

1. *On the DISPUTED AFFINITY of the MAMMALIAN GENUS Plagiaulax, from the PURBECK BEDS.* By HUGH FALCONER, M.D., F.R.S., F.G.S., &c.

ONE of the most accurate observers and original thinkers of our time has discoursed with emphatic eloquence on the imperfection of the geological record*. Besides what is yet to be discovered, so much has been irrecoverably lost that we may never hope to write more than disconnected pages of the palæo-biography of nature. The truth of the assertion comes home to the conviction of all; but so far from discouraging, it only renders us the more eager to pursue what we may attain. Every now and then, in palæontology, an unknown form is discovered of so unexpected a character, that our habitual train of ideas is diverted by it into a new avenue of thought. It may confirm a position which has before been merely conjectural, or but faintly shadowed out; or it may shake the foundations of some cherished, but unsound, hypothesis. It is hailed with more especial satisfaction if it contribute to fill up any of the great gaps in our existing knowledge. The form itself is often presented to the first observer in such a mutilated or imperfect aspect, that at the best he can effect little beyond an approximative idea of the outline. From the same cause, or from a balanced conjunction of unusual characters, he may fail in his first attempt at the interpretation; but he has no reason to be ashamed of the failure, if he has devoted his powers fairly to the investigation; for a great part of the solid progress made in science is mainly effected by the later observer correcting the errors of those who have preceded him. Reproach can only be felt when we allow some bias unduly to influence our interpretation—when we strain facts to countenance a particular view. If the observer has guarded himself against this weakness, and with care used the proper means of investigation, whatever opposition his results may at first encounter, generally speaking, he may be at ease, in the assurance, that further research and future discovery will only confirm and extend them. If the conclusions are challenged, science is invariably benefited by the controversy. Different modes of analysis and different trains of ideas are brought into conflict; and landmarks are established for the warning and guidance of future observers.

Among the mammalian forms brought to light through Mr. Beckles's important researches in the Purbeck Beds, there was one which struck me with especial interest. I found in it a singular combination of characters:—the dentition modified by suppression to as great an extent as in any existing form; strong analogies, in some respects, with known genera, while in others it diverged from them very widely. Early in 1857 I communicated to the Geological Society an account of the genus *Plagiaulax*, which appeared in the 13th volume of the 'Quarterly Journal' (p. 261). About the same time an abridged description of the form, illustrated by figures, was brought out in the Supplement to the 5th edition of Sir

* Darwin, 'On the Origin of Species,' p. 287.

Charles Lyell's 'Manual of Geology' (1857, p. 17). On both occasions I arrived at the conclusion that "*Plagiaulax* may be regarded in the natural system as a Marsupial form of Rodent*, constituting a peculiar type of the family to which *Hypsiprymnus* belongs," although widely distinct from that genus.

The only comment impugning this determination that has come under my notice, appeared in the Article "Palæontology," by Professor Owen, in the 8th edition of the 'Encyclopædia Britannica †,' published in January 1859, and subsequently reproduced as a separate work ‡. The two accounts differ in some unimportant particulars. I here cite the later in date, as presumably conveying the latest views of the author. The following are extracts:—

"Two specimens exemplified the shape and proportions of the entire jaw of this species [*Plagiaulax Becklesii*]. The foremost tooth is a very large one, shaped like a canine, but implanted by a thick root in the fore part of the jaw, like the large lower incisor of a Shrew or Wombat. The three anterior teeth in place have compressed trenchant crowns, and rapidly augment in size from the first to the third. They are followed by sockets of two much smaller teeth, shown in other specimens to have subtuberculate crowns resembling those of *Microlestes*. The large front tooth of *Plagiaulax* is formed to pierce, retain, and kill; the succeeding teeth, like the carnassials of *Carnivora*, are, like the blades of shears, adapted to cut and divide soft substances, such as flesh. As in *Carnivora*, also, these sectorial teeth are succeeded by a few small tubercular ones. The jaw conforms to this character of the dentition. It is short in proportion to its depth, and consequently robust, sending up a broad and high coronoid process, for the adequate grasp of a large temporal muscle; and the condyle is placed below the level of the grinding teeth,—a character unknown in any herbivorous or mixed-feeding Mammal; it is pedunculate, as in the predaceous *Marsupialia*, whilst the lever of the coronoid process is made the stronger by the condyle being carried further back from it than in any known carnivorous or herbivorous animal. The angle of the jaw makes no projection below the condyle, but is slightly bent inward, according to the Marsupial type."

"In the general shape and proportions of the large premolars and succeeding molars, *Plagiaulax* most resembles *Thylacoleo* (fig. 173, *pm*, 1 and 2), a much larger extinct predaceous Marsupial from tertiary beds in Australia. But the sectorial teeth in *Plagiaulax* are more deeply grooved; whence its name. The single compressed premolar of the Kangaroo-rat is also grooved; but it is differently shaped, and is succeeded by four square-crowned, double-ridged grinders, adapted

* I leave the words as they originally stood; but my meaning would have been more accurately conveyed by the expression "Rodent type of Marsupial,"—rodent being here used in the large sense, having reference to the plan of dentition, characterized by two collateral incisors in the lower jaw, as typically shown in the placental series by the *Rodentia* and *Cheiromys*; and in the *Marsupialia* by *Phascalomys*, modified in the *Macropodidæ* and the *Phalangistidæ* by the opposition, in the upper jaw, of several incisors. (See Cuvier, *Oss. Foss.*, 4th edit. tom. v. p. 3.)

† Vol. xvii. p. 161.

‡ Palæontology, 2nd edit. p. 353.

for vegetable food; and the position of the condyle, the slenderness of the coronoid, and other characters of the lower jaw are in conformity to that regimen. In *Thylacoleo* the lower canine or canine-shaped incisor projected from the fore part of the jaw, close to the symphysis, and the corresponding tooth in *Plagiaulax* more closely resembles it in shape and direction than it does the procumbent incisor of *Hypsiprymnus*. From this genus *Plagiaulax* differs by the obliquity of the grooves on its premolars; by having only two true molars in each ramus of the jaw, instead of four; by the salient angle which the surfaces of the molar and premolar teeth form, instead of presenting a uniform level line; by the broader, higher, and more vertical coronoid; and by the very low position of the articular condyle.

“The physiological deductions from the above-described characteristics of the lower jaw and teeth of *Plagiaulax* are, that it was a carnivorous Marsupial. It probably found its prey in the contemporary small insectivorous Mammals and Lizards, supposing no herbivorous form, like *Stereognathus*, to have co-existed during the Upper Oolitic period”*.

We have here an opinion, professing to be founded on the high ground of a connected series of physiological correlations, that *Plagiaulax* was a carnivorous Marsupial; while the same materials led me to infer that it was phytophagous. These diametrically opposed inferences recall, in some degree, the discussion, famous in its day, respecting the disputed affinities of *Amphitherium*. The question then was, whether the fossil was mammal or reptile; and the foundations of Palæontology were supposed to be concerned in the issue. In the present instance the area of the field of difference is less, but the interests involved are still important. Are the indications of palæontology, more especially in its great stronghold in the Mammalia—the teeth and correlated organs—so unstable or so obscure, that of two palæontologists, the same dental and mandibular materials shall lead the one to infer that the fossil form was a vegetable feeder, and the other that it was a predaceous carnivore? Or does this conflict of opinion arise from different methods having been followed by the observers in dealing with the evidence?

