XIII. *Observations on the different Species of Asiatic Elephants, and their Mode of Dentition.* By John Corse, *Esq.*, *Communicated by the Right Hon. Sir* Joseph Banks, *Bart. K. B. P. R. S.*

Read May 23, 1799.

HAVING already communicated some particulars respecting the manners and habits of the elephant, which have been favourably received by the Royal Society, I trust the following observations, chiefly on the dentition of this useful animal, will not be deemed unworthy of their attention.

Before I enter on this new and curious subject, I think it will be proper to premise a few general observations on the various casts* of the Asiatic elephant, and also on the tusks; as the form and size of these give a diversity of appearance, which may be considered as forming varieties of the same species of elephant.

Both males and females are divided into two casts, by the natives of Bengal, *viz.* the *koomareah*† and the *merghee*;‡ and this, without any regard to the appearance, shape, or size of

* *Zat* is the word used by the natives.

† *Koomareah* signifies of a princely race; being derived from *koomārah*, a prince, or king's son.

‡ *Merghee*, properly *mrigee*, from *mrigah*, a deer, or hunting, signifies an elephant used in hunting; or it is so called from its slender make.

the tusks in the male, as these serve merely to characterize some varieties in the species. The *koomareah* is a deep-bodied, strong, compact elephant, with a large trunk, legs short, but thick, in proportion to the size of the animal. The *merghee* cast, when full grown, is generally taller than the former, but has not so compact a form, nor is he so strong, or so capable of bearing fatigue; his legs are long, he travels fast, has a lighter body, and his trunk is both short and slender, in proportion to his height.

A large trunk is always esteemed a great beauty in an elephant; so that the *koomareah* is preferred, not only for this, but for its superior strength, by which it can undergo greater fatigue, and carry heavier loads, than the *merghee*.

As there appears, however, no predilection in any of these elephants to have connection with his own particular kind, from an indiscriminate intercourse several varieties are produced, partaking of the qualities of their respective progenitors. This mixed breed is in greater or less estimation, in proportion as it partakes of the qualities of the *koomareah*, or *merghee* cast.

A breed from a pure *koomareah* and *merghee* is termed *sunkareah*,* or *mergha-bauliah*;† but, a further mixture or crossing of the breed, renders it extremely difficult for the hunters to ascertain the variety.

Besides the *koomareah*, *merghee*, and *sunkareah* breeds, several varieties are generally to be found in the same herd; but, the

* *Sunkareah* signifies a mixed breed, from *sunkarah*, a mixture.

† *Mergha-bauliah* signifies for the most part *merghee*; that is, partaking more of this cast than of the *koomareah*.

nearer an elephant approaches to the true *koomareah* species, the more he is preferred, especially by the natives, and the higher price he will consequently bear.

Europeans are not so particular, and will sometimes prefer a *merghee* female for hunting and riding on, when she is known to have remarkably good paces, and to be of a mild and tractable disposition.

The elephants for the service of the Honourable East India Company, are generally taken in the provinces of Chittigong and Tiperah; but, from what I have heard, those to the southward of Chittigong, in the Burmah territories and kingdom of Pegu, are of a superior breed. In confirmation of this opinion, I may observe, that the elephants taken to the south of the Goomty river, which divides the province of Tiperah from east to west, are generally better than those taken to the north of that river; and, though elephants are taken at Pilibet, as far north as latitude 29°, in the Vizier of Oude's territories, yet the Vizier, and also the officers of his court, give those taken in Chittigong and Tiperah a decided preference, they being much larger and stronger than the Pilibet elephant.

Till the year 1790, Tiperah was a part of the Chittigong province; and, so sensible was the Bengal government of the superiority of the southern elephants, for carrying burdens, enduring fatigue, and being less liable to casualties, that, in the late contracts for supplying the army with those useful animals, the contractor was bound not to send any elephant to the military stations, taken north of the Chittigong province.

Hence we may conclude the torrid zone to be the natural clime, and the most favourable for producing the largest, the

best, and the hardiest elephant; and that, when this animal migrates beyond the tropics, the species degenerates. On the coast of Malabar, elephants are taken as far north as the territories of the Coorgah Rajah; but these are much inferior to the Ceylon elephant, and, from this circumstance, the report of the superiority of the Ceylon elephant to all others has probably originated. Most of the accounts we have had respecting the Asiatic elephant, have been given by gentlemen who resided many years ago on the coast of Malabar or Coromandel; where, at that time, they had but few opportunities of seeing the Chittigong or Pegu elephant.

After premising these general observations, I may here observe, that elephants have two tusks, in the upper jaw only; but those in some of the females are so small as not to appear beyond the lip, whilst in others they are almost as large as in one variety of the male, named *mooknah.**

Elephants have no incisores or cutting teeth; and the grinders are so much alike in males and females, that one description will serve for both.

The largest tusks, from which the best ivory is supplied, are taken from that species of male named *dauntelah,*† in consequence of his large tusks, and whose countenance, from this circumstance, is the most opposite, in appearance, to that of the *mooknah;* which, as I have just observed, is hardly to be distinguished, by his head, from a female elephant. Though there is a material difference in the appearance of a *mooknah* and a *dauntelah,* as well as in the value of the tusks, yet, if

* Probably from *mookh,* the mouth or face.

† *Dauntelah* signifies toothy; having large or fine teeth.

they are of the same cast, (*zat,*) size, and disposition, and perfect, that is, free from any defect or blemish, there is scarcely any difference in their price.

An elephant is said to be perfect, when his ears are large and rounded, not ragged or indented at the margin; his eyes of a dark hazle colour, free from specks; the roof of his mouth, and his tongue, without dark or black spots of any considerable size; his trunk large, and his tail long, with a tuft of hair reaching nearly to the ground. There must be five nails on each of his fore feet, and four on each of the hind ones, making eighteen in all; his head well set on, and carried rather high. The arch or curve of his back rising gradually from the shoulder to the middle, and thence descending to the insertion of the tail; and all his joints firm and strong. There are several other points, of less consequence, which are taken notice of by the natives as well as Europeans.

The *dauntelah* is generally more daring, and less manageable, than the *mooknah;* for this reason, until the temper and disposition of the two species are ascertained, Europeans will prefer the *mooknah;* but the natives, who are fond of show, generally take their chance, and prefer the *dauntelah;* which, when known to be of a mild and gentle disposition, will always be preferred, both by Europeans and natives.

The varieties between the *mooknah* and *dauntelah* are considerable, and for these there are appropriate names, according as the form of the tusks varies from the projecting horizontal, but rather elevated, curve of the *pullung daunt** of the perfect

* *Pullung* signifies a bed or cot, and *daunt,* teeth; and, from the tusks projecting so regularly, and being a little curved and elevated at the extremities, the natives suppose a man might lie on them at his ease, as on a bed.

dauntelah, to the nearly straight tusks of the *mooknah*, which point directly downwards.

When a *dauntelah* has never had but one tusk, and this of the *pullung* sort, he is said to be a *goneish* or *ganesa*,* and will sell to the Hindoo princes for a very high price, to be kept in state, and worshipped as a divinity. I have seen elephants apparently of this kind; but, when accurately examined, the tusk wanting appeared to me to have been lost by accident, so that I cannot say I ever saw a male which had originally only one tusk.

A second variety of the *dauntelah* is, when the large tusks point downwards, projecting only a little way beyond the trunk; he is then said to have *soor* or *choor daunt*.†

A third variety is the *puttel-dauntee*, whose tusks are straight, like those of the *mooknah*, only much longer, and thicker.

A fourth variety is the *ankoos-dauntee*,‡ where one tusk grows nearly horizontal, like the *pullung-daunt*, and the other like the *puttel-daunt*.

Besides these, the elephant-keepers notice other varieties, which are less distinct.

All these tusks, in the male, are fixed very deep in the upper jaw; and the root or upper part, which is hollow and filled with a core, goes as high as the insertion of the trunk, round the margin of the nasal opening to the throat; which opening is just below the protuberance of the forehead.

* *Ganesa* is the name of the Hindoo god of wisdom, who is represented with a head like an elephant's, with only one tooth. (See Asiatic Researches, Vol. I. Art. On the Gods of Greece, Italy, and India.)

† *Soor* or *choor-daunt* signifies hogs' teeth; from the tusks having some distant resemblance to those in the lower jaw of the hog.

‡ *Ankoos* signifies a crook, and is particularly applied to the weapon the drivers use to govern the elephant, to which these irregular tusks bear some resemblance.

Through this opening the elephant breathes, and by its means he sucks up water into his trunk; between it and the roots of the tusks there is only a thin bony plate.

The first or milk tusks of an elephant never grow to any size,-(Tab. V. Fig. 1.) but are shed between the first and second year, when not two inches in length. (Fig. 2.) These, as well as the first grinders, are named by the natives *dood-kau-daunt*, which literally signifies milk teeth. The tusks which are shed have a considerable part of the root or fang absorbed before this happens; as may be seen, by comparing one that has been shed, with another lodged in the socket of a young elephant, before it had cut the gum. (Fig. 1 and 2.)

The time at which the tusks cut the gum, varies considerably. I have known a young one get his tusks when about five months old; whereas, the tusks of another did not cut the gum till he was seven months old. Those tusks which are deciduous, are perfect, and without any hollow in the root, in a fœtus which is come to its full time; at this period, the socket of the permanent tusk begins to be formed, on the inner side of the deciduous tusk. (Fig. 1.)

A young elephant shed one of his milk tusks on the 6th of November, 1790, when near thirteen months old, and the other on the 27th of December, when above fourteen months old: they were merely two black-coloured stumps, when shed; but, two months afterwards the permanent ones cut the gum, and, on the 19th of April, 1791, they were an inch long, but black and ragged at the ends. When they became longer, and projected beyond the lip, they soon were worn smooth, by the motion and friction of the trunk.

Another young elephant did not shed his milk tusks till he

was sixteen months old; which proves that there is considerable variety in the time at which this happens.

The permanent tusks of the female are very small, in comparison with those of the male, and do not take their rise so deep in the jaw; but they use them as weapons of offence, in the same manner as the male named *mooknah*, that is, by putting their head above another elephant, and pressing their tusks down into the animal.

These tusks are never shed, and sometimes grow to a very large size in the male. The largest I have known in Bengal, did not exceed 72 pounds, avoirdupois: at Tiperah, they seldom exceed 50 pounds; but both these weights are very inferior to that of the tusks brought from other places to the India House, where I have seen some near 150 pounds each. From what part of Asia they came, I could not learn, but suspect they were imported from Pegu to Calcutta, and thence to London.

The African elephant is said to be smaller than the Asiatic; yet I am credibly informed, by the ivory-dealers in London, that the largest tusks generally come from Africa, and are of a better texture, and less liable to turn yellow, than the Indian ivory, after being manufactured. This probably is owing to the tusks having lain longer in Africa, before they were imported, than those brought from Asia. In the latter country, most of the tusks exported are taken from elephants immediately after their death; whereas, the Africans find many teeth in the desert places which have been frequented by this animal. The intense heat of a vertical sun will undoubtedly render the ivory firmer and harder, if the tusks happen to lie on the scorching sand, or in any other dry situation.

The increase of the tusk arises from circular layers of ivory,

applied internally, from the core on which they are formed, similar to what happens in the growth of the horns of some animals. When the tusks of the living elephant are sawn through, and the remaining portion exposed some months to the air, this structure is clearly shown.

If the period in which one of these circular layers is completed could be ascertained, this might lead us to fix, with tolerable precision, the age of an elephant, by counting the circles in each tusk.

Cutting off a portion of the tusks of a living elephant, is a common practice; it is done with a view to make the tusks grow thicker, when they are too long and slender, and also sometimes for the sake of uniformity, when they grow in a wrong direction.

In describing the structure of the grinders, it must be observed, that a grinder is composed of several distinct laminæ or teeth, each covered with its proper enamel; and that these teeth are merely joined to each other by an intermediate softer substance, acting like a cement. I accordingly use the words teeth, strata, layers, and laminæ, as synonimous, when speaking of the structure of the grinders.

