very dense, and rising with scarcely any noise, but very fast, up the almost perpendicular face of the hill, which rises to the height of 600 or 700 feet behind it. By a short circuit we got to the top of this cliff and could look down into the lake, but we saw only the windward half of it; underneath us was solid-looking steam, rising up to where we were standing. As seen from above, the lake looks like the bottom of a large crater two or three miles across, with high hills on three sides, but having the windward side (the south-east) open. There was no appearance of any old craters beside this; but all the eastern side of the hill that forms the northern boundary of the crater is full of little vents, which sometimes can all be seen smoking, but commonly only a few small puffs are visible from the sea. Three years since, flames were seen apparently rising from the place; and eight years since, the mountain was very active: large quantities of ashes fell at Mota, ten miles to windward, withering the leaves of some of the trees there. When we stood by the lake, we felt a slight trembling of the earth, but only when very near to it.

APRIL 8, 1868.

W. F. Webb, Esq., Newstead Abbey, Notts; The Rev. H. W. Crosskey, 10 Corunna Terrace, Glasgow; G. H. West, Esq., B.A., Christchurch, Oxford; T. Ainstie, Esq., B.A., C.E., Devizes; R. H. Brunton, Esq., C.E., 84 George Street, Edinburgh; and H. B. Woodward, Esq., of the Geological Survey of England, were elected Fellows of the Society.

The following communications were read:—

1. *On the AFFINITIES and PROBABLE HABITS of the extinct AUSTRALIAN MARSUPIAL, Thylacoleo carnifex, Owen.* By WILLIAM HENRY FLOWER, F.R.C.S., F.G.S., F.R.S., &c., Conservator of the Museum of the Royal College of Surgeons.

THE late Dr. Falconer, in a paper published in the Quarterly Journal of this Society for November 1862*, has given a masterly and detailed statement of the arguments which led him to infer that the small oolitic mammal, *Plagiaulax*, known only by its lower jaw, was a phytophagous or mixed-feeding animal, having its nearest allies among the recent *Hypsiprymni*, or Rat-kangaroos. This paper was written in consequence of Professor Owen having published his conclusion, from precisely the same data, that *Plagiaulax* was a "carnivorous marsupial," its teeth being fitted to "pierce, retain, and kill," and "cut and divide soft substances such as flesh."

As justly stated by Dr. Falconer, the interests involved in the case are important. "Are the indications of palæontology," he inquires, "more especially in its great stronghold in the mammalia—the teeth and correlated organs—so unstable and 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

* Quart. Journ. Geol. Soc. vol. xviii. pp. 348–369.

feeder, and the other that it was a predaceous carnivore? Or does the conflict of opinion arise from different methods having been followed by the observers in dealing with the evidence?" He concludes that the question will not rest in its present disputed state. "Other palæontologists will examine the evidence, and give their verdict."

For my part, I cannot hesitate to express my full conviction of the soundness of Dr. Falconer's views, as far as may be deduced from the evidence before us. There is one point, however, referred to incidentally but frequently in the course of his paper, on which I am obliged to differ from that distinguished palæontologist, without in the slightest degree wishing to impugn his well-known and justly esteemed acumen and discernment in such matters; for it is a point on which he had evidently never concentrated those powers of mind which led him to so logical a conclusion in the closely reasoned case of *Plagiaulax*.

This animal had been associated by Professor Owen with *Thylacoleo*, "a much larger extinct predaceous marsupial from Tertiary beds in Australia"*. Dr. Falconer, in his anxiety to show that *Plagiaulax* could not have been carnivorous, has endeavoured to separate it as much as possible from *Thylacoleo*, laying great emphasis on all the points of divergence that could be found between them. He was evidently under the impression that the latter had been proved to be a carnivorous marsupial, without staying to inquire into the arguments on which the assumption rested—the real fact, however, being, as I shall endeavour to show, that the affinities of *Plagiaulax* and *Thylacoleo*, correctly discerned by Professor Owen, tend rather to strengthen, instead of detracting from, Dr. Falconer's main argument.

