DESCRIPTIONS

OF THE

INFERIOR MAXILLARY BONES

OF

MASTODONS,

IN THE

CABINET OF THE AMERICAN PHILOSOPHICAL SOCIETY,

WITH

REMARKS ON THE GENUS TETRACAULODON, &c.

BY ISAAC HAYS, M.D.

EXTRACTED FROM THE TRANSACTIONS OF THE AMERICAN PHILOSOPHICAL SOCIETY, VOL. IV. N. S.

PRINTED BY

JAMES KAY, JUN. AND CO., PHILADELPHIA,

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Descriptions of the Specimens of Inferior Maxillary Bones of Mastodons in the Cabinet of the American Philosophical Society, with Remarks on the genus Tetracaulodon (Godman), &c. By Isaac Hays, M.D. Read May 20, 1831.

MY friend, the late Dr Godman, communicated to the Society about eighteen months since, an account of an extinct fossil animal, closely resembling the *Mastodon* in most of its characters, but differing from it, in possessing tusks in the *lower* jaw. This difference Dr Godman thought of sufficient importance to constitute a new genus, to which he gave the name of *Tetracaulodon.**

The immediate subject of Dr Godman's description having been a young animal,† a distinguished naturalist‡ of New York suggested the opinion that the *Tetracaulodon* was nothing but the young of the gigantic *Mastodon*, and that the tusks were merely milk teeth, which were lost as the animal became adult.§ The same opinion has since been confidently advanced by others.‖

Had Dr Godman been able to examine the specimens in our cabinets with his own eyes, instead of being obliged to rely upon those of others, his own memoir would doubtless have contained all the proofs necessary for refuting the opinion that he had committed the error of

* See Vol. III. N. S., p. 478.

† Dr Godman states, however, that there are two adult jaw bones of the same animal in the cabinet of the University of Virginia. Vol. III. N. S., p. 484.

‡ William Cooper, Esq.

§ See Silliman's Journal, Vol. XIX. p. 159, 160, October 1330.

‖ See Ferussac's Bulletin for August 1830, &c.

describing, as a new animal, the young of a known species. The account of the *Tetracaulodon* was, however, written by the author, literally on his death bed.* There is no need of the Society's being reminded of the generous and lofty ambition, by which Dr Godman was always actuated, or that he was compelled through life, to struggle against difficulties, which no ordinary man could have overcome; and they will at once understand his expression to his friends, on announcing that he was preparing an account of a new fossil animal,—"I have all my life," said he, "been compelled to labour for bread, I shall now do something for my fame."

These remarks will account for such imperfections as may have occurred in Dr Godman's memoir, as also explain my anxiety to secure to him the credit which appears to me to be his due.

It is not my purpose to inquire into the value of the tusk, in the lower jaw, as constituting a generic distinction between the *Mastodon* and *Tetracaulodon*.† Generic divisions in science are, for the most part, as yet too arbitrary—the characters upon which they are founded too ill determined—and our materials at present too scanty, to induce us to venture any remarks upon this subject, even had we not determined to restrict ourselves to a detail of facts.

A more important subject of inquiry, is whether the *Tetracaulodon* is merely the young of the gigantic *Mastodon*, and the tusks in its lower jaw only milk teeth, which are lost when the animal becomes adult and are never replaced. Fortunately the cabinet of the Society furnishes us with materials for at once settling this question. It contains portions of three lower jaws, which I have the honour of exhibiting, and which will be particularly described hereafter. The first is that of a young Mastodon, *M. giganteum* (Plate XX.), entirely destitute of tusks or alveoli for tusks; the two others appertain to *aged adult* animals (Plates XXVIII. and XXIX.), and exhibit distinct sockets for tusks. A more complete refutation then of the assertion that the *Tetra-*

* Dr Godman died before the number containing his memoir was published.

† Mr Titian R. Peale, who was the first naturalist by whom the *Tetracaulodon* was seen, suggested to Dr Godman that the tusks in the lower jaw might be merely a sexual character. It is impossible, in the existing state of our knowledge, and with our present materials, either to confirm or positively refute this suggestion.

caulodon is only the young gigantic *Mastodon*, is hardly possible, and the merit of having contributed to the Fauna of this country, one of its largest antediluvian animals, is confirmed to Dr Godman.

The object which originally prompted this communication, being thus accomplished, I might here close it; but from the great number of specimens which I have been so fortunate as to have had opportunities of examining (about forty lower jaws, and upwards of two hundred teeth), some facts have been presented, to which my friends attach so much interest, as to induce me to lay an account of them before the Society.

The first specimen I shall describe is a fragment of the left side of the lower jaw, consisting of the ramus, chin and portion of the coronoid process. (Plate XX., fig. 1 and 2.) This fragment is sixteen inches long, and weighs nine pounds. The teeth, as well as the loose texture of the bone, show it to have belonged to a young animal. The condyloid process and angle of the jaw are deficient, and the chin is slightly broken, so that it is impossible to determine whether it had the foliated termination so conspicuous in the adult. (Plate XXIII., *s*.) The coronoid process rises nearly perpendicularly as in the *giganteum;* but the ramus of the jaw is rather more cylindrical than in the adult of that species.

This fragment contains two teeth. The posterior one (Plate XX., *d*) had just commenced to pierce the gum; its crown is perfect, but its roots are not yet formed. This tooth is four inches and one-tenth* long, and two inches and seven-tenths broad. It has three wedge-shaped denticules, each of which is divided, by a longitudinal groove, into two processes, the inner of which is somewhat the wider; and each of these processes is superficially divided into two or more points —the exterior points being the largest.

The anterior tooth (Plate XX., *c*) resembles that just described in its general characters; its crown is, however, somewhat worn, particularly its anterior points. Its length is three inches and three-tenths, its breadth is two inches and five-tenths.

* All the measures were taken with callipers.

Anterior to this tooth are three alveolar depressions (Plate XX., *m*, *n*, *o*) which mark the place of teeth which have been lost.

Beneath the anterior socket is a foramen for the passage of blood-vessels and nerve. (Plate XX., fig. *r*.) At the anterior portion of the chin are two foramina for the same purpose: that on the left side is lower and larger than the other, pyramidal, and at a short distance bifurcates. A *fine* needle may be passed some distance into each of these divisions.

In one of the lower jaws of an adolescent *Mastodon* in the Finnel collection at New York, the foramen in the chin is two lines in diameter and passes directly into the large foramen in the ramus of the jaw occupied by the maxillary nerve and blood-vessels.

The next specimen to be noticed, is a fragment of the right side of the inferior maxillary bone of an adolescent gigantic *Mastodon*, (Plate XXI.) belonging to the splendid Wistar Museum of the University of Pennsylvania. This fragment is two feet five inches long. The general form of this jaw is similar to that of the gigantic *Mastodon* represented in Plate XXIII., but the ramus is rather more cylindrical, in which respect it resembles the specimen just described (Plate XX.). The upper portion of the coronoid, and the condyloid processes are deficient, as also the angle. The chin is also broken, but there are manifest indications of an expansion similar to that represented in Plate XXIII., *s*. Just above the base of the ramus internally are a number of circular depressions, probably formed by the lobules of the inferior maxillary gland.

This fragment contains two teeth, and anterior to these a portion of the alveolus of a third tooth. The anterior tooth (Plate XXI. *e*) has three denticules, with two points each: it is five inches and eight-tenths long, and three inches and seven-tenths broad. The posterior tooth (Plate XXI. *f*) has five denticules or pairs of points, and a trifid heel. This tooth is eight inches and one-tenth long, and four inches and three-tenths broad.

The cabinet of the Society does not contain any specimen of the lower jaw presenting all the characters of the *Mastodon giganteum*, except a small fragment represented in Plate XXII. This fragment is twelve

inches long, and consists of a portion of the ramus of the jaw, with the base of the coronoid process. It contains one tooth, the posterior molar. This tooth has five denticules with two points each, and a heel; it is six inches and nine-tenths long, and three inches and eight-tenths broad.

I have the pleasure, however, of exhibiting to the society, one of the most perfect specimens of the lower jaw of this species, that has as yet been obtained. (Plate XXIII.) This jaw belongs to the Baltimore Museum. It is the one dug up by the late Mr Peale on the farm of Peter Millspaw, twenty miles west of the Hudson, which is described by Mr Rembrandt Peale in his "Narrative of the discovery and exhumation of the skeleton of the Mastodon,"* and drawings and a description of which were communicated by Mr Peale to Baron Cuvier, and from which the latter drew many of his characters of this interesting animal. When found this jaw was perfect; but about two years since it was unfortunately broken by accident. The largest fragment, consisting of the whole right side of the jaw, the coronoid and condyloid processes, the chin and nearly two inches of the left side, all in a remarkably fine state of preservation, are represented in Plate XXIII.

The length of this jaw is two feet six inches and a half, the height of the coronoid process above a line drawn along the base of the jaw fourteen inches and a half.

The articulating surface of the condyloid process is divided by a superficial groove (x) at about two-thirds of the distance from its inner edge. The direction of the condyle is inwards and rather forwards.

The coronoid process rises nearly perpendicularly; the upper part curves somewhat outwards; it is one inch and a half higher than the condyloid process.

Just below the condyle a ridge (t) commences, which, after passing downwards and a little forwards a short distance, becomes nearly horizontal, and above this is a considerable depression, an inch in depth at its deepest part.

That portion of the jaw which is covered by the masseter muscle, is much flattened and rough; the angle is also very rough.

* Copied in Godman's American Natural History, Vol. II. p. 211.

The ramus of the jaw is slightly flattened on its external aspect, and somewhat excavated on its internal one. The anterior maxillary foramina are two (Plate XXIII., fig. 1, *p*, *q*); there are several smaller foramina near the chin for the passage of the blood vessels and nerves.

