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THE IDENTITY OF A SUPPOSED HUMAN MOLAR FROM THE WELLINGTON CAVES OF NEW SOUTH WALES.

By H. H. FINLAYSON.

(Plates xii-xiii; and Figure 1.)

In 1870 appeared the first publication of the finding by Gerard Krefft[1] of a portion of a human molar tooth in the Wellington Caves of New South Wales. After a period of uncertainty as to the exact circumstances of the find it was established that the fragment, though developed from its matrix shortly after its discovery, was originally embedded in the characteristic cave breccia in association with extinct marsupials such as *Diprotodon* and *Thylacoleo* at a period estimated by David[5] to be from 7,000 to 12,000 years ago.

Since its first identification the fossil has been written upon at greater or less length by Krefft[2] in 1874, Etheridge,[3] 1890 (who quotes the opinion of Pedley), Etheridge[4] 1916, David[5] 1923, and Anderson[6] 1933, all of whom have apparently accepted the human origin of the fragment, and Anderson's remark (op. cit.) that "it is one of the best pieces of evidence as to the early existence of man in Australia" embodies a view which seems to have been very generally accepted.

In a recent re-examination of the tooth by Dr. T. D. Campbell[7] its human relationships have been strongly contraindicated and at his suggestion I have considered *de novo* its possible relation to the lower mammals. To this end the morphology of the fragment and the type and sequence of the attrition which has produced its crown pattern have been minutely compared with all indigenous Australian mammals, with all introduced and domestic mammals, and with many exotic species as well, which could possibly yield a dental fragment of the size of the fossil. As a result there would now appear no reasonable doubt that the fossil is derived from the Pleistocene macropod *Macropus* (*Protemnodon*) *anak* Owen, a giant "Wallaby", remains of which are already known from the Wellington Caves, and which also occur in profusion in beds of similar and earlier age over a large part of eastern and south-eastern Australia.

Preliminary consideration of the general dental anatomy of the fossil brings one to conclusions which have an important bearing on the subsequent examination of its detail.

Regarded as a *molar*, its outstanding peculiarities are, firstly, its extreme functional brachydonty and, secondly, the simultaneous presence in juxtaposition upon the occlusal surface of large exposures of dentine, with broad major enamel features. While both these conditions may be found separately in several groups of mammals, their concurrence in one species is generally precluded by the structural ground plan of the tooth. In the great majority of molars reduction of the enamel of the wall of the crown to the relative level which obtains in the fossil, simultaneously reduces the occlusal surface to a featureless expanse of dentine, while the few forms among the polyprotodont marsupials and lower carnivores, in which the requisite degree of brachydonty pre-exists, are incapable of yielding the occlusal surface.

This fundamental peculiarity in the structure of the fragment early led the writer to abandon the "molar theory" of its origin altogether. On transferring attention to premolar teeth, close analogies in ground plan were discovered amongst the 3rd and 4th

premolars of the Macropodinae. Teeth of both these categories are, however, in the intact or moderately worn state, such as is usually seen, narrow and high-crowned with strongly developed trenchant and perforant functions, and therefore in marked contrast to the flat-surfaced triturating fossil. In much-worn examples, however, especially in P^4 of the upper series, this contrast disappears, and on examining large numbers of such, several examples were found to show patterns of the occlusal surface, very similar to that of the fossil. Further, a study of the successive stages of attrition through which such teeth have passed, correlates in the clearest way all the main structures of the fossil with their originating centres in the unworn seccator, and indicates that in many species of macropods its characteristic occlusal pattern must be produced as a transient and quickly obliterated phase.