As the Geological Society gave to my original communication a place in its Journal, I feel bound, in the interest of science, either to support the opinion which I then advanced, or frankly to admit the correction, if I am found to be in error. I am further impelled by my sense of self-respect, as an observer, to consider whether—apart from the conclusions—I have fallen into such errors of observation and description as would necessarily be implied, should Professor Owen’s manner of viewing the objects prove correct; and if so, to explain the fallacious train of reasoning which led me astray; for I cannot plead the excuse that the account was written in haste, or without due consideration.

If the data, upon which the author of ‘Palæontology’ professes

* Palæontology, p. 353. I entertain strong doubts about the soundness of the deduction which makes *Stereognathus* to have been herbivorous.

to rest his physiological deductions, were sound, the demonstration would be complete. They are put together with an exemplary show of harmony, and, with a single exception, every link in the chain is supplied. But there are, in the case, considerations of paramount import in an argument of this nature, that lead me to question their soundness, and to dissent from the conclusions.

And first, as regards the admitted facts. Professor Owen agrees that the Purbeck remains establish two species of *Plagiaulax*; and, as he has adopted two of the wood-cuts given in my original description of these species, it is presumed that the correctness of the figures is not questioned. The marsupial nature of the forms is not disputed, nor is there any difference of opinion about the number or designation of the teeth.

In both species there is a solitary incisor on each side of the lower jaw, in the fore part of the incisive border, closely followed, without the interposition of a canine, by a series either of three or of four premolars. The rami converge to a narrow point in front, so that the tooth occupies the entire width of the incisive border on each side; and fig. 13, p. 280, of my former communication, representing the symphyseal portion endwise, shows (what is confirmed by the other figures) that the two incisors were approximated and collateral, as in the rodent type, placental or marsupial. In *P. minor*, fig. 15, the tooth is procumbent. In the other and larger species, *P. Becklesii*, it is more robust, with a thicker root, and with a more decided curvature upwards, suggesting, at the first sight, some resemblance to the form of a canine. In both species the point is bevelled*; and I failed to observe in either any mark of the play of an opposed upper tooth.

What was the function of these incisors? Professor Owen's opinion is expressed thus: "The large front tooth of *Plagianulax* is formed to pierce, retain, and kill." This conclusion arrived at, the other characters are naturally regarded in unison with it, until the genus is finally presented to us as a predaceous carnivore. It is therefore necessary to examine the evidence closely. Now, in solving a question of this kind, comparative anatomy supplies for our guidance fundamental principles, which govern the interpretation of mere form. Let us revert to the known marsupial genera, and see what light generalized observation upon them throws upon the question. In all the Carnivorous genera and species, fossil or recent, of which the dentition has been accurately determined, there are three or more incisors, followed by a canine, on each side of the jaw, above and below; and the empirically observed result is consistent with a rational interpretation of the arrangement, in reference to their food and the means of procuring it. On the other hand, in all the existing strictly phytophagous genera, there is only a solitary incisor (being that next the axis) on either side of the lower jaw, and no canine; or if, as among the Phalangians, additional teeth are developed, the *outer* incisors and canine are alike rudimentary. The pair

* Not in the sense of being denuded of enamel by wear; but the posterior surface is flattened near the apex, so as to yield a slightly bevelled point (*op. cit.* p. 268).

of developed incisors are approximated and placed collaterally, as in the placental Rodents; and commonly they are projected forwards with but a very slight upward inclination. They are unequally opposed in the upper jaw by two or more incisors on either side. Why there should be this plurality of incisors above, and only two invariably occupying the same position below, is wholly unknown to us; but the constancy of the structure makes it certain that there must be a sufficient cause for it in nature; and we employ the generalization, empirically arrived at, with as much confidence as we do the law of necessary correlation*. In many critical cases, where the evidence is limited or defective, the empirical is even a safer guide than the rational law, since it is freer from the risk of errors of interpretation. Applied to the instance before us, it is manifest that the principle on which the incisors in *Plagiaulax* are framed, in regard of number, order of suppression, collateral position, and relation to the premolars, corresponds exactly with the type of the Marsupial Herbivores, such as *Halmaturus*, *Hypsiprymnus*, and *Phascolarctus*, and that it is wholly at variance with the Carnivorous type.

Let us now test the opinion in its professed character as a physiological deduction. Throughout the *Mammalia*, where teeth perform the functions of canines, "to pierce, retain, and kill," they are held well apart through the interposition of a line of incisors,—the end being obvious: the points of penetration are doubled, the grasp is strengthened by widening the base, and the dilacerating and killing powers are multiplied. To arrange them collaterally in the axis would be to place them at a disadvantage to the end to be attained. But when a gnawing power is required, the middle incisors are powerfully developed, and placed collaterally in the axis of the jaws, one on each side, above and below, as typically exemplified in the placental Rodents and *Cheiromys*. Doubtless, a Rat when seized can inflict a smart wound on the hand: but the power is a secondary attribute, complementary to the main function. Regarded in this aspect, it is negatively stamped upon the incisors of *Plagiaulax* by their collateral position, that they are not constructed upon the Carnivorous plan of design, nor in rational correlation thereto.

It is obvious that this position of the teeth in *Plagiaulax* was not overlooked by the author of 'Palæontology;' for, on the first occasion, he describes the incisor of *P. Becklesii* as being "very large, shaped like a canine, but implanted by a thick root in the fore-part of the jaw, like the large lower incisor of a Kangaroo† or Wombat." But the shape of the tooth prevailed in deciding him to pronounce it carnivorous. Now, the form differs in the two species: and I ask any Comparative Anatomist to look at fig. 15 of my former communication (p. 281), and say whether the tooth there represented is formed to pierce, retain, and kill—being the attributes with which Professor Owen invests the incisor of *P. Becklesii*. It is projected forwards with a slight upward inclination, somewhat as in the vege-

* Cuvier, 'Discours Préliminaire,' p. 51.

† Encyclop. Brit., 8th edit. vol. xvii. p. 161. "Shrew and Wombat" are substituted in the 'Palæontology,' p. 353.

table-feeding Koala (*Phascolarctus cinereus*). The incisor of *P. Becklesii** is undoubtedly curved more decidedly upward; and, when viewed sidewise, it is not very unlike a canine. But the same may be said equally of the lower incisor of the Lemurine Aye-Aye (p. 368, fig. 20, *a*). In this remarkable form, the affinities of which were so keenly disputed by the great French anatomists, Cuvier and Blainville, the solitary incisors are collateral, on the Rodent type; compressed laterally, and very deep at the base, they sweep upwards in a bold curve, being scooped vertically behind, to terminate in a sharp edge; so that, regarded sidewise, so far as vertical direction goes, they are more canine-like than in either species of *Plagiaulax*. But the resemblance goes no further. In the former the incisor, which is only partially invested with enamel, is continued backwards below the molars, the pulp-nucleus being persistent, and the chisel-shaped edge is constantly maintained by use†—conditions which are wanting in the latter. Should the construction of the skull and other parts of the skeleton of *P. Becklesii* be ever discovered, there is little doubt but that modifications will be detected throughout, in conformity with those of its incisors, as in the felicitous instance cited by Cuvier, of the secret relation between the upper canine-shaped incisors of the Camel and the bones of the tarsus: this exceptional character does not remove the Camel from among the Ruminants, nor does the form of the incisor of *P. Becklesii* appear to me to be of sufficient weight to counterbalance the clear evidence of a phytophagous and rodent plan of construction.