The chin terminates in a remarkable expansion, the edges of which are exceedingly rough. (Plate XXIII. *s*.) There are no alveoli for tusks, nor any trace of there ever having been any.

This jaw contained but one tooth in each side. The sockets for the molars anterior to these are completely filled up. The tooth which remains (the last molar) was somewhat injured by the accident to which we have already referred, but it appears to have had ten points and a heel. The direction of this tooth in the jaw is outward anteriorly, as is seen from fig. 2.

The foramen for the inferior maxillary nerve and blood vessels is just below the condyle internally (fig. 2, *y*), and is one inch and a quarter in diameter.

On the upper surface of the ramus, just at the base of the coronoid process, is the commencement of a small groove, which immediately divides and diverges. It is evidently caused by a blood vessel; and we mention it because a similar groove occurs in the fragment represented in Plate XXII. It is not to be found in any other specimen in the collection.*

The lower jaw represented in Plate XXIV. differs considerably in its form from the jaws of the *M. giganteum* we have described. Its base is more curved antero-posteriorly—the external aspect of its ramus is more flattened, and that portion of the jaw covered by the masseter muscle less so. The groove for the tongue is deeper and narrower; and the chin appears pointed, but the specimen being partly worn it is impossible to determine the exact form of this part.

* There is in the Cabinet of the Lyceum of Natural History of New York, a fragment of an inferior maxillary bone, which agrees in all its characters with that just described, except that the direction of its condyle is inwards and backwards, and that its posterior molar has but four denticules. This bone was found in New Jersey, and is figured in Mitchell's edition of Cuvier's Theory of the earth; and copied into Cuvier's *Ossemens Fossiles; Grand Mastodonte*, Plate III. fig. 5.

The posterior molar (Plate XXIV. *f*) has but eight points, and the heel is broad, whilst in our specimens of the *M. giganteum* the posterior molar has ten points and a mammillaform heel. The direction of the teeth is also very divergent anteriorly. Are these differences sufficient to indicate its belonging to a different species from the *M. giganteum?*

There is, in the cabinet of the Society, a portion of another jaw, consisting of the left ramus, containing two teeth, and the chin; which is entirely similar to the above in its characters, but somewhat distorted, no doubt from injury when the animal was young. There is another specimen resembling the above in its general characters, among the lower jaw bones of Mastodons belonging to J. P. Wetherill, Esq. and which are deposited in the valuable cabinet of the Academy of Natural Sciences of this city. This fragment, however, has had the teeth broken out.*

The cabinet of our Society contains a portion of an inferior maxillary bone, (Plate XXV.) which differs in its form from any of those hitherto described. This fragment consists of the chin, the right ramus, with the posterior molares, and a portion of the left ramus. The anterior molar (Plate XXV. *e*) has three denticules with two points each; the posterior (fig. *f*) has four denticules, with two points each; and a ridge posteriorly. The ramus of this jaw is straighter, and more cylindrical; the height from the base to the edge of the alveole is less; the groove for the tongue broader and shallower; and the direction of the teeth less diverging than in the maxilla figured in Plate XXIV. The crowns of the teeth are also less elevated in the former than in the latter.

In the collection deposited by Mr Wetherill in the Cabinet of the Academy of Natural Sciences, there is a fragment of a lower jaw, which exhibits the same characters as the one just described. This fragment consists of the chin, about eight inches of the left and twelve inches of the right ramus. The alveolar processes are much broken, and the teeth are lost.

* This jaw was exhibited to the Society.

The inferior maxillary bone described by Dr Godman* is very accurately represented in Plate XXVI., fig. 1 and 2. The chin, the right ramus and a portion of the *coronoid* process, and about three-fourths of the left ramus are perfect. The mental ridge, each side of the labial groove, is sharp and smooth, without that remarkable foliated expansion so conspicuous in the *M. giganteum* (Plate XXIII. *s*). In the left ramus there is still the first deciduous tooth (Plate XXVI. fig. 2, *a*); on the right side the corresponding tooth has fallen out, and its socket is partly obliterated. This tooth (fig. 2) is one inch and five-tenths long, and one inch and one-twentieth broad; its surface is considerably worn, most so anteriorly. It had four points; anteriorly there is a fold of enamel which, commencing at the external edge of the base of the crown and passing upwards and inwards, terminates in a point; posteriorly there is a somewhat similar and rather broader fold of enamel. Anteriorly the crown is rounded; posteriorly it is flattened from contact with its successor; its grinding surface is considerably worn. It has two roots, one anterior, the other posterior.

We have seen in the cabinet of William Cooper, Esq. of New York, a fragment of a lower jaw containing one of these teeth exceedingly perfect; its points are scarcely perceptibly worn. Another specimen is in the cabinet of the Academy of Natural Sciences.†

The second tooth (Plate XXVI. *b*) is one inch and eight-tenths long, and one inch and eleven-twentieths broad. This tooth, like the preceding, had two denticules, with two points each. On the anterior of the crown there is a flat fold of enamel similar to that on the first tooth. This tooth has also a heel which rises highest towards its inner aspect, forming a small fifth point. The grinding surface of this tooth is considerably worn. This tooth like the preceding one has two roots; one anterior, the other posterior.

In the Finnel collection there is one of these teeth; it is one inch and seven-tenths long, and one inch and five-tenths wide.

* Vol. III. p. 478.

† This tooth is described in the "Fauna Americana," as appertaining to a new species of Tapir to which the name *T. Mastodontoideus* is given. Mr William Cooper was we believe the first to detect this error; we have carefully examined the tooth, and there can be no doubt of its being the first milk tooth of the animal we are describing.

The third tooth (Plate XXVI. *c*) is three inches and one-tenth long, and two inches and two-tenths broad. This tooth has three denticules, with two points each. On the anterior surface of the crown, it has a fold of enamel rising up in a small point; and along the base of the crown posteriorly there is an horizontal ridge, consisting of a number of very small mammillaform processes. This tooth has three roots corresponding to its denticules.

The fourth tooth (*d*) is three inches and seven-tenths long, and two inches and eight-tenths broad; it has three denticules, each of which is divided by a deep groove into two rather flattened points, of which the inner is the broader; each of these is again superficially divided by a slight groove. At the base of the crown, both anteriorly and posteriorly, there is a ridge of very small mammillaform points. Each denticule has on its external point, both on its anterior and posterior surface, a ridge of enamel, which commences at the base of the process near the central groove and passes upwards and outwards. This ridge appears to exist on all the teeth until it is worn down by use, and we find traces of it also in the teeth of the *M. giganteum*. The crowns of all the teeth rise on their inner surface nearly perpendicularly, but on the outer side they slope obliquely inwards.

The tusk belonging to this jaw is so accurately described by Dr Godman, and so correctly represented in the plate to his paper, that there is no necessity for my doing more than to refer to it. (See Vol. III. N. S., Plate XVIII. fig. 2.)

The tusk represented in Plate XXVI. fig. 3, is that of an adult animal. It is eleven inches long, and its largest diameter is two inches, its section is oval. This tusk consists of a central column composed of thin plates nearly parallel to its base; the whole covered with a coat of enamel, which becomes very thick towards its projecting extremity. The enamel is entirely worn off to the termination of this tusk, and even the central bony column is evidently worn down and smooth, as if from use by the animal; it is also worn at one side. This tusk belongs to the collection of J. P. Wetherill, Esq.*

* There is in the cabinet of the Academy of Natural Sciences, deposited by Mr J. Fisher, by whom it was obtained at Big-bone lick, a tusk much smaller than the one we have described—it is also much less perfect.

The next specimen we shall describe is the right side of an inferior maxillary bone, in a remarkably perfect state of preservation, belonging to the cabinet of the Society. (Plate XXVIII.)

The condyloid process in this jaw is considerably higher than in the *M. giganteum* (Plate XXIII.). The direction of the condyle also differs, being inwards and *backwards.*

The coronoid process appears to have risen nearly perpendicularly, but its anterior edge and termination are broken. The semilunar notch was evidently deeper in this than in the *M. giganteum*, though its exact form cannot be determined in its present injured condition.

The posterior angle is much rounder than in the *M. giganteum.* The outer surface, where the temporal muscle was inserted, is very rough, being over a considerable space quite tuberculated; and there is a distinct semi-circular ridge of these rough elevations, as will be seen on reference to the drawing. (Plate XXVIII. fig. 1, t, t′, t″.) Immediately anterior to this semicircular ridge, there is an excavation, distinctly striated with muscular impressions (*a*). The ramus is remarkably cylindrical, and its base much more curved than that of the *M. giganteum* (Plate XXIII.). The anterior mental foramen (*q*) is smaller, and nearer to the upper edge of the jaw, than in the other specimens, and the posterior mental foramen is larger than in any of the specimens hitherto described, its largest diameter being nearly nine-tenths of an inch.

The ridge at the side of the labial groove is broken, but it appears to have been expanded; whether or not, as in the *M. giganteum*, and with irregular terminations, it is of course impossible to divine.

This specimen contains but a single tooth. This tooth is six inches long, and three inches and four-tenths broad. It has four denticules with two points each. The enamel on the posterior face of the crown is broken off, and the characters of the heel cannot consequently be determined. The grinding surface of the crown is somewhat worn, and presents the same arrangement of enamel as in the *M. giganteum.*

In the chin there is a small part of the alveole of the tusk remaining. The direction of this alveole is outwards and considerably downwards. It has been found impossible to give a good view of this alveole in the plate, but its position is marked by the dotted lines representing a tusk.

In the cabinet of the Society there is another fragment of a lower jaw, but of the left side, in all respects similar to the preceding, though much less perfect. The upper parts of both the condyloid and coronoid processes are deficient, but the anterior edge of the latter is more perfect than in the preceding specimen, and rises nearly perpendicularly from the ramus. The chin in this specimen is entirely deficient, as is also the whole of the inner table of the ramus, so that the maxillary canal is laid entirely open. This bone must have belonged to an animal nearly of the same age as the preceding, or perhaps somewhat younger; the last molar, as is seen from the alveole, for the tooth is wanting, not having advanced by upwards of an inch as far forward as that in the former jaw.