The history of the last-named remarkable animal is as follows:—In a paper in the Philosophical Transactions for 1859 (p. 309), under the title "Description of a mutilated skull of a large Marsupial Carnivore (*Thylacoleo carnifex*, Owen) from a calcareous conglomerate stratum, eighty miles S.W. of Melbourne, Victoria," Professor Owen gave a detailed and illustrated description of a specimen, discovered by Mr. W. Adeney, and presented, in 1846, to the Museum of the Royal College of Surgeons, by Dr. Hobson, of Melbourne, proving beyond question its marsupial character, and stating that "the chief conclusion as to the affinities of the animal to which they the [fossil remains] belonged had been indicated by the term *Thylacoleo*, i. e. Marsupial or Pouched Lion," and that "amongst existing *Marsupialia* the *Sarcophilus*, or *Dasyurus ursinus*—at present the largest existing species of its genus—seems to me to have the nearest affinities to the *Thylacoleo*, although the interval be still very great between them." It was further stated in this paper, "From the size and form of the carnassials of *Thylacoleo*, especially the upper one, we may infer that it was one of the fellest and most destructive of predatory beasts."

In a later volume of the Philosophical Transactions (1866, p. 73),

* Owen, 'Palæontology,' 2nd edit. p. 354 (1861).

Professor Owen described and figured a more complete skull, belonging to "the same large carnivorous marsupial." The specimen was obtained from "that part of the freshwater deposits of Darling Downs through which the river Condamine has cut its bed." The additional evidence afforded by the more perfect condition of the specimen appears to have modified Professor Owen's views as to the affinities, though not as to the diet and habits, of the animal. "*Thylacoleo*," we now read, "exemplifies the simplest and most effective dental machinery for predatory life and carnivorous diet known in the mammalian class. It is the extreme modification, to this end, of the Diprotodont type of *Marsupialia*. Besides the full confirmation which the additional fossils here described give of the marsupiality of *Thylacoleo*, its closer affinities in that order are shown to be, not to the existing carnivorous marsupials, *e.g.* *Sarcophilus*, *Dasyurus*, *Thylacinus*, *Didelphys*, but to the Diprotodons, *Nototheres*, *Koalas*, *Phalangers*, and *Kangaroos*."

Beyond this incomplete cranium and mandible, nothing is at present known with certainty of the structure of this remarkable animal*. But from the information contained in the above-quoted memoirs, with some additional observations derived from the examination of some more recently received fragments in the British Museum, and part of a mandible (from the Wellington Valley) in the Museum of the College of Surgeons, the dental characters are sufficiently apparent to enable us to draw with tolerable certainty all such conclusions as to affinity, food, and general mode of life as may legitimately be derived from the study of this most important part of its organization.

The first subject upon which the attention will naturally be engaged when any new object of this nature is brought to light is a comparison with already known forms, with a view to ascertain to which of them it most nearly approximates. This inquiry must precede any purely deductive speculations as to its characters or purpose.

The most striking feature in the dentition of *Thylacoleo* (see fig. 1, p. 312) is the single huge compressed trenchant premolar† tooth in either jaw. This tooth alone, interpreted by a mere empirical comparison with teeth of known animals, appears sufficient to furnish the key to the whole question at issue. Professor Owen, naturally pursuing this method of proceeding, fixed upon the so-called "sectorial," or "carnassial" tooth of the Lion as its nearest similitude among mammalian teeth, and has ever since spoken of it as a "sectorial" or "carnassial," and assigned corresponding functions to all the other teeth. It was the examination of this same tooth, resulting in finding that it agreed more closely with a tooth of a very different animal, that has led me to another conclusion.

That the resemblance of the great premolar of *Thylacoleo* to the

* That the metacarpal bone figured in the Phil. Trans. 1859, pl. xiii. belonged to the same animal as the skull, is only conjectural.

† So called from its apparent homology with the posterior premolar of the recent marsupials.

"carnassial" of the true Carnivora is merely superficial is easily shown. Indeed the differences between the upper tooth, with its simple crown and "even and uniform" trenchant edge "describing a very feeble concavity lengthwise," and the trilobed crown of the Feline carnassial, and especially the absence of any distinct inner lobe or tubercle supported by a third fang, have been so clearly pointed out in the original description (Phil. Trans. 1859, p. 311) that little more need be said on this point. There is another striking difference in the lower tooth from that of the true Carnivora. As is well seen in the jaw in the Museum of the Royal College of Surgeons, in which the tooth is broken off rather below the base of the crown, it has two roots, of which the anterior is considerably smaller than the posterior, whereas in the lower sectorial tooth of the cats and hyænas, these proportions are always exactly reversed.