The structure of the grinders, even from the first glance, must appear very curious, being composed of a number of perpendicular laminæ, which may be considered as so many teeth; each covered with a strong enamel, and joined to one another by the common osseous matter. This, being much softer than the enamel, wears away faster by the mastication of the food; and, in a few months after some of these teeth cut the gum, the enamel remains considerably higher, so that the surface of each grinder soon acquires a ribbed appearance, as if originally

formed with ridges: this however is not the case, as may be seen by examining a grinder just cutting the gum, (Tab. VII. X. and XII.) but both its sides have a fluted form, owing to the junction of the different strata. (Tab. VI. VIII. IX. X. and XI.)

These strata, when first formed, have no firm attachment to each other, but always appear separate and distinct, when contained in their bony sockets within the jaw, after their membranes and soft parts are destroyed. Before any part of a grinder cuts the gum, there is a bony crust formed above the enamel, which gives a smoothness to the grinding surface. (Tab. VII. and XII.)

But, after the grinders cut the gum, and the convex surface has been worn down a little by the trituration of the food, each lamina appears to have been formed on several points,* which are covered by a strong enamel. There are from four to eight of these points, joined together by the common bony matter, which fills up the space between the enamelled portions.

When the grinder, however, is farther advanced in the mouth, its foremost laminæ are gradually worn down by the mastication of the food; and these enamelled points or denticuli disappear, one after another, till the enamel, at last, runs quite

* This appearance has been observed by PATRICK BLAIR, M. D. F. R. S. who, in his *Osteographia Elephantina*, published in 1713, calls it digitations. The above work, which was put into my hands by my friend Dr. ALEXANDER MONRO, junior, since this Paper was written, contains some useful information. The ingenious author had, in several particulars, a tolerable idea of the formation and structure of the grinders; yet, far from suspecting a regular succession of them, he attempts to prove such succession to be impossible. He is equally erroneous in many other respects.

across the tooth, surrounding the central part on which it was formed, and taking the irregular indented plaited shape of the lamellæ. (Tab. VI. Fig. 2.) This bony centre, on which the enamel is formed, is harder than the matter which joins the teeth together, does not wear so fast, and consequently remains higher. Tab. VII. IX. and X. show these processes very distinctly.

The number of teeth of which a grinder is composed, varies from four to twenty-three, according as the elephant advances in years; so that a grinder or case of teeth, in full grown elephants, is more than sufficient to fill one side of the mouth; (Tab. X. and XI.) in proportion, however, as the foremost layers are worn away, the succeeding ones come forward, to supply their places.

The denticuli of which each layer or tooth is composed, are much larger, and fewer in number, in old than in young elephants; (Tab. VI. Fig. 1 and 2. also Tab. VII. VIII. IX. X. and XI.) in consequence of this, the same number of laminæ generally fills the jaw of a young or of an old elephant; and, from three till fifty years, there are from ten to twelve teeth or laminæ in use, in each side of either jaw, for the mastication of the food. (Tab. VII. X. and XI.)

When several of the anterior teeth of which a grinder is composed have been completely formed, and each tooth covered with its proper enamel, they become firmly united (beginning at the fore part) by the intervention of the common bony matter, which gradually fills up the interstices between them.

When the bodies of several of the anterior laminæ have been connected together, the inferior edge of each becomes united, in

the same manner, to the one next it, till the whole are thus gradually joined, and form a grinder or case of teeth.

As soon as the anterior part of the grinder is thus firmly united, the fangs or roots are next added: these, at first, appear in the form of a thin curtain or lamella of bone, extending backwards, along some of the anterior laminæ, at their lower edges. (Tab. VI. VII. VIII. and XI.) A fang common to the three anterior teeth, first begins to be formed (Tab. VII. and XI.) by the ossification shooting across from each side, in a circular direction, at the anterior portion of the first, and the posterior part of the third lamina. These join and become longer, assuming a conical shape: the hollow is gradually filled up by successive layers of the substance of the tooth, as the fang lengthens, till at last it becomes solid. (Tab. XII.) This, however, does not happen, till the three layers to which the fang is attached are nearly worn away. When its ossification is almost completed, another process begins to take place, which is, the absorption of the fang from its external surface. (Tab. VII. and XII.)

By the time that the anterior layers of the grinders are completely worn down, both the fangs and the alveolar processes begin to be absorbed. (Tab. VII. X. and XII.) Their places are gradually supplied by the next laminæ of the grinder, and their fangs, coming forward in a constant succession. When the last tooth of a grinder has advanced sufficiently in the jaw, to supply the place of its predecessor, the anterior tooth of the next succeeding grinder comes forward, to supply its place.

From the peculiar manner in which the grinders are supplied from behind, but never from beneath, a preceding grinder, (as is

the case in the human species, and in most other animals,) it must appear evident, that an elephant can never shed his teeth; but, from this regular succession, he may, at one period, have only a single grinder in each side of either jaw; (Tab. X. and XI.) at another, there may be one and part of a succeeding grinder; (Tab. VII.) even a still greater variety in the appearance of the grinders will take place, according as the anterior one is more or less worn away, and the waste supplied by its successor.

In this manner, the growth of new teeth, to compose a succeeding grinder, and the ossification and formation of the fangs, are constantly going on, in regular succession; so that, after the second year, the mouth of the elephant is constantly filled with as many laminæ of the grinders on each side as it can hold. This process is beautifully and clearly exemplified in Tab. VI. VII. X. XI. and XII.

While the grinders thus advance forward in the mouth, in regular succession, the alveolus of each advances along with them; and, as the anterior fangs are absorbed, the same process is going on in the alveoli.

This is evident from Tab. VII. where the partition between the alveolus of the anterior and succeeding grinder, appears equally distinct as the one behind the last grinder, but will afterwards disappear, as soon as the roots of its preceding grinder are absorbed. In like manner, the partition between this and the incipient alveolus of the next succeeding grinder will come forward in the jaw, in proportion as the grinder itself comes into use.

In the partition between each alveolus there is a communication, which, in young elephants, is larger than in those far-

ther advanced in years; (Tab. VI. and VII.) and it is probable, that this canal or sinus between the different alveoli, admits the passage of an elongation of the membrane, from the anterior to the posterior grinder.

The time requisite for the complete formation of one of these cases of teeth, constituting a grinder, varies from two to six or eight years; and, when an elephant has attained its full size, a considerable number of the anterior laminæ must be worn away, and the fangs absorbed, before the posterior ones can be sufficiently advanced to cut the gum. (Tab. VII. X. and XII.)

From the curved line in which the grinders of the upper jaw advance, it must be evident, that some of the anterior laminæ must be obliterated, before the last can come into use: this may be made to appear more clearly, by drawing lines parallel to the surface of the grinder (Tab. VII.) of the upper jaw; and is plainly shewn in Tab. X. where the three anterior laminæ are worn down to the fangs; yet there are ten of the posterior ones that cannot (as is evident from their convex surface) come into action, till the same number of their predecessors are worn away in regular succession. Before this could have happened, several years must have elapsed, during which, the posterior laminæ would have been completed; for, in the present state, the three aftermost layers are not even now attached to each other, or to the rest which are anterior; the membrane between, and connecting these laminæ, not being ossified at the time of the animal's death. In this grinder, there are twenty-three laminæ, which is the greatest number I have seen.

In the lower jaw, the same circumstances take place; the teeth of the grinders rise by the addition of their fangs, force their

way through the alveoli, and cut the gum, as they advance forward in the jaw. The grinding surface has rather a concave form, to adapt itself to that of the grinder in the upper jaw. The number of layers does not always correspond with those of the grinder in the upper jaw; but, like them, consists of from four to about twenty-three teeth or laminæ. (Tab. VI. and XI.)

In both jaws, the alveoli are firmly attached, anteriorly and laterally, to the bony plates of which the jaw is composed; but, at the posterior part, these alveoli are separate from the jaw, and have only a membranous attachment. The alveoli terminate in an apex or point, (Tab. VII. IX. X. and XI.) and become thicker and stronger, (Tab. VI. IX. and XI.) as the elephant advances in years.

In the lower jaw, the portion of the alveolus which is attached to the inner plate, is thick and spongy; and, through the under part of this spongy substance, there is a pretty large foramen, for transmitting the blood-vessels and nerves which supply the teeth and lower jaw. The alveolus of the grinder advances in the same manner in the lower as in the upper jaw; and, as the fangs are absorbed, it is absorbed also.

In proportion as the fangs or roots are added to the grinder, it rises through the alveolus, and cuts the gum; at the same time, the bottom of the alveolus, in which the grinder is formed, becomes more spongy, and shoots up between the fangs, firmly embracing them, and thus preventing the grinder from being shaken or disturbed by the trituration of the food. (Tab. VI. VII. and XI.)

As the grinders of the upper and under jaws wear away, the roots of them are lengthened, and become more solid, by the

internal addition of new matter, till the cavity is entirely filled up. (Tab. XII.)

This lengthening of the roots is necessary, to give that portion of the grinder in use sufficient firmness in the jaw, as well as to keep the surface at a proper level above the gum. That the alveolus shoots up between the roots, instead of the roots striking deeper into the sockets, as they lengthen, is obvious from Tab. VI. VII. and XI.; where, a line drawn along the points of the roots, will follow the direction of those parts of the grinder which have not any roots.

When the anterior teeth are worn down to the roots, these, with the sockets, begin to be absorbed, to make room for their successors, which are coming forwards.

The shape of a grinder of the lower jaw is very different from that of one of the upper: in the latter, the grinder advances from behind straight forwards, and the back part has a very convex shape; whereas, the lower grinder advances rather in a bent or curved direction, adapting itself to the shape of the jaw. (Tab. XI.)

The surface of this grinder is somewhat of a concave figure, adapted to the form of the corresponding grinder in the upper jaw. The upper and lower grinders, (Tab. VIII.) and the section of a grinder, (Tab. XII.) shew, in the clearest manner, the progress of ossification in the roots, and the manner in which the different teeth are joined.

In a young elephant, soon after birth, the milk grinders, with their roots, are completely formed; and, even the succeeding or second set of grinders have the roots partly added to some of the anterior teeth, which are soon to cut the gum; but the posterior layers are then without roots. (Tab. VI. Fig. 1.)

Farther back in the jaw, the third grinder, which is composed of about thirteen teeth, has no appearance of roots; nor have the different teeth any connection with each other, except by the common membranes. When these are destroyed, the teeth or rudiments of a succeeding grinder can be easily separated from each other. At this period, the enamel of the third grinder has not been formed, but only the substance of the teeth, which it afterwards covers, adapting itself to the irregularities of the surface. (Tab. VI. Fig. 2.) When a grinder is considerably worn down, these irregularities of the central lamellæ are evident, from the enamel of each tooth being indented and puckered, as it were, all round. (Tab. VII. IX. and X.)

Having thus attempted to explain, in a clear and satisfactory manner, the progressive growth and regular succession of the grinders, I will next point out the periods in which I conceive these respective changes to take place. Here, however, I am in considerable doubt and uncertainty; but will fairly state the circumstances which first drew my attention particularly to this subject, as well as the grounds upon which my conclusions have been made.

In November, 1795, I sent a couple of elephants' heads, through my friend Mr. FAIRLIE, of Calcutta, to D. SCOTT, Esq. of Upper Harley-street, to be placed by him in some public museum.* In my letter, dated the 17th of that month, I mentioned the most remarkable peculiarities of these heads, and particularly the grinders; but at the same time made this remark, "there is only one tooth in each side of either jaw, till "an elephant attains its full growth." Upon examining after-

* These were afterwards sent to the Right Hon. Sir JOSEPH BANKS, Bart. and by him to the British Museum, where they now are.

wards the heads of some younger elephants, I perceived I had made a mistake, and that there was not always only one grinder in each side of the jaw. This want of uniformity in the appearance of the grinders of young elephants, of the same size, and nearly of the same age, showed me my mistake, and puzzled me a good deal; nor did I perceive any means whereby I could satisfactorily and rationally account for it, till I had carefully compared a number of heads, of different ages, with each other.

To effect this, I immediately began to collect the heads of such elephants as died at Tiperah, with the size and qualities of which I was perfectly acquainted: in the course of the year 1796, I procured above thirty heads, and, beginning with the youngest of these, I arranged them as nearly as possible according to their respective ages.