Whether or not the specimen described by Dr Godman, and the jaws last noticed belong to the same species, cannot be determined positively without further specimens. The jaw next to be described, however, exhibits differences, which would justify the suspicion that it is specifically different from either.

This specimen is represented in Plate XXIX. It consists of a portion of the right ramus of the lower jaw, twenty-two inches and a half long. It contains a single tooth, the posterior molar. The exterior aspect of this jaw, at its angle, is entirely smooth, without any of the rugosities presented in the two preceding specimens. Between the posterior molar and the coronoid process there is a large smooth excavation, *x*. The ramus of this jaw is much less cylindrical than that of the species figured in Plate XXVIII., it is much flattened on its exterior aspect, and its base is almost straight. The posterior mental foramen is exceedingly large, upwards of one inch and a quarter in diameter. The posterior molar is seven inches and two-tenths long, and four inches and one-tenth wide; it has eight points and a broad heel consisting of a row of small mammilla, four of which on the inside are very distinct. This tooth differs in various particulars from the posterior molar belonging to the specimen figured in Plate XXVIII. It is one inch and a half longer, and seven-tenths of an inch wider, the denticules are higher, and the inner points much higher above the exterior ones. Thus in the former, the second denticule (Plate XXVIII. *v*) rises one inch and eight-tenths from its root, and the inner one two inches and two-tenths; whilst in the latter (Plate XXIX. *v*) the corresponding

exterior point rises two inches and three-tenths from the root and the inner one three inches and three-tenths, making a difference in the former of half an inch, and in the latter of one inch and one-tenth.

The chin in this specimen contains about one half of the alveole for the exserted tusk (fig. 2, *z*). This alveole is rather more than two inches in diameter; its direction is outwards and downwards, less downwards however than in the preceding species; indeed there is a distinct difference in the position of these sockets in the two specimens. The base of the socket is smooth and flat, and its position somewhat oblique, so that it is rather deeper towards the exterior, than towards the interior; it is perforated by two small foramina for the nutrient arteries, and the nerves of the tusk.

It is to be lamented that little positive can be ascertained, as to the localities in which the bones belonging to the Society, and which we have just described, were found, their position in the soil, &c. All that can be collected is, the probability, that they are from the Big-bone lick, and that they are those presented by our late president Thomas Jefferson, Esq., and which are noticed in the communication of Professor Wistar, in Vol. I. N. S., p. 376, of the Transactions.

Dentition of the Mastodon.

The specimens we have just described furnish some interesting information relative to the dentition of the *Mastodon*, which we shall now proceed to lay before the Society. The form, and differences, succession and number of the teeth are all subjects of great interest; and in describing them we shall follow Cuvier, adding such additional information as our investigations have brought to light.

The crown of the teeth more or less approaches the rectangular form, slightly inclined however to rhomboidal, and rather narrower anteriorly than posteriorly. It consists of two substances, the interior osseous, the exterior enamel. The crown is divided by deep furrows into a number of ridges or denticules, and these denticules are subdivided by one or more superficial and narrow processes or tubercles. The outer face of the crown rises nearly perpendicularly, the inner face rises obliquely inwards. In the lower jaw, the outer point is higher than the

inner; in the upper jaw it is the reverse. As the teeth are used, their points become worn down, and the enamel presents a lozenge form, with bone in the centre. The roots of the teeth are formed after the crown. With the remains of the animal described by Dr Godman, there were found a number of points, evidently parts of very young teeth, of which the bodies by which they were to have been connected together had not yet been formed. These points are now in the Museum of Mr Rubens Peale, New York.

The number of the roots may be said to correspond to the number of the denticules. In the teeth with two denticules, the two roots are distinct; in those with more than two denticules, the anterior and sometimes the second root are distinct, the others are united but marked by distinct grooves. The roots are flattened anteriorly and posteriorly; externally they are slightly and internally deeply grooved.

The upper teeth may be distinguished from those of the lower jaw by their roots being more divergent laterally, and by their crowns being broader.

The teeth *differ* from one another principally in their size and in the number of their denticules.

In the species of *Mastodon* which inhabited this country there are three kinds of teeth.

The first nearly square and having two denticules;

The second rectangular with three denticules;

The third longer, generally contracted posteriorly, and having four or five denticules and a heel, of various forms.

The first mentioned teeth are always anterior, next follow those with three denticules, and lastly those with four and five denticules; but we have never seen those with five distinct denticules in the upper jaw, they appear to belong exclusively to the lower.

In the young jaw described by Dr Godman, we find, 1st, a small square tooth, with two denticules; 2d, one rectangular with two denticules; 3d, a tooth with three denticules; 4th, one rather larger, also with three denticules. In the upper jaw there are corresponding teeth. Each of the two adult lower jaws having tusks (Plates XXVIII. and XXIX.) contains a tooth with eight points; and it is manifest that there was a corresponding tooth in the upper jaw. The whole number of teeth possessed by the animal described by Dr Godman (*Tetracaulodon*) is then at least twenty; and we think that it is at least probable

that the animal possessed an intermediate tooth between the second tooth with three denticules (Plate XXVI. *d*), and that with four denticules (Plate XXIX. *f*), for we cannot believe the former tooth corresponds with that represented in Plate XXVII. *e*. Should we be correct in our views, this animal possessed three teeth, with three denticules in each side of each jaw, making the whole number of teeth twenty-four; but to render this certain would require specimens of intermediate ages to those hitherto described.

Cuvier attributes to the *gigantic Mastodon* but sixteen teeth, eight in each jaw; of these teeth he saw the three posterior only of each side; but he indicates the fourth from an alveole in the young specimen presented to the French Museum by Mr Jefferson, and he asks, whether this tooth had two or three denticules. In the young specimen belonging to the cabinet of our Society, there are two teeth with three denticules each; and anteriorly an alveole with three depressions, Plate XX. fig. 2, *m*, *n*, *o*. Was there in this alveole a tooth with three denticules, or were there two teeth with two denticules each, of which the anterior tooth having sometime previously fallen out the alveole for its anterior root has been obliterated? We are inclined to believe that the latter was the fact. It may also be asked whether the tooth represented in Plate XX. fig. 1, *d*, corresponds with that in Plate XXI. *e*, in Plate XXIV. *e*, and in Plate XXV. *e*? We think not. Cuvier, it is true, considers the tooth with three denticules, in the adult jaw represented in Plate III. fig. 1, *Grande Mastodonte*,* to correspond with the posterior tooth with three denticules in the young jaw represented in the same plate, fig. 3 and 4; but the difference in the size of these two teeth, and even in their shape, the former being proportionably broader, is very striking. In all the jaws we have examined, this character is constant; thus, compare the tooth represented in Plate XX. *d*, with that in Plate XXI. *e*, Plate XXIV. *e*, and Plate XXV. *e*. It would therefore seem that the Mastodon has three teeth with three denticules; but to render this certain will require further specimens.

The *succession* of the teeth in the *Mastodon*, takes place as follows:—In all the jaws the anterior teeth will be observed to be most worn. As the anterior teeth are worn down others are formed posterior; the anterior teeth successively fall out, their alveoles are obliterated, and

* Recherches sur les Ossemens Fossiles, Tom. I. Paris, 1831.

their successors advance forwards. The number of teeth which are in use in the young animal represented in Plate XXVI. at the same time seems to have been twelve, but probably at a more advanced age was usually not more than eight; and in old age only four. The fact of the jaws represented in Plates XXVIII. and XXIX. having belonged to adult animals is thus conclusively established, all the teeth having been lost, except the posterior molar in each jaw, and that has advanced considerably forward and is much worn.

We subjoin the admeasurements of various teeth, appertaining to the lower jaw of the animals under notice.

Tooth.	Dimensions of Crown in inches.		SPECIMEN.
	Length.	Breadth.	
1.	1.5	1.1	Peale's Museum, New York, Pl. XXVI.
	1.4	1	Academy of Natural Sciences—described in Fauna Americana as the *Tapir Mastodontoideus.*
2.	1.8	1.55	Peale's Museum, New York, Pl. XXVI.
	1.7	1.5	Finnel Collection, New York.
3.	3.1	2.2	Peale's Museum, New York, Pl. XXVI.
	2.9	1.9	Cabinet of Mr Lea.
	3.3	2.5	Cabinet of American Philosophical Society, Pl. XX.
	3.2	2.5	French Museum,* figured by Cuvier.
4.	3.7	2.8	Peale's Museum, New York, Pl. XXVI.
	4.1	2.7	Cabinet of American Philosophical Society, Pl. XX.
	3.8	2.6	French Museum,* figured by Cuvier.
5.	4.6	3.5	Cabinet of American Philosophical Society, Pl. XXIV.
	4.5	3.3	Cabinet of American Philosophical Society, Pl. XXV.
	5.8	3.7	Wistar Museum, Pl. XXI.
	4.4	3.4	French Museum, figured by Cuvier.
	4.3	3.2	Philadelphia Museum.
	4.9	3.6	Virginia University, Pl. XXVII.
6.	8.1	4.3	Wistar Museum, Pl. XXI.
	6.9	3.8	Cabinet of American Philosophical Society.
	7.1	3.7	Baltimore Museum, Pl. XXIII.
	7.2	4.1	Cabinet of American Philosophical Society, Pl. XXIX.
	6	3.4	Cabinet of American Philosophical Society, Pl. XXVIII.
	7	3.8	Cabinet of American Philosophical Society, Pl. XXIV.
	6.5	3.6	Cabinet of American Philosophical Society, Pl. XXV.
	7	3.5	French Museum, figured by Cuvier.
	7.1	3.7	Philadelphia Museum.

