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REPORTS OF THE

PRINCETON UNIVERSITY EXPEDITIONS

TO PATAGONIA, 1896-1899

J. B. HATCHER
IN CHARGE

EDITED BY
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VOLUME VI,

PALÆONTOLOGY III

PRINCETON, N. J.
THE UNIVERSITY

STUTTGART
SCHWEIZERBART'SCHE VERLAGSHANDLUNG (E. NÄGELE)

1909–28

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VOLUME VI.

MAMMALIA OF THE SANTA CRUZ BEDS

I. TYPOTHERIA

BY

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PRINCETON UNIVERSITY

II. TOXODONTA
III. ENTELONYCHIA
IV. ASTRAPOTHERIA
V. PRIMATES

BY

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VOLUME VI—PALÆONTOLOGY

PART I. TYPOTHERIA OF THE SANTA CRUZ BEDS

BY

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(Pp. 1-110 Pls. I-XI)

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MAMMALIA OF THE SANTA CRUZ BEDS.

PART I. TYPOTHERIA.

BY

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INTRODUCTION.

PERHAPS no element in the Santa Cruz fauna has been less understood, or has given rise to more phylogenetic speculation than the Typotheria. These animals form a comparatively small part of the total fauna, only four genera occurring in the Santa Cruz formation, but what they lack in generic and specific diversity they make up in the abundance of individuals. Considerable variation, apparently individual in character, is observable and, with the fragmentary material hitherto available, it is not surprising that the number of species has been inordinately increased, no less than fifty-one being listed from the Santa Cruz alone.

Professor W. B. Scott has most generously placed at the writer's disposal for study and description the large collection of Santa Cruz Typotheria brought together in the museum of Princeton University by Messrs. Hatcher and Peterson. The writer is further indebted to him not only for many helpful suggestions, but for the use of notes and photographs of type specimens in the Ameghino collection. Through the kindness of Professor Henry F. Osborn it has been possible to study in connection with the Princeton material the Santa Cruz Typotheria of the American Museum of Natural History. A collection obtained from Dr. Ameghino of Buenos Aires, Argentina, by the Akademie der Wissenschaften at Munich, accompanied by his original manuscript labels, access to which was kindly permitted by Dr. F. Broili and Dr. Max Schlosser, has been especially valuable in working out the synonymy adopted.

With the exception of Plates IX and XI, the illustrations are by Mr. Bruce Horsfall, whose earnest coöperation has added in no small degree to whatever of interest and value the present memoir may contain.

CLASSIFICATION OF THE SANTA CRUZ TYPOTHERIA.

The Typotheria are grouped by Scott (1904, p. 590) as a suborder of the Toxodontia and may be defined as follows:

Plantigrade or digitigrade mammals with pentadactyl* or tetradactyl feet, strongly interlocking carpus, without os centrale, and serial or slightly interlocking tarsus with hemispherical astragalar head. Dentition usually complete but tending toward reduction of lateral incisors, canine and anterior premolars in specialized forms. Median incisor more or less enlarged and functional as a cropping tooth. Molars hypsodont, lophoselenodont in crown-pattern, curving inward above and outward below. A clavicle is present in some forms. Femur with third trochanter. Fibula articulating with calcaneum.

Two well marked families are recognizable among the Santa Cruz representatives of the suborder, for which the names Interatheriidæ and Hegetotheriidæ proposed by Ameghino may be retained, having priority. Each contains a large and a small form, of which the larger is the less specialized. The following key to the families and genera may be of use in facilitating the determination of new material:

Order TOXODONTIA Owen.

Suborder TYPOTHERIA Zittel.

A. Family: INTERATHERIIDÆ. Median incisors rooted; third and fourth premolars not completely molariform; squamoso-mastoid region dilated and cancellous; malar long and narrow, inclosed between temporal processes of maxillary and squamosal; maxillary orbital; carotid canal and foramen lacerum posterius fused; tibia and fibula unfused distally; pes paraxonic, digits II and V equally reduced and small, digits III and IV large and of equal length; astragalar trochlea bilaterally symmetrical; no naviculo-calcaneal facet; calcaneum with large fibular facet.

1. *Protypotherium.* Dental formula $\frac{3}{3}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$ in close series. Lateral incisors unreduced; canine incisiform; upper molars with deep internal inflection and slight antero-external ridges; $M_{\overline{3}}$ externally bilobate; temporal bar of maxillary with slight descending process; humerus with internal epicondylar foramen; terminal phalanges laterally compressed, hoofs, with slight clefts in manus.

(*P. australe*, *praerutilum*, *attenuatum*, Santa Cruz formation, Patagonia.)

* Ameghino figures a pentadactyl manus in *Pachyrukhos typicus* (1889, Pl. 13, fig. 14) and *Typotherium* (ibid., Pl. 18, fig. 5).

2. *Interatherium.* Dental formula $\frac{3}{3}$, $\frac{1}{1}$, $\frac{4}{4}$, $\frac{3}{3}$, with diastemata between the lateral incisor, canine and first premolar, varying with the species. I^{3} reduced, often wanting; upper molars with deep internal inflection and prominent antero-external ridges; M_{3} externally trilobate; temporal bar of maxillary with strong descending process; humerus without internal epicondylar foramen; terminal phalanges laterally compressed hoofs, with or without clefts.

(*I. robustum, extensum, excavatum,* Santa Cruz formation, Patagonia.)

B. Family: HEGETOTHERIIDÆ. Median incisor rootless; third and fourth premolars molariform; mastoid dilated inclosing a large hollow cavity; malar large, excluding maxillary from orbit; carotid canal and foramen lacerum posterius widely separated; tibia and fibula firmly fused both proximally and distally; pes approaching mesaxonic symmetry with digit III the longest, digit V greatly reduced and digits II and IV shorter than III, but robust; astragalar trochlea bilaterally asymmetrical; navicular and calcaneum in articulation; a small fibulo-calcaneal facet.

1. *Hegetotherium.* Dental formula $\frac{3}{3}$, $\frac{1}{1}$, $\frac{4}{4}$, $\frac{3}{3}$, I^{2}, ^{3} and $_{3}$ vestigial; canine vestigial; upper molars internally convex, without inflection except in M^{3}; ectoloph smooth; terminal phalanges greatly flattened transversely with conspicuous clefts.

(*H. mirabile,* Santa Cruz formation, Patagonia).