The differences which exist between these teeth of *Thylacoleo* and their supposed representatives in the implacental carnivora are still greater. Indeed there is no tooth, either of the upper or lower jaw, of any of the Thylacines, Dasyures, or Opossums that can be with any reason compared with them. When, however, we pass to another group of the same subclass, the *Hypsiprymni* or Rat-kangaroos (fig. 2, p. 312), we see at once in the great cutting premolar a miniature of that of *Thylacoleo*. The position in the jaws, the shutting of the upper tooth against the outer edge of the lower one, as shown by the wearing and polishing of the respective surfaces, the general character of the simple, compressed, trenchant crown, without any accessory cusps or tubercles, and the relative proportions of the anterior and posterior fangs of the lower teeth precisely correspond.

On comparing a large series of skulls of *Hypsiprymni* of different species it will be found that this tooth, though always retaining the above general characters, varies greatly in the details of its configuration and in relative size. In some species it is much larger in proportion to the size of the skull and the other teeth than in others. In some the internal and external surfaces are nearly flat, in others concave. The free margin in some is nearly straight, in others (and this is more often the case) more or less concave. Lastly, the vertical grooves and ridges on the sides of the crown, found in nearly all, vary greatly in number and character, being numerous, fine, regularly parallel, deeply cut, and closely placed in some, as *H. Gaimardii* and *H. Grayii*, or few in number and almost obsolete, as in *H. campestris*, *murinus*, and *rufescens*. Among all these modifications the corresponding tooth of *Thylacoleo* would easily find a place, although it agrees exactly with no one existing species. The vertical grooves and ridges, though distinct enough to show its adherence to the type, are as little marked as in some of the existing species mentioned above. In relative size it considerably exceeds even that of *H. rufescens* or *Dorcopsis Mülleri*.

To pass to the other teeth of *Thylacoleo*, the incisors in the upper jaw are three on each side, known only by their sockets and the broken stump of the first, which was clearly much larger than the other two; below there was a single large compressed inci-

isor close to the middle line, directed obliquely upwards and forwards. In the number and arrangement of these teeth, therefore, *Thylacoleo* corresponds exactly with the modern families *Macropodidæ* and *Phalangistidæ*, and differs completely from the carnivorous marsupials. The same may be said of the canines, which are entirely absent in the lower jaw, and represented above by a very small, simple, conical tooth (fig. 1, c), exactly as in the *Phalangistidæ* and the greater number of *Macropodidæ*, especially *Hypsiprymnus* (fig. 2, c). Between the canine in the upper jaw, and the great trenchant premolar, there are moreover two small simple teeth, with rounded crowns, which must be regarded as anterior premolars. In the presence of these teeth *Thylacoleo* differs from *Hypsiprymnus* and all the *Macropodidæ*; but in *Phalangista* one or more of such small teeth in front of the large posterior premolar (undoubtedly homologous with the great premolar of *Hypsiprymnus* and therefore probably with that of *Thylacoleo*) are the rule.

One of the most remarkable features in the dentition of this animal is the reduction in number and size of the true molars, of which but one is present in the upper, and two in the lower jaw. This reduction is evidently in relation with the excessive development of the great trenchant premolar. It is interesting to observe a tendency to the same occurrence in the recent allied forms. While in the true Kangaroos, where the premolar is relatively small, the true molars increase in size from the first to the fourth, in all the Rat-kangaroos, on the contrary, they decrease, and the last is always notably smaller than the others. In many species this is quite rudimentary; and it is occasionally altogether absent on one or both sides, reducing the number of true molars to three, as in specimens of *H. Ogilbyi* in the British Museum. The form of the molars differs greatly in different members of the *Macropodidæ*; but these teeth in *Thylacoleo*, in their rudimentary and stunted condition, offer no characters by which they can be compared very closely with any of the known forms.