As it may be satisfactory to many members of the Royal Society, to learn the means by which I was enabled to collect the heads of so many elephants, whose heights and qualities I had accurately ascertained, I shall just observe, that between the beginning of November, 1795, and the 1st of April, 1796, there were four herds of elephants taken in Tiperah.

Three of these herds were taken under my immediate inspection: the fourth, consisting of about fifty elephants, was taken by the Rajah's hunters, but was afterwards so terribly neglected, and almost starved to death, that I was requested by the Rajah to take them under my management; to this I consented, and his servants were ordered to obey implicitly my directions. In consequence, however, of the former ill treatment the elephants had received, above half of them died in the course of a few months; these, with some other casualties, enabled me to form the numerous collection above mentioned.

The elephants from which the heads were taken being well known to me, I was enabled to form a tolerable estimate of the ages of several of them; those young ones whose ages are particularly specified, were brought forth after their dams were secured.

After arranging and comparing the heads with each other, I endeavoured to ascertain the different periods necessary for the formation of the grinders, in young and old elephants, and thence to draw some conclusions, respecting the progress of dentition in this useful animal.

The first set of grinders, or milk teeth, begin to cut the gum eight or ten days after birth; and the grinders of the upper jaw appear before those of the lower one. Though this happens at first, yet, in a few months, the grinders in the lower jaw come forward faster than those of the upper, as I have observed in the heads of several elephants. (Tab. VII. and IX.)

In about six weeks, the first set of grinders can be easily felt, consisting of four teeth, *viz.* one on each side of either jaw; and, as young elephants begin to eat grass, or some soft succulent food, before they are three months old, we may conclude, that the first set of grinders* have then completely cut the gum, and that dentition is not attended with any symptoms of pain, or irritation, in the system.

The milk grinders are not shed, as the tusks are, but are gradually worn away, during the time the second set are coming forward; and, as soon as the body of the grinder is nearly worn away, the fangs begin to be absorbed. (Tab. VI. Fig. 3.)

I have not been able to ascertain the exact time when the

* By a set, I mean four, one grinder in each side of either jaw.

second set of grinders make their appearance, as I could never get an elephant to open his mouth in such a manner as to permit me to examine his teeth accurately; but, when the elephant is about two years old, the second set are completely in use.

At this period, the third set begin to cut the gum. From the end of the second to the beginning of the sixth year, the third set come gradually forward, as the jaw lengthens, not only to fill up this additional space, but also to supply the place of the second set, which are, during the same period, gradually worn away, and their fangs absorbed.

From the beginning of the sixth to the end of the ninth year, the fourth set of grinders come forward, to supply the gradual waste of the third set.

After this period, several other sets are produced. In what time these succeeding grinders come forward, in proportion to their predecessors, I have not been able to ascertain; but, from the data already given, I conclude, that every succeeding grinder takes at least a year more than its predecessor to be completed; consequently, that the fifth, sixth, seventh, and eighth set of grinders (a further succession I have not been able to trace) will take from five to eight years, (and probably much longer,) each set, before the posterior lamina has cut the gum.

The milk grinders consist each of four teeth or laminæ; the second set of grinders of eight or nine laminæ; the third set of twelve or thirteen; (Tab. VI. Fig. 1.) the fourth set of fifteen; and so on, to the seventh or eighth set, when each grinder consists of twenty-two or twenty-three, (Tab. X. and XI.) which is the greatest number I have observed.

All these circumstances considered, I may venture to affirm, that the formation of the teeth and mode of dentition, in the

elephant, has but little analogy with those of any other quadruped; nature having, by a peculiar and wonderful contrivance, and in the most convenient manner, supplied this animal with a regular succession of teeth, until he attains a very advanced period of life. An advantage which, as far as we know, no other quadruped possesses.

The mode in which the elephant's grinders are originally formed, my short stay at Tiperah did not allow me sufficient opportunities to investigate; but, since my return to England, I have had frequent conversations with my friend Mr. HOME upon that subject, who, from an examination of the teeth brought home by me, and some preparations in the late Mr. HUNTER'S collection, has been able to prosecute the subject with considerable success. His observations will be laid before the Royal Society, immediately after the present Paper, as a continuation of the same subject.

EXPLANATION OF THE PLATES.

Tab. V.

Fig. 1. Is intended to represent the deciduous or milk tusks of a young elephant, and the process of absorption taking place in the fang of a tusk, before it can be shed: also the incipient alveolus of the permanent tusk on the left side. To show these distinctly, part of the anterior plate of the bone is removed. On the right side, the bones of the face and deciduous tusk remain in their natural situation.

AAAA. Represents the fore part of the skull of a young female elephant, (nearly of its natural size,) which died soon after birth.

BB. The nasal opening, round which the trunk is inserted.

C. Shows the deciduous tusk *in situ*.

D. The middle of the tusk, where the process of absorption has commenced.

E. The crooked fang, which must be absorbed, before the body of the tusk can be shed.

F. The small rounded cavity on the interior side of the deciduous tusk, which is the incipient socket for the permanent one.

GG. Are two cells, one on each side of the root of the deciduous tusk, which communicate.

H. The right deciduous tusk, in its natural state.

Fig. 2. Represents the deciduous tusk of an elephant, when it has been shed.

A. The ragged point of the tusk.

B. The body of the tusk next the fang, as seen in its natural situation at D, Fig. 1. the fang having been absorbed.

Tab. VI.

Fig. 1. Exhibits the left side of the lower jaw, of nearly its natural size, with the plate of the interior side removed, to show the first, second, and third succeeding grinders *in situ.*

A. The condyloid process.

B. The coronoid process.

C. The symphysis of the lower jaw.

D. The anterior or milk grinder, the body of which consists of four laminæ; of these, the three foremost had cut the gum.

EE. The two fangs, nearly completed, but still hollow at the points.

F. The canal for lodging the blood-vessels.

G. The canal for the passage of the larger blood-vessels that supplied the jaw and teeth, extending from below the root of the second grinder to where the interior plate of the jaw has been removed.

HH. The second grinder, no part of which had cut the gum; it consists of nine teeth.

I. The fang common to the three anterior ones, partly formed.

K. The bony lamella or incipient roots, partly added to the next three teeth.

LLL. The three posterior teeth or laminæ, which were not united to the anterior ones when the animal died.

MM. The third succeeding grinder, consisting of thirteen laminæ or rudiments of future teeth: it remains within the bony socket, and, except the two anterior laminæ, all the rest have no adhesion.

N. The alveolar process behind the grinder MM: it does

not adhere to the jaw, but appears in the form of a thin bony lamella.

O. The partition between the second and aftermost grinder.

P. The opening or communication, in that partition, between the second and third grinder.

Fig. 2. Represents a tooth of the third grinder, consisting of eight points at the top, partly covered with enamel. The lower part has a puckered or plaited form, probably intended to give firmer adhesion to the enamel which is afterwards to cover it.

Fig. 3. Shows a milk grinder worn down to the fangs; part of which, and of the body of the grinder, are absorbed. Where the absorption has taken place, the grinders and roots have a rough ulcerated appearance.

Tab. VII.

Represents the third grinder of the left side of the upper jaw, worn away almost to the fangs, even at the posterior part: the anterior part completely worn away, and great part of the roots and their alveolar processes absorbed. In this grinder, the indented puckered form of the enamel is shown, and also its ribbed surface.

Of the three teeth of the succeeding grinder, which had cut the gum, the aftermost tooth shows eight denticuli or points, each surrounded with its proper enamel: the next shows five denticuli; but the anterior tooth of this grinder has the centre completely surrounded with enamel. The appearance of this grinder is very happily represented; the posterior teeth nearest the gum being covered with a whitish bony crust above the enamel; but, nearer the roots, they are not yet joined together.

The six anterior laminæ have the roots partly added; but the eight posterior ones are entirely without any appearance of roots.

Immediately above this grinder, the incipient alveolus of a fifth succeeding grinder begins to be formed. The canal between this and the anterior alveolus, appears at the upper part of the bony partition which divides the alveoli.

The external plate of the upper jaw bone and part of the alveolus are removed, to show these grinders *in situ*.

The apex or upper part of the bony case, in which the grinders are lodged, appears distinct, and unconnected with the bones of the jaw.

AAAA. The division of the bones of the upper jaw and the alveoli, to show the grinders *in situ*.

BBB. The alveoli or sockets of the two grinders; *b*, the incipient alveolus of a succeeding grinder.

C. The communication between this and its anterior alveolus.

DD. The partitions between the alveoli.

EEEEE. The alveolar processes, which proceed from the alveolus, between the roots of the grinders.

F. The smooth bony surface of the three anterior layers of the grinder, without enamel, which has been completely worn away.

GGG. The enamel of the different teeth, surrounding their bony centres.

HHH. The centres of the teeth of which a grinder is composed.

III. The bony matter which joins the teeth to each other.

KK. The denticuli or points of the tooth, before they are much worn down; each point surrounded with its proper enamel.

A line drawn between L and L, will show that some of the anterior teeth must be worn down to the fangs, before several of the posterior ones can cut the gum.

Tab. VIII.

Fig. 1. Shows the inferior parts of the teeth of the second grinder in the lower jaw, represented in Tab. VI. and the manner in which each tooth or lamina is joined to the one next it. The three anterior teeth are completely joined to each other, and are partly seen within their common fang; but the junction of the three posterior ones is not complete, except at the centre. The roots of these, at the lower part, are beginning to be formed; but, anteriorly, are farther advanced, and join the fang common to the three foremost teeth.

AA. The nine teeth of which the grinder is composed.

B. The three anterior teeth, completely joined to each other.

C. Three of the posterior teeth, where the union is completed only in the middle.

DDD. The space between the lamellæ of the separate teeth, where they are approaching to join each other, and cover the enamel, as shewn in Tab. XII.

EEEEE. The centres of the different teeth, which will afterwards be filled up, as the ossification of the fangs advances.

Fig. 2. Is intended to show the same process in the aftermost grinder of the upper jaw, represented in Tab. VII. The six anterior teeth are completely joined, and the roots partly added. The four next are connected at the external and internal sides only. The four aftermost layers remain quite separate and distinct from each other, where the roots are to be added. The incipient roots appear in the shape of a thin bony lamella.

A. The incipient fang of three anterior teeth.

BBB. The incipient roots of the posterior laminæ, extending along the grinder.

CC. The opposite lamellæ of two contiguous teeth, beginning to join.

DDDDD. The centres of the posterior teeth, where the lamellæ have not yet begun to join with each other.

EEEE. The divisions between the teeth, which have at first a membrane interposed, but are afterwards filled up by the common bony matter, when the enamel is completed.

Tab. IX.

Shows part of the left side of the lower jaw of the elephant whose grinders are represented in Tab. VII. The grinders are represented nearly of their natural size. Here the fourth succeeding grinder is farther advanced than its corresponding one in the upper jaw. Six layers of this had cut the gum; whereas, only three in the former appeared through the gum. Part of the external plate of the interior side of the jaw, to which the alveolus or bony case does not adhere, is removed, to show the incipient alveolus of the fifth grinder, which, when opened, contained one denticulus.

Between this and the anterior alveolus, is distinctly seen the canal of communication, which serves to connect the membranes of each grinder. Beneath the alveolus there is a very large canal, for the transmission of the blood-vessels and nerves; which, as it advances forwards, passes through the alveolus, where this is attached to the jaw bone.

The termination of the alveolus in an apex, is very distinctly marked in this, as well as in Tab. VII.

The fluted appearance of the grinder, and also the plaited form of the enamel of each tooth, are distinctly seen.

AAAA. The divided surface of the portion of bone that was removed, to show the apex of the bony case of the grinders, and incipient alveolus of the fifth grinder.

BB. The alveolus, as far as it is unconnected with the jaw.

C. A small portion of the jaw bone, adhering inseparably to the alveolus.

D. The incipient alveolus.

E. The canal of communication between the alveoli.

FF. The uneven surface of the grinder.

GG. The fluted appearance of the grinder, by the junction of the different teeth of which it is composed.

HH. The canal for the transmission of the blood-vessels and nerves which supply the teeth and lower jaw.

Tab. X.