2. *Pachyrukhos.* Dental formula $\frac{1}{2}$, $\frac{0}{0}$, $\frac{3}{3}$, $\frac{3}{3}$. All the upper molars internally convex; ectoloph smooth; terminal phalanges hoof-like, without clefts in Santa Cruz species.

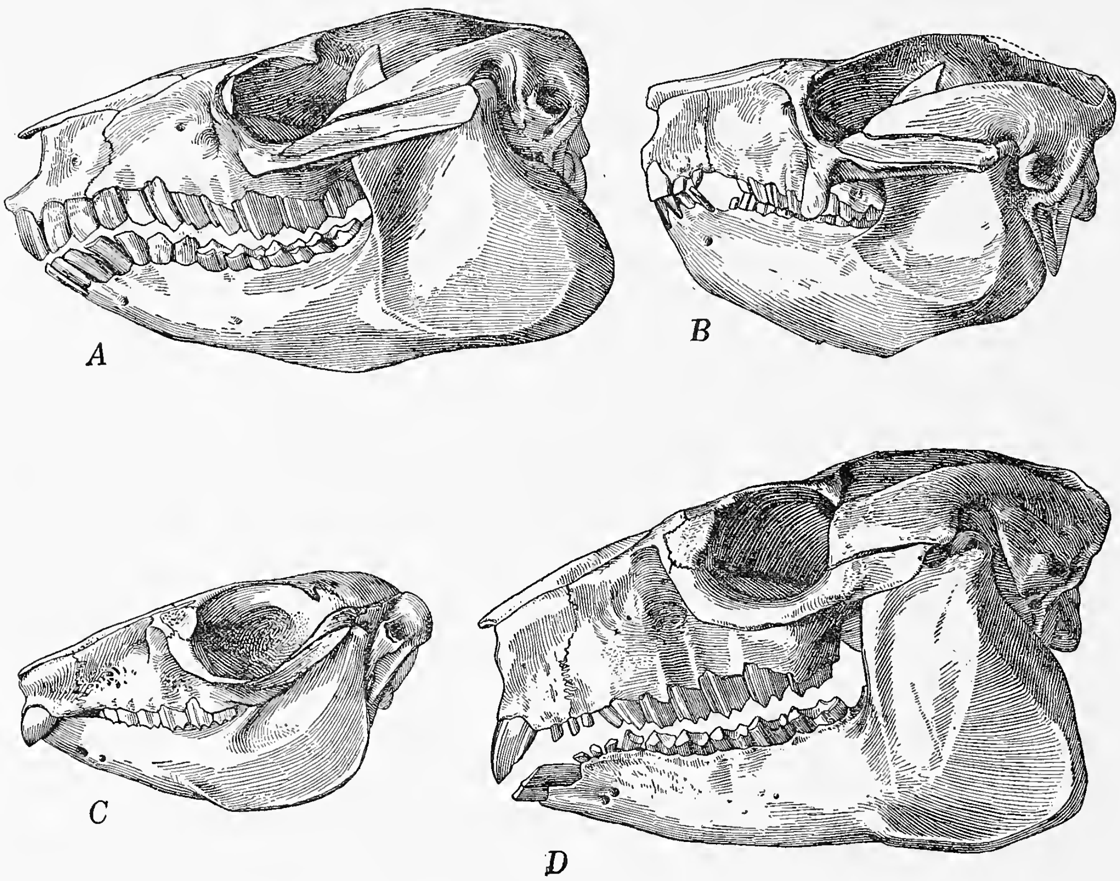
(*P. moyani,* Santa Cruz, formation, Patagonia.)

The Santa Cruz typotheres are animals of somewhat rodent-like appearance, varying in size from a cotton-tail rabbit to a cavy. A review of the more important skeletal characters of the group, although involving some repetition, may be of interest.

1. *The Skull.*—The facial portion of the skull is slender and more or less excavated longitudinally, while the cranium is broad and well expanded. The orbits are central, circular in outline, quite prominent in *Hegetotherium*, *Pachyrukhos* and *Interatherium* and unenclosed posteriorly. The arches are robust in all except *Pachyrukhos* and moderately expanded. The premaxillæ are short and heavy, with scarcely any ascending process, the nasals are broad posteriorly, tapering forward to blunt points, the interorbital tract is plane and the sagittal and lambdoidal crests low. The most prominent feature of the back of the skull is the greatly distended mastoid tract, which may either be filled with cancellæ or lodge a large cavity. In either case there is direct communication with the tympanic bulla and the dilatation appears to have functioned as a secondary resonator, perhaps associated with nocturnal habits. The palate is concave throughout, terminating posteriorly in a pair of stout processes. The mandible is heavy and deep without trace of suture in the firmly fused symphysis.

2. *Dentition.* — Beginning with the normal incisor formula in *Protypotherium*, the Santa Cruz typotheres show a well-marked tendency toward an increase in size of the median pair at the expense of the lateral incisors, the canine and the anterior premolar, until the extreme stage of reduction in *Pachyrukhos* is attained. The teeth approaching elimination are reduced to simple cylinders. It is not to be understood, however, that

Fig. 1.



Skulls of Santa Cruz Typotheria, three-fourths the natural size. *A, Protypotherium australe* (No. 9565, American Museum of Natural History collection); *B, Interatherium robustum* (No. 9263 American Museum of Natural History collection); *C. Pachyrukhos moyani* (reconstructed from several specimens); *D, Hegetotherium mirabile* (No. 15,542 Princeton University).

Protypotherium, *Interatherium*, *Hegetotherium* and *Pachyrukhos* constitute a phyletic series because they represent successive stages in this process of dental reduction associated with the hypertrophy of the median incisors. As already indicated in the generic key, two divergent lines are represented. A rather curious feature of the lower incisors in *Protypotherium* is the presence in the first and second of a deep median cleft (Pl. V, figs. 13, 14) producing a fork-like effect, resembling the somewhat similar subdivision of the lower incisor crowns in the Hyracoidea. In all the Santa Cruz typotheres the enamel layer on the enlarged incisors tends to be confined to the anterior surface of the crown. The molars in all the genera are constructed on much the same plan, but only in *Protypotherium* are absolutely unworn teeth known, consisting essentially of a broadly concave ectoloph (*e*, text fig. 5, *A*) and a pair of internally convex crescents (*ac*, *pc*, text fig. 5, *A*), of which the anterior horns are fused with the ectoloph, inclosing a reëntrant. A crista-like ridge from the ectoloph (*c*, text fig. 5, *A*) is separated from the anterior crescent by a deep notch. A slight ridge (*pp*, text fig. 5, *A*) blocks the shallow valley inclosed by the posterior crescent. As the tooth wears, the antero-external angle of the crown elongates and is channeled by a shallow groove, producing the ridges noted in the key to the genera.