There is nothing, in the structure of such portions of the cranium and mandible of *Thylacoleo* as are known, which belies the conclusions arrived at as to its affinities from the dentition. It differs much from any of the now existing *Macropodidæ* in the small relative size of the brain-cavity, and in the great development of the temporal ridges, which meet in the middle line at the top of the skull, forming a sagittal crest. This is probably only a difference of the kind always observable in comparing large with small species of a natural group, and not an indication of its affinity with the smaller-brained carnivorous Dasyures and Opossums. In the phytophagous Phalangiers, moreover, the sagittal crest is as strongly developed, and the brain-case almost as small as in *Thylacoleo*.

In the conspicuous development of the postorbital processes it differs from nearly all the members of the two families to which otherwise it appears most closely related; but some *Hypsiprymni*, as *H. murinus*, have such processes well marked; and their unimportance as a family character is shown in the Wombats, where they

Fig. 1.—*Thylacoleo carnifex*, restored. *One-third the natural size.*
From specimens in the British Museum and Museum of the Royal College of Surgeons.

The unshaded parts are conjectural. *c.* The canine. The small upper tubercular molar is concealed behind the large compressed trenchant premolar. The cutting edges of the premolars, especially of the lower one, are much worn.

Fig. 2.—*Thylacoleo carnifex*, restored. *One-third the natural size.*

Fig. 3.—*Rat-kangaroo*, *Hypsiprymnus Grayii*. *Natural size.* From a skull in the *British Museum*.

Fig. 4.—*Koala*, *Phascolarctos cinereus*. *A phytophagous Marsupial.* *Three-fourths the natural size.* From a skull in the *Museum of the Royal College of Surgeons*.

Fig. 5.—*Dasyurus ursinus*. *A predaceous carnivorous Marsupial.* *Three-fourths the natural size.* From a skull in the *Museum of the Royal College of Surgeons*.

are absent in one, and strongly developed in another species (*Phascolumys vombatus* and *P. latifrons*). The anterior part of the face, whether seen from above, the side, or in front, presents a stronger resemblance to the corresponding part of the Koala (*Phascolarctos*) (fig. 4, p. 313), and the Phalangiers of the subgenus *Cuscus* (especially *P. maculosa*) than to that of any other known marsupials.

The ascending ramus, condyle, and angle of the lower jaw are unknown; but one important and highly characteristic part is present in the specimen in the Museum of the Royal College of Surgeons, as well as in those figured (from a cast and photograph) in the Philosophical Transactions. This is the anterior boundary of the fossa for the insertion of the temporary muscle. The extraordinary depth of this fossa and its sharply defined, evenly curved, almost semicircular anterior boundary form one of the most distinguishing osteological features of the recent *Macropodidæ**. In the carnivorous marsupials, on the other hand, the fossa is comparatively shallow. In the Thylacine the prominent upper and lower margins, approaching each other at an acute angle, scarcely meet in front, and the fossa at this part passes insensibly into the outer surface of the horizontal ramus. In most *Dasyuri* and true Opossums the margin is much more complete; and the fossa is deepest and best defined in *Dasyurus ursinus*. In the Phalangiers, which are undoubtedly closely related to the Kangaroos in many parts of their organization, and which agree with them, generally, in the nature of their food, the fossa is as shallow as in the carnivorous Opossums, showing that its characters give little indication on which to found affinities in a broad sense.

Thylacoleo, in the regular wide curve and sharp definition of the anterior margin of the fossa, resembles the Kangaroos more than the Dasyures; but the shallowness of the fossa itself (deeper, however, than in any known carnivorous marsupial) decidedly shuts it out from the family *Macropodidæ* as ordinarily defined†. It is probable that herein, as in the additional small upper premolar teeth, it shows affinities with the Phalangiers. This character is certainly not in itself any evidence of its relation to the Dasyures.

As far, then, as the dental and cranial characters show, I think that there can be no question that *Thylacoleo* is a highly modified and aberrant form of the type of Marsupials now represented by the *Macropodidæ* and *Phalangistidæ*, though not belonging to either of these families as now restricted.

Although these relationships are not brought out in any detail by Professor Owen, and scarcely a single comparison is instituted with the skull or teeth of any phytophagous marsupial, the quotation given above from the second paper (Phil. Trans. 1866) shows that they have been fully recognized by him. It may therefore be assumed that these are admitted facts, and we may pass to the consideration of the evidence of the predatory nature of *Thylacoleo carnifex*. Why should this animal be branded with such a direful title?