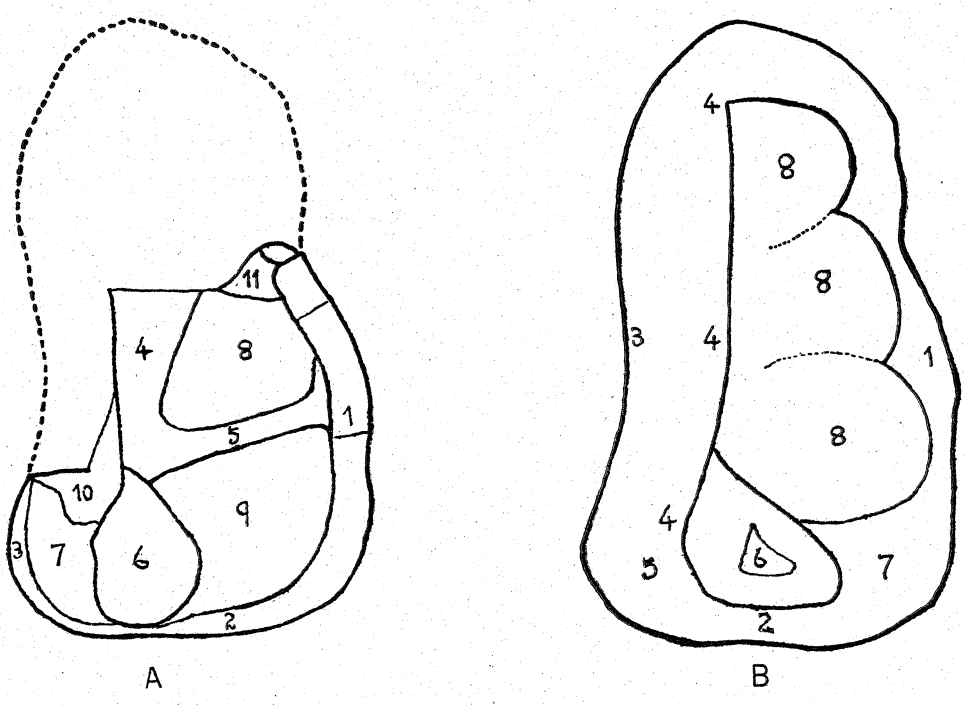

Figure 1.

Diagram correlating the main structures of the occlusal surface of (A), the fossil from the Wellington Caves, with (B) their originating centres in an unworn right upper fourth premolar (seccator) of a type found in *Macropus* (*Protemnodon*) *anak*.

(A). 1, enamel band of part of the lingual (internal) margin; 2, enamel band of the entire posterior (proximal) margin; 3, enamel band of part of the buccal (external) margin; 4, the cuneiform facet; 5, the transverse element; 6, the pyriform facet; 7, the reniform facet; 8, the anterior fossa; 9, the posterior fossa; 10, the second dentine exposure; 11, the third dentine exposure.

(B). 1, the lingual (internal) margin; 2, the posterior (proximal) margin; 3, the buccal (external) margin; 4, free crest of the main blade; 5, the posterior cusp of the main blade (postero-buccal cusp); 6, the posterior fossette; 7, the postero-internal or talon cusp (postero-lingual); 8, anterior, median, and posterior segments of the internal ledge.

The fossil, in the present view, represents the posterior half of the upper fourth premolar (seccator) of the right side of *Macropus* (*Protemnodon*) *anak* Owen in a very advanced state of wear. Among the teeth of *M. anak* which have been used for direct comparison, and in the figures of the same by Owen[8] and DeVis,[9] are several which qualify in dimensions and structure as potential originators of such a fragment, though none presents the requisite stage of wear. However, the existing Black Tailed Wallaby, *M.* (*Wallabia*) *ualabatus* L. and G., has a dentition similar to that of *anak*

both morphologically and in its attrition sequence, and has been available in sufficient numbers to yield both the crown pattern of the fossil and stages earlier and later than this, which are in close agreement with the examples of *anak* in hand.

In previous descriptions the cusp nomenclature and general orientation adopted have been based on or influenced by the assumption of its human origin and are unsuitable for illustration of the present conclusions. A brief redescription is therefore provided in which the orientation of the parts is altered to conform to this view of its identity, and in which general descriptive terms are employed to indicate the main morphological features of the fragment; these features are then homologized in detail with those of the macropod seccator in general and of *M. anak* in particular.