Represents the seventh or eighth succeeding grinder, in the left side of the upper jaw of an elephant, in the completest state possible, though on a small scale, about half the natural size. The two anterior teeth are quite worn down to the fangs; and the three farthest back are not so far advanced as to adhere to the teeth immediately before them. The denticuli of which the teeth appear to be formed, are larger than in young elephants.

This grinder consists of twenty-three teeth. The anterior one is worn away; twelve are in use; and ten remain to come through the gum. The dark margin, round the grinding surface, shows where the gum was attached: it is also seen in Tab. VII.

By drawing lines parallel to the grinding surface of the teeth in the upper jaw, it will appear, that several of the anterior

layers must be completely worn away, before the posterior teeth can cut the gum.

Above the last layer of this grinder, there appears an incipient alveolus for another succeeding grinder; though the elephant to which this head belonged appeared aged.

AAA. The line of separation between the alveolus and bones of the upper jaw.

BBB. The surface of the tooth to which the gum is attached.

C. An incipient alveolus for a succeeding grinder.

Tab. XI.

Represents, *in situ*, a very complete grinder, about half the natural size, in the right side of the lower jaw of a full grown elephant. It consists of twenty-two layers or teeth, and the three farthest back are not yet attached to their anterior laminæ. Here the gradual progress of ossification in the fangs is distinctly seen; and, from the apex of the alveolus, to near the centre of the grinder, it is not attached to the jaw. A small portion of the jaw bone, covering the large foramen through which the apex ascends, has not been removed. In this, as well as in the last plate, the grinder completely fills the jaw, and only half of the grinder is employed for masticating the food. The anterior teeth appear evidently to rise by the addition of the fangs; which here, as well as in the grinders of the upper jaw, lengthen as the teeth wear away, till, the roots being completed, they begin to be absorbed. The anterior fangs are very distinct, but still hollow at the points. The bony lamella appears extending backwards, as the foundation of the succeeding roots.

In this and the preceding plate, the enamel and centre of each tooth appear higher than the divisions between the teeth.

A. The condyle.

B. The coronoid process.

C. The apex of the alveolus.

DDD. The section of the portion of the jaw bone and alveolus, which were removed to show the grinder *in situ*.

EE. The division between the alveolus and jaw bone, where there is only a membranous attachment.

FF. The spongy substance of the alveolus, which becomes thicker as it advances forward, and from which the alveolar processes shoot up between the roots of the teeth, in proportion as they are lengthened.

GG. The grinding surface employed in masticating the food.

HHH. Three anterior fangs, considerably lengthened, but still hollow.

II. The bony lamella, or incipient roots of the posterior teeth.

Tab. XII.

Represents a grinder of the upper jaw, divided longitudinally, and its surface polished, to show the structure. The anterior fang is solid, almost to the extremity, and part is already absorbed, where it appears rough and ulcerated. The hollow that formerly existed between the three next teeth and their roots is filled up; and the ossification of the fangs to the bodies of the teeth, is seen proceeding regularly backwards.

The roots of the four teeth farthest back are still very hollow. The centres of the four anterior ones are completely filled up; and the progress of ossification is less complete as you go back.

The dark parts represent the divisions between each tooth: the white is the enamel; and the penniform or striated parts represent the centre of each tooth. The grinding surface appears serrated, the enamel being highest: the centre or body of the teeth next; and the bony divisions between each appear rather the lowest. The seven teeth farthest back have their enamel complete, and a bony crust laid over them; but, as they cut the gum, this is soon worn away, and the teeth themselves become gradually worn down by the mastication of the food.

By tracing the centre of a tooth from its apex to the roots, the mode in which the teeth are joined to each other will appear evident. The centres of the teeth are not entirely filled up, till the fangs become nearly solid.

From A to A are fifteen teeth, of which this grinder is made up.

B. The anterior fang, become quite solid, except at the extremity.

C. The hollow that formerly existed between the three anterior teeth and their fangs, completely ossified.

DD. The ossification extending from the fangs to the bodies of the teeth, which, in time, would have filled up the intermediate space between them.

EE. The fangs of the grinder, considerably lengthened, and nearly solid, except at the posterior part.

FFF. The bony crust covering the teeth, before they cut the gum.

GG. The serrated surface of the grinder, produced by the mastication of the food; the enamel and centre of the teeth being higher than the intermediate bony substance.

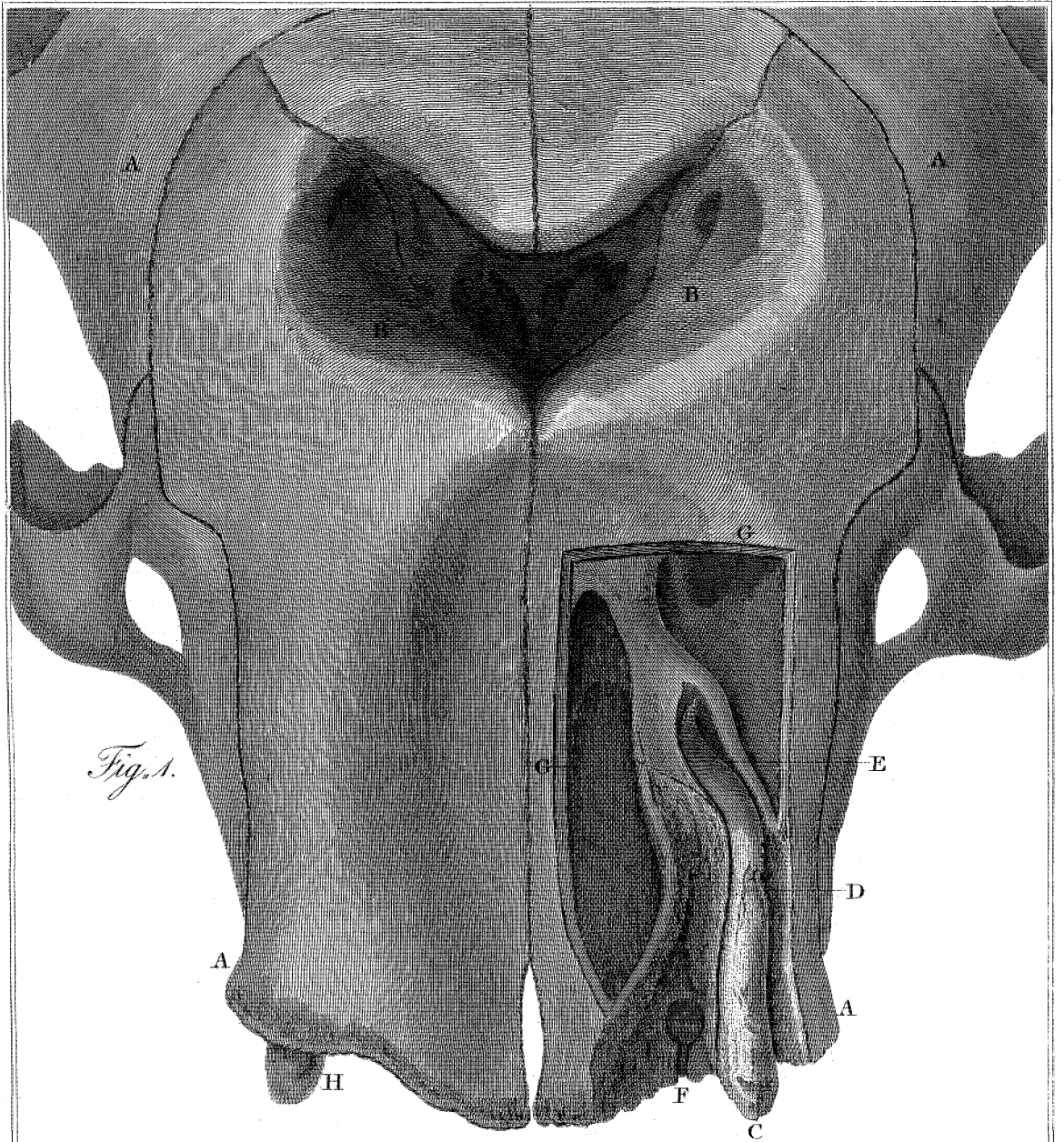
HHH. The bony matter, filling up the interstices between,

and uniting the teeth. From these three, which are marked, the rest can be readily known.

III. The respective teeth or laminæ, each covered with its proper enamel. Only three of them are marked, but, from these, the rest must appear obvious.

KKK. The enamel, extending from the apex and grinding surface to the roots of the teeth, where it joins the enamel of the next tooth.

LL. Points out the manner in which the bony centres of contiguous teeth join, and cover the enamel; this junction takes place before the enamel is completed. Vide Tab. VIII. Fig. 1 and 2.



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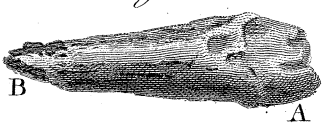

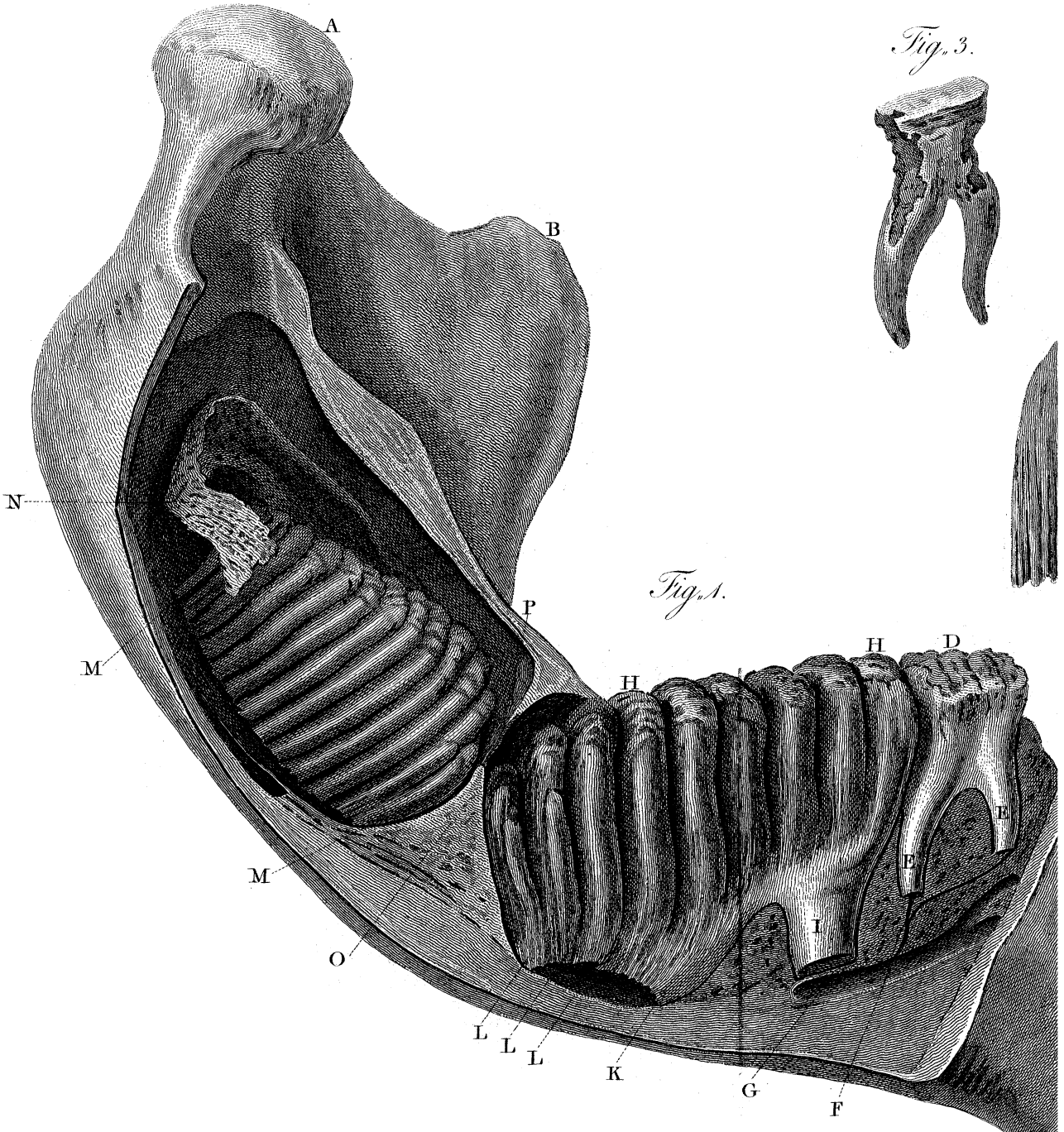
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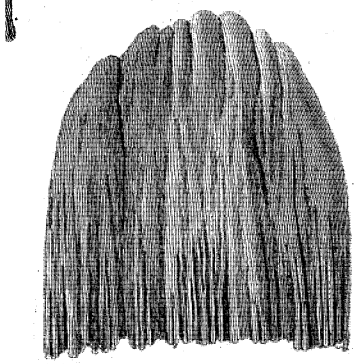