* The Wombats present the same character in a modified form.

† *Diprotodon* also differs from the recent *Macropodidæ* in this respect.

The consideration of this subject involves a glance at the whole question, as to whether, and, if so, within what limits, the characters of an animal's teeth afford a guide to a knowledge of the nature of its food and general habits. Although it may be asserted broadly that certain strongly marked forms of dentition are constantly associated with the function of seizing and masticating certain kinds of alimentary substances, there are so many instances of allied animals having very different dietetic habits without any corresponding modification of dental structure (to take the well-known case of the Bears, for example), that too much caution cannot be exercised before pronouncing a positive opinion in regard to any newly discovered form the habits of which are totally unknown, as is necessarily the case with an extinct animal. I think, however, that the following proposition will be generally accepted as the first step in the process of forming a conclusion upon the subject:—That if all the known species of a large group of animals with teeth formed upon one peculiar type lead lives peaceable and inoffensive to their neighbours, and feed mainly on vegetable substances, the probabilities, in the case of any newly discovered species having teeth constructed upon the same general type, are greatly in favour of its having possessed similar habits, and been nourished by a corresponding diet.

To apply this to the present case, it is a well-known fact that all the animals belonging to the families *Macropodidæ** and *Phalangistidæ*†, including upwards of seventy species, are in the main phytophagous, feeding either on grass, roots, fruits, buds, or leaves, the larger proportion of them exclusively so, though a few (the arboreal Phalangers) are said also to partake occasionally of insects and small birds. Not one of the group is known to be exclusively carnivorous, or ever to attack or destroy animals approaching to itself in size.

The presumption in the case of *Thylacoleo* is, therefore, that it was also a vegetable feeder; and this presumption can only be overruled by pointing out some special modifications of its dental structure of such a nature and extent as to warrant our inferring a total subversion of the habits of its congeners.

In order to test how far such modifications have been shown to exist, I will cite Professor Owen's principal arguments for the predatory nature of this animal. "In existing carnivorous mammals," he says, "the ferocity of the species is in the ratio of the 'carnassiality' of the sectorial molar, *i. e.* of the predominance of the 'blade' over the 'tubercle'; and this ratio is shown more particularly in the upper sectorial, in which, as the tubercular part enlarges, the species becomes more of a mixed feeder, and is less devoted to the destruction of living prey. From the size and form of the carnassials of *Thylacoleo*, especially of the upper one, we may infer that

* Equivalent to Prof. Owen's division *Poephaga*, or "Grass-eating" Marsupials.

† Equivalent to Prof. Owen's *Carpophaga*, or "Fruit-eating" Marsupials.

it was one of the fellest and most destructive of predatory beasts." (Phil. Trans. 1859, p. 319.)

Again, "the size of the laniary canine in *Felis* being here transferred to the first incisor, its function as killer was similarly provided for by the approximation to the moving power, through the extreme shortness of both upper and lower jaws, especially anterior to the chief molar. In *Felis* the small incisors are very little in advance of the canine; this large tooth is almost at the fore part of both upper and lower jaws; and in *Thylacoleo* the relative position of the incisor tusk to the enormous temporal fossa is such as to give it the advantage of a harder or closer grip during the action of the powerful temporal muscles." And further, "the chief business of the teeth has been delegated to the tusks and carnassials; development has been concentrated on these at the cost of the rest of the normal or typical dental series. The foremost teeth seized, pierced, lacerated, or killed; the carnassials divided the nutritive fibres of the prey. *Thylacoleo* exemplifies the simplest and most effective dental machinery for predatory life and carnivorous diet known in the Mammalian class." (Phil. Trans. 1866, pp. 79, 80, 81.)