The fossil (Text-fig. 1A; Plate xii, figs. C, G; Plate xiii, figs. B, C, D) is a thin plate-like fragment of irregular shape, comprising portion of a crown of a tooth separated from its roots by a fracture through the cervix. Its transverse diameter from the buccal to the lingual margin near the posterior angles is 10·7 mm.; its maximum antero-posterior diameter is 11·1 mm.; and its maximum depth near the posterior angle of the buccal wall is 6·0 mm. Of these dimensions the first only is of value here as a specific test and it lies well within, though towards the upper limit of, the range of variation for this diameter in *M. anak* (*sen. lat.*). The outline of the crown from the occlusal aspect is bounded by fracture lines over most of the buccal and distal margins, but the remainder is intact and has smoothly rounded posterior angles, the whole rather suggesting derivation from a simple quadrate tooth, except that at the anterior lingual site the re-entrance of the curve is less than at the posterior angles and foreshadows an anterior extension of the tooth there. The marginal outline is very similar to that of worn examples of *anak*, except possibly for this same anterior lingual section which has a buccal inclination steeper than in examples which I have had in hand, though the condition is approached in one of Owen's[8] figures (Pl. lxxxvii, fig. 9). The discrepancy is less than would be inferred from a comparison of fig. D with fig. C of Plate xii, the margin in D being represented at a much higher level than in the fossil. It may be noted that in this detail the fossil may be nearer the third premolar of *anak* than the fourth, but as there is little else in support of such an identification, it is here ascribed to individual variation of the seccator.

Of the lateral walls of the crown both the posterior and lingual are complete vertically, being bounded below by the cervical dentine, and the posterior is complete horizontally as well. Both are of interest as illustrating the degree of denudation of enamel which has taken place, and the posterior carries an important attrition feature. The buccal wall is represented by a remnant only at its posterior extremity, and this shares the characters of the adjoining posterior wall.

The posterior (proximal) wall (Plate xii, fig. G) attains its maximum height of enamel (6·0 mm.) at the buccal angle, thence declining to a minimum of 2·0 mm. on the lingual side of the centre, and rises again slightly to 2·6 mm. at the lingual angle. Its occlusal profile is thus rather markedly concave, while the lateral profiles are both convex. At the cervix the junction with the dentine is a shallow sigmoid with its major convexity opposing the concavity of the free profile; in virgin or slightly worn seccators of most macropods this cervical junction is strictly transverse or nearly so (Plate xii, figs. E and H) and the sigmoid condition is definitely an age character (Plate xii, fig. F).

Nearly half of the surface of the posterior wall towards the buccal margin is occupied by an interdental attrition facet hollowed out into a shallow depression which is divided further by ridges of low relief into three compartments, the upper of which is scored by a series of minor parallel incisions. The feature differs markedly from the flat interdental facets commonly developed on the molars of many mammals, but is highly characteristic of the macropod fourth premolar. In the production of the usual type of facet between molars the teeth are opposed to one another on about the

same level and the planing effect is produced between two surfaces. In the macropod jaw, however, in adult life, the first molar abuts on a fourth premolar which has a much higher crown. The resulting interdental attrition takes the form of a gouging effect of the anterior rim of the molar upon the posterior wall of the premolar and tends to the production of shallow polished grooves, which vary markedly in pattern and site with the age of the animal. These variations are partly due to the different rates at which the crowns of the two teeth are reduced in height, partly to alveolar instability of the molar as age advances, but still more to the well-known slow forward movement of the whole molar series against the premolar. This results in the first molar being pushed across the rear wall of the premolar from the lingual to the buccal side, where (in a disintegrating state) it is finally shed. The facet tends to shift in the same direction, being usually found on the lingual side in young animals, where it is soon obliterated by the planing down of the occlusal surface, and in old age towards the buccal side, where it finds a permanent refuge after the molar has gone. The first and an intermediate condition are well illustrated by a slightly worn example of *M. anak* (Plate xii, fig. H) and the last by the fossil and an aged example of *M. ualabatus* (Plate xii, figs. G, F).