* Same jaw.

Before concluding it may be interesting to offer a few general remarks on the animals, which are the subject of this communication, with a brief notice of the species hitherto described.

For a long time the large animal whose remains are found in this country, was considered as the same with the Mammoth of Siberia, which is a true Elephant. It has been shown however by Baron Cuvier that they are generically different, the teeth of the latter consisting of layers of enamel penetrating the whole extent of the tooth, with bony matter interposed between them; whilst in the former the enamel forms only a covering to the bony substance, and does not penetrate it. From the crowns of the teeth, in the species of this genus first known to Cuvier, consisting of mammillaform processes, he named the genus *Mastodon*, from μαστος mammilla, and οδους dens.

Of this genus nine species are admitted by naturalists. Of these, six are indicated by Cuvier, viz.

Species 1. *M. giganteum*, the well known gigantic *Mastodon* of this country.

Species 2. *M. angustidens;* remains of which are found at Simorre in the south of France, in Germany, Tuscany, Switzerland and South America. Cuvier indicates the following characters as distinguishing it from the *M. giganteum*. "Le principal et le plus général est que les cônes de leur couronne sont sillonnées plus ou moins profondément, et tantôt terminés par plusieurs pointes, et tantôt accompagnés d'autres cônes plus petits sur leur côtés ou dans leurs intervalles: d'où il résulte que la mastication produit d'abord sur cette couronne plusieurs petits cercles, et ensuite des trèfles ou figures à trois lobes, mais jamais de losanges." Recherches sur les Ossemens Fossiles, Tom. I. p. 254. These differences will be at once perceived on comparing the partially worn tooth of the *M. giganteum*, Plate XXI., and Plate XXIV. *e*, with the teeth of the *M. angustidens* represented in Cuvier's Ossemens Fossiles, Divers Mastodontes, Plate I. fig. 4, and Plate III. fig. 2 and 4.

Species 3. *M. Cordillerarum*. This species is founded on a tooth discovered near the volcano of Imbaburra, in the kingdom of Quito, and two teeth from the province of Chiquitos, near St Crux de la Sierra. The tubercles of these teeth are divided like those of the *angus-*

tidens, whilst their proportions are the same as those of the *giganteum* with three denticules, but they are distinguished by the figure (*trèfle*) formed by the enamel in the partially worn tooth, being different from the lozenge in the *M. giganteum*. See Cuvier's Ossemens Fossiles, Divers Mastodontes, Pl. II. fig. 1.

Species 4. *M. Humboldtii*. This species is founded on a tooth obtained by M. Humboldt at Conception du Chili. This tooth is nearly square, and smaller than the preceding. See Cuvier's Ossemens Fossiles. Divers Mastodontes, Pl. II. fig. 5.

Species 5. *M. parvus*, founded on a tooth discovered in Europe, and which M. Cuvier thinks too small to be referred to any of the preceding species. It is represented in the Ossemens Fossiles, Divers Mastodontes, Pl. II. fig. 11.

Species 6. *M. Tapyroides*. This is founded on a tooth obtained at Montabusard, near Orleans. Its crown, simply indented, is not so exactly divided into two points, as those of the preceding species, which has led Cuvier to suspect that it may belong to a different species. It is figured in the Ossemens Fossiles, Divers Mastodontes, Pl. III. fig. 6.

Species 7. *M. Arvernensis*. This species was founded by M.M. Croizet and Jobert, Sen., upon a fragment of an upper jaw, a humerus, &c. found in the department of the Puy de Dôme, in France.* A portion of the left side of the upper jaw and some separate teeth have since been found at Eppelsheim, not far from Alzei, in the grand duchy of Hessen, and are now in the museum at Darmstadt.†

Species 8. *M. latidens*. This species and the following are described by Mr Clift, in the second volume of the Transactions of the Geological Society of London, second series. They are founded upon some remains collected by Mr Crawford along the course of the river Irawadi, between Rangoon and Ava, in Asia. The teeth in the *M. latidens* consist of "seven denticules, which are elevated, rounded, and mammillated, the mammillæ being from three to four in number." See Plate XXXVIII., Trans. Geolog. Soc. Lond. Vol. 2, New Series.

* Recherches sur les Ossemens Fossiles du Departement du Puy de Dome; par l'Abbé Croizet et Jobert, ainé. Paris, 4to, avec un atlas des Planches.

† Ueber *Mastodon arvernensis* bei Eppelsheim. Von Herm. v. Meyer, M. d. A. d. N. (Bei der Akademie eingegangen den 24 Juli, 1829.) Acta Acad. Caes. Leop. Carol. Nat. Cur. Vol. XV. Part II.

Species 9. *M. elephantoides.* Distinguished by the teeth being smaller, the denticules more compressed and closer together, and the enamel thinner than in the preceding species. The denticules form a series of plates, mucronate with small points. There is no apparent commissure, nor any central depression, on the contrary, the plates rise in the middle. The teeth have ten denticules, with from five to eight mammillæ. See Geological Transactions of London, Vol. II. Second Series, Pl. XXXVIII.

Mr Meyer, in his account of the remains of the *Mastodon Arvernensis*, found at Eppelsheim, alludes to another species, the *M. turicensis*, as occurring in the brown coal of the molass formation of Switzerland; but by whom this species has been described, or what are its characters, we have been unable to discover.

In the third volume of the *Memorie della Reale Accademia delle Scienze di Torino*, professor Borson has described a tooth, found at Villanova d'Astica, in Piedmont, and which he ascribes to the *giganteum*. After a careful examination of the description and drawing, in the work referred to, and of a cast of the tooth, in the Cabinet of the Academy of Natural Sciences of this city, we feel persuaded that it does not appertain to that species, the denticules having no longitudinal commissure. It probably belongs to a new species, and we would suggest the propriety of dedicating it to professor Borson, under the name of *M. Borsoni*.

If the differences presented by the specimens we have described, be considered as sufficient to indicate a difference in species, or should future researches confirm my suspicions on this subject, four new species will be added to our Fauna; and we would dedicate the first to Baron Cuvier, (*M. Cuvieri*, Pl. XXIV.) to whom science is under such immense obligations; the second to Mr Jefferson, (*M. Jeffersoni*, Pl. XXV.) to whom the Society is indebted for the valuable specimens of this animal in their cabinet; the third to our vice-president, Mr Z. Collins, (*T. Collinsii*, Pl. XXVIII.) one of the most zealous naturalists of whom this country can boast; and the fourth to our lamented Godman (*T. Godmani*, Pl. XXIX.).

In the Finnel collection there are several jaws, differing in many respects from any we have described. There are the portions of two inferior maxillary bones belonging to the left side, flattened superiorly, and their rami exceedingly thick. They contain one tooth each, with

five denticules, the tooth situated towards the inner side of the thick ramus. There is also in the same collection, a fragment of the anterior portion of a lower jaw, with the chin rostrated somewhat, like that of the *Tetracaulodon*, but more expanded, and without alveoli. It conveyed the idea to some of the naturalists who had examined it, of its being the adolescent state of the animal described by Dr Godman, the tusks having fallen out, and their alveoli being just obliterated. We cannot, however, consider such a view as the correct one; the fact shown by our specimens, that the tusks exist in all ages of the animal, is a sufficient disproval of it.

I must not close this communication without expressing the obligations I am under to various gentlemen, for the liberality with which they have facilitated my investigations, and even placed at my disposal such specimens as I wished to collect together for the purpose of minute comparison.

To the liberality of the trustees of the Baltimore Museum, I am indebted for the use of the splendid jaw of the *M. giganteum*, belonging to that collection. J. P. Wetherill, Esq., with his characteristic liberality, has also placed at my disposal his valuable collection, deposited in the cabinet of the Academy of Natural Sciences, and the most interesting specimens belonging to which are submitted to the inspection of the members. Mr Rubens Peale, the proprietor of the remains of the animal described by Dr Godman, has also placed at my disposition those remains, and the inferior maxillary is now in the cabinet of the Society. To the trustees of the University of Pennsylvania and Dr Horner, I am indebted for the opportunity of figuring and describing a very fine fragment of a lower jaw belonging to the Wistar Museum.* The proprietors of the magnificent collection of bones, recently disinterred at Big-bone Lick, by captain Finnel, and now exhibiting at New York, liberally afforded me the greatest facilities in examining that collection, and even allowed me the loan of a highly interesting tooth belonging to it.†

* The trustees of the University of Pennsylvania subsequently allowed this jaw to be deposited, for several months, in the cabinet of the Philosophical Society.

† In this collection there are portions of fourteen inferior maxillary bones of the Mastodon, about one hundred teeth, some enormous tusks, and the most perfect cranium that has ever yet been discovered.

To William Cooper, Esq., of New York, I am indebted for the opportunity of examining the valuable collection of Mastodon bones, in the cabinet of the Lyceum of Natural History of that city; and still further, for having communicated to me some highly interesting specimens belonging to his private cabinet. This liberality will be at once appreciated by the naturalist, when it is stated, that Mr Cooper has himself been long engaged in the investigation of the history of the Mastodon;* that he has visited Big-bone Lick, for the purpose of obtaining materials; and that upwards of a year since, he communicated to the Lyceum of Natural History, New York, some observations on the dentition of that animal.†

We have reason, further to hope, through the exertion of our friend, Professor Patterson, of the University of Virginia, to be able to exhibit to the Society, the lower jaw belonging to the museum of that university, noticed by Dr Godman; and also, to present a description and drawing of that bone.

It may be allowable here to add, that great confidence may be placed in the accuracy of the drawings, which accompany this paper, and which were all taken with the aid of a camera lucida, by Mr Drayton, whose skill and accuracy in his art, the Transactions of the Society bear ample evidence.