In the first place, it may be replied that the great cutting premolar of *Thylacoleo*, as has been already shown, bears no real comparison with the carnassial tooth of the Carnivora, but with the compressed premolar of the *Hypsiprymni*. It would certainly be to the purpose to prove that those Rat-kangaroos which have the largest development of this tooth show specially bloodthirsty inclinations, or have any greater preference for animal food than the rest; but I am unable to find any evidence to this effect. That their diet may be composed more largely of roots than grass and leaves is very probable; at all events, it is known that the members of the genus are generally more rhizophagous than the true Kangaroos; and this fact may perhaps afford some indication of the mode of life of *Thylacoleo**. The Phalangers of the section *Cuscus*, to which semi-carnivorous habits have been attributed, differ completely from *Thylacoleo* in the construction of the molars, and especially in having tolerably well-developed upper canines, though, as before mentioned, in some of the characters of the skull (the shortness of the muzzle, and verticality of the symphysis of the lower jaw, and consequently of the incisors) they are not so far removed from it. These latter common characters are shared, however, by the purely phytophagous and harmless Koala (*Phascolarctos*) (p. 313, fig. 4).

With regard to the second question, the peculiar adaptation of the greatly developed middle incisors to a predatory life, exactly similar views applied to *Plagiulax* were thus met by Dr. Falconer:—"Let us now test the opinion in its professed character as a physiological deduction. Throughout the Mammalia, where teeth perform the function of canines 'to pierce, retain, and kill,' they are held well apart through the interposition of a line of incisors, the end being ob-

* The Rat-kangaroos, like so many other animals, are almost omnivorous in confinement; but this circumstance affords little indication of their habits in their natural state.

vicious : 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 *Chiromys*. 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 therewith" (*op. cit.* p. 352).

It is certainly one of the most significant circumstances connected with the relation of dental armature to food and habits, that every known true predaceous carnivorous animal (by which I mean one which kills and eats creatures at all comparable to itself in bulk and capable of making any effectual resistance) has powerful and pointed canine teeth in both jaws, combined with comparatively small incisors, which diminish in size as they approach the middle line (see fig. 5, p. 313. A typical placental carnivore, as *Felis*, would have exemplified this even more strongly) ; and, moreover, this adaptive type of dentition is found equally well marked in animals having similar habits, both in the placental and implantal series, which differ so entirely in the far more fundamental or deep-seated conditions of organization, including the characters of dental development and succession*. This relation of canines to incisors is evidently more especially related to the predaceous mode of life than the characters of the molars. The compressed trenchant form of the crown of the carnassial tooth, for example, is a special peculiarity of the Cats and a few allied forms, and is not met with in any of the carnivorous Marsupials.

Now, to the above-described type of dentition, common to placental and marsupial carnivores, *Thylacoleo* presents no sort of an approximation : its lower canines are absent, its upper ones rudimentary and probably functionless ; its central incisors in both jaws were greatly developed. If such a dental machinery is of the most effective type for predatory life, Lions, Tigers, Hyænas, Wolves, Dasyures and Thylacines must all be ill-fitted for the part they have to play in nature's great arena.

There is certainly one group of flesh-eating animals, the Shrews and Hedgehogs, in which the type of dentition characteristic of the true carnivora is widely departed from, the development of the anterior incisors taking place at the expense of the lateral incisors and canines ; but the living prey of all these animals is comparatively small, feeble, and unresisting. They cannot on account of their habits any more than their structure be regarded as typically carnivorous : the *modus operandi* of the Hedgehog in snapping up and

* See Phil. Trans. 1867, part 2, p. 631, "On the Development and Succession of the teeth in the Marsupialia."

devouring a beetle is totally different from that of a cat in seizing and killing a rat or a rabbit; and the dental structure is suited to each case. In many of the smaller *Dasyures*, as well as in some *Lemurs*, which are more or less insectivorous in their habits, there is generally a tendency to enlargement of the central incisors.

There are also animals which, belonging to groups generally phytophagous, and with teeth constructed on much the same pattern as the rest, may on occasions be more or less predatory and carnivorous, as in the well-known case of the Rat, among *Rodents**. But then, how inferior is the development of these qualities in such an animal, compared with a true carnivore of corresponding size! How mild is the ferocity and destructive power of the most predatory of Rats compared with that of its enemy the Ferret!

The interpretation of the function of the hinder teeth of *Thylacoleo* is certainly not easy; as a herbivore with rudimentary true molars is almost as anomalous as a carnivore without canines. There is, however, no reason to suppose that the large trenchant premolars were not as well adapted for chopping up succulent roots and vegetables as for "dividing the nutritive fibres" of animal prey.