Professor Owen draws an argument, in confirmation of his view, from the dentition of *Thylacoleo*. The statement is:—"In *Thylacoleo* the lower canine, or canine-shaped incisor, projected from the fore-part of the jaw, close to the symphysis; and the corresponding tooth in *Plagiaulax* more closely resembles it in shape and direction than it does the procumbent incisor of *Hypsiprymnus*"‡. But, on referring to his detailed description of *Thylacoleo*, we find that the body of the tooth, of which the shape and direction are adduced as terms of comparison, together with the fore part of the symphysis and incisive border, is wanting §:—"The symphysis (pl. 13. fig. 4, *s*) begins behind, at a vertical line dropped from a little in advance of the middle of the sectorial, *p* 4; it is of a wide and oval form. To judge from the cast, but little of the jaw appears to have

* *Loc. cit.*, fig. 1. p. 278.

† Blainville asserts that the incisors of the Aye-Aye are invested all round with a shell of enamel, and that the posterior facet is not the result of wear (*Mémoire sur l'Aye-Aye*, p. 23); while Dr. Sandwith, in his interesting account of the habits of this animal, affirms that the facet is denuded, as in the Rodents (*Zool. Proc.*, Feb. 22, 1859, p. 111). In a finely preserved cranium, for the transmission of which to London I am indebted to the great courtesy of M. Édouard Verreaux of Paris, it is distinctly seen that the coat of enamel is limited to a belt which sheathes only the anterior half of the incisors.

‡ *Palæontology*, p. 353.

§ "Unfortunately, this morceau is much mutilated, the incisor being broken at its entrance into the alveolus; its form cannot therefore be precisely given; but it is evident that it was curved upwards."—Stutchbury, Report on the Discovery of Gold in Australia, 1855, p. 53.

been broken away from the fore-part of the symphysis. The upper and fore-part shows the alveolus and base of a tooth (pl. 11. fig. 3, *c*) which has projected obliquely upward and forward. It is separated by an interspace of 3 lines from the sectorial, and would seem to be the sole tooth in advance of it. If the ramus be really produced at the upper part of the symphysis further than is indicated by the present cast, *it may have contained one or more incisors, and the broken tooth in question may be the lower canine.* If, however, this be really the foremost tooth of the jaw, it would appear to be one of a pair of large incisors, according to the Marsupial type exhibited by the *Macropodidæ* and *Phalangistidæ**. “But in the lower jaw the carnassial is succeeded by two very small tubercular teeth, as in *Plagiaulax*; and there is a socket close to the symphysis of the lower jaw of *Thylacoleo*, which indicates that the canine may have terminated the dental series there, and afforded an additional feature of resemblance to the *Plagiaulax*” †.

In all this, it will be seen, the argument is within the domain of conjecture; the tooth oscillates between canine and incisor; and not merely so, but the principles which are followed as guides in this walk of investigation are set aside, to give place to the illusory indications of mutilated external form. If the tooth represented by a stump or socket proves to be a canine, the comparison will not hold; but if it be solitary with the position of an incisor, will it even then bear out Professor Owen’s hypothesis, that *Thylacoleo*, which he infers to have been one of “the fellest and most destructive of predatory beasts ‡,” may have had the laniary portion of its teeth in the lower jaw constructed on the type of the most meek and defenceless of herbivorous marsupials? Bearing in mind the sense in which the term “type” is accepted among naturalists, I must avow, that I have some difficulty in realizing the conception. But, should the unusual conjunction of characters assumed above be hereafter established, there are theoretical considerations which would prove to demonstration that the types of construction are still absolutely distinct. For in the supposed case the outermost incisor would be the one developed, the inner ones being suppressed; while, conversely, in the *Macropodidæ* it is the *innermost* incisor which is developed, the outer ones being suppressed. Morphologically, therefore, the types of construction would be radically different. If palæontological investigations were conducted in this manner, there would be no limit to conjecture; the landmarks which we profess to follow would be disregarded, and disorder would face us everywhere. But, happily, science furnishes unerring principles, which provide the corrective. I need hardly add that the argument drawn from *Thylacoleo* has, in my view, no bearing on the incisors of *Plagiaulax*, and gives no support to the carnivorous inference.

Next, as regards the premolars. From their peculiar characters, and remarkable development, they furnish the most striking features

* Phil. Trans., vol. cxlix. p. 318.

† Palæontology, p. 432.

‡ Phil. Trans., vol. cxlix. p. 319.

in the dentition of the fossil genus. In *P. Becklesii* there are three, and in *P. minor*, four of these teeth, which diminish rapidly in size from the last to the first*. I here take the last as the most determinate in form, and in its nature the most constant. I compared it rigorously with the corresponding tooth of *Hypsiprymnus Gaimardi*, and I affirm now, as I did in my original paper, that these homologous teeth, in the two genera, are identical in every essential point of form and construction. In proof, I refer to figures 5 and 6 of the representations above cited, the former showing the last premolar of *Plagiaulax*, the latter of *Hypsiprymnus*. The resemblance is so manifest and direct, that I never contemplated that it could be called in question; but, as it has been questioned, it is necessary to descend to particulars. In both, the crown viewed from the side is of a quadrately oblong form, the length exceeding the height; in both, it is compressed and trenchant, the sides sloping uniformly from the base to a thin edge like a wedge; in both, the basal part of the tooth presents a smooth surface, above which the crown is traversed by a series of close-set, uniform, and exquisitely defined parallel grooves, sharply angular, and bounded by linear ridges; in both, these grooves occupy both sides of the tooth; and in both, the channeled sides meet in a finely serrated edge. Not the least remarkable point in this striking list of agreements is the curious numerical coincidence,—these grooves being developed seven in number, alike in the homologous premolars of *Pl. Becklesii* and of *Hypsiprymnus Gaimardi*.

As to the points of difference: in *Plagiaulax* there are three or four of these teeth, while in *Hypsiprymnus* there is but one; in the former, they are presented with the *maximum* of development, in the latter with the *minimum*; in the former the grooves are diagonal, in the latter vertical. With this exception, and with some trivial details of difference in the proportion of the length of crown to its height, and in the amount of the basal surface free from grooving, the last premolar in *Hypsiprymnus* is identical in its characters with that of *Plagiaulax*. The two convey to my mind the impression of being typically alike.

The objects strike Professor Owen in a very different light. His statement is that, “in the general shape and proportions of the large premolar and succeeding molars, *Plagiaulax* most resembles *Thylacoleo*, a much larger predaceous marsupial, from the tertiary beds in Australia. But the sectorial teeth in *Plagiaulax* are more deeply grooved; whence its name. The single compressed premolar of the Kangaroo-rat is also grooved; but it is differently shaped,” &c. Now, apart from the inferences, here is a conflict of description, which can be settled by an appeal to the original specimens. I have described the large premolar as essentially alike in form, in the Kangaroo-rat and in *Plagiaulax*. Professor Owen states that it is differently shaped in the two: if so, I invite him to show wherein the difference consists (I have failed to detect, and he as yet to indicate it),—bearing in mind that here it is not a question of slight difference,

* See Quart. Journ. Geol. Soc., vol. xiii. pp. 278–281, figs. 1–15.

such as a modification in the outline of the same organ in two nearly allied forms, but a difference of type—or of ordinal importance.