On the lingual wall (Plate xiii, fig. C) the enamel is deepest in the middle (3·2 mm.), declining to 2·5 mm. at the posterior angle and 1·8 mm. at the anterior; its occlusal profile is thus slightly convex. The enamel-dentine junction at the cervix is slightly concave to the occlusal. In the seccators of *M. anak* in hand, and especially in the example figured, the lingual wall is marked by a deep notch at the posterior third of its length, towards which the cervical enamel line dips from both sides; such teeth would scarcely be expected to yield the nearly rectilinear junction of the fossil, in which the notch is represented by a mere indentation. However, the detailed sculpture of the lingual wall in *anak* is apparently variable, as it is in some recent species. In an example figured by Owen[8] (Plate lxxxiv, fig. 15) the condition is substantially as in the fossil.

Towards the posterior margin of the fractured surface of the radical aspect of the fossil (Plate xiii, fig. B) a remnant of a pulp cavity persists in the form of a transversely elongate hollow of dimensions 5 × 1·5 mm. It is shallowest in mid-course, descending at either extremity to small outwardly diverging cornua, and is in close agreement with a corresponding cavity in a seccator of *M. anak* fractured at the same level.

The occlusal surface (Text-fig. 1, A; Plate xii, fig. C) has been planed down by wear to an almost flat triturating base which slopes from its highest point on the buccal margin to a slight antero-posterior trough lying on the lingual side of the central axis, thence rising slightly to the inner margin. In view of the degree of wear which it has sustained, it presents a surprising development of enamel structures which, though in very low vertical relief, are discrete and easily traced and, together with the areas they enclose, are of decisive importance in the identification.

Along the central axes of the plane lies a three-membered enamel structure of roughly trefoil pattern, raised noticeably above the surrounding areas. Although the three arms are conjoined at a common centre, they arise from functionally distinct portions of the original tooth and will be considered separately.

(1) A pyriform facet (Text-fig. 1A, 6) forms the posterior or proximal element of the trefoil and has its base on the posterior margin of the tooth and its apex at the common centre of the three. Its surface is highly polished and bevelled off by wear towards the postero-lingual angle, and its edges are sharply angulated but, except possibly to a small extent at its antero-buccal corner, have not been modified by fracture. At its postero-lingual angle its surface is marked by a shallow sulcate stigma. This characteristic feature of the fossil represents portion of the floor of the posterior

fossette (Text-fig. 1B, 6) of the original seccator, which is enclosed against the inner wall of the postero-external cusp of the main blade by a deep strongly marked enamel fold of V-shaped outline. The fossette occurs in the seccator of many species of macropods and is particularly well developed in *M. anak* and *ualabatus* (Plate xii, figs. D and A). The substance of the floor is dense and resistant and when the enamel walls are completely demolished it remains as a conspicuous disk raised above the surrounding surface. The stigma is a remnant of the deepest recess of the fossette which has escaped complete obliteration by wear, and is a familiar landmark in worn premolars in this group of marsupials, persisting as a pigmented spot towards the posterior margin of the tooth long after the facet as such has disappeared.

At the postero-buccal angle adjoining the pyriform is a reniform facet (Text-fig. 1A, 7) of about the same area, but much less highly polished and bevelled in a different plane. Distally it is bounded by a dentine exposure which also separates its upper course from the pyriform. It occupies the highest portion of the occlusal surface and together with the pyriform and dentine exposure represents an irregularly horizontal section near the base of the original jutting cone of the postero-external cusp of the main blade.

(2) The distal arm of the trefoil is a more elongate cuneiform facet (Text-fig. 1A, 4) lying on the same longitudinal axis as the pyriform. It is abruptly truncated by fracture at its distal extremity and bounded on its buccal margin by an exposure of dentine which has also been fractured. Lingually it is less distinct than the pyriform and tends to merge with the general contours of the anterior fossa. Its surface is bevelled at the same angle as the pyriform but in a plane slightly inclined towards the antero-lingual angle.