In the lower molars the convexity of the crescents is reversed, so that the reëntrant fold is external (text figs. 1, *A*; 1, *D*; 6, *A*). A prominent lobe spanning the arc of the posterior crescent (*pp*, text fig. 6, *A*) is not peculiar to the teeth of the Typotheria alone, but is present also in *Nesodon* (text fig. 6, *B*), *Astrapotherium*, *Theosodon* and other extinct ungulates from South America. In the last lower molar the development of the third lobe present in *Interatherium* is accomplished by the deepening of the shallow groove indicated in *Protypotherium* at the point marked *pc* in text fig. 6, *A*.

As mentioned in the generic key, the premolars are sometimes molariform and sometimes not, differing from the molars in the latter case in having the anterior crescentic lobe smaller than the posterior.

Roots are developed only in the deciduous premolars, but as these have been observed only in *Protypotherium* and *Interatherium*, it is not altogether certain whether this character is of family or subordinal value. So far as can be ascertained, the crown-pattern seems to have been the same in the deciduous and permanent series, the milk-teeth resembling their successors. The order of replacement seems to have been the normal one.

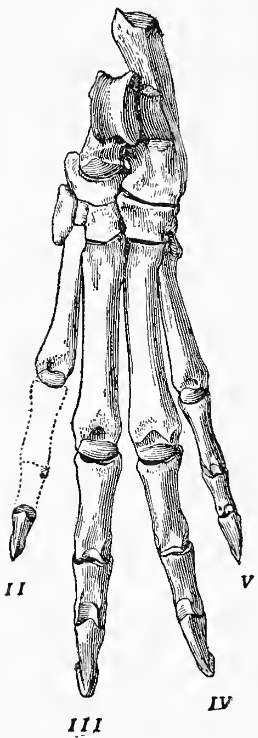
A thin layer of cement is usually observable on the molars and premolars of all the genera.

3. *Axial Skeleton.* — The dorso-lumbar vertebral formula in *Interatherium* is twenty-two, of which fifteen are dorsals. It was probably the

same in *Protypotherium*, but in *Pachyrukhos* eight lumbars are present. Five vertebræ are coössified in the sacral complex, of which three are true sacrals in contact with the ilium, and two belong to the caudal series. The length of the tail seems to have varied. In *Protypotherium* and *Interatherium* it is both long and heavy, while in *Pachyrukhos* there is reason to believe that it was quite short.

4. *Foot Structure.* — Almost nothing has hitherto been known of the structure of the feet in the Santa Cruz typotheres, but definite information is now available for all the genera except *Hegetotherium*, in which the manus is still unknown, but from the close resemblance of *Hegetotherium* and *Pachyrukhos* it is probable that it was not unlike that of the latter, which, in turn, does not differ materially from the manus of *Interatherium* and *Protypotherium* (text fig. 3, *A*). In the Santa Cruz forms both manus and pes are tetradactyl, without the slightest trace of an opposable thumb or great toe. The carpus is strongly interlocking, without free centrale. Two types of hind feet are developed (text figs. 2, 4, *A*) simulating the paraxonic and mesaxonic symmetry of the feet of the Artiodactyla and Perissodactyla respectively. These are probably to be correlated in the Typotheria with cursorial and saltatorial modes of progression. *Pachyrukhos* was certainly a jumping animal, as shown by the greater length and strength of the hind limbs and inner digits of the pes. In fact, the structure of both the fore and hind limbs in this animal closely resembles that of a hare. From the numerous structural similarities between *Pachyrukhos* and *Hegetotherium* it may be inferred that the latter was also saltatorial. Its broad, shallow astragalar trochlea is in contrast with the narrow, more deeply incised trochlea of the cursorial *Protypotherium* and *Interatherium*. Both of these genera have limbs of approximately equal length. The terminal phalanges in the Santa Cruz typotheres are hoof-like and in *Hegetotherium* have conspicuous median clefts.

FIG. 2.



Left hind foot of *Protypotherium australe*, three fourths the natural size. (No. 9149 American Museum of Natural History collection.)

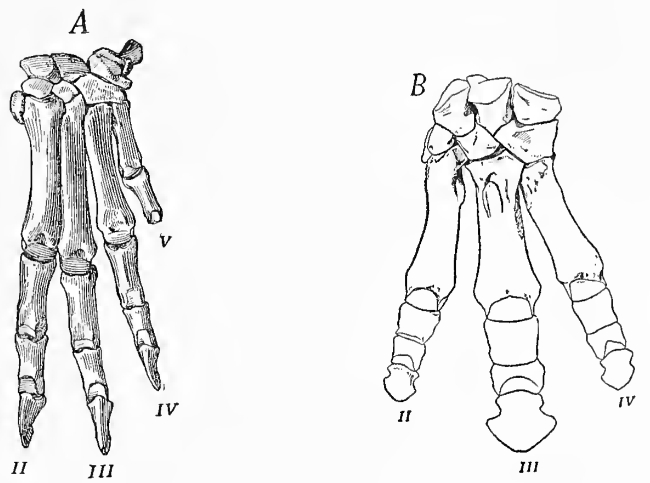
RELATIONSHIPS OF THE SANTA CRUZ TYPOTHERIA.

I. WITH THE TOXODONTA.

The Santa Cruz Typotheria represent a stage in the evolution of certain structures which is less advanced than that displayed by the contemporary Nesodons. This is especially true of the feet and teeth.

The feet of *Nesodon* (text figs. 3, *B*; 4, *B*) are tridactyl, with the axis passing through the third digit. The manus has been derived from a

FIG. 3.