Since I had the honour of submitting to the Society, in May last, the preceding communication, I have been favoured by the liberality of the visiters of the University of Virginia, with the loan of the inferior maxillary bone of the *Tetracaulodon*, alluded to by the late Dr Godman in his memoir, published in the third volume, page 478, of our

* The Society may expect to receive from Mr Cooper some of the results of these researches, and we have no doubt that he will supply many of the deficiencies in this memoir. He will also probably describe many bones of the Mastodon, which it would have taken us too far from our main purpose (which was to refute the belief, that Dr Godman's animal was only the young of the gigantic Mastodon) to describe.

† These have not been published, the author being unable to satisfy himself in relation to some points, which we have been so fortunate as to establish from the specimens in the cabinet of our Society.

Transactions; and I have now the gratification of exhibiting it to the Society, and of presenting to them the accompanying description and drawings.

This specimen consists of the right half of the lower jaw, two teeth, the chin, and a portion of one tusk, with the socket for the other. Its length is two feet three inches; height, from the base of the ramus to the upper edge of the alveolar process, six inches.

In general form, this bone corresponds in the most marked manner with two of the specimens belonging to the Society, and one of which is represented in Plate XXVIII. The muscular impressions and tuberosities, at the outer and posterior portion of the jaw, are, however, less strongly marked in the former as was to be expected from the difference in age of the animals. It will be also observed, that the anterior and upper edge of the coronoid process projects forward in the latter; but it must be recollected, that that part is mutilated in the jaw represented in Plate XXVIII.

The condyloid process is deficient, and the upper edge of the semilunar notch and of the coronoid process is slightly mutilated.

The posterior tooth is contained in a bony cavity, at the base of the coronoid process, but is visible at the inner aspect of the jaw. It has eight points and a large talon; it is impossible, from its position in the jaw, to obtain correctly its admeasurements.

Anterior to this tooth is another, possessing six points, slightly worn; it is four inches and nine-tenths long, and three inches six-tenths wide.

Portions of the sockets for the two teeth immediately preceding this still remain, but, unfortunately, the teeth are lost. Had they been still in the jaw, it would have enabled us to settle the point respecting the number of teeth possessed by the animal.

The anterior surface of the chin is slightly mutilated. The plate of bone, forming the base of the sockets for the tusks, is deficient. The left alveolus is empty, the right contains a fragment of a tusk. This tusk extends, anteriorly, but slightly beyond the chin; it projects somewhat inwardly, apparently driven in by violence; its anterior extremity is smooth; its base is cup-shaped.

The accompanying drawings are so accurate as to render further description unnecessary.

EXPLANATION OF THE PLATES.

All the figures are one-fourth the natural size.

Plate XX. Two views of a fragment of the lower jaw, left side, of a young Mastodon, in the cabinet of the American Philosophical Society.

Fig. 1. External view. Fig. 2. Superior view.

m. n. o. Alveoli from which the teeth have fallen out.

c. Molar, with three denticules.

d. Molar, with three denticules.

r. Mental foramen for nerve and blood-vessel.

Plate XXI. Three views of a fragment of the lower jaw, left side, of an adolescent Mastodon, in the Wistar Museum, University of Pennsylvania.

Fig. 1. Exterior view. Fig. 2. Superior view. Fig. 3. Interior view.

f. Posterior molar, with five denticules and a heel.

e. Penultimate molar, with three denticules.

Plate XXII. Fig. 1 and 2. Two views of a small fragment of the lower jaw, right side, of a Mastodon, in the cabinet of the American Philosophical Society.

Fig. 3 and 4. Two views of a molar tooth, upper jaw, of a Mastodon, in the cabinet of the American Philosophical Society. This tooth appears to differ from any hitherto described. It resembles the teeth represented in Cuvier, (Ossemens Fossiles, Plate IV. fig. 1, 3, 4, and 6, Divers Mastodontes) in the enamel being crenulated; but it differs from them in the arrangement of the enamel. It is probably an undescribed species, and we propose to dedicate it to our estimable friend, the distinguished professor of the institutes and practice of medicine in the University of Pennsylvania, and Vice-President of this Society, Dr Chapman.

Plate XXIII. Two views of a portion of the lower jaw, right side, of the *Mastodon giganteum*, in the Baltimore Museum.

f. Posterior molar.

p. q. Anterior mental foramina.

s. Foliated expansion of the chin.

x. Depression in the articulating surface of the condyloid process.

y. Foramen for the passage of the inferior maxillary nerve, and artery to the teeth.

Plate XXIV. Two views of a fragment of the lower jaw, right side, of a Mastodon, in the cabinet of the American Philosophical Society.

f. Posterior molar, with four points and a broad heel.

e. Penultimate molar, with three points.

Plate XXV. Two views of a fragment of a lower jaw, right side, of a Mastodon, in the cabinet of the American Philosophical Society.

f. Posterior molar, with four points and a broad heel.

e. Penultimate molar, with three points.

Plate XXVI. Fig. 1 and 2. Two views of the fragment of a lower jaw of a young Tetracaulodon, in Peale's Museum, New York, described by Dr Godman, in Vol. III. N. S. of the Transactions of the American Philosophical Society.

a. Anterior milk molar, with two denticules.

b. Second milk molar, with two denticules, and a small process.

c. Third milk molar, with three denticules.

The tusk belonging to this jaw is accurately represented in Plate XVIII. fig. 2, in Vol. III. N. S. of these Transactions.

Fig. 3. Tusk of an adult Tetracaulodon, in the cabinet of the Academy of Natural Sciences of Philadelphia, deposited by J. P. Wetherill, Esq.

Plate XXVII. Three views of a portion of a lower jaw, right side, of an adolescent Tetracaulodon, in the Museum of the University of Virginia, and to which allusion is made by Dr Godman, in his memoir in the preceding volume of these Transactions.

f. Posterior molar, with four denticules and a heel.

e. Penultimate molar, with three points.

Plate XXVIII. Two views of a portion of the lower jaw, right side, of an adult Tetracaulodon in the cabinet of the American Philosophical Society.

f. Posterior molar with four points.

p. *q*. Mental foramina.

r. Radiated muscular impressions.

t. *t*. Tubercles, where the muscle was inserted.

v. Inner point of second denticule.

The socket for the tusk could not be exhibited, but its situation is shown by the dotted line representing a tusk.

Plate XXIX. Two views of a fragment of a lower jaw, right side, of an adult Tetracaulodon, in the cabinet of the American Philosophical Society.

x. Excavation between the coronoid process and posterior molar.

f. Posterior molar, with four points and a heel.

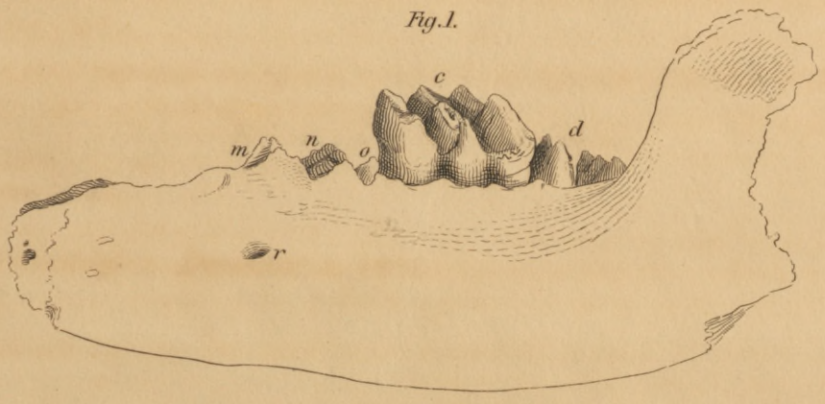
z. Socket for tusk.

Philadelphia, December 2, 1831.

Note.—The Society have had casts taken from the bones represented in the accompanying plates; and sets of them may be obtained.

Fig. 2.

Fig. 1.



Mastodon *(young)*

Cabinet Am. Philos. Soc.

Fig. 3.

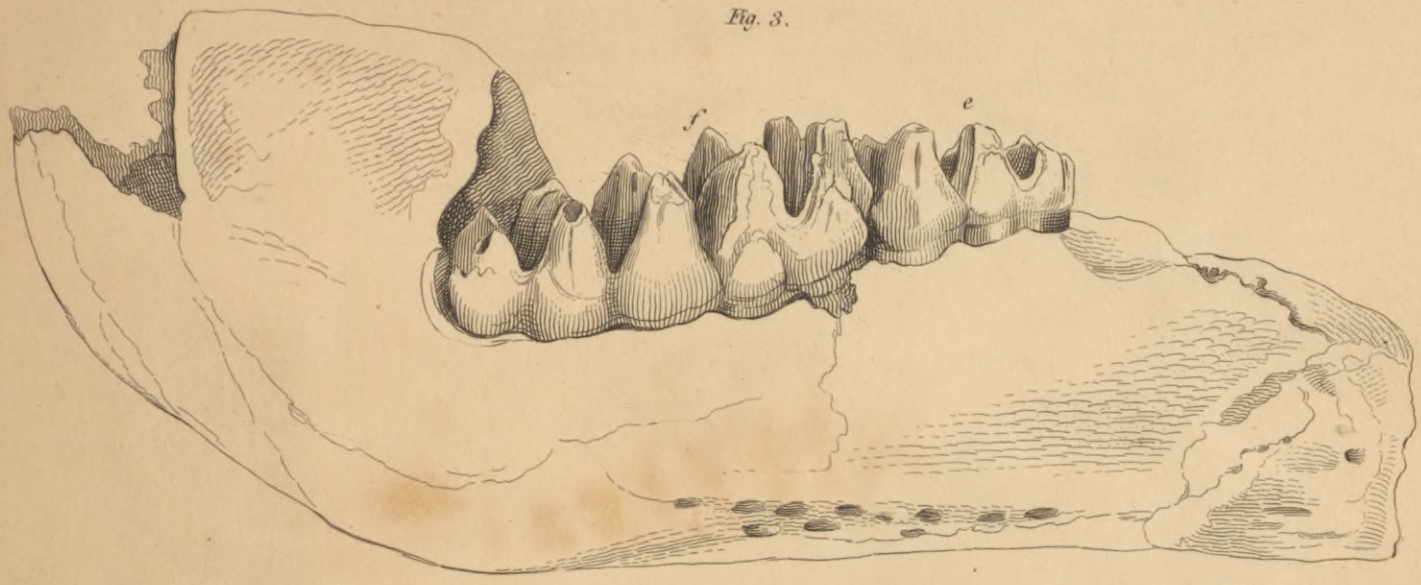


Fig. 2.