In species such as *anak* and *ualabatus*, which possess a continuous uncleft main blade to the seccator, a long faceted strip of enamel bounded by a dentine exposure externally is constantly developed in advanced wear on the posterior and median portions of the lingual slope of the blade (Plate xii, fig. B), and there can be no doubt of the derivation of the cuneiform facet of the fossil from such a strip by truncation distally by a fracture (Plate xii, fig. C).

(3) The transverse element (Text-fig. 1A, 5) is a narrow rib of enamel which passes across the longitudinal trough of the tooth from the junction of the two facets just noted to the lingual margin. Its course is slightly distal of the transverse and undulates with the contours of the trough. It is sharply defined on its posterior side, where it abuts on an area of dentine, but elsewhere merges in a wide enamel expanse, of which it forms the posterior boundary and with which its substance is continuous. It is highly polished but not faceted, except at the junction with the cuneiform facet. It is homologous with the distal sloping anterior wall of the postero-internal cusp or talon of the unworn seccator (Plate xii, figs. A, D) and represents a low level, almost basal section of that structure.

The depressed areas of the occlusal surface are divided by the above transverse element, which acts as a raised septum, into two fossae. The anterior fossa (Text-fig. 1A, 8), which is the shallower, is floored entirely by enamel which is integral with that of the cuneiform facet and the transverse rib, which bound it on two sides. Lingually it terminates in a tumescence abutting on the margin of the tooth, while distally it is open and confluent with a minor dentine exposure at the apex. This fossa represents the median third of the "internal ledge" of the intact seccator, in which it is the lowest portion of the occlusal surface. In the fossil it has sustained less change than any other part and vestiges of the coarse irregular ribbing of its floor, characteristic of *anak*, persist upon it as smooth convolutions.

The posterior fossa (Text-fig. 1A, 9) is entirely floored with yellowish dentine, the limits of which are clearly indicated by sharp discontinuities of its substance with the

bluish-white enamel which everywhere surrounds it. Its surface is scored by scratches, probably artificially produced. Its shape is characteristic and of much diagnostic importance—subquadrangular, with the postero-lingual angle suppressed and rounded and the others acute. In this form it may be recognized with certainty as a mere facet on the summit of the lingual angle of the postero-internal cusp or talon in the scarcely worn premolar of *anak* and many other species of macropods (Plate xii, figs. B and D). As it grows in area and deepens with wear its anterior boundary is thrust steadily forward, until the base of the talon wall is reached, when, as in the fossil, it presents virtually a horizontal section of the cusp near base level, 2 mm. above the cervix. Its characteristic shape is retained until the pyriform is engulfed, when it links up with a long strip-like exposure of dentine near the buccal margin, a fragment of which is preserved in the fossil (Text-fig. 1A, 10) and which is shown entire in Plate xii, fig. B. At a still later stage of wear, the dentine exposure of the buccal margin extends across the floor of the internal ledge and appears upon the lingual margin of the tooth. The fossil had reached this third phase and a small portion of this lingual dentine exposure is preserved at the antero-lingual angle of the fragment (Text-fig. 1A, 11).

Finally a conspicuous feature of the occlusal surface, though of less intrinsic importance than the foregoing, is the marginal enamel band (Text-fig. 1A, 1, 2, 3) which everywhere invests its boundary except where removed by the main fracture. It takes the form of a raised highly-polished, smoothly-rounded rim everywhere separated from the structures it encloses, by a hair-like fissure. It is broadest at the postero-lingual angle (1·6 mm.) and is constricted to 0·5 mm. by the interdental facet opposite the base of the pyriform. It is a familiar feature in much worn teeth of several categories in many species, especially after weathering, and in the Macropodidae, has been noted by DeVis as the "basal rim". It presents no features in the fossil which are at variance with the present identification.