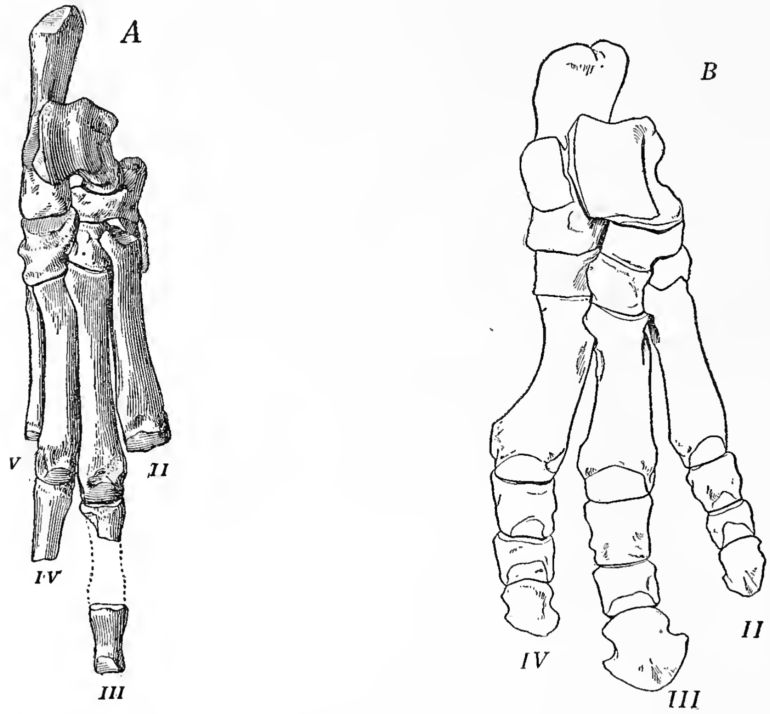


A, *Protypotherium australe*, left fore foot, × $\frac{3}{4}$ (No. 9149 American Museum); *B*, *Nesodon imbricatus*, left fore foot, about × $\frac{1}{5}$ (No. 15,460).

tetradactyl foot like that of *Protypotherium* (text fig. 3, *A*; Pl. V, fig. 3) or *Pachyrukhos* (Pl. X, fig. 14) by the loss of the fifth digit, a vestigial metacarpal V still remaining. The mutual relationships of the carpal and metacarpal elements are similar in both.

The three-toed pes of *Nesodon* (text fig. 4, *B*) is the outcome of a stage of digital reduction already well advanced in *Hegetotherium* (text fig. 4, *A*; Pl. II, fig. 19), attained by the complete loss of digit V and the fusion of the ento- and mesocuneiforms. The naviculo-calcaneal contact, overlap of metatarsal II on the ectocuneiform and the strongly interlocking proximal articulations between the third and fourth metatarsals (see Pls. II, fig. 18; V, fig. 2) are present in *Nesodon* as in *Hegetotherium*. In *Nesodon* the shortening of the neck of the astragalus and the increase in size of the fibular facet on the calcaneum are, perhaps, adaptations to the support of weight.

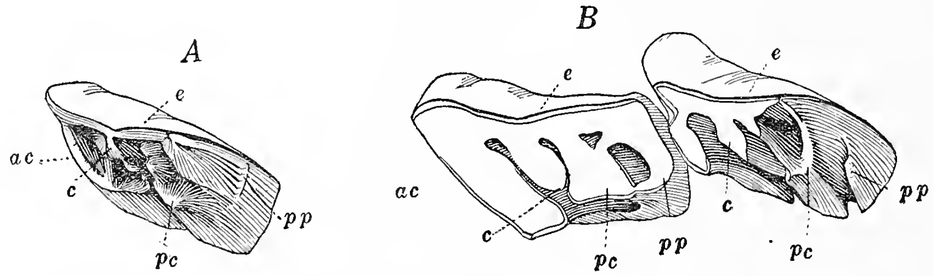
FIG. 4.



A, Hegetotherium mirabile, right hind foot, × ¾ (No. 15,542); *B, Nesodon imbricatus*, right hind foot, about × ⅓ (No. 15,460).

Although the molars of *Nesodon* (text figs. 5, *B*; 6, *B*) appear exceedingly complex, owing to the development of secondary enamel folds, the primary elements can be homologized with those displayed in the simpler crown-pattern of *Protypotherium*, as indicated by the similar lettering in the figures. This comparison cannot, at present, be extended to the other Santa Cruz genera, as unworn molars of *Hegetotherium, Pachyrukhos* and *Interatherium* are not available. *Nesodon* differs from the Typo-

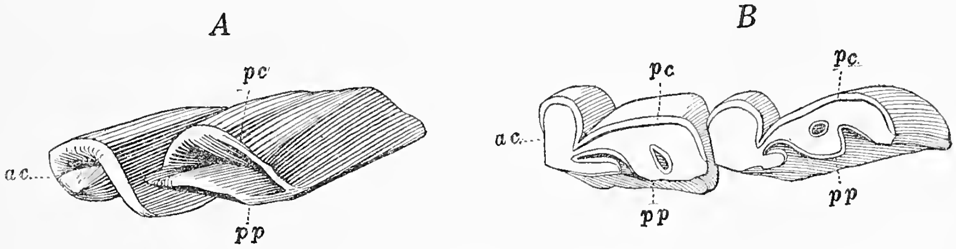
FIG. 5.



A, Protypotherium sp., unworn M$\frac{3}{}$, × $\frac{3}{2}$ (No. 9482 American Museum); *B, Nesodon imbricatus*, second and third upper molars slightly worn, × ¾ (No. 15,135). *ac*, antero-internal crescent; *pc*, postero-internal crescent; *e*, ectoloph; *c*, crista; *pp*, posterior pillar.

theria in having the second incisor above and the third below greatly enlarged and caniniform, while in the Typotheria the median incisor in both jaws is the only one tending toward great increase in size. In none

FIG. 6.



A, *Protypotherium* sp., unworn $M_{\overline{3}}$, $\times \frac{9}{2}$ (No. 9482 American Museum); *B*, *Nesodon imbricatus*, two lower molars, $\times \frac{3}{4}$ (No. 15,135). *ac*, anterior crescent; *pc*, posterior crescent; *pp*. posterior pillar.

of the Santa Cruz Typotheria is there any trace of a double deciduous dentition as in *Nesodon*.

From the resemblances in dentition and foot-structure already pointed out it may be inferred that the Toxodonta and Typotheria had a common origin, but the facts at present available do not justify a more extended discussion of relationships.

II. WITH TYPOTHERIUM.

Difficult as it is to ascertain the relationship existing between the Santa Cruz Typotheria and the Toxodonta, it is even more so to determine their degree of kinship with *Typotherium*, the ancestor of which would appear to be *Eutrachytherus*, as suggested by Ameghino. From their small size it is quite probable that none are in the direct line of descent culminating in *Typotherium*, and this seems to be borne out by a consideration of the degree of specialization in dentition and foot-structure which the latter displays. *Typotherium* is more specialized in dental structure, showing greater complexity of folding in the molar crowns than is attained by any of its Santa Cruz predecessors, but less specialized in foot-structure, possessing a pollex in the manus which has been lost in the most generalized of the Santa Cruz Typotheria (*Protypotherium*) and with digit V of the pes less reduced than in the most specialized of the latter (*Pachyrukhos*). A pollex is figured by Ameghino (1889, pl. 13, fig. 14) in the manus of *Pachyrukhos typicus*, but none has been found in any Santa Cruz specimen. The manus in *Hegetotherium* is unknown and the above statement regarding the degree of specialization in foot-structure displayed by *Typotherium* may, accordingly, require modification in the light of fuller knowledge.