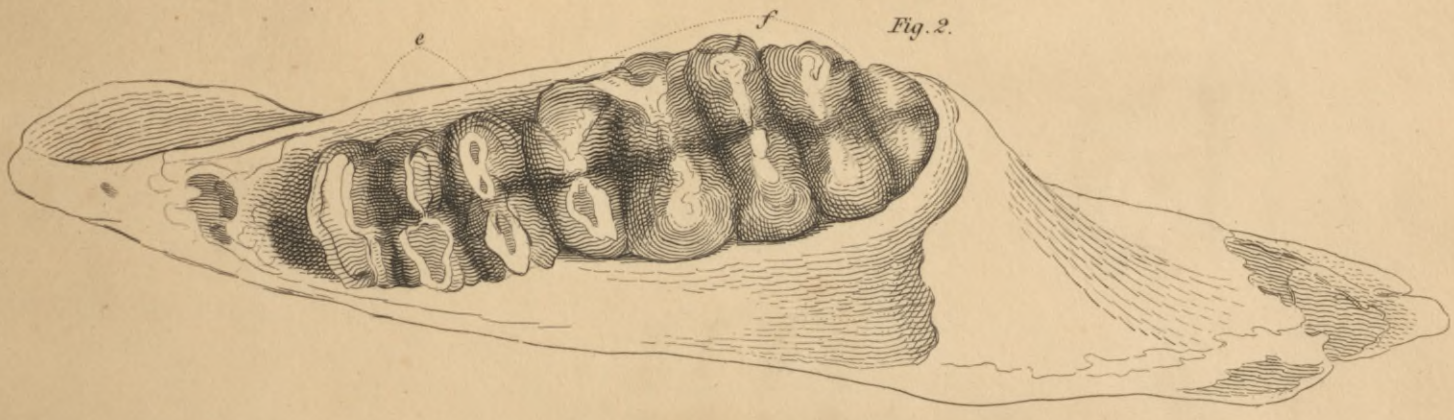
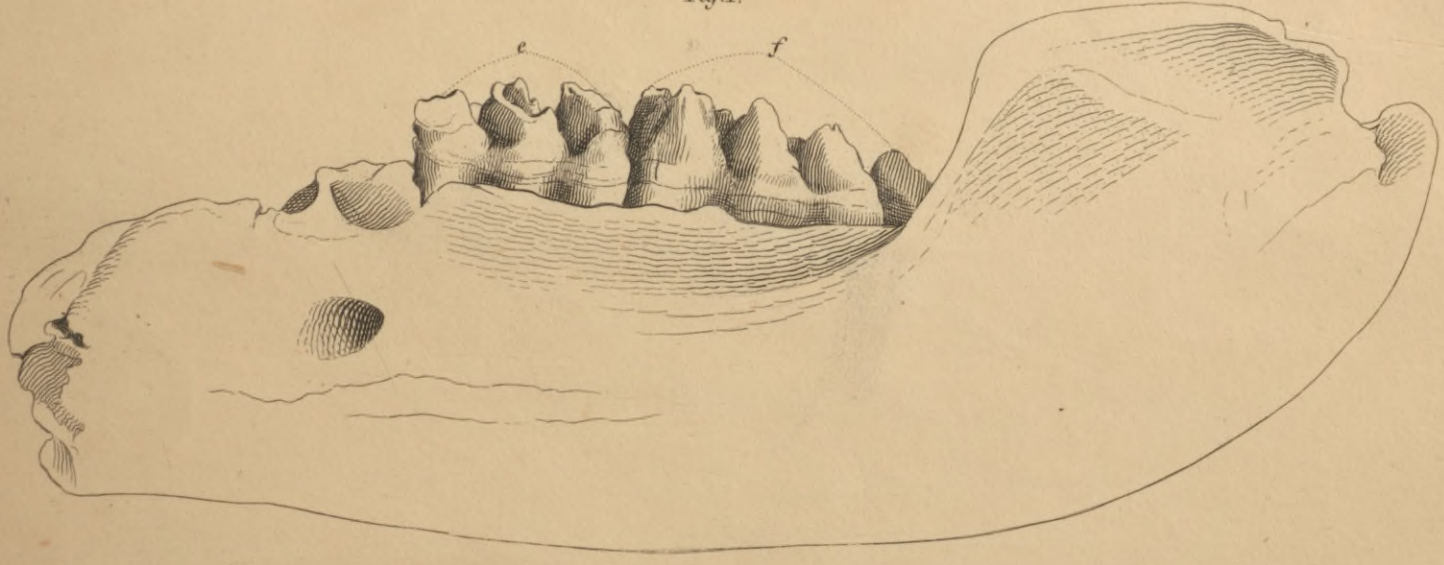


Fig. 1.



Mastodon *(adolescent)*

Wistar Museum.

Fig. 2.

Fig. 4

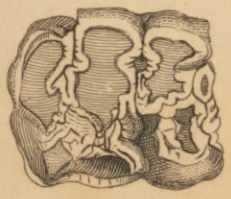
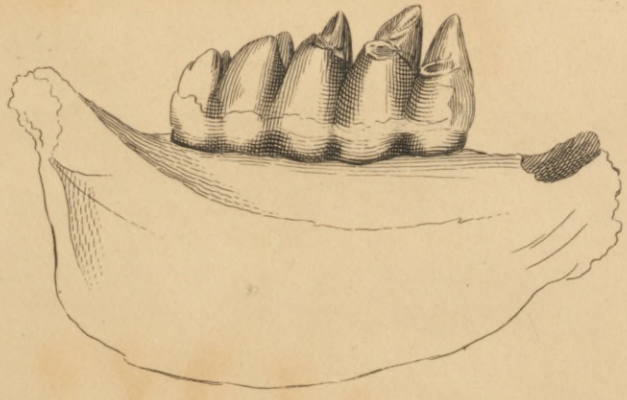


Fig. 3.

Fig. 1.



Mastodon *(adult)*

Cabinet Am. Philos. Soc.

Fig. 2.

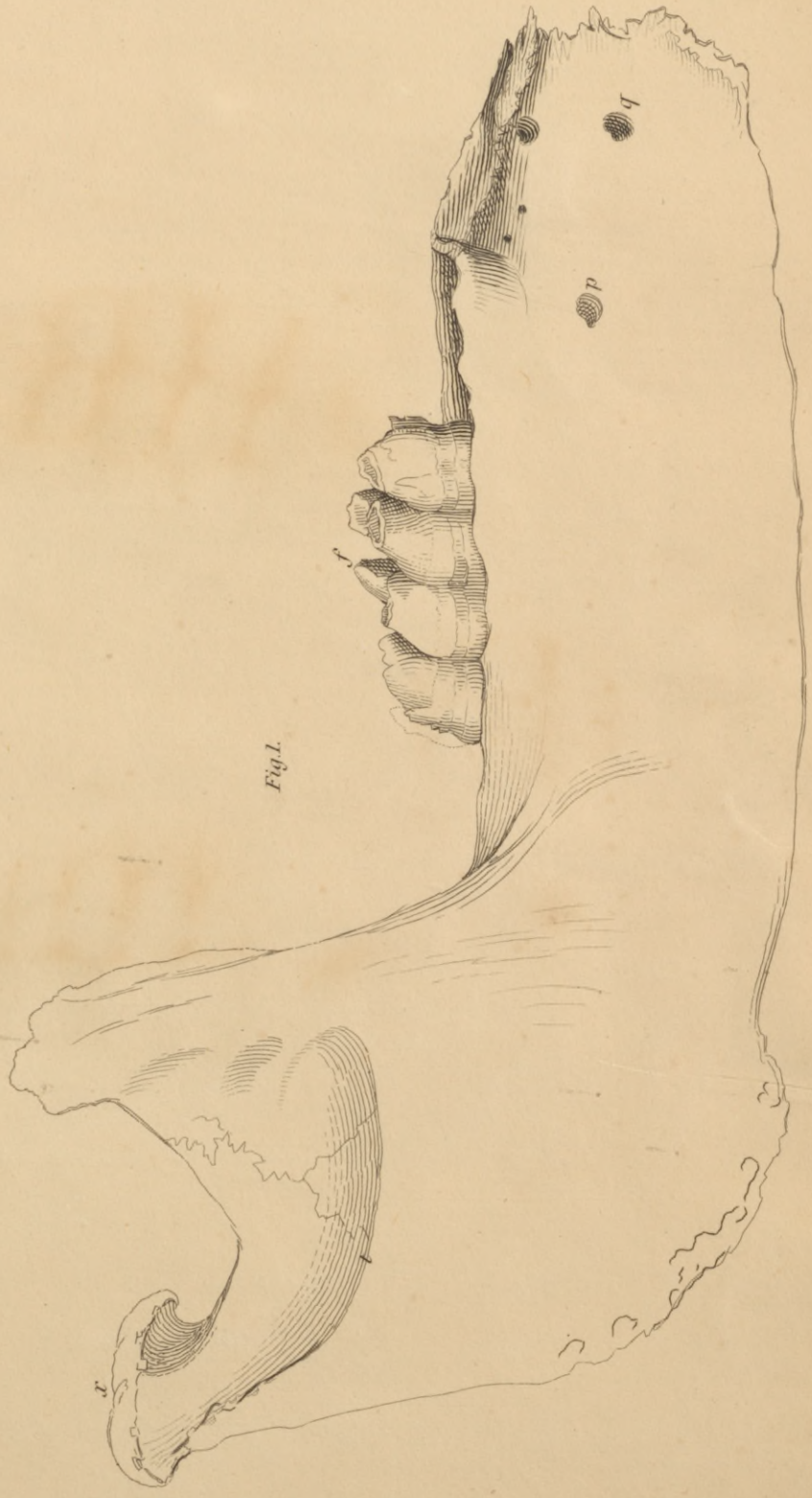


Fig. 1.