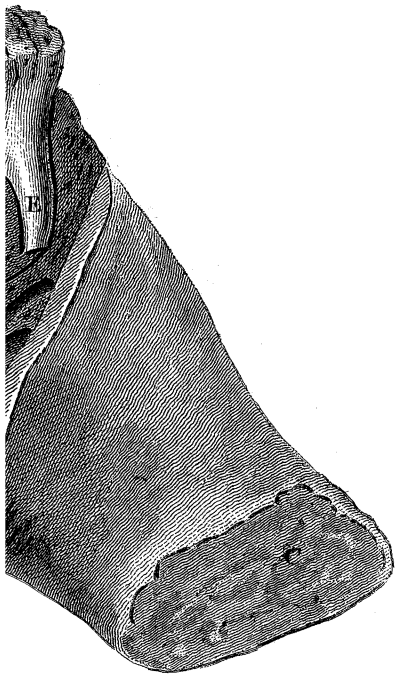

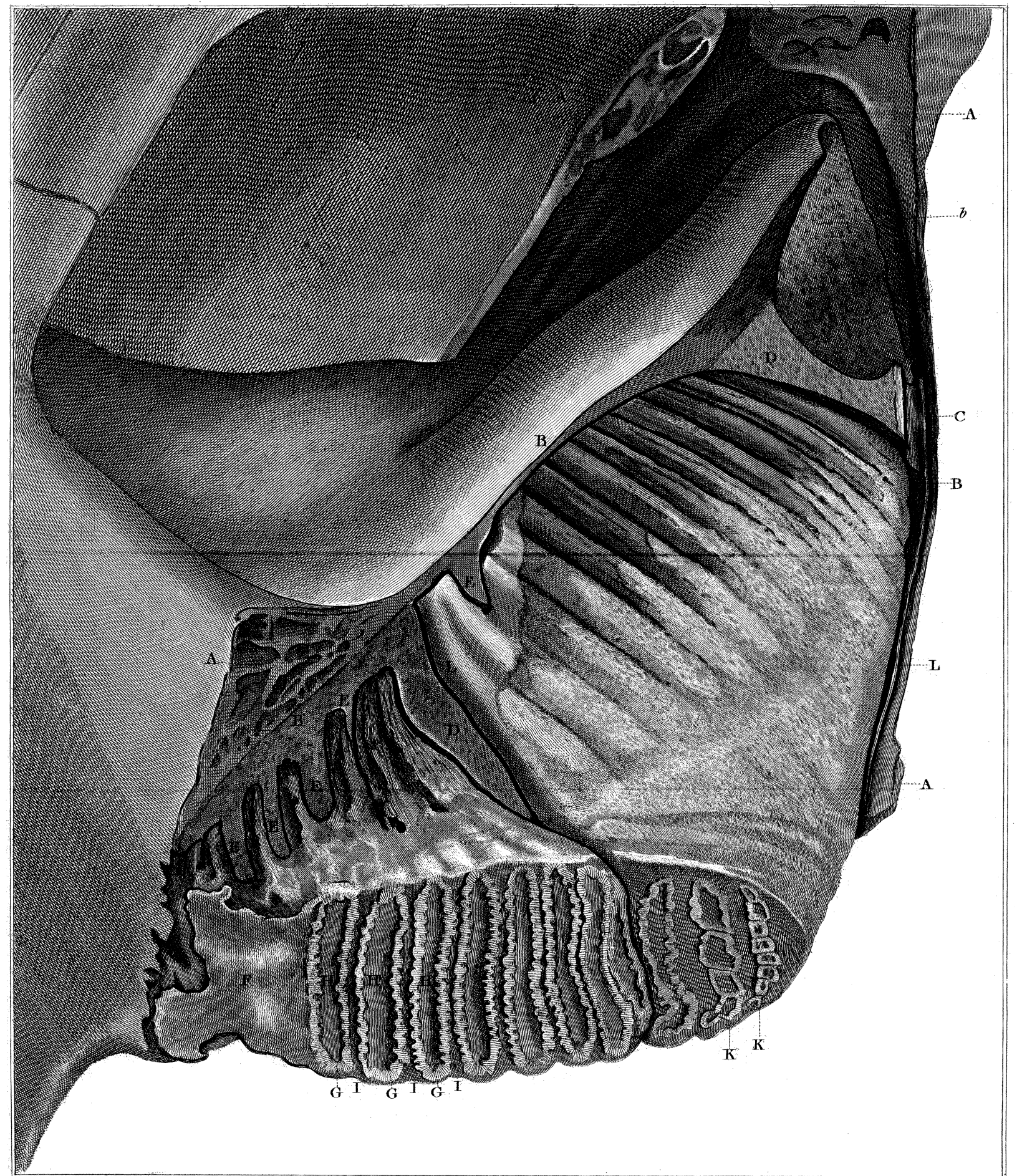

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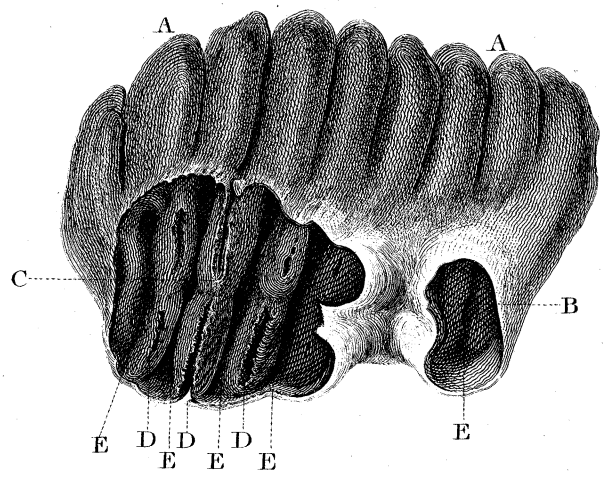

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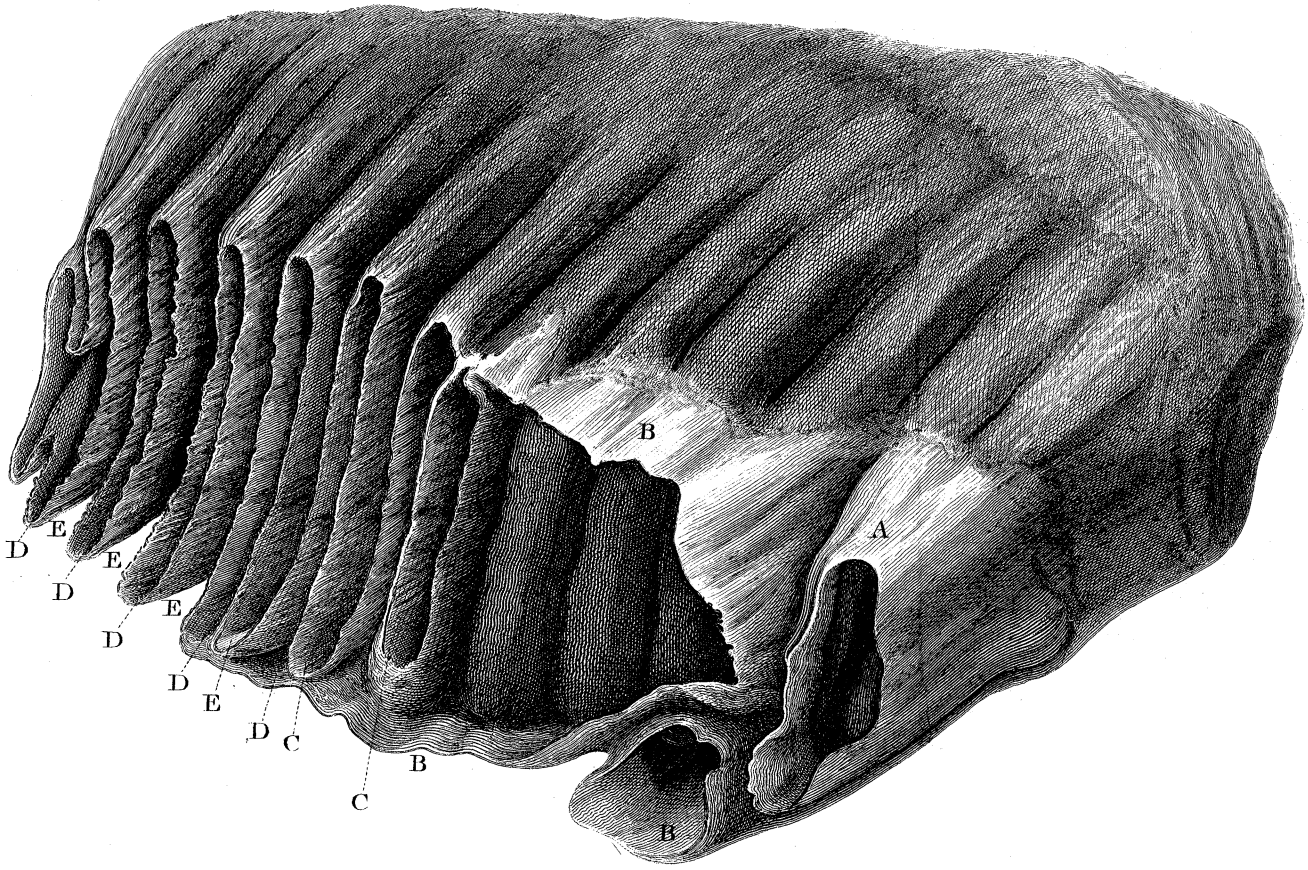