III. With the Rodentia.

In many features of skull and skeleton the Typotheria resemble the rodents. This is most apparent in the specialized forms like *Pachyrukhos.* In none of the Typotheria are the following characters peculiar to rodents developed:

1. Persistently growing, chisel-shaped incisors ($I\frac{2}{2}$ of the permanent series, Weber, 1904, p. 480). $I\frac{1}{1}$ of the permanent series is enlarged in some of the Typotheria and may grow persistently, but is modified for cropping and not for gnawing.

2. More or less antero-posterior elongation of the mandibular condyle and corresponding modification of the glenoid fossa to permit backward and forward movement of the mandible. In the Typotheria the condyle is transversely extended, approximately circular in outline, with the glenoid surface flattened, and the movement of the mandible is from side to side.

3. Frequent outward curvature of the crowns of the upper molars and inward curvature of those of the inferior series in hypsodont forms. The reverse is true in the Typotheria.

4. Contact of ascending process of premaxillary with frontal. This process is short and robust in the Typotheria and is widely separated from the frontal by the maxillary.

5. Elongation of the mandibular angle. The angle is evenly convex in the Typotheria.

6. The rodent astragalus is characterized by a broad, short, rather shallow trochlea, with the crests sharp and equally developed, distinct neck and flattened head, convex distally; trochlea symmetrical to the vertical plane; fibular and internal malleolar facets vertical; body limited posteriorly; no astragalar foramen. In the Santa Cruz Typotheria, the astragalar trochlea is deeper than in rodents, the crests may or may not be equally developed and the head is globular without antero-posterior flattening. The symmetry of the trochlea with respect to the vertical plane varies in the different families (pp. 2–3). In the other characters they resemble the rodents.

7. The presence of a free centrale in the carpus in all rodents except the

Hystricidæ and *Cælogenys*, and the general fusion of scaphoid and lunar in all except the Bathyergidæ, Ctenodactilidæ and the Lagomorpha (Weber, 1904, p. 476). The centrale is always wanting in the carpus of the Typotheria and the fusion of the scaphoid and lunar does not occur.

8. Presence of a tibial sesamoid in all simplicidentate rodents. This is not present in the tarsus of the Typotheria.

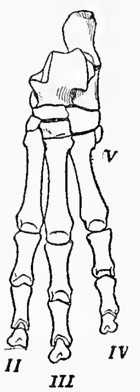
The Typotheria resemble rodents in the elongation of the anterior portion of the skull, with reduction in the incisor-canine-premolar series, in the enlargement and often permanent growth of the median incisors (not homologous with enlarged incisors in rodents, see under 1, p. 10), in the development of a mastoid dilatation, which may be filled with cancellæ (Interatheriidæ), as in many rodents, and connected with the auditory bulla, in the shape of the proximal articular surfaces between radius and ulna (see Pls. II, fig. 6; IV, fig. 16), in the broad, anteriorly directed transverse processes of the lumbar vertebræ and in several other characters of minor importance.

In view of the striking differences in structure indicated in the preceding paragraphs, it seems impossible to interpret these resemblances otherwise than as due to convergence.

IV. With the Hyracoidea.

Various writers have suggested a more or less intimate relationship between the Typotheria and the Hyracoidea, which the complete material now available has failed to substantiate. In the Hyracoidea the carpus is arranged on the linear plan with separate os centrale, while in the tarsus the astragalus differs from that of any other mammal in possessing a large step-like articulation for the internal tibial malleolus (text fig. 7). On the contrary, in the Typotheria the carpus is strongly interlocking, without centrale, and the internal tibial malleolus is applied to the lateral surface of the trochlea, with no trace of the supporting shelf characteristic of the Hyracoidea. The flat head of the astragalus and the articulation of the fibula with the latter element instead of with the calcaneum also serve to separate the Hyracoidea from the Typotheria. These differences in foot-structure are more than sufficient to offset similarities in the skull, which are confined to a few points, such as the cancellous dilatation of the mastoid, the shape of the posterior border of the palate and the increase in depth posteriorly of the mandible. In all living species of Hyracoidea the malar takes part in forming the outer portion of the glenoid cavity and the parietal enters into the postorbital process. Neither of these characters is exhibited by the Typotheria. Again, in the Hyracoidea, the first upper incisor of the permanent series is a persistently growing, downwardly curved tusk, triangular in section, while in the Typotheria this tooth, although growing persistently in some forms, is always antero-posteriorly compressed, transversely expanded and functional as a cropping tooth. The molars in *Procavia* are lopho-selenodont and either brachyodont or short hypsodont, while in the Typotheria they are extremely hypsodont, developing roots only in the deciduous series. In crown-pattern, they bear less resemblance to the teeth of the Hyracoidea than do the molars of the early horses and rhinoceroses, which differ from *Procavia* as fundamentally in foot-structure as do the Typotheria.

FIG. 7.



Dendrohyrax arboreus, left pes, dorsum, × $\frac{3}{4}$ (No. 365, Princeton University osteological collection).

The so-called Hyracoidea from the Fayum of Egypt (*Saghatherium*, *Megalohyrax*) are as yet known only from fragments of the skull and dentition. It would naturally be supposed that they should bear a closer resemblance to the Miocene Typotheria than to the recent hyraces, if the two groups are related. So far as the available material permits comparison, this is not found to be the case, the Egyptian forms showing no closer approximation to the Typotheria than do the modern hyraces.

Mr. Walter Granger has called the writer's attention to the apparently constant presence in the Hyracoidea, as well as in these so-called hyracoids from the Fayum, of a superior branch of the alveolar canal, which perforates the base of the coronoid process of the mandible behind the last molar, as in *Lepus* and the Santa Cruz diprotodont marsupial *Abderites.* Although thus shown not to be strictly confined to the Hyracoidea, this perforation is conspicuously absent in the Typotheria and may be interpreted as a further indication of their lack of Hyracoidean affinities.