Mastodon giganteum *(adult)*

Baltimore Museum.

Fig. 2.

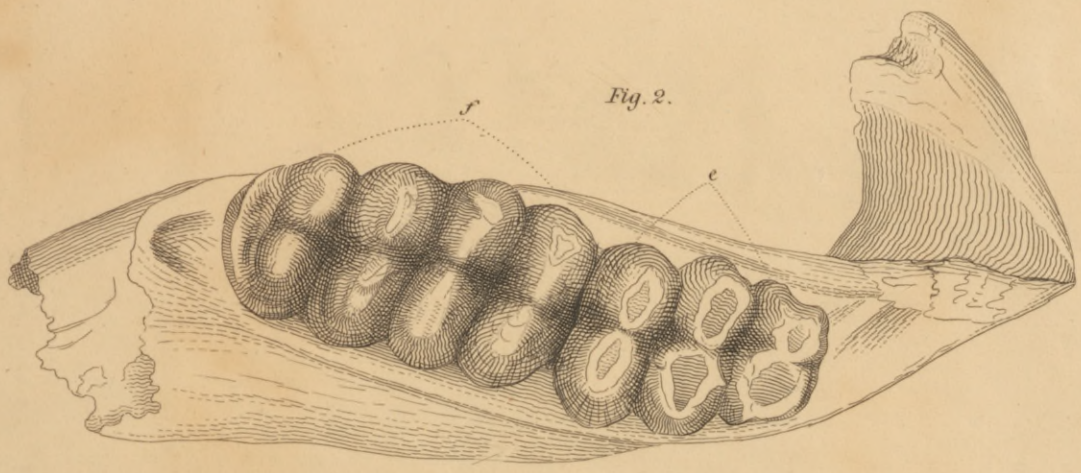
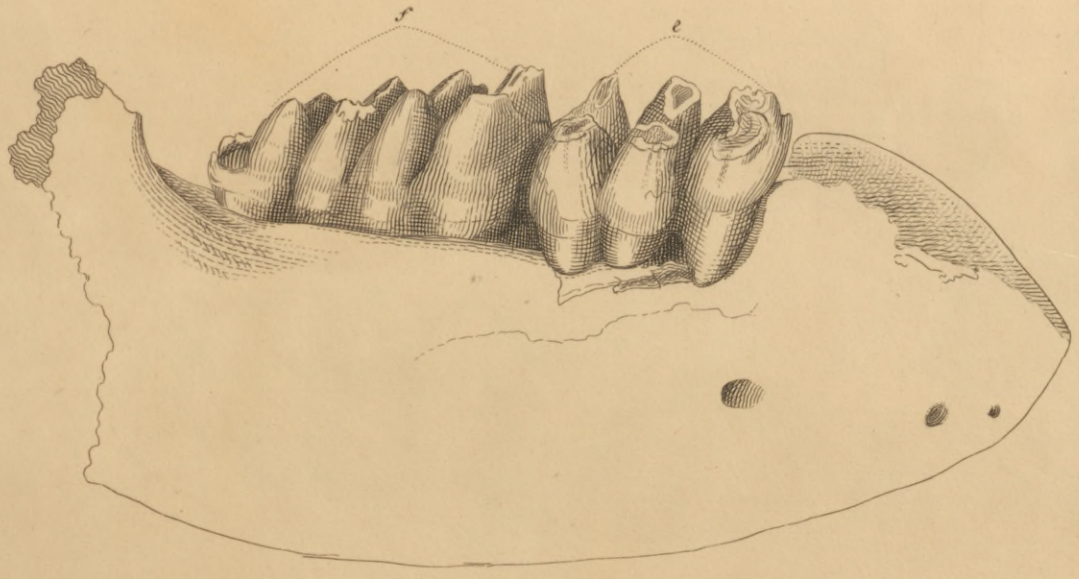


Fig. 1.



Mastodon *(Cuvieri)*

Cabinet Am. Philos. Soc.

Fig. 2.

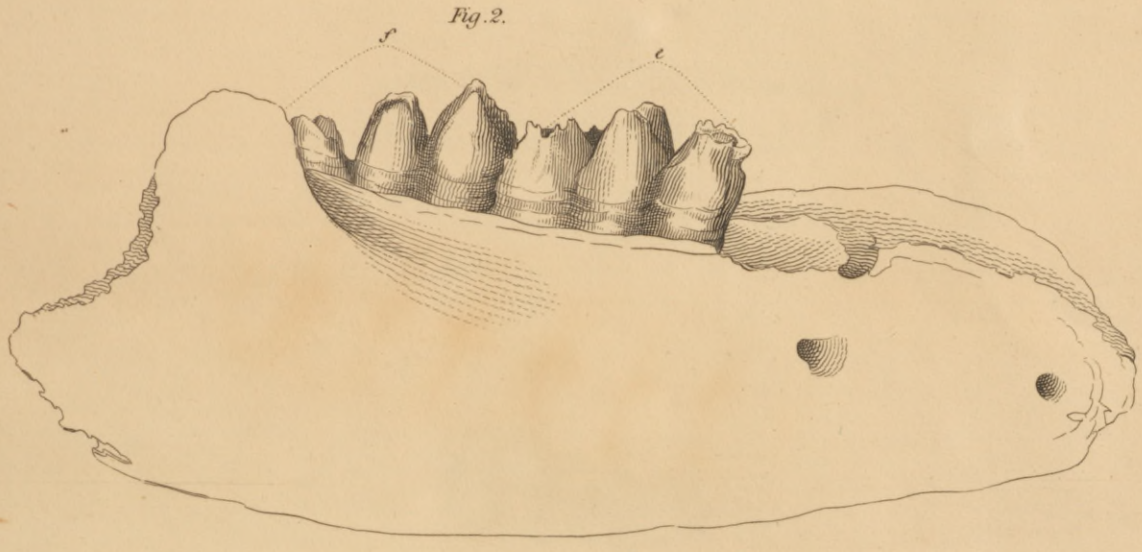


Fig. 1.

Mastodon *(Jeffersonii.)*

Cabinet Am. Philos. Soc.

Fig. 3.

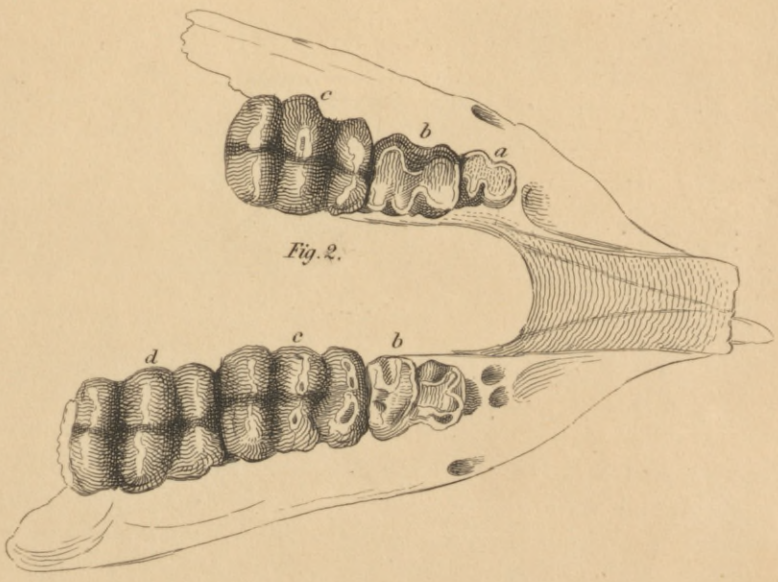
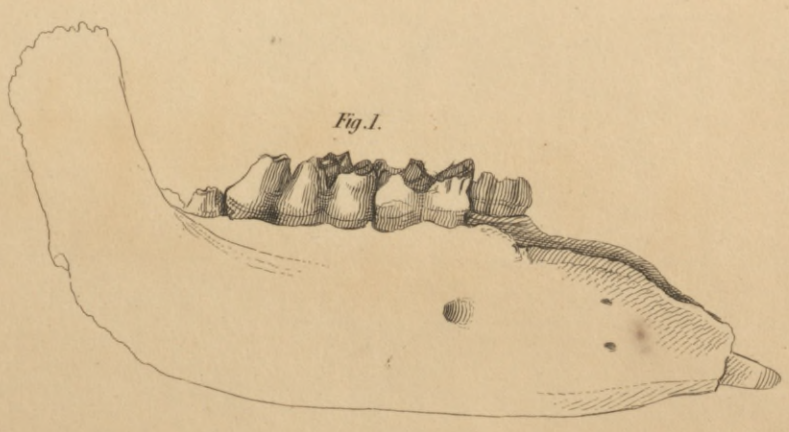


Fig. 2.

Fig. 1.



Tetracaulodon *(young.)*

Peales Museum New York.

PL. XXVII.