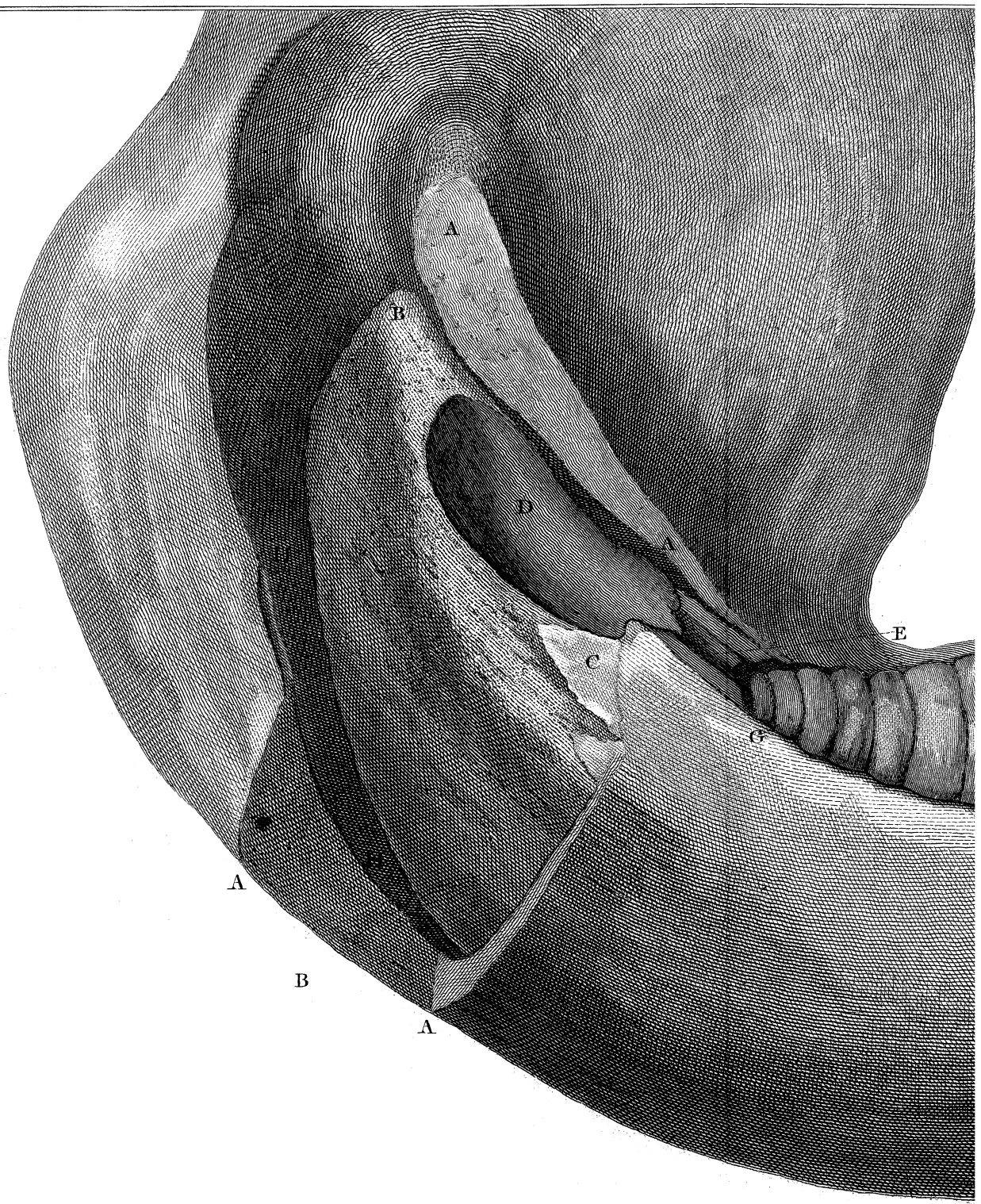

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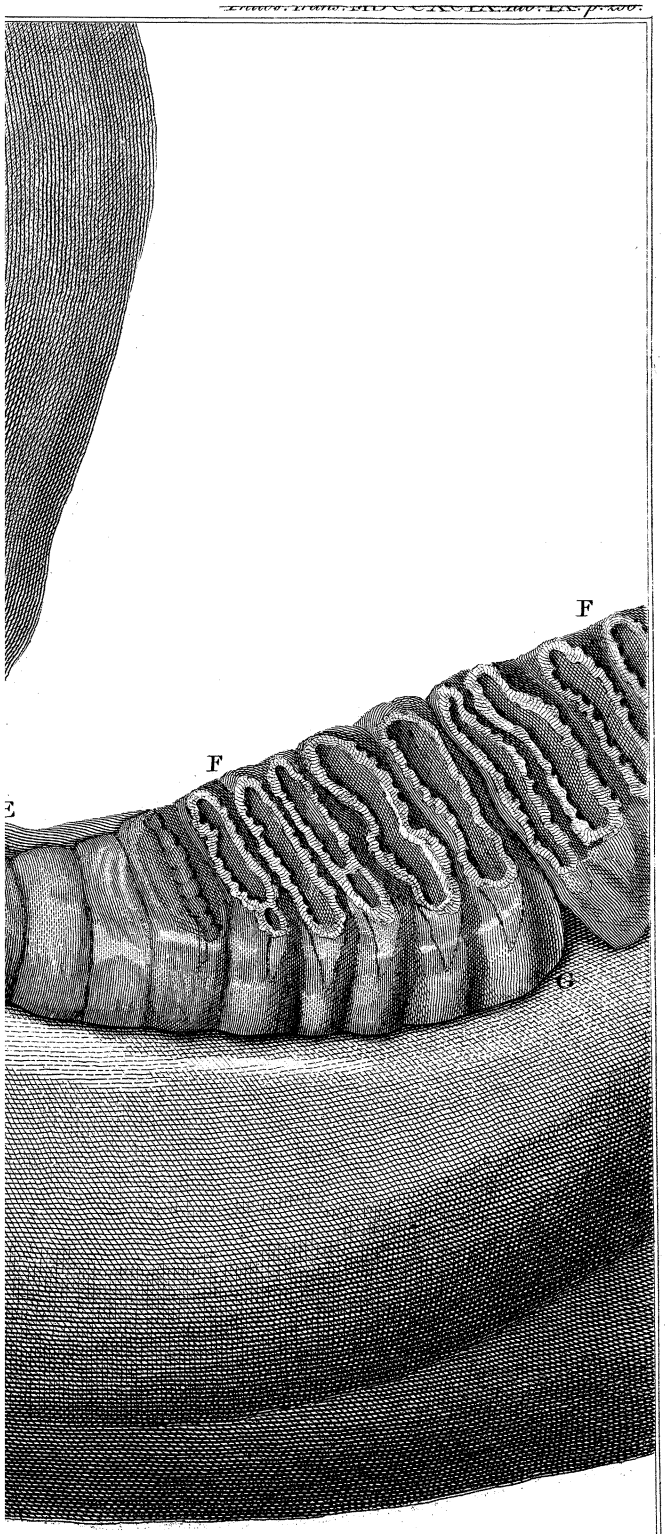

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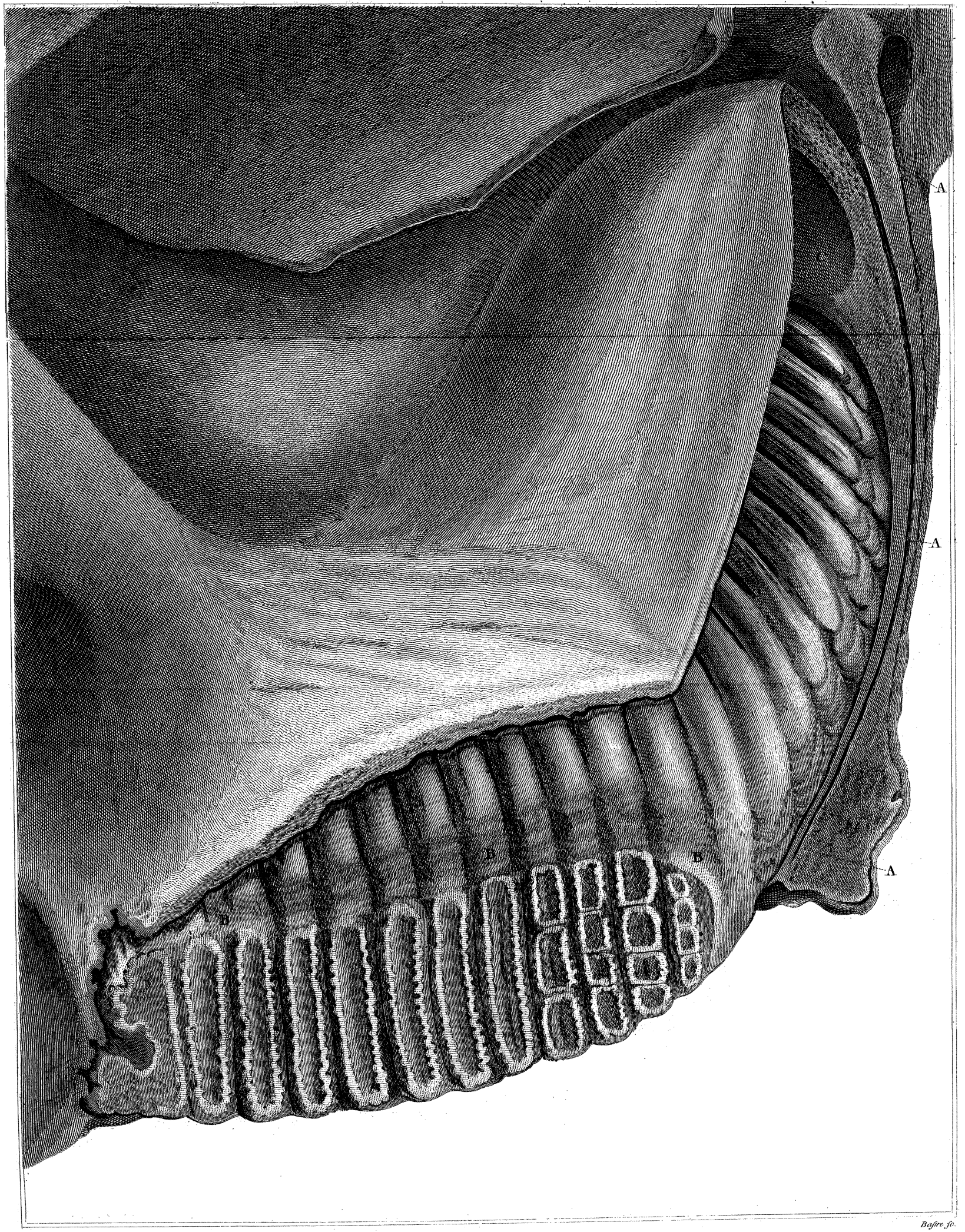

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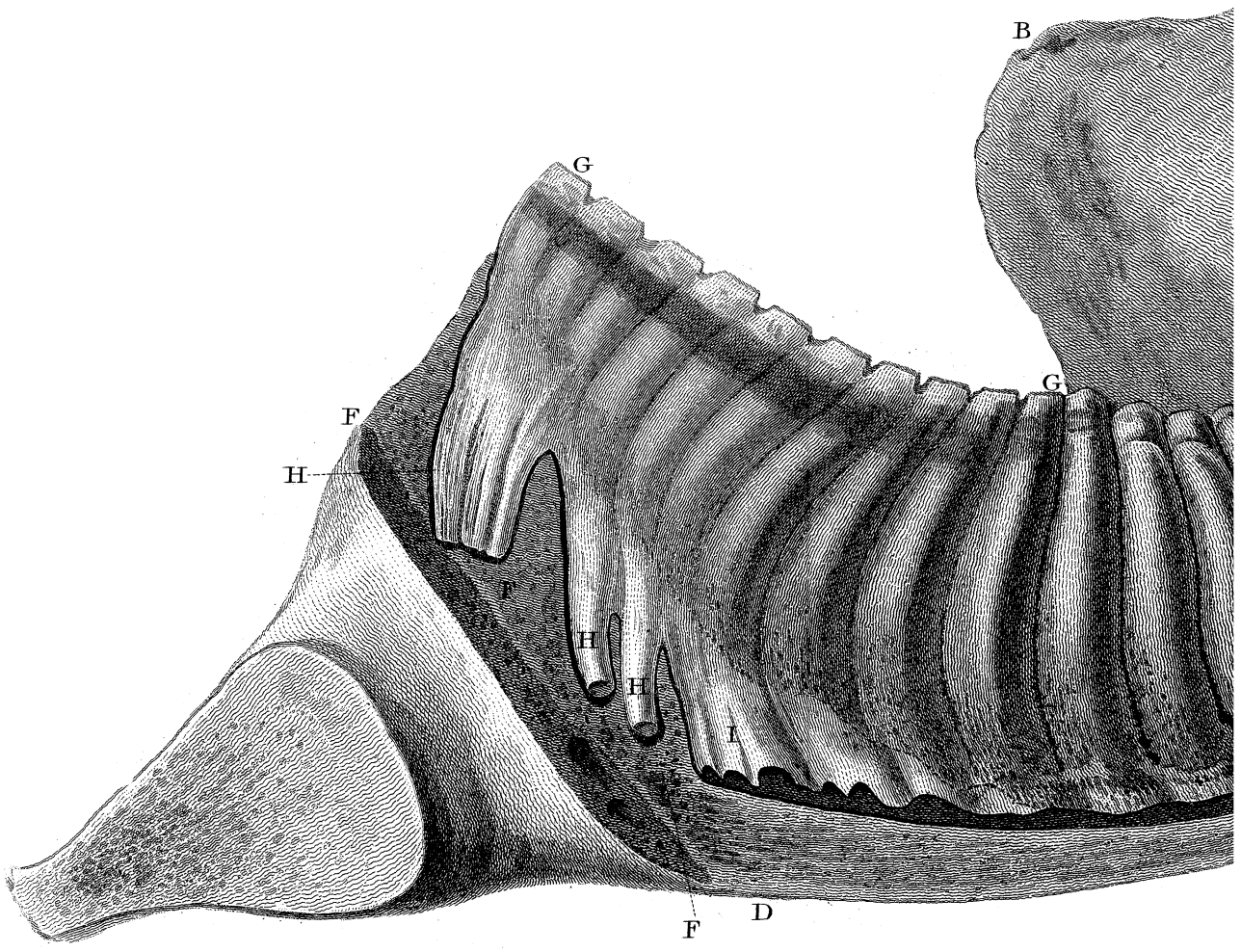

