, and indeed most of its characters do not agree well with the hypothesis that it lodged an accessory jaw element.

2. The groove is not fortuitous but constant and is usually so regularly developed as to make its essential character evident.

3. Bensley gave no reasons why the groove could not be vascular or nervous, merely showing that in its usual development it resembles the supposed Meckelian groove of recent mammals rather more than the mylohyoid groove of recent forms. Even on the basis of resemblance, there is something to be said against this, for the Mesozoic groove often curves away from the skull or passes well below the dental foramen, which the Meckelian groove should not theoretically and does not in recent mammals actually do. Nor does its rare position along the lower border or its more frequent opening out into the symphyseal surface agree well with the Meckelian hypothesis, although not impossible to a Meckelian groove. On the other hand, there is now abundant evidence that the groove in the Jurassic forms had a dual cause or

was due to a double structure, and it often branches posteriorly. In the writer's opinion this proves conclusively that it could not have the Meckelian cartilage as its sole, or even principal, cause. Less positive, but very important, are certain theoretical considerations. Since the internal groove is often very strong, regular, and definite even in the most senile animals, it could only mean that, if due to the Meckelian cartilage, this must have persisted throughout life. But the fact that these are known to be true mammals, with the mammalian ear structure and jaw articulation, makes such persistence almost impossible of acceptance.

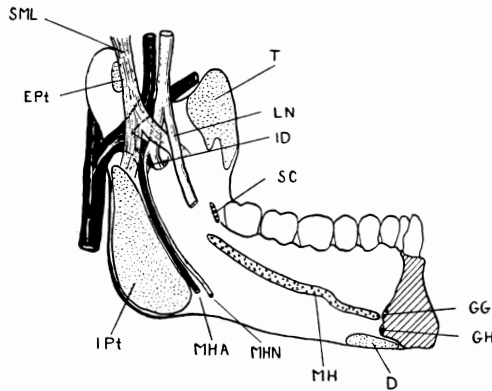


Fig. 6. *Homo sapiens*. Diagram of the anatomy of the internal aspect of the left ramus of the mandible. D, insertion of digastric muscle. EPT, insertion of external pterygoid muscle. GG, origin of genioglossus muscle. GH, origin of geniohyoid muscle. ID, inferior dental nerve and artery entering the dental foramen. IPT, insertion of internal pterygoid muscle. LN, lingual nerve. MH, origin of mylohyoid muscle. MHA, mylohyoid artery. MHN, mylohyoid nerve. SC, origin of superior constrictor muscle. SML, spheno-mandibular ligament.

4. The muscle attachments of recent mammals on the jaw are almost always marked by projections or flat surfaces, but grooves do very rarely occur, as in *Ornithorhynchus*. The broadly rounded bottom usually seen, the type of branching, relationship to the dental foramen and the symphysis, and other features make it seem very improbable that the Jurassic groove was a muscle attachment, although they do not absolutely exclude the possibility.

5. This hypothesis, the oldest one, abandoned after Bensley's work, must once more be considered as most probable.

Specific comparison with the typical mylohyoid groove shows, it is true, numerous minor differences, especially:

- a. The recent mylohyoid groove is usually broader and shorter.
- b. It usually has a less horizontal course.
- c. It rarely reaches the symphysis.
- d. It does not branch posteriorly, although its dual origin offers a possible explanation of such branching.
- e. It is sometimes less linear and more irregular.

None of these considerations is at all conclusive as opposing the vascular and nervous origin of the internal groove, especially in view of the vast differences in time and in zoologi-

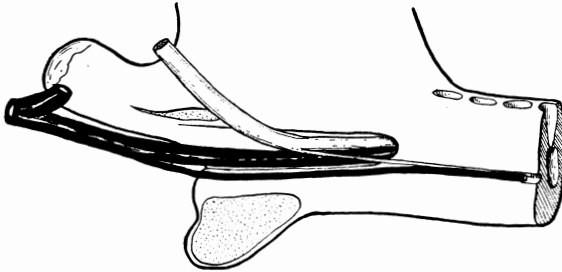


Fig. 7. Hypothetical restoration of some anatomical features of a microcynodont Jurassic pantotherian, showing branches from the dental nerve and artery forming separate grooves posteriorly which join to form the single internal groove. Cf, Fig. 3. Pterygoid muscle insertions stippled.

cal differentiation. Grooves do occur in recent mammals which are known to be for vessels or nerves and which resemble the Jurassic groove, at least as much as does the Meckelian groove. This is especially seen in forms which have short necks, skulls in continuation of the line of the spinal column (which was probably true of the Jurassic mammals)—of importance as regards the direction of the grooves—and in which the symphysis is loosely knit and the lower jaw highly vascular, for instance, in pinnipeds and cetaceans. In fact the view that the internal groove owes its presence to pressure from an important and only slightly variable artery and probably also nerve explains all its known features more readily than any other theory. The relationship of the groove or of its nerve-bearing branch to the dental foramen; the communication of the artery with the vascular unknit symphysis; the

occasional double nature of the groove (for nerve and artery) and the probability that even when apparently single it had a dual cause (like the mylohyoid groove); the branching, a lower broader branch for the artery and an upper narrower one in more direct relationship to the dental foramen for the nerve; the lack of sure relationship to the ear region or jaw articulation; even the usual regularity but occasional irregularity—all are well accounted for on this hypothesis.

6. It would be possible still to cling to the Meckelian hypothesis if one supposed that the conditions impossible of explanation on this hypothesis alone were due to the occasional participation of some other elements. But:

a. Clear evidence of dual origin is so common that this was probably the normal condition, even when the groove is apparently simple.

b. There is a certain presumption that the two causes must have been related (as are the mylohyoid nerve and artery) rather than quite unrelated save accidentally (as are the Meckelian cartilage and the nerves and blood vessels).

c. We cannot suppose the groove due now to one cause, now to another, for it always is present.

d. It is unnecessary to advance so complicated an explanation when a simpler one suffices.

e. There remains the possible difficulty of explaining the usual persistence of the Meckelian cartilage in true mammals.

It is indeed possible, even probable, that the groove follows the approximate course of the embryonic Meckelian cartilage, as the mylohyoid groove may do in recent mammals, but it is very improbable that the groove in the adult owes its character directly to this cause.

CONCLUSION.

1. The internal groove of the mandible of the Jurassic orders Triconodonta, Symmetrodonta, and Pantotheria is constant in occurrence, although inconstant in detailed structure.

2. The chief known variations in morphology have been described.

3. The groove cannot owe its character wholly to the Meckelian cartilage and probably has only an indirect relationship, if any, to that structure.

4. It is not actually disproven, but quite improbable, that it owes its character to muscle attachment.

5. Most probable is the old view that it followed the course of an artery and nerve.

6. In view of the doubt which still remains, it is preferable to apply to it a descriptive name, "internal groove," which is unambiguous yet noncommittal.

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The figures of American Jurassic mammals are based on materials in the Yale Peabody Museum and those of British forms on specimens in the British Museum (Natural History).

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