What was the particular form of food associated with the most singular dentition of *Thylacoleo*, it would be hazardous to do more than conjecture. As the flora of the country in which this strange animal existed has probably undergone as great a change as the fauna, it is not unlikely that the material upon which it subsisted has passed away with the creature itself. It may have been some kind of root or bulb; it may have been fruit; it may have been flesh. But the hypothesis that *Thylacoleo* was the destroyer of the gigantic herbivorous marsupials (many times as large as itself) with which its remains are found associated, the *Diprotodons* and the *Nototheres*, appears to me to require more proof than has yet been adduced in its favour.

What the remaining portions of this interesting animal were like, and whether its hind foot was constructed upon the syndactylous type with which the diprotodont form of dentition is at present always associated, remain to be proved by the result of further explorations in the country which has already yielded so rich a harvest of palæontological novelties. That the Posttertiary deposits of Australia should supply forms more or less allied to those now inhabiting the same land is only what might be expected; but that in the vastly distant ages of the deposition of the Purbeck, or still older Rhætic beds†, mammals should have existed with teeth constructed on the same or a closely similar and equally specialized type is a circumstance of much wider interest to the

* The fact that such exceptions occur only shows the caution that should be exercised in positively assigning a particular mode of life to an animal whose habits are unknown. We cannot by their aid justify an inference which is proved to be at variance with the larger proportion of known analogies.

† "On the Discovery of a new Fossil Mammal in the Grey Marls beneath the Bone-bed" (*Hypsiprymnopsis Rhæticus*), by W. B. Dawkins. Quart. Journ. Geol. Soc. 1864, p. 406.

geologist. I must remark, however, that, notwithstanding the resemblances pointed out so forcibly by Dr. Falconer, *Plagiaulax* appears to me to be, on the whole, further removed in structure from the existing forms than *Thylacoleo*; and as long as we have not the evidence that its cranium and upper teeth would afford, its affinities must be regarded as less definitely determined.

POSTSCRIPT.—Since the above was written, my attention has been called to some remarks “On the Dentition of *Thylacoleo carnifex*, Ow.,” by Mr. Gerard Krefft, the able Curator of the Australian Museum, Sydney, in the *Ann. & Mag. Nat. Hist.* vol. xviii. ser. 3, p. 148, 1866, in which he gives his opinion that “this famous marsupial lion was not much more carnivorous than the Phalangiers of the present time,” and adds a conjectural restoration of the then unknown anterior part of the skull and incisor teeth, which subsequent discoveries have in great measure confirmed.

2. *On the THICKNESS of the CARBONIFEROUS ROCKS of the PENDLE RANGE of HILLS, LANCASHIRE, as illustrating the Author's views regarding the “SOUTH-EASTERLY ATTENUATION of the CARBONIFEROUS SEDIMENTARY STRATA of the NORTH of ENGLAND.”* By EDWARD HULL, Esq., M.A. (Dublin), F.R.S., F.G.S., of the Geological Survey of Scotland*.

IN the following paper I purpose bringing forward some new facts recently ascertained in the district of Burnley and the Pendle Range, in confirmation of certain views advanced on a previous occasion, regarding the relative distribution of the “sedimentary” and “calcareous” strata of the Carboniferous series in the North of England. These views are published in the *Journal of this Society*†; and as introductory to the matter in the present communication I must ask permission very briefly to recapitulate them.

In the paper referred to, I endeavoured to prove that to the north of an old neck of land, or “barrier,” which stretched across the centre of England from Shropshire, and which was formed of Silurian and Cambrian rocks, the Carboniferous strata were deposited originally upon the following plan:—On the one hand, the calcareous member (the Mountain-limestone) attained its greatest vertical development along the northern flanks of this barrier in Derbyshire, and thence thinned away northward and westward, and, as had been long since pointed out by older geologists, became intercalated with sandstones, shales, and beds of coal in the North of England and Scotland, where it appears in its most debased and attenuated form; on the other hand, the sedimentary beds of sandstone, shale, &c. were deposited in greatest force towards the north-west, diminishing in thickness towards the south-east of England,—the development of the one set of strata being in the inverse ratio of that of the other.

* Communicated with the consent of the Director-General of the Geological Survey.

† Vol. xviii. p. 127.