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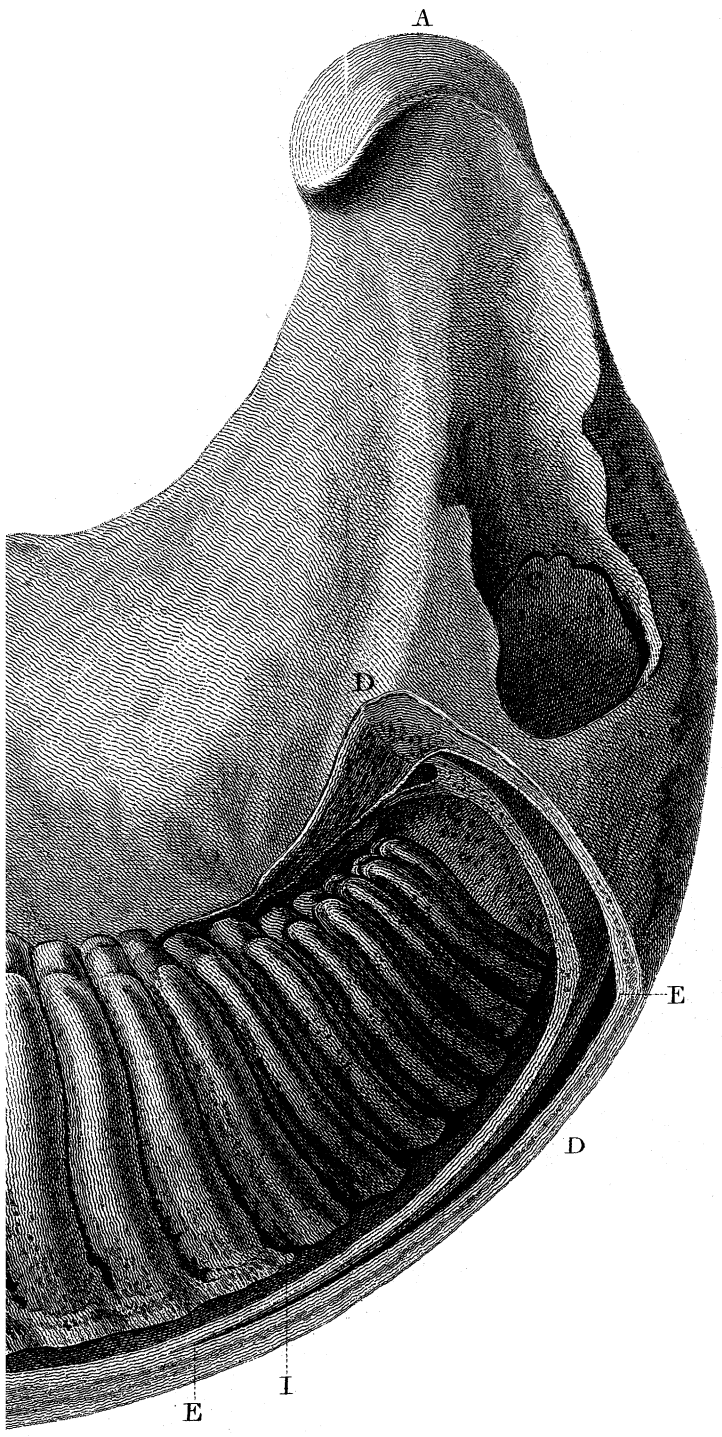

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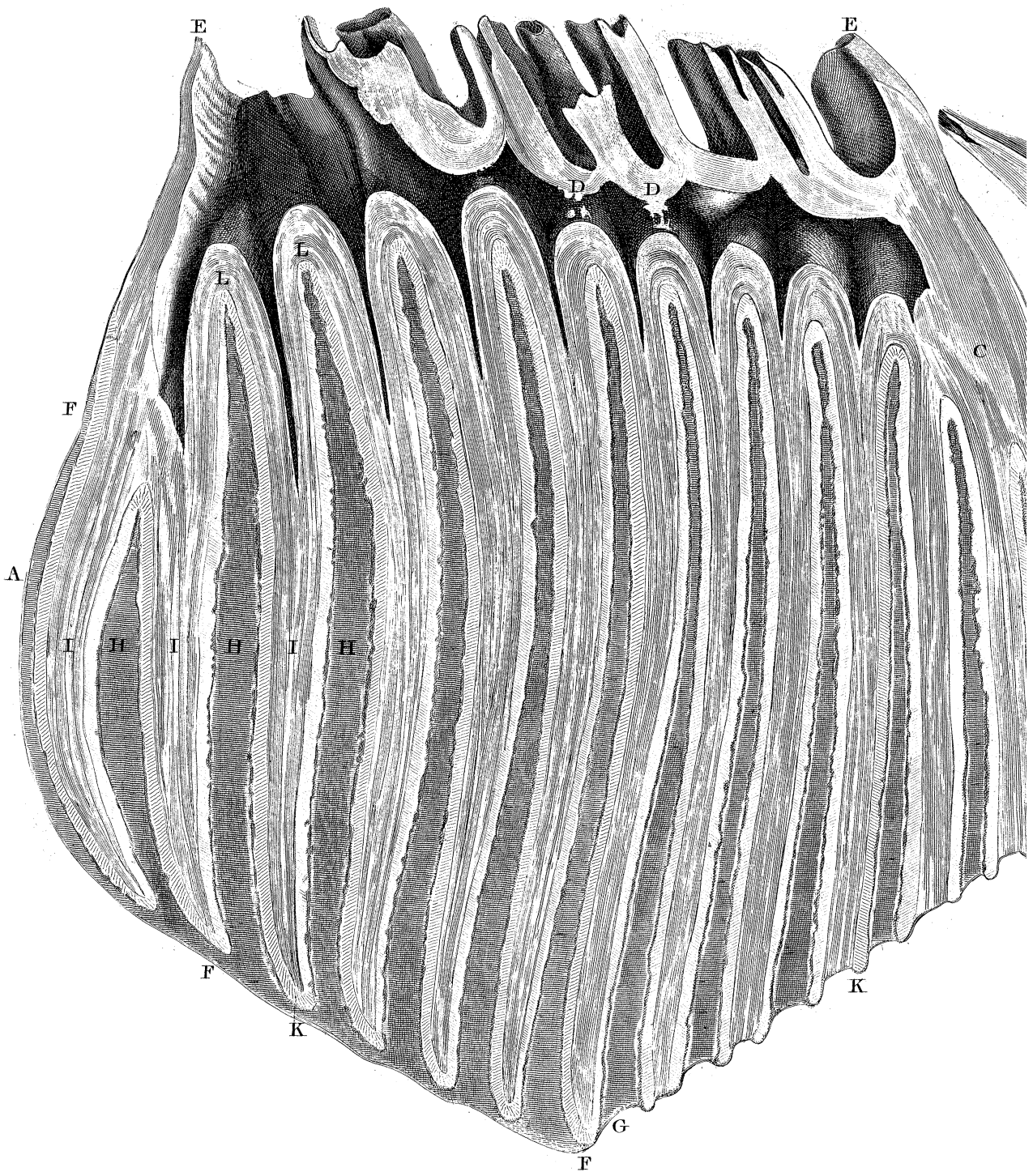
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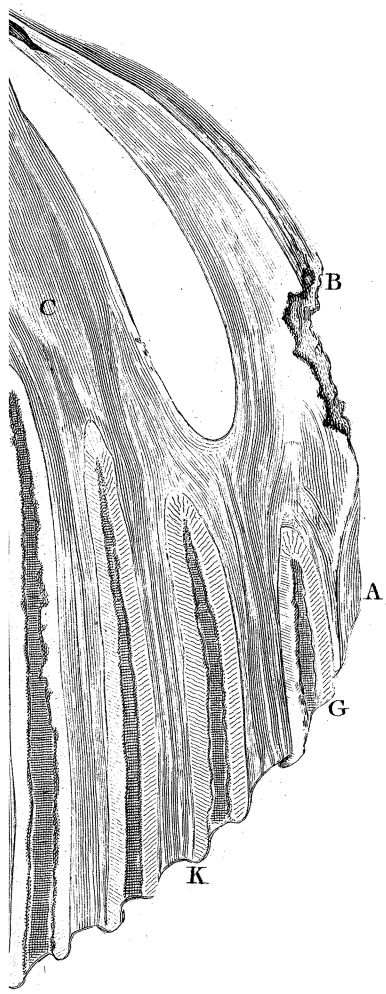
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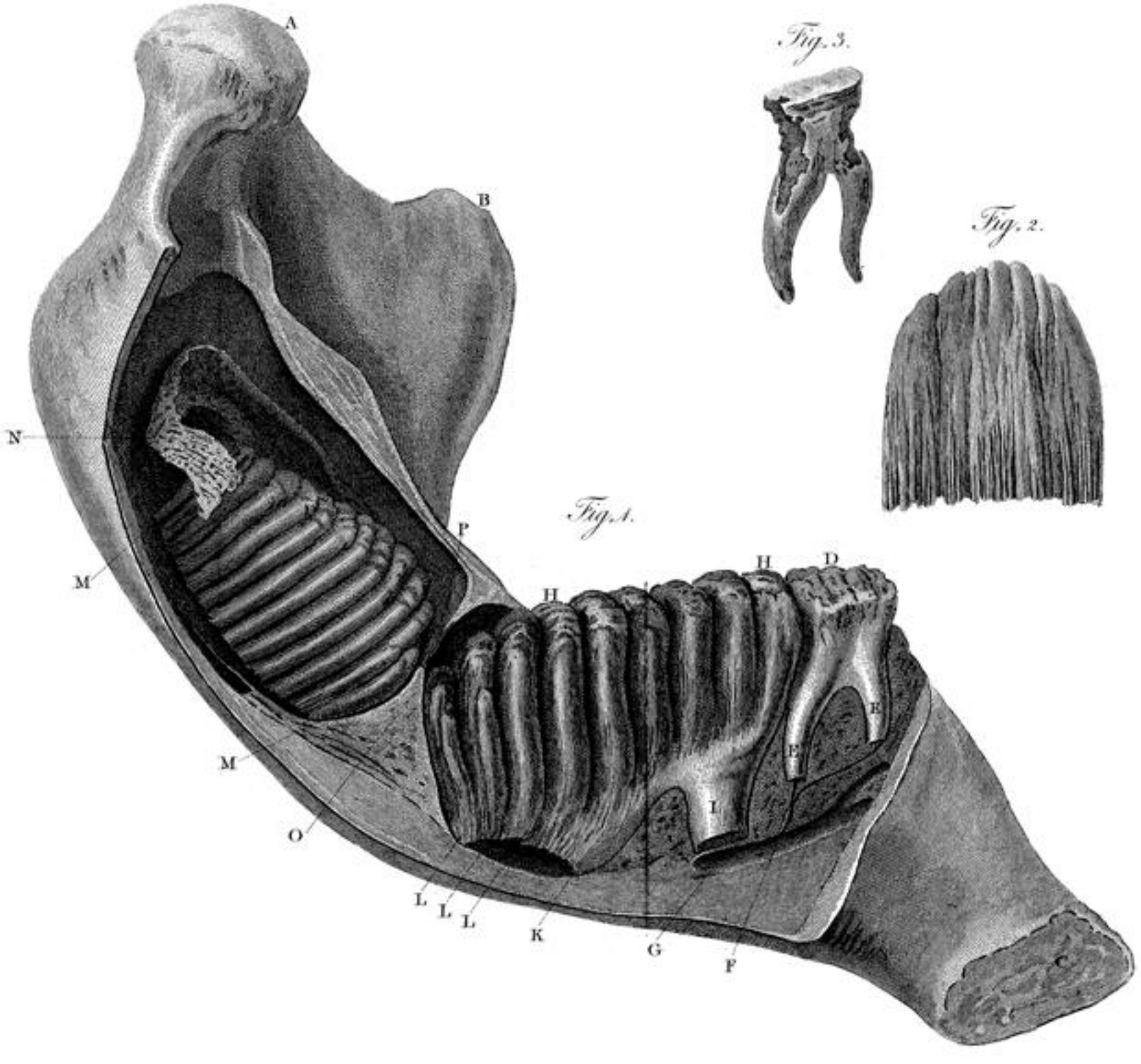