Next as regards the assertion that in the general shape the large premolar of *Plagiaulax* most resembles *Thylacoleo*. For convenience, I separate the two terms of the comparison in the sentence. Professor Owen has figured and described the sectorial teeth of this large Marsupial, in his late memoir on the “Fossil Mammalia of Australia”*. In *Thylacoleo* the inferior premolars are reduced to a single, but enormously large and massive, carnassial, with two small tubercular teeth behind it. This carnassial (figs. 16–19) consists of a long blade, high in front and lower behind, so that, if notched in the middle, the divisions would in some degree resemble the anterior and posterior lobes of the corresponding tooth in the placental Carnivora †; and the worn summit is distinctly concave lengthwise: conversely, in both species of *Plagiaulax* the corresponding tooth is convex, and the outline of the whole series describes a convex curve, of which the last premolar forms the most salient part. The base of the carnassial in *Thylacoleo* is “slightly grooved vertically” on the inside (fig. 16). These indentations disappear about half-way up towards the edge, where the surface becomes reticulately rugose, being precisely the reverse of what occurs in the last premolar of *Hypsiprymnus* and *Plagiaulax*. Besides the difference of their position upon the tooth, the grooves of the carnassial of *Thylacoleo* present the appearance of furrows, separating superficial undulations of the enamel. A transverse section of the basal part of the crown would yield a faintly crenated outline, wholly different from the salient and reentering angles of the close-set parallel grooves of *Plagiaulax* and *Hypsiprymnus*. These undulations are exhibited chiefly, if not solely, on the inner side; their presence on the outer is not mentioned. Further, if the indentations on the premolar of *Thylacoleo* are to count for anything as significant of affinity, it should be with *Hypsiprymnus* rather than with *Plagiaulax*, since the furrows are vertical in the two former. In fact, in the outline and proportions of the vertical section, the premolar of *Thylacoleo* differs less from *Hypsiprymnus* than it does from that of *Plagiaulax*. I have failed to realize the asserted resemblance between *Plagiaulax* and *Thylacoleo* in the form of the last premolars; and in the details of outline, section, curvature of edge, crenulation, surface-markings, &c., I am more impressed with the differences than with any one point of agreement.

Let us now consider the inference as to the function of these teeth. It is expressed thus:—“The large front tooth is formed to pierce, retain, and kill: the succeeding teeth are like the blades of shears, adapted to cut and divide soft substances like flesh,” &c. Professor Owen has elsewhere described the premolar of *Hypsiprymnus* as

* Phil. Trans., vol. cxlix. p. 318, pls. 11 and 13.

† “The first molar is lunate, the cusps turning inwards, the anterior cusp rising at a salient angle, the edge is trenchant outwards; the second molar is triangular with a large anterior cusp, and a slight ridge passing to a small depressed posterior cusp.”—Stutchbury, *loc. cit.*

trenchant*, and I have shown above that the tooth is essentially alike in *Plagiaulax*. If, therefore, the function is to be deduced with such facile certainty from the mere form, the premolar of *Hypsiprymnus* ought also to be carnivorous. But we know that the genus is so strictly herbivorous that the family to which it belongs has been regarded as representing in the *Marsupialia* the Ruminants of the Placental Mammals. With this fact before us, is it likely that the premolars of *Plagiaulax* were applied to cut and divide flesh? Does the serrated edge indicate a flesh-cutting function? The singular agreement between the two genera in their premolars, down even to the number of grooves, however trivial and unimportant the character may appear to be, has, I confess, weighed greatly with me in forming my opinion. No special function has, as yet, been connected with the peculiarly grooved tooth of the living Kangaroo-rat. The agreement is therefore purely empirical; but as the character, according to our present knowledge, is confined, among many hundred genera of Mammalia, to certain species of *Hypsiprymnus* and to *Plagiaulax*, those who have faith in the constancy of the manifestations of nature will not lightly believe that it was common to these two genera alone without implying affinity; and when this is coupled with the obviously phytophagous type of the incisors, the conviction will be confirmed. I need hardly add that I regard the carnivorous deduction from the shape to be arbitrary and untenable.

[William Hunter, a century ago, by a parity of reasoning, arrived at the conclusion that the *Mastodon* of North America, from the trenchant form of the transverse crown-ridges of its molar teeth, was an extinct, colossal, carnivorous animal, in short, a kind of predaceous flesh-eating Elephant†. The error in his case, as in the corresponding one of Leibnitz, was excusable, comparative anatomy having been then in its infancy. But it is not a little startling to see the same sort of unsound deduction reproduced, in regard of one of the most pigmy of Mammals, half a century after Cuvier, by his luminous demonstrations, had indicated the method by which such signal mistakes might be avoided in future.—Oct. 15th.]

Professor Owen perceives another indication of resemblance between *Thylacoleo* and *Plagiaulax* in the proportions of the large premolar to the succeeding molars. In both, there are but two molars, and in so far the agreement is clear; but no further. In *Plagiaulax* there are as many as four premolars; while in *Thylacoleo* the enormous development of the solitary premolar or carnassial is effected at the expense of the rest of the premolars, which are suppressed, and of the tubercular teeth, which are dwarfed. In the former, as pointed out in my earlier description, “the premolars are inordinately developed, while the true molars are dwarfed and rudimentary in proportion.” The operation of the well-known law of *Anamorphosis* or *Balancement* is visible in both. But examples of it are everywhere seen throughout animated nature, in the same

* Odontography, vol. i. p. 389.

† Phil. Trans. 1767, vol. lviii. p. 38.

organ, without reference to affinity, as, for instance, among the *Mammalia*, in the canine of *Machairodus* and of the Musk-deer. *Thylacoleo* and *Plagiaulax* may be regarded as being as wide apart among the Marsupials as the two former are among Placental Mammals. The solitary trenchant premolar in some of the species of *Hypsiprymnus* is said to attain a very large development. We have the authority of Professor Owen for the statement, that in two Potoroos of New Guinea its antero-posterior extent nearly equals that of the three succeeding molars*. If the teeth of *Thylacoleo* and *Plagiaulax* had been on the same morphological plan of construction, the agreement in the number of molars would clearly have carried weight; but, as such does not appear to be the case, the coincidence ought not to overrule the other indications, more especially as the form of the crowns of the molars in the two genera is totally different. In *Thylacoleo*, the first tubercular tooth has the crown compressed, supporting two cusps on its axis, the anterior lobe being more or less conical, with a smaller lobe behind it, both on the usual carnivorous type of construction. The second tubercular is only known through its socket. In both species of *Plagiaulax*, the two molars present oblong crowns, supporting two opposed lines of marginal eminences, separated by a depression. In my original description, I referred to the fact that in *Dromicia* and *Acrobata* the molars are reduced from the ordinary number, four, to three. In *Plagiaulax* the suppression is carried still further, two only being developed. The agreement in this respect between the latter and *Thylacoleo* does not impress me with the idea of affinity, although admitting, as I do, that it ought to be duly weighed.

I have entered in such detail upon the dental characters, because, by the consent of all observers, they are of paramount weight in the solution of a question of this nature. If the type be distinctly indicated by them to be herbivorous or carnivorous, the other characters, however modified they may be, will ultimately be found to be in relation to the teeth. The author of 'Palæontology,' having formed his opinion on the teeth, then examines the characters of the lower jaw and finds them in conformity. He adduces the shortness of the horizontal ramus in proportion to its depth as indicative of robustness; also the broad and high coronoid process, and the pedunculate condyle placed below the level of the grinding teeth (above, p. 349). They are all regarded as proving a carnivorous type. They were not overlooked in my former communication:—"The characters of the jaw are so peculiar, and in some respects of so mixed and complex a nature, that they ought to be weighed with caution, in conjunction with the teeth, in forming any opinion of the affinities of *Plagiaulax*. The low position of the condyle is so pronounced, and the elevation of the coronoid above it so considerable, that, regarded *per se*, supposing no teeth had been discovered, they might have been considered to imply with some degree of certainty a predaceous animal"†. But there were other characters, which, taken in conjunction

* Odontography, vol. i. p. 389.