Various pre-Santa Cruz genera (*Archæohyrax*, *Argyrohyrax*) have been referred to the Hyracoidea. The foot-structure of these is unknown, but the skull and dentition, in the writer's opinion, are not hyracoidean in character. Too little is known of these forms to warrant a discussion of their relationship to the Santa Cruz Typotheria, but from the available descriptions and figures and from such photographs of the type specimens as the writer has examined, they seem to be referable to the same suborder as the forms described in this memoir.

CONCLUSIONS.

The present investigation demonstrates, in the writer's opinion, that the Typotheria are to be regarded as a suborder of the Toxodontia, differing from the suborder Toxodonta, to which *Nesodon*, *Toxodon* and their allies are referable, in the more primitive structure of the teeth and feet. The origin of the group is entirely unknown, but was probably in South America. No complete phyletic series can be traced from its first appearance in the Notostylops beds to its disappearance in the Pampean. The Santa Cruz Typotheria are not ancestral to *Typotherium*. No rodent or hyracoid affinities can be claimed for them.

SYNONYMY.

In working out the synonymy adopted in the systematic part of this memoir the writer has depended largely on a series of photographs of the type specimens taken by Professor W. B. Scott and on the measurements given in Dr. Ameghino's published descriptions. The specimens in the collection of the Akademie der Wissenschaften at Munich are accompanied by Dr. Ameghino's manuscript labels and are practically cotypes. A large number of species which could not be identified with any of the material in the collections studied have been listed, at the end of the present memoir, as Typotheria Incertæ Sedis, but, as there explained, it does not follow that these are all invalid.

INTERATHERIIDÆ.

PROTYPOTHERIUM Ameghino.

(Plates III; IV; V; VI, Figs. 1–10, 14, 15; VII; Text Figs. 1*A*, 2, 3*A*, 4*A*, 5*A*, 6*A*, 8, 9.)

Protypotherium Amegh.; Catalogo de la provincia de Buenos Aires en la Exposicion Continentale Sud-amer., March, 1882 (*nomen nudum*); Observaciones generales sobre el orden de mamiferos estinguidos sud-americanos llamados Toxodontes (Toxodontia), etc., p. 52, 1887; Enum. Sistematica, etc., p. 15, 1887.

Toxodontophanus Moreno; Patagonia resto de un antiguo continente hoy submerjido, p. 23, 1882 (*nomen nudum*); Ameghino, Observaciones generales, etc., p. 64, 1887.

Patriarchus Amegh.; Contrib. al conoc. de los Mam. Fos. de la Repub. Argentina, pp. 480–481, 1889.

Of all the Santa Cruz Typotheria, *Protypotherium* is the least specialized in dentition and foot-structure, probably approaching more closely than any of the other genera the ancestral form from which the group as a whole originated.

Dentition (Pls. III, figs. 1, 3, 5, 6; IV, fig. 15; V, figs. 11–15*a*, 21, 22).—The dentition is complete and in close series in both jaws. The median upper incisors have broad, antero-posteriorly compressed, strongly curved crowns, covered externally with enamel, producing chisel-like cutting edges when worn. These teeth do not grow persistently, but have tapering roots. Externally, the crown is convex transversely, with a faint suggestion of a broad median groove on the anterior face. Internally, it is rendered concave by another broad groove. The second and third incisors are of about the same size. The unworn crowns are pointed, the point lying at the intersection of a prominent enamel ridge on the anterior face with the cutting edge of the tooth. The inner surface of the crown is flat in unworn teeth, but in worn specimens develops a median groove. The canine is incisiform and indistinguishable from the teeth in front. The incisors and the canine are inserted obliquely and imbricate, the posterior border of each overlapping externally the tooth next succeeding. The canine is lodged entirely in the maxillary. The premolars increase in size posteriorly, but none become completely molariform and all grow from persistent pulps. The first is approximately cylindrical in section, with a prominent ridge on the external face of the crown, which decreases in elevation toward the alveolar border and finally disappears, so that in the worn specimens the first premolar is a simple curved cylinder. A slight anterior ridge is observable in little-worn teeth corresponding to the first of the two external ridges in the remaining premolars. Internally the crown, if well worn, is convex antero-posteriorly, but in less worn teeth a shallow anterior groove is discernible. The second, third and fourth premolars may be described together. Each has a deep antero-external groove bounded by two ridges. In all the species represented in the collections studied these ridges persist, irrespective of the stage of wear attained. Internally, a groove, less deep than in the molars, divides the lingual aspect of the tooth-crown into a pair of crescentic lobes, of which the anterior is the smaller. The imbrication of the premolars and the succeeding molars is opposed to that of the incisor-canine series. The crown-pattern produced by wear is a shallow basin overshadowed externally by a high cusp marking the termination of the second of the external ridges, preceded by a smaller cusp at the termination of the anterior ridge, the deep notch between being produced by the external groove mentioned above. There are no specimens in the collection with unworn premolars, but in a young individual retaining the milk dentition (No. 9482 American Museum, Pl. V, figs. 11–14*a*) the first premolar, which is rootless and probably to be interpreted as belonging to the permanent series, is but little worn, showing two internal crescents, of which the anterior is the smaller and less perfect. With the exception of the deep groove inclosed between the anterior horn of the smaller inner crescent and the anterior margin of the ectoloph, and the prominent ridges formed by the same parts, the outer surface of the tooth is broadly concave. The molars decrease in size posteriorly, but are otherwise so much alike that all may be described together. Antero-externally, the ectoloph is rendered slightly undulatory by two ridges corresponding in position to the external ridges already described in the premolars, but less distinct and almost disappearing in worn teeth. Internally, the crown is divided by a reëntering fold into a pair of approximately equal lobes. On the margin of the ectoloph a series of cuspules is developed as a result of contact with the teeth of the lower jaw, each ridge on the ectoloph terminating in a cusp. A third cusp marks the junction of the posterior plane surface of the ectoloph with the triturating surface and in the third molar the elongated postero-external corner terminates in a fourth cusp. In No. 9482, American Museum, the third molar had not yet become functional. That of the left side (Pl. V, fig. 11*b*; text fig. 5, *A*) shows a broadly convex outer wall and two internal crescents joining the ectoloph anteriorly and overlapping posteriorly, giving rise to the deep internal fold. The central portion of the anterior crescent is partly united with the outer wall by a crista-like fold (text fig. 5, *A*, *c*). The margin of the ectoloph is serrate, with prominent anterior and less distinct posterior cuspules. The former persists as the cusp at the termination of the second external ridge; the latter is intensified by wear and becomes the third external serration mentioned above. The prominent antero-external serration exhibited in worn teeth is developed from the elongated antero-external angle and is not indicated in unworn molars. A thin layer of cement is quite generally present on the premolars and molars. The crowns of these teeth are characterized by a strong inward curvature, as in all the Santa Cruz Typotheria.