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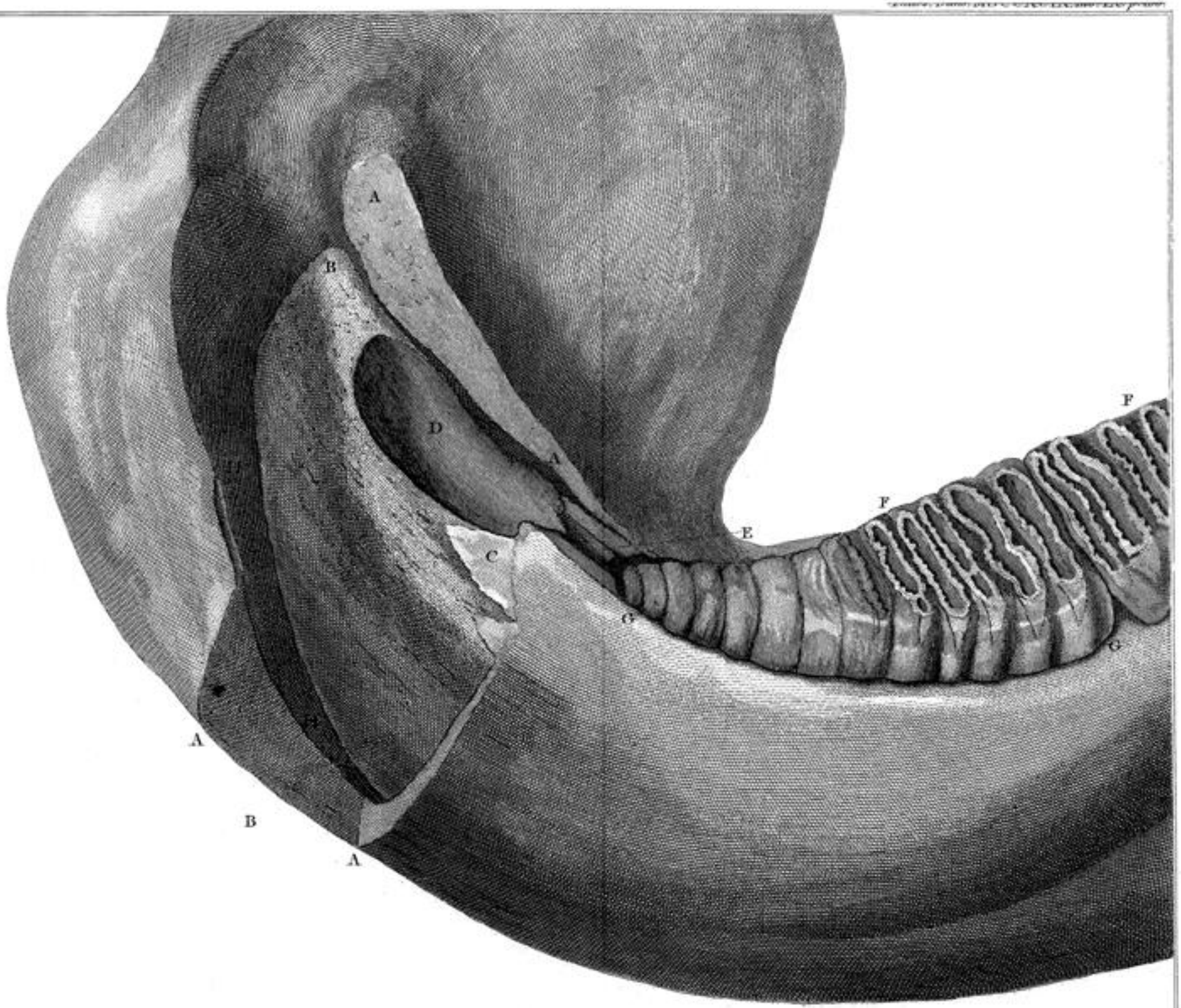

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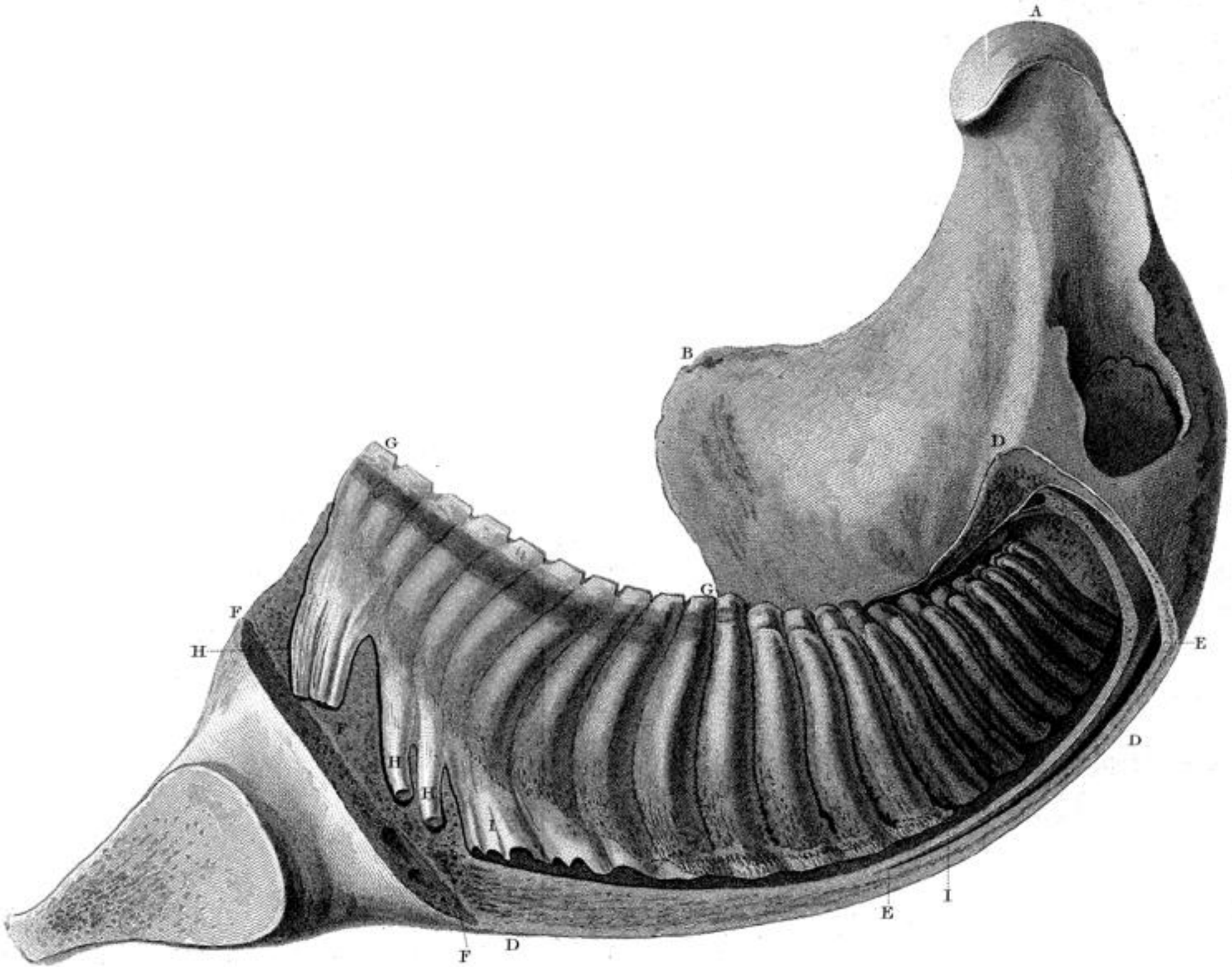
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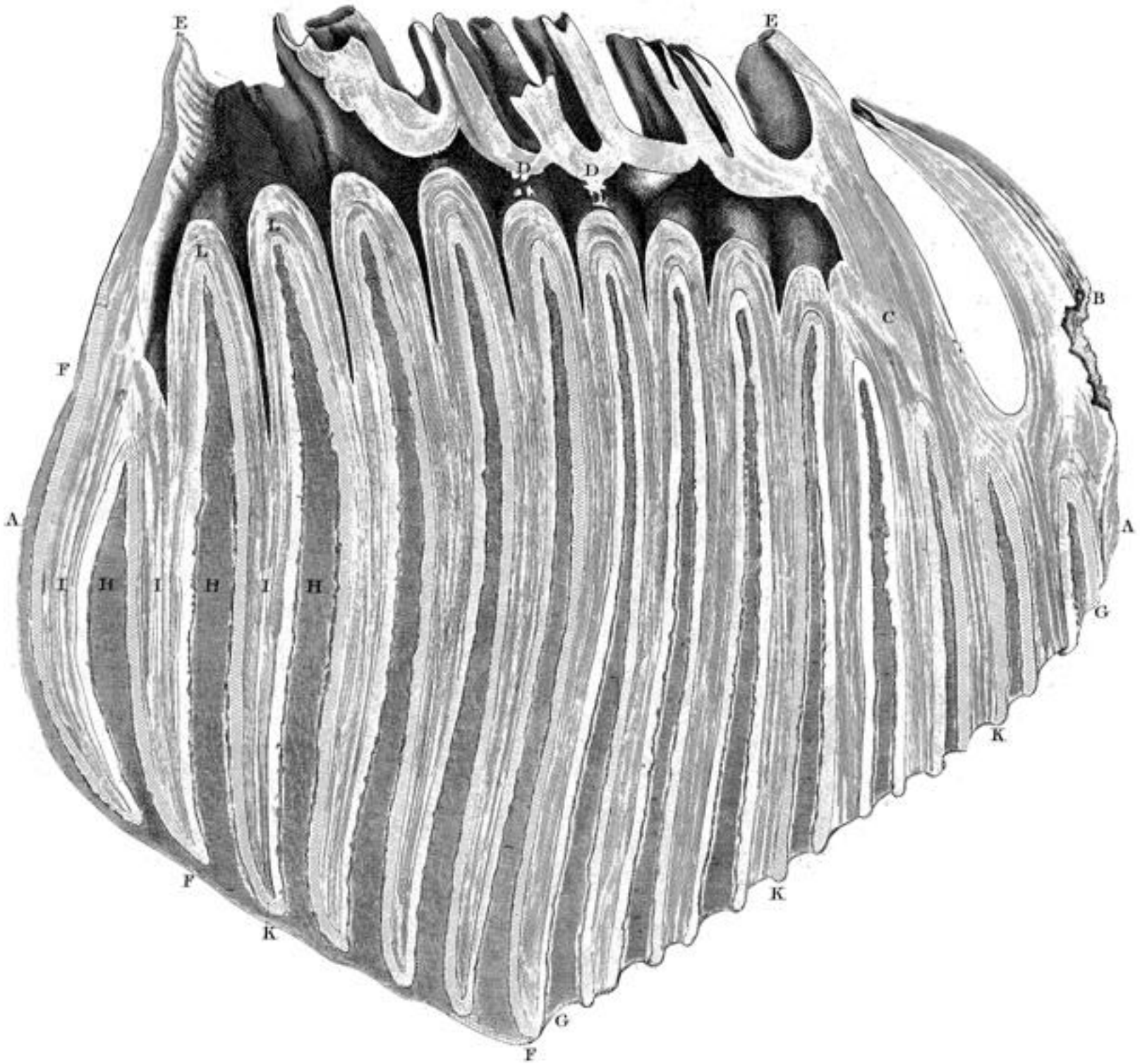
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