† Quart. Journ. Geol. Soc., vol. xiii. p. 273.

with the jaw, appeared to me to counterbalance these indications : namely, the moderate extent and low elevation of the coronoid above the grinding-plane of the teeth ; the long neck and horizontal projection of the condyle behind the coronoid ; the form of the condyle itself ; and the absence of a stout angular process behind it. With one exception, I shall consider these mandibular characters briefly.

And first, as regards the shortness of the horizontal ramus in proportion to its depth. I refer my reader to fig. 20 of the accompanying illustrations, representing the side view of the lower jaw of the Aye-Aye. A glance will satisfy him that the horizontal ramus is much deeper in proportion to the length in this form than it is in *P. Becklesii*. The fact is so obvious that I do not think it necessary to enter upon the metrical details. Commonly we connect the idea of robustness in the lower jaw with the form and section of the mandible presented by the Hyæna and Tiger. If the sections, figs. 2 and 3, p. 278, of my original paper are referred to, it will be seen that they are totally different. The jaw of *Plagiaulax* in this respect also closely resembles that of the Aye-Aye*.

The coronoid process comes next for consideration. For the details of my description of it, I refer my readers to p. 268 of my former paper. It is there stated that "in general form the coronoid process in *Plagiaulax* resembles more that of the predaceous marsupials, and of the Ursine *Dasyurus* especially, than that of the herbivorous families. It differs very markedly from the elevated strap-shaped coronoid of *Hypsiprymnus* and the other herbivorous marsupials. It is to be remarked, however, that it is less elevated, and its surface of less area, than in the predaceous genera, whether marsupial or placental." Here, it will be observed, the comparison was restricted to marsupial forms, beyond which I did not then think it necessary to carry it. If extended to the Aye-Aye (fig. 20), additional light is thrown upon the character. In both, the anterior edge reclines at an angle of about 45°; in both, the summit is not much elevated above the grinding-plane of the teeth. The appearance of elevation, which is at first sight suggested by the coronoid of *Plagiaulax*, arises from the great depth of the sigmoid notch and the low position of the condyle. If fig. 1 of the illustrations of my former paper be referred to, it will be seen that the process itself is not raised much above the summit of the premolars. There is a further agreement between the Aye-Aye and *Plagiaulax* in the amount of area occupied by the surface of the coronoid. This is partly disguised in the lower jaw of the former, by the broad neck of the condyle, and the shallowness of the lunate notch between it and the coronoid ; if the notch were deepened, as indicated by the dotted line, the resemblance would be complete. I do not, therefore, admit the force of Professor Owen's remarks, as significant of carnivore affinities, that "the lower

* In the Koala (*Phascolarctus cinereus*), in which the procumbent incisors, as already observed (above, p. 353), are projected with an inclination resembling that of *Plagiaulax minor*, the horizontal rami of the lower jaw present great depth in proportion to the length, with a compressed section. (Waterhouse, 'Mammalia,' vol. i. p. 264.) But the ascending ramus, in that genus, is on a totally different plan of construction.

jaw is short in proportion to its depth, sending up a broad and high coronoid process for the adequate grasp of a large temporal muscle"—seeing that all these characters are combined in an existing gliriform Lemur, which is not a carnivore. The descriptive terms applied to the coronoid would be suitable for that of a Tiger or Stoat, but they seem hardly applicable to the process of *Plagiaulax*.

The author of 'Palæontology' lays stress on the low position of the condyle, and its long horizontal neck: "The condyle is placed below the level of the grinding-teeth,—a character unknown in any herbivorous or mixed-feeding Mammal; it is pedunculate, as in the predaceous *Marsupialia*; whilst the lever of the coronoid is made the stronger by the condyle being carried further back than in any known carnivorous animal." But it is not a little remarkable that he is silent regarding the form of the condyle itself,—the most important of all the mandibular characters after the teeth; for the peduncle, on which he lays weight, is, like the fang of a tooth, but the stalk upon which the organ performing the function is borne. I think it necessary therefore to call attention to the remarks on the subject contained in my former paper. In the true Carnivorous type, the condyle shows more or less of a cylindrical or terete surface, having invariably a transverse direction, by which it is locked in the glenoid cavity of the upper jaw, thus constituting a pivot like that of a pair of scissors, which constrains the blades to a vertical motion. In *Plagiaulax* all these conditions are reversed, the condyle being convex, with its long diameter disposed subvertically; regarded endwise, it is narrow in proportion to the height, and the outline is ovate or pyriform, the broad end being uppermost. This is a form which is unknown among the *Carnivora*, but common in the Placental Rodents, with the difference, however, that in the latter, the condyle having to work backwards and forwards in a groove, its articular surface is disposed longitudinally. In the common Norway Rat, the articular surface of the condyle is partly vertical, with the pyriform outline of *Plagiaulax*, but more compressed; and in one of the American Marmots (No. 2259, Mus. R. Coll. of Surgeons) it still more closely resembles that of the fossil genus. I cite these instances, to show the undercurrent of Rodent analogy which pervades the jaw of *Plagiaulax* throughout. But a more conclusive and irresistible case of correspondence can be adduced in the condyle of the Aye-Aye. In the words of the celebrated French anatomist who first settled the affinities of the genus, "La forme générale de la mâchoire inférieure de l'Aye-Aye dénote une partie forte, large, ou mieux haute et très comprimée; la branche horizontale beaucoup plus longue que la verticale, qui est presque dans la même direction. Le condyle qui termine cette branche verticale, dans les autres animaux, est droite ici, et presque a l'extrémité postérieure de toute la mâchoire," &c.* The condyle of the Aye-Aye has the same ovate form as that of *Plagiaulax*, but reversed, the narrow end being uppermost (fig. 20); the articular surface is broader and somewhat flatter than in that genus, but the direction of the greater axis is the same, that is, longitudinal and

* De Blainville, 'Ostéographie: mémoire sur l'Aye-Aye,' p. 19.

subvertical*. The glenoid surface of the upper jaw is modified in correspondence—being broad and flat, and placed on an inclined plane that would intersect the tips of the nasals and the middle of the occipital foramen. Here, then, is a signal failure in the chain of physiological deductions requisite to prove that *Plagiaulax* was a marsupial carnivore.

Next, as regards the depressed position of the condyle—below the level of the grinding-teeth. The author of 'Palæontology' states that it is a "character unknown among any herbivorous or mixed-feeding animal." I again refer my reader to the figure (fig. 20) of the lower jaw of the Aye-Aye. In it, the articular surface of the condyle, although directed subvertically, or at the most diagonally, is wholly below the grinding-plane of the molars. It looks still more depressed in *Plagiaulax Becklesii*; but this is, in part, owing to the inflected margin of the angle being broken off in the fossil, while it is entire and salient in the recent form, thus elevating the condyle above the lower plane of the ramus, and leading to an appearance of a greater amount of difference than exists in nature †.