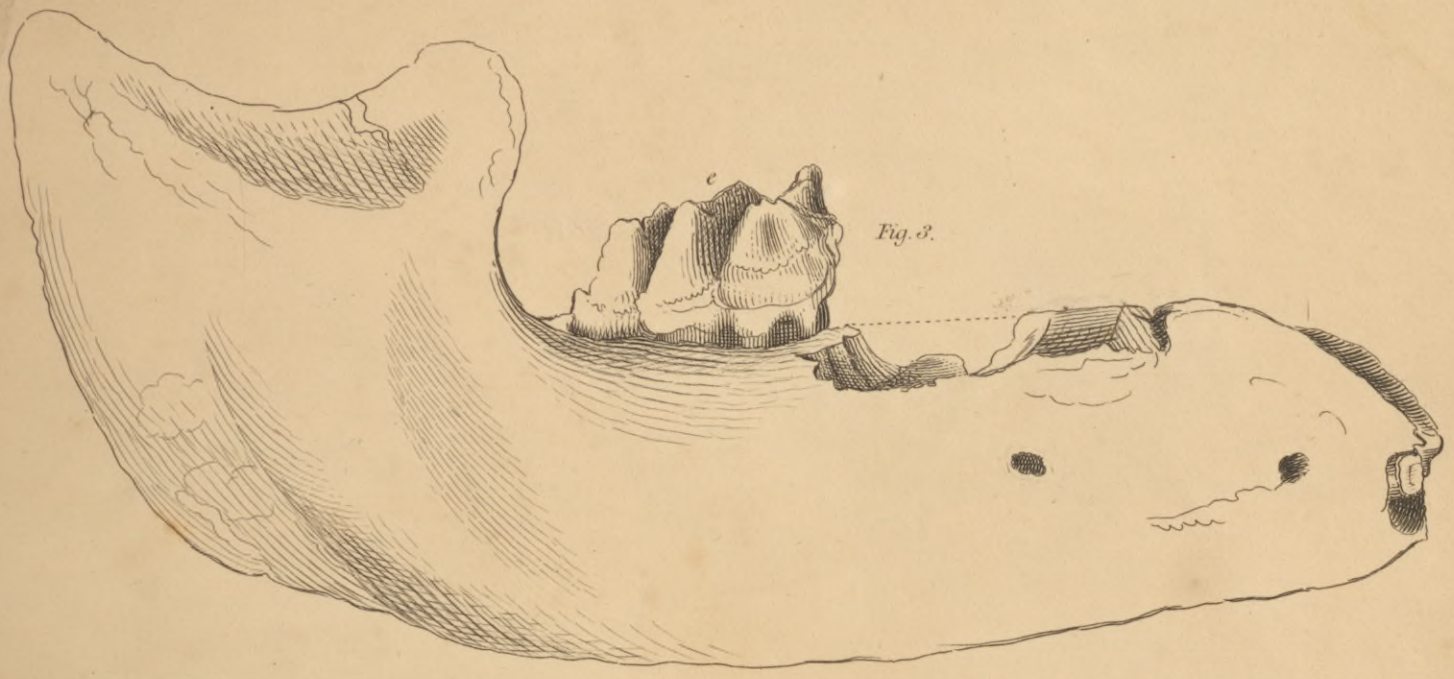


Fig. 3.

Fig. 2.

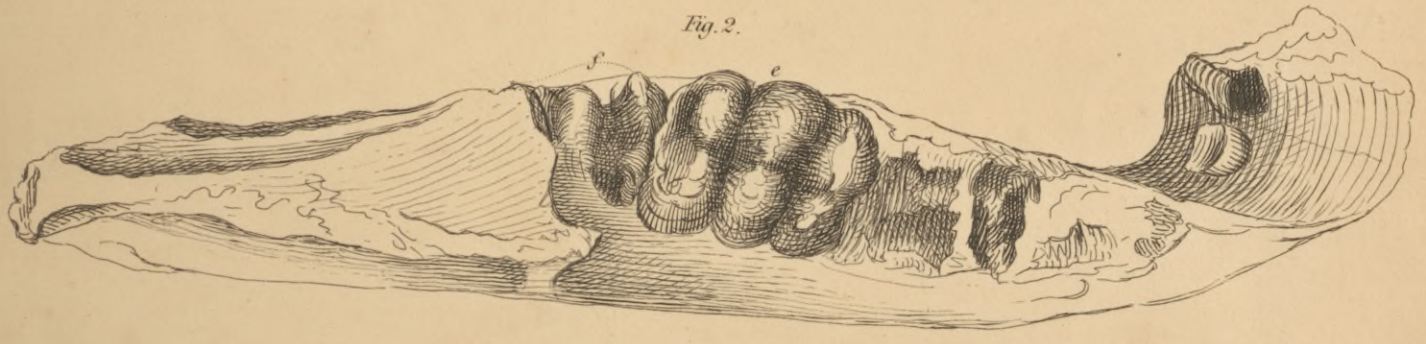
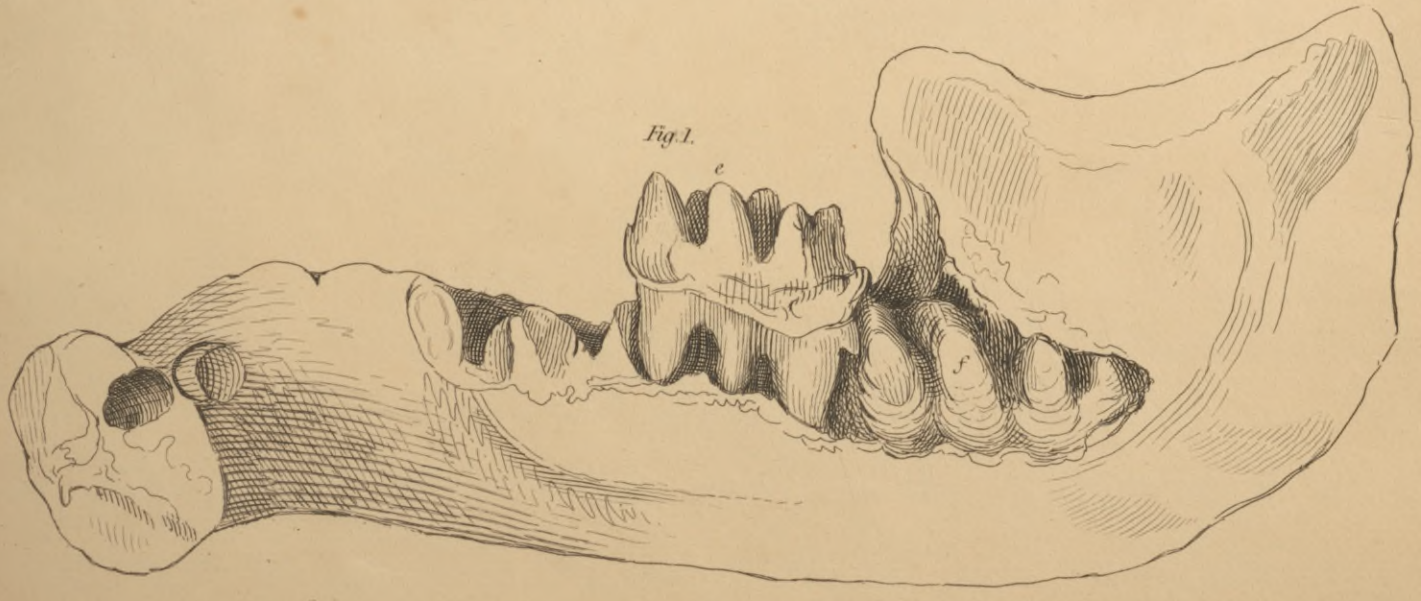


Fig. 1.



Tetracaulodon *(Adolescent)*

PL. XXVIII.

Fig. 2.

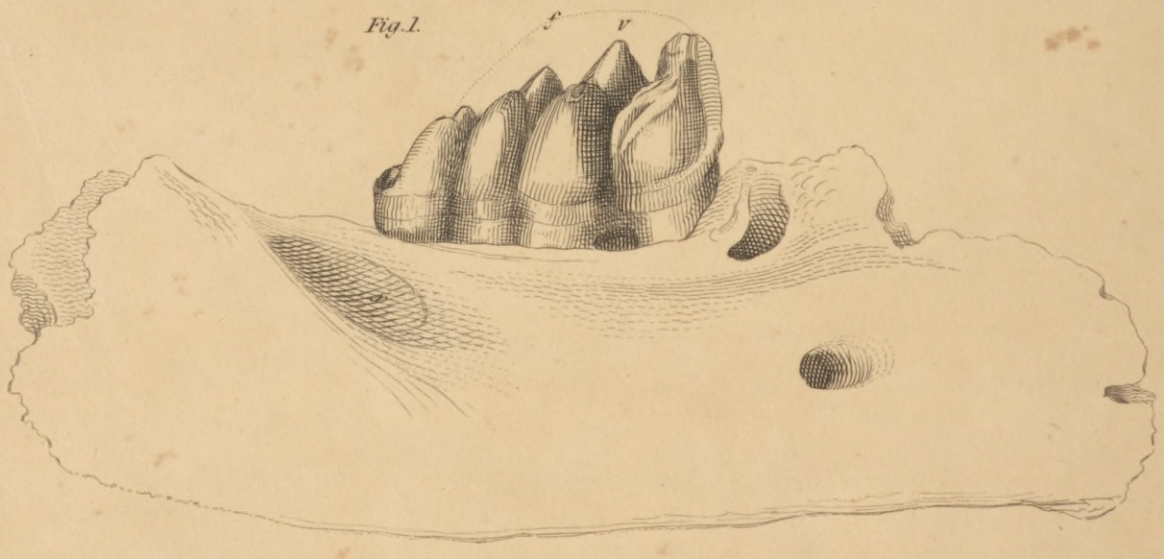
Fig. 1.

Tetracaulodon (*Collinsii*)

Cabinet Am. Philos Soc.

Fig.2.

Fig.1.



Tetracaulodon *(Godmani)*

Cabinet Am. Philos Soc.