While several points of minor discrepancy between the fossil and the corresponding teeth of *M. anak* which have been available have been brought to light by the foregoing examination, they are of no significance when measured against the general agreement in characters of major importance, and may fairly be placed to the account of individual or racial variation. Throughout this comparison *M. anak* has been used in *sensu lato* to embrace the whole *anak-brehus-raechus* complex of species or subspecies, as suggested by DeVis.[9] The geographical range of this complex in the Pleistocene is fairly closely paralleled by the present range of existing races of *M. ualabatus* which have a similar premolar dentition, and one in which variation is sufficiently wide to justify this view of the discrepancies.

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The identification of Krefft's find which is here advanced is necessarily inferential rather than absolute, but the inference is of the strongest and most acceptable kind.

In conclusion, I have to thank the Director and Trustees of the Australian Museum for the opportunity of studying the fossil, and to express my indebtedness to Dr. T. D. Campbell, whose stout and consistent rejection of the human origin of the fragment early brought a clarifying influence to bear on the work.

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EXPLANATION OF PLATES XII-XIII.

The teeth figured are upper fourth premolars of the right side, except for D and H of Plate xii, and A of Plate xiii, which represent the same tooth of the left side. In D and H of Plate xii the image has been laterally transposed to facilitate comparison.

PLATE XII.

Fig. A.—Occlusal aspect of the unworn tooth in *Macropus* (*Wallabia*) *ualabatus* (× 5·2).

Fig. B.—Occlusal aspect at an advanced stage of wear in *Macropus* (*Wallabia*) *ualabatus* (× 6·0). Illustrating the development of the characteristic attrition pattern of the fossil, in a much smaller recent species.

Fig. C.—Occlusal aspect in the *fossil* (× 3·0). (Australian Museum Collection, registered number, F1438.)

Fig. D.—Occlusal aspect in a moderately worn tooth of *Macropus* (*Protemnodon*) *anak* (× 3·0). Showing structural relations to the fossil (which has similar dimensions) parallel to those shown by A to B.

Fig. E.—Posterior wall and cervical region of specimen figured in A (× 7·0).

Fig. F.—Posterior wall and cervical region of specimen figured in B (× 6·2). Showing conditions in marginal profile, interdental facet and cervical junction, induced by wear and similar to those of the fossil.

Fig. G.—Posterior wall and cervical region of the fossil (× 3·2).

Fig. H.—Posterior wall and cervical region of the specimen figured in D (× 3·0). Showing relations to the fossil parallel to those of E to F.

PLATE XIII.