For my reasoning as regards the signification of the long neck or pedicle of the condyle, I refer the reader to my former communication (*op. cit.* pp. 269 and 275). It is there stated that the low position of the condyle "is counterbalanced by another character, of which, so far as I am aware, there is no example among any of the predaceous genera, either placental or marsupial, recent or fossil, namely, the long neck and horizontal projection of the condyle behind the coronoid," &c.; and further on I added that the "arrangement is equally without a parallel among the herbivorous or omnivorous tribes." This latter remark was premature. I was then acquainted with the Aye-Aye only through the figures given by Blainville ‡, in which the lower jaw is shown in opposition with the skull, thus concealing the coronoid, and its relation to the condyle. But if the accompanying figure (fig. 20) of the lower jaw detached be referred to, it will be seen that the condyle is not only below the level of the grinding-plane, but that it is projected a long way behind the posterior edge of the coronoid, exactly as in *Plagiaulax*, and on the same plan of construction, —the sole difference being that the sigmoid notch is shallow in the Aye-Aye, and deeply excavated in *Plagiaulax*. If the notch were deepened in the former, by removing the plate of bone behind and below the posterior edge of the coronoid, in the manner indicated by the dotted line (*f*), the resemblance would be complete. In order to place these facts of agreement beyond question, I give the following

* "La mâchoire inférieure, comme celle des autres rongeurs, se meut évidemment au moyen d'un condyle longitudinal, de manière à empêcher tout mouvement horizontal, si ce n'est de l'arrière à l'avant et *vice versa*." (Sandwith, Zoological Proceedings, 1859, p. 113.)

† In some of the families of the *Rodentia* the condyle is barely elevated above the grinding-plane of the molars. See Blainville 'Ostéographie: genus *Cavia*,' pl. 2. Figs. *Cavia Cobaya* and *C. Capybara*; genus *Hystrix*, pl. 2, and *Sciurus maximus*, pl. 1, while in others, e. g. *Castor*, both condyle and coronoid are well raised above the same plane.

‡ Ostéographie: genus *Lemur*, pl. 5.

measurements of the relative proportions of the lower jaw in the Aye-Aye and *P. Becklesii**:—

	<i>Cheiromys</i> Madagasc.	<i>Plag.</i> <i>Becklesii</i> .
	inch.	inch.
Length of jaw from condyle to incisive border.....	2·3	2·0
From condyle to posterior edge of coronoid.....	·6	·5
Height of jaw to summit of coronoid	1·2	1·0
Height of ramus in front of first true molar.....	·7	·6
Height of ramus behind the incisor	·65	·45
Height from condyle to a line dropped vertically behind last molar	1·25	1·05
Height from the latter point to posterior edge of incisor at diasteme	·8	·75

From these proportions it will be seen that both in *Cheiromys* and *Plagiaulax* the condyle projects behind the edge of the coronoid to the excessive extent of about one-fourth of the entire length of the ramus. Professor Owen meets the argument in my paper, by the assertion that the condyle of *Plagiaulax* is “pedunculate as in the predaceous marsupials.” If so, I invite him to adduce the instance, bearing in mind that the question here is one of degree. The lower jaw of a Tiger now before me measures 9·2 inches from the condyle to the incisive border, while the projection of the articular surface behind the fall of the coronoid does not exceed ·7 of an inch, or one-thirteenth of the length of the jaw. In *Dasyurus* and *Thylacinus* † the condyle projects behind the coronoid, but nothing approaching the extent seen in the Aye-Aye and *Plagiaulax*.

As regards the functional effect of the condyle being carried so far back behind the edge of the coronoid, it is a plain question of animal mechanics, which the author of the ‘Palæontology’ thus interprets: “It is pedunculate, as in the predaceous *Marsupialia*, whilst the lever of the coronoid process is made stronger by the condyle being carried further back than in any known carnivorous or herbivorous animal.” As I regard it, a necessary effect would be to restrict the power of separating the jaws in front, essential to a predaceous animal having laniary teeth constructed to pierce, retain, and kill. And we have the direct proof in the Aye-Aye, that the same arrangement there is not applied to a carnivorous function ‡.

* It must be borne in mind that fig. 1 of my previous communication (*op. cit.* p. 278), from which the measurements of *P. Becklesii* are taken, is *magnified* two diameters; the dimensions are therefore doubled. But this does not interfere with the ratios of proportion. Further, in the Aye-Aye the posterior margin of the coronoid is assumed to be continued down vertically, in order to get corresponding measurements. The dimensions of *Cheiromys* are of the natural size.

† In the Ursine *Dasyurus* (No. 1900, Mus. R. Coll. of Surgeons) the length of the lower jaw is 4·2 inches, and the projection of the articular surface behind the deepest part of the sigmoid notch ·4 inch., or about one-tenth of the entire length of the jaw. In *Thylacinus* (No. 1903 A of the same collection) the projection of the condyle is about one-eighth the length of the jaw. But in both these forms the posterior edge of the apex of the coronoid overhangs the condyle; while both in *Pl. Becklesii* and the Aye-Aye the articular surface of the condyle is removed about one-fourth of the length of the jaw behind the fall of the coronoid.

‡ In the typical *Carnivora* the fulcrum is a fixed point, the form of the glenoid

With reference to the angular process, I have nothing to add to what is set forth in my former communication. This process, which is a very constant character of the carnivorous jaw, is wanting as a salient apophysis in *Plagiaulax*, although well developed in the minute insectivorous *Myrmecobius*.

I have one remark more to make in reference to the form of *Plagiaulax*. Fig. 15 of my original description gives a representation of what remains of the lower jaw of *P. minor*, magnified to a scale of four diameters. The entire length of the specimen, including the six molars and premolars, together with the procumbent incisor (according to the metrical line *e*), does not exceed $\cdot 4$ of an inch, of which the six cheek-teeth united make only about two and a half lines ($\cdot 25$ inch). I ask any zoologist or comparative anatomist to look at it, and say whether the dental apparatus of this extremely minute creature is competent to perform the duties required of a predaceous carnivore. Magnitude in this case is an important ingredient, as it necessarily involves measure of force. Could *P. minor* have preyed on small Mammals and Lizards? Is it not more probable that this pigmy form was itself an object of prey in the Purbeck Fauna?

In the preceding observations I have gone *seriatim* into the objections raised against the view which I advanced of the affinities of *Plagiaulax*. In the work referred to, every detail of external form was regarded in a light different from that in which it was viewed by me; every inference was controverted; and the conclusion drawn from the whole was diametrically the converse arrived at by me. The verdict of Comparative Anatomists will decide which is right. I have reconsidered my first inferences, and tried to test their validity by the strongly contrasted and extreme view put forward by Professor Owen; and the result has been to confirm the opinion that *Plagiaulax* did not belong to a carnivorous type of Marsupials. Regarded morphologically, in the plan of its dental system,—rationally, through its condyle and correlated characters,—and empirically, by comparison with *Hypsiprymnus* and *Cheiromys*, it has led me, through every aspect, to this conclusion. Enough has been adduced in the foregoing pages to show that, to whatever family comparative anatomy may ultimately consign the genus, it must always be held to be a singularly modified form. I have directed attention to the numerous points of analogy between the lower jaw of *Plagiaulax* and that of the Aye-Aye, itself one of the rarest and most aberrant of existing

cavity preventing protrusion or retraction of the lower jaw; and the muscular power being applied close to the condyle leaves the free part of the lever longer, or, in other words, admits of a wider separation of the jaws in front, for the canines and cutting-teeth to act. In the Aye-Aye and Rodents (e. g. *Cavia* and *Hystrix*) the fulcrum is moveable, the condyle playing on a flat glenoid surface; the point of insertion of the muscular power is more advanced, leaving a short portion of the lever free, and thus restricting the aperture of the jaws. These conditions, combined with the oblique direction of the temporal muscle, implied by the reclining coronoid, conspire to produce the antero-posterior and lateral motions required by the regimen of these forms. The same reasoning applies to *Plagiaulax*.