The median lower incisors (Pls. IV, fig. 15; V, figs. 13, 14, 22) are inclined forward obliquely, continuing the slope of the inner surface of the symphysis. The crowns of the first and second are cylindrical and symmetrically divided longitudinally by a deep cleft, producing a structure resembling the tines of a fork. A similar subdivision into three tines is observable in the lower incisors of *Procavia*. As the tooth wears, the cleft disappears completely. Apparently the incisors continue to elongate until the adult condition is reached, or even later, as the length of these teeth below the alveolar border is great, but the tooth does not grow persistently, becoming greatly constricted transversely toward the extremity of the root. The third incisor and the canine have broad crowns convex externally, but excavated internally by a broad groove, producing a serrate effect on the cutting edge. The bifurcation of the inferior incisors has been used as a character to separate the genus *Patriarchus* from *Protypotherium*, but as the bifurcation is present in all unworn teeth and absent in well worn specimens, with all transitional stages between the two extremes, and as there are no other characters of generic importance to separate individuals with this peculiarity well developed from those without it, *Patriarchus* cannot be regarded as a valid genus and is here made synonymous with *Protypotherium*. The third incisor overlaps internally on the second, the canine on the third incisor and the first premolar on the canine. The two teeth last mentioned are indistinguishable from each other structurally and in many specimens are of approximately the same size. The second premolar and the teeth succeeding are also inclined to the long axis of the tooth-row, but in a direction opposite to the incisors, canine and first premolar, the anterior margin of each overlapping externally the tooth preceding, instead of overlapping internally, as in the case of the teeth first mentioned. The second, third and fourth premolars increase regularly in size posteriorly, but none is completely molariform. Externally, they are rendered bilobate by a deep groove. Of the two lobes thus produced the posterior is the smaller. Internally, there is a deep groove opposite the external groove just mentioned and another broader but shorter furrow anterior to it, which disappears with wear, while the first persists, even in well-worn teeth, and is overshadowed anteriorly by a prominent ridge. The crown-pattern of the unworn premolars is well shown in No. 9559, American Museum, (Pl. V, figs. 15, 15*a*) the right ramus of a mandible, in which the second premolar is just erupting. On the external side, the otherwise convex crown is broadly grooved posteriorly, while internally it is rendered concave by the two grooves, already mentioned, of which the anterior in the unworn tooth is the broader, deeper, and more conspicuous. Consequent upon these grooves three serrations are developed on the sharp cutting edge of the crown, of which the second is the most prominent. Like the premolars, the molars are also bilobate, but the posterior lobe is larger than the anterior and in the third molar greatly exceeds the latter in size, with a faint trace of a broad external groove and a deeper, more persistent groove internally. The worn surfaces of the anterior and posterior lobes in the first and second molars are triangular in outline with elevated corners, inclosing a basin-shaped depression. This applies also to the anterior half of the third molar, but the posterior half is irregularly elliptical in outline and the depression on the triturating surface has its margins interrupted by the shallow grooves described above. Internally, the molars exhibit the same persistent groove, with anterior bounding ridge, as in the premolars. The ectoloph on either side of this groove is slightly concave. Both molars and premolars are hypsodont and cement-covered. In the immature individual figured on Plate V, figures 13, 14, the last molar is just appearing above the alveolar border and the tooth preceding it is but little worn. Each molar is composed of a pair of crescentic lobes concave internally. The anterior crescent is breached on the inner side by a broad groove corresponding to the shallow anterior groove already mentioned in describing the unworn premolars. The cutting edge of this crescent is sharp, forming a high external cusp. The anterior horn is recurved, terminating in a small blunt tubercle. The posterior horn is produced beyond the anterior extremity of the posterior crescent, giving rise to the persistent internal ridge and groove observable even in worn molars. The posterior lobe incloses a depression bounded by sharp edges, formed by the postero-external crescent and a long straight ridge (text fig. 6, *A*, posterior pillar) trending posteriorly from the anterior horn of the former. The depression inclosed by these elements rapidly disappears, leaving no trace of enamel lakes. The posterior lobe of the third molar differs from that of the second only in its greater length antero-posteriorly.

Milk Dentition (Pl. V, figs. 11–14.) — The milk-premolars may be readily recognized by the presence of roots. So far as can be ascertained, the order of replacement seems to be the normal one. In the dental series figured on Plate V, figures 11 and 12, the first and second permanent molars are in place and already somewhat worn, the first more so than the second. The third is just appearing below the alveolar border. Anterior to these are three double-rooted deciduous teeth. Of the two roots the anterior is the larger. $Dp^{\underline{4}}$ is almost completely molariform, showing the same arrangement of external and internal grooves as in the permanent molars. $Dp^{\underline{2}}$ and $dp^{\underline{3}}$ are deeply grooved externally, as in their permanent successors, but the groove is continued but a short distance above the alveolar border up the outer side of the anterior root. Internally, the crowns are slightly grooved, producing the same separation into anterior and posterior lobes as in the permanent premolars. $P^{\underline{1}}$ seems to have had no deciduous predecessor. The crown-pattern of the deciduous premolars (Pl. V, fig. 11*a*) is the same as that of their permanent successors, so far as can be determined from the partly worn teeth available for comparison. As already explained, this consists of a pair of internal crescents and a broadly concave ectoloph. The depressions inclosed between the crescents and the ectoloph are shallow and soon disappear. Only in little worn teeth are isolated lakelets, due to the partial obliteration of these depressions, observable on the triturating surface of the crown (Pl. V, fig. 11). Sufficient material is not available for determining the order of replacement of the incisors and canine.

In the lower jaw, the eruption of the true molars follows the same order as in the superior series. $Dp_{\overline{4}}$ is identical in pattern with the molars, while $Dp_{\overline{3}}$ and $Dp_{\overline{2}}$ resembles their permanent successors. As in the superior series, $P_{\overline{1}}$ appears to have been without a deciduous predecessor, as the little-worn tooth is hypsodont. The order of replacement of the milk dentition is believed to have been from behind forward, judging from the fact that $P_{\overline{2}}$ does not appear until some time after the eruption of the third and fourth premolars (Pl. V, fig. 15).