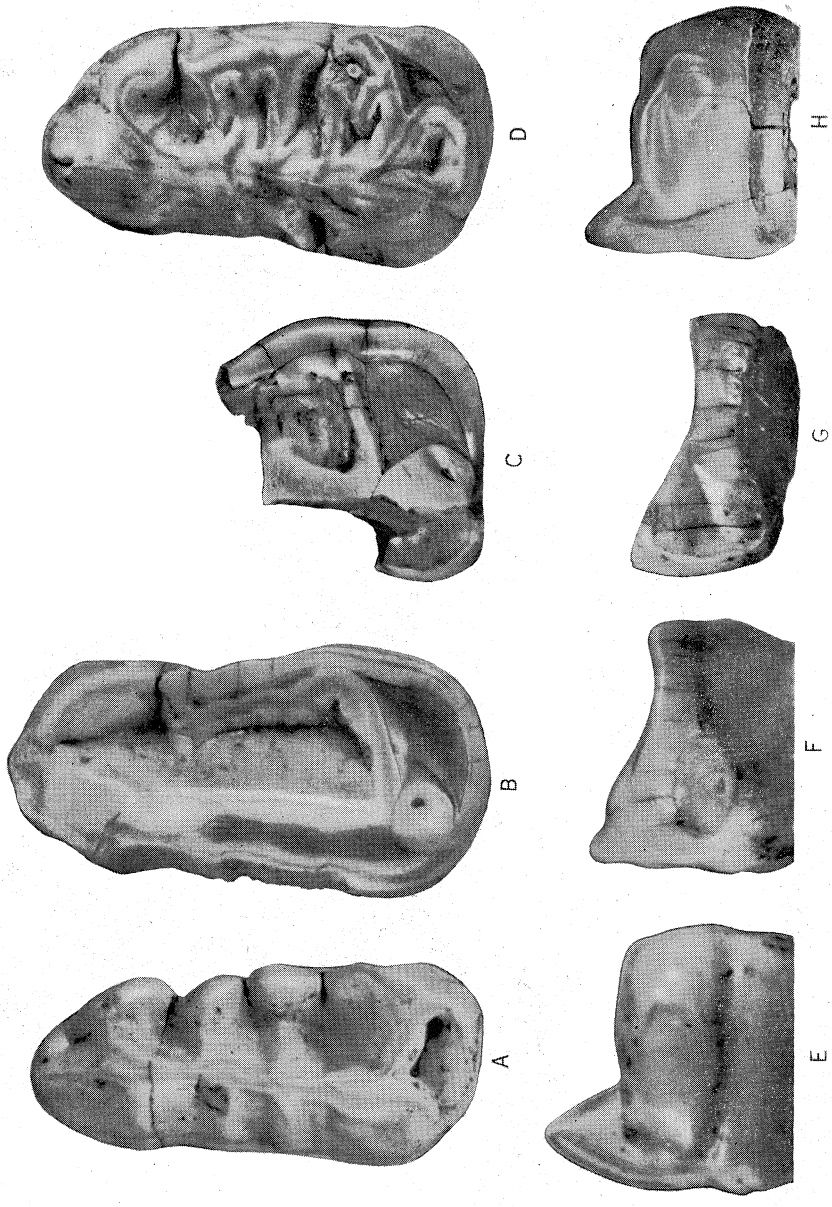
Fig. A.—Lingual aspect of the tooth in *Macropus* (*Protemnodon*) *anak* (× 3·0). Showing further the general characteristics of the tooth from which the fossil was derived by advanced attrition. (The view is sublateral to disclose the full height of the blade).

Fig. B.—Radical aspect of the fossil (× 3·0). Showing remnant of pulp cavity (oblique view).

Fig. C.—Lingual aspect of the fossil (× 3·0).

Fig. D.—Buccal aspect of the fossil (× 3·0).

Photos.—H. H. Finlayson.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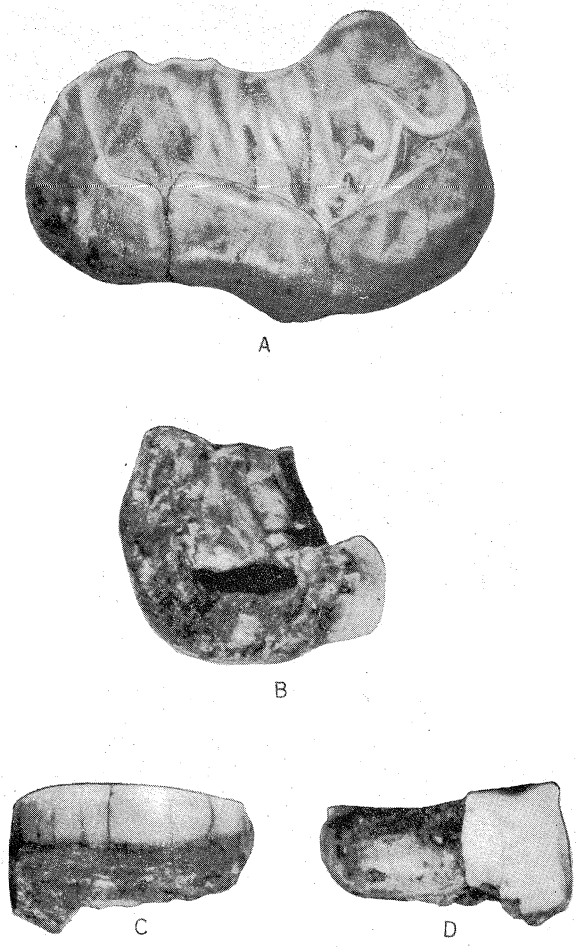
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