Mammalia. They agree in the collateral position and upward direction of their strong incisors; in the depth and shortness of the horizontal ramus; in the backward continuation of the ascending ramus in the same horizontal line with the body of the jaw, and in the terminal position of the condyle,—the two latter characters not being found, so far as is at present known, in any other *Mammalia*, fossil or recent. They agree further in the form and direction of the articular surface, in the reclinate coronoid, and in the backward projection of the condyle behind it. The two jaws are on the same plan of construction. Starting from the deep narrow incisors of the Aye-Aye, carried back below the molars, the great depth of its jaw, and the other associated characters, can be seen to be in necessary correlation. In *Plagiaulax* they are all presented in a less degree of development. The resemblance goes no further. I doubt if in the fossil genus the lower incisors were opposed in the upper jaw by only two chisel-shaped teeth as in the Aye-Aye. In all the other dental characters they are widely distinct. In *Plagiaulax* the force of the dental system is manifested in the great development of the premolars, of which there are none, at least in the adult state, in *Cheiromys*, but a vacant bar instead. In the latter there are three molars, in the former only two. While, therefore, admitting that the common construction of the jaw involves some trait of habit common to the two and essential to their existence, it does not impress me with the idea of affinity. For the reasons which have led me to regard the nearest relationship of the fossil genus as being in the direction of *Hypsiprymnus*, I refer to my former communication *passim*, and to the preceding pages. Both genera appear to be Marsupial: their incisors are on the same morphological plan, and their premolars are in the main identical, except in point of number. The Aye-Aye is a nocturnal animal, which uses its strong incisors as a nipping-apparatus, for breaking and detaching bark and wood in pursuit of the larvæ upon which, in part, it is said to feed. One of the live specimens procured by Sonnerat, on the first discovery of this form, lived in captivity two months fed on boiled rice*. The species of *Hypsiprymnus* are strictly vegetable-feeders.

I shall adduce a celebrated case to show how little we should be authorized to pronounce with confidence on the nearest affinities of *Plagiaulax* from the small measure of evidence we now possess. The Aye-Aye (*Cheiromys Madagascariensis*) was discovered by Sonnerat before 1782. The elder Geoffroy and Cuvier placed it among the Rodents. In 1816, Blainville submitted the skull and teeth, together with the bones of the fore-arm, to a rigorous examination, and convincingly pronounced the Aye-Aye to be a Lemurine Quadrumane.

* "Il a vécu près de deux mois, n'ayant pour toute nourriture que du riz cuit; il se servait, pour le manger, de ses deux doigts comme les Chinois, de baguettes." (Sonnerat, quoted in Buffon, Supplement, tom. vii. p. 268.) The early account of the French traveller has been confirmed by the later and excellent observations of Dr. Sandwith, who fed his captive Aye-Aye upon bananas and dates, the latter of which he took to with great relish, gnawing the larvæ of insects out of the branches of trees, and feeding on them when he had the opportunity. (Sandwith, Zoological Proceedings, 1859, p. 113.)

Notwithstanding the evidence supplied by the brain-case, teeth, and bones of the fore-arm, Cuvier persisted in regarding the animal to be a Rodent, and in the 'Règne Animal,' of 1829*, he places it between the Squirrels and Marmots. If, with such a full measure of evidence before him, the position of *Cheiromys* in the natural system was so long erroneously contested by Cuvier, how little warranted should we be to pronounce dogmatically upon the food and habits of *Plagiaulax* from the slender evidence of the lower jaw! Supposing that *Cheiromys* were only known to us through its mandible, what would now be its inferred position among the *Mammalia*? While, therefore, regarding *Plagiaulax* to have been of a phytophagous type in its affinities, we should not be justified in affirming that it may not have been a mixed-feeder; it may have fed on buds or fruits, like the Phalangiers; or on roots like *Hypsiprymnus*; or on a mixed regimen of fruits and insects, like the Aye-Aye.

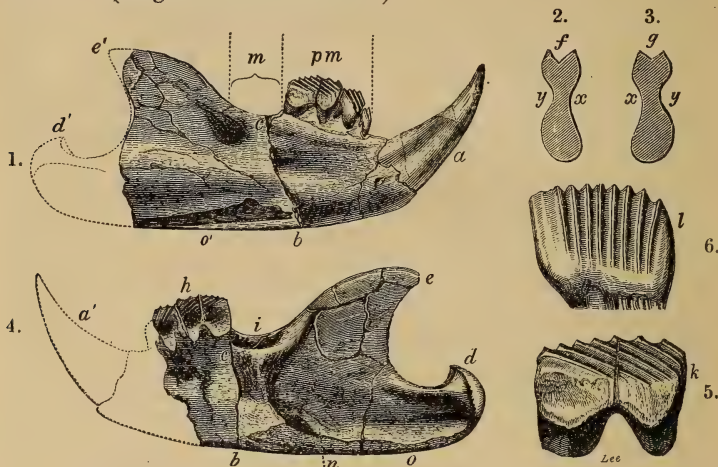
But I maintain that every argument which has been adduced by the author of 'Palæontology' to prove that *Plagiaulax* was carnivorous has been met in the preceding pages. The methods by which the opposite conclusions have been arrived at are as different as the results themselves. Professor Owen, in so far as his method is disclosed to us, has gone direct from the indications of form to the supposed function; and he claims for the inferences, that they are physiological deductions. Comparative anatomists will decide how far they are entitled to the name. Mere external form must be handled with caution as an instrument of research; signal mistakes in Palæontology have been committed through too confident reliance upon it. On the other hand, the method which I have attempted to pursue was, first to ascertain upon what morphological plan the teeth of *Plagiaulax* were constructed, and, having determined this, to supply the rest empirically by comparison with known forms, using at the same time rational analysis where it could be applied, *e. g.* to the condyle. The case is of sufficient interest and importance to test the sufficiency of the respective modes of analysis.

In the general remarks appended to my former communication, I called attention to the contradictory bearing of the dental system of *Plagiaulax* upon the assumption that the earliest Mammals had the full complement of teeth. To that fact may now be added the further evidence of specialization, in the analogy of its mandible with that of the Aye-Aye, one of the most exceptional of Mammals. If we cast a glance over the instructive table given in Lyell's 'Supplement' (page 23), and reflect on the interpretation of the hiatus between the Upper Oolitic beds and the 'Sables de Bracheux,' how vast the interval in time by which they are separated, and how modern in comparison the earliest of Tertiary Mammals! If, on the other hand, *Plagiaulax* be regarded through the medium of the view advocated with such power by Darwin, through what a number of intermediate forms must not the genus have passed before it attained the specialized condition in which the fossils come before us! What a variety of Mammals may we not hope to disentomb from

* *Op. cit.* p. 195.

Figs. 1–6.—*Plagiaulax Becklesii* (figs. 1–5), and *Hypsiprymnus Gaimardi* (fig. 6).

Figs. 1 & 4 show the entire *Right Ramus of the Lower Jaw of Plagiaulax Becklesii*, in two pieces, on reversed slabs of the same piece of matrix. (Magnified two diameters.)



[Figs. 1 & 4 represent the same right ramus of the lower jaw seen on the opposite surfaces of a split stone, the two taken together affording data for a complete restoration of the jaw.]

Fig. 1. *a b e'*. Outer side of the anterior portion of the right ramus of lower jaw; magnified two diameters. *a b*, outer side. *b o' d' e'*, impression of inner side.

a. Incisor.

b c. Line of vertical fracture behind the premolars.

d'. Impression in the matrix of the condyle.

e'. Impression of top of coronoid process.

o'. Broken-off inflected fold of inner margin buried in the matrix.

m. Place of the two molars.

pm. Three premolars, the third or last divided by a crack.

Fig. 2. *f*. Section of the anterior piece of the jaw at the fracture *b c*; *x*, inner surface; *y*, outer. The notch at the top is formed by one of the sockets of the double-fanged true molar.

Fig. 3. *g*. Section of the hinder piece near *b c*; *x*, inner surface; *y*, outer surface.

Fig. 4. *a' d*. Inner side of the posterior portion of the same lower jaw on the opposite slab of stone; *b d e*, inner side; *b a' h*, cast and impression of outer side.

a'. Outline of the incisor restored.

b c. Line of vertical fracture.

d. Condyle.

e. Coronoid process.

h. Impression of the three premolars on the matrix.

i. Empty sockets of the two true molars.

n. Orifice of dentary canal.

o. Indication of the raised and inflected fold of the posterior inner margin.

Fig. 5. *k*. Third or largest premolar, showing the seven diagonal grooves; magnified $5\frac{1}{2}$ diameters.

Fig. 6. *l*. Corresponding premolar in the recent Australian *Hypsiprymnus Gaimardi*, showing the seven vertical grooves; magnified $3\frac{1}{2}$ diameters.

Figs. 11, 12, & 13.—*Plagiaulax Becklesii*. *Fragment consisting of the anterior portion of the Right Ramus of the Lower Jaw*. Magnified 2 diameters.

Fig. 11. Outer surface.

Fig. 12. Inner surface.

Fig. 13. Vertical view, seen from above.

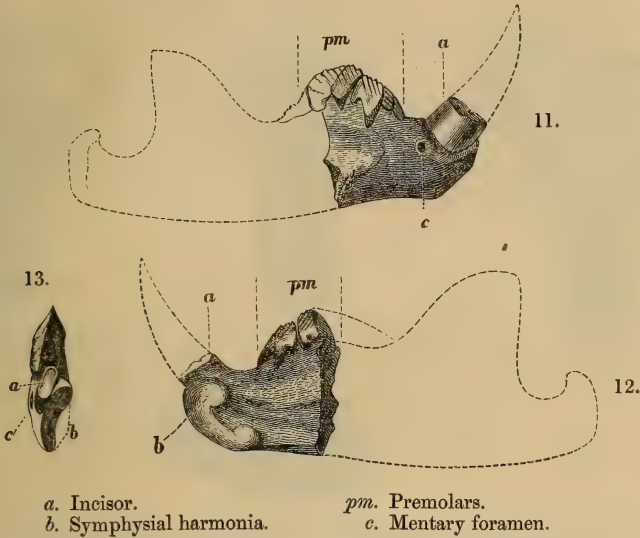
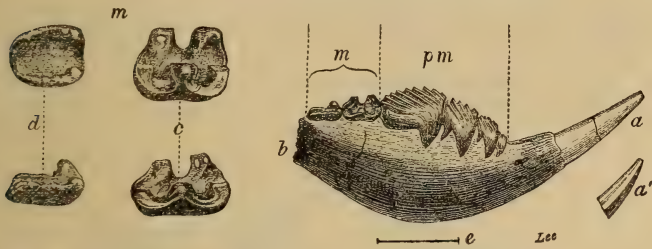


Fig. 15.—*Plagiaulax minor*. *Outside of the Right Ramus of the Lower Jaw; and the two Molars*. Magnified.



[All the teeth in this specimen are in place and well preserved. The hinder part of the jaw-bone, with the ascending ramus and posterior angle, are broken away.]

a b. Right ramus of lower jaw, with all the teeth; magnified 4 diameters.

a. Incisor with point broken off. a', impression of same, showing that the inner side near the apex was hollowed out in a longitudinal direction.

b. Offset of coronoid, the rest of which is wanting.

m, m. The two true molars.

pm. The four premolars.

c. The first molar; magnified 8 diameters. Upper figure, the crown. Lower figure, side-view.

d. Second molar; the crown and side-view.

e. The length of the jaw, natural size.

Figs. 16-19.—*Posterior half of a Carnassial Tooth* (pm 4) from the left side of the Lower Jaw of *Thylacoleo Carnifex*. (Preserved in the Museum of the Royal College of Surgeons.)

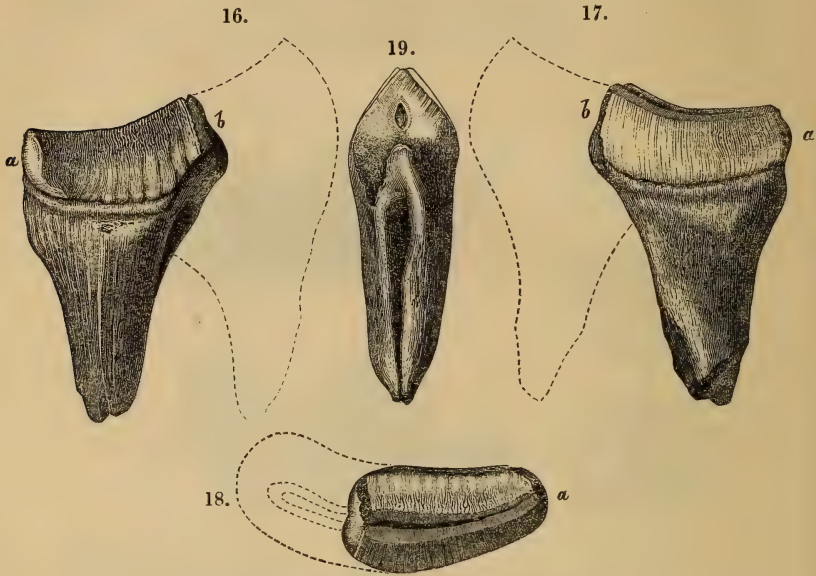


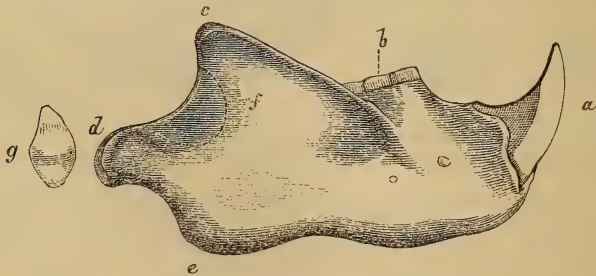
Fig. 16. Inner side. *a*, hinder end, showing the undulations of the enamel-surface on the base of the crown, and the rugosely reticulate surface below the summit. For comparison with figs. 5 & 6 (page 366); the same teeth in *Plagiaulax* and *Hypsiprymnus*.

Fig. 17. Outer side. *a*, hinder end.

Fig. 18. Top aspect, showing the undulations. *a*, hinder end.

Fig. 19. Section, showing the broken edge of the middle of the crown.

Fig. 20.—*The Right Ramus of the Lower Jaw of the Aye-Aye* (*Cheiromys Madagascariensis*); the outer aspect. Nat. size.



a. Incisor.

b. Molar teeth.

c. Coronoid process.

d. Condyle, having its articular surface below the grinding-plane of the Molars.

e. Angle of Jaw.

f. Conjectural dotted line.

g. End-view of condyle.