Skull (Plates III; V, fig 21). — There is little difference, apart from size, between the skulls of the various species, the specific characters depending more on dimensions than on structural peculiarities. In side view (Pl. III, figs. 1, 5, 6), the upper profile of the skull slopes forward gradually from the elevated parietal region, with a more abrupt slope backward, especially in *P. attenuatum*, in which the parietal tract is considerably elevated and globose. The orbits are central and widely open posteriorly, of moderate size and less prominent than in *Interatherium*, *Hegetotherium* or *Pachyrukhos*. The rostrum is laterally compressed and excavated longitudinally. The facial portion of the premaxillary is broad, with short ascending process and attenuated anterior extremity, terminating in a prominent anterior nasal spine. On the palatal surface, the incisive foramina are confined almost entirely to the premaxillæ, touching the maxillæ posteriorly along the line of the premaxillo-maxillary suture. The canine is implanted entirely in the maxillary, the suture between the premaxillary and the maxillary passing between the third incisor and the canine. The maxillary forms the entire lower surface of the zygomatic arch, supporting anteriorly a small descending process. It extends as far back as the posterior border of the glenoid cavity and forms with the malar a prominent buttress preventing the lateral displacement of the lower jaw. The maxillary enters also into the anterior and inferior boundary of the orbit. Its ascending process is acute and greatly prolonged, extending almost as far as the middle of the orbit, where it is received in a deep notch in the frontal. The facial expanse of the maxillary is broadly excavated horizontally. At the posterior margin of this excavation, the large infraorbital foramen perforates the base of the elevated orbital rim. Neither maxilla nor premaxilla is firmly united with the nasals, which, owing to a lack of support, are frequently crushed down into the narial chamber. The lachrymal is scale-like, with but little facial expansion. It supports a prominent tubercle, beneath which, on the orbital surface, is the lachrymal duct. A small "lachrymal" tubercle is present also on the maxillary (Pl. III, fig. 5). The malar is a long, narrow element confined entirely to the zygomatic arch, where it is supported beneath by the maxillary and is overlapped above by the temporal process of the squamosal. Anteriorly, it touches the orbital rim, while posteriorly it extends slightly beyond the maxillary process. The root of the temporal process of the squamosal and a large part of the cranial expanse of the same element are dilated and filled with cancellæ (Pl. III, fig. 7), the chambers communicating with each other as well as with the tympanic cavity. The dilatation is not confined to the squamosal but extends also to the mastoid, with which the former is closely fused, resulting in the inclusion of the external auditory meatus in a puffy mass of bone extending from the postglenoid process to the base of the paroccipital.

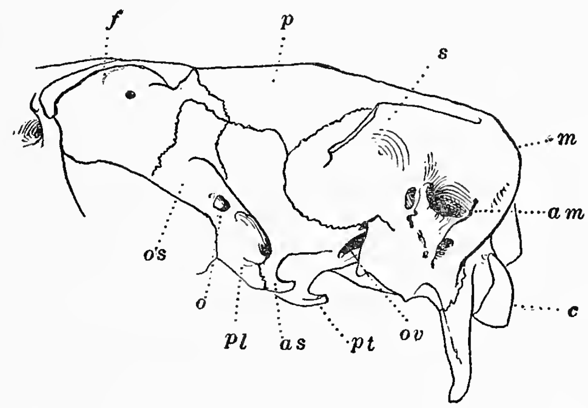
A view of the upper surface of the skull (Pl. III, fig. 2) shows that the nasals are long, broad behind, where they are in contact with the frontals, but tapering anteriorly to round points, which project slightly beyond the terminal narial opening. The nasals are convex in cross section anteriorly, but are excavated longitudinally farther back, producing a sigmoid cross-section. As previously explained, the nasals are but slightly supported on either side by the maxillary and premaxillary.

A more or less elongated frontal process extends between the nasal and maxillary, while a second process, in contact with the lachrymal, is applied to the outer surface of the ascending process of the maxillary, excluding the latter from the orbit. The interorbital tract is approximately plane (in some specimens slightly concave, but this may be due to crushing). It is slightly elevated in the region of the ascending maxillary processes and sometimes also along the line of the interfrontal suture, which is more or less persistent. The temporal ridges are low, but sharply defined, and converge rapidly to form a low but strong sagittal crest. The postorbital processes are long and pointed, the posterior border coinciding with the temporal ridges. Just back of these processes the brain case is greatly constricted, but rapidly expands posteriorly, and in *P. attenuatum* superiorly. The sagittal and lambdoidal crests join each other at a right angle. The latter bifurcates, sending one branch forward as the superior boundary of the temporal process of the squamosal and the other downward and forward over the inion to the base of the paroccipital process, bounding the lateral expanse of the distended squamosal and mastoid (Pl. III, fig. 2). The temporal fossa is continued backward to the lambdoidal crest as a deep trough floored by the parietal and squamosal. Many foramina pierce the latter element, unlike *Hegetotherium*, in which most of the foramina in this region perforate the parietal.

On the back of the skull (Pl. III, fig. 4) there is a large expanse of cancellous squamosal and mastoid, but so completely are these elements fused that the suture between them is not apparent. The supra- and exoccipitals are also fused. Dorsally, the supraoccipital is expanded, overlapping the mastoid and supporting prominent tubercles for the recti capitis muscles. About midway, the occipital plate is strongly constricted transversely, lodging the mastoid foramen on the suture between the mastoid and the occipital at the point of greatest constriction of the latter. Inferiorly, the occipital expands, supporting long fang-like paroccipital processes, the points of which curve forward. Above the foramen magnum the occipital surface is convex, sometimes broadly so, sometimes with a slight median keel. The condyles are oblique and semi-cylindrical in shape.

The palate (Pl. III, fig. 3) is concave in all dimensions, but less deeply so antero-posteriorly than transversely. The palatine extends as far

FIG. 8.



Protypotherium australe, zygomatic arch removed to show the arrangement of the cranial elements in the temporal fossa, × $\frac{1}{1}$. *am*, auditory meatus ; *as*, alisphenoid ; *c*, condyle ; *f*, frontal ; *m*, mastoid ; *o*, optic foramen ; *os*, orbitosphenoid ; *ov*, foramen ovale and lacerum medium ; *p*, parietal ; *pl*, palatine ; *pt*, pterygoid ; *s*, squamosal.

forward as the anterior lobe of M^1. Opposite the posterior margin of the last molar, it is constricted by deep notches, beyond which it expands again, terminating in a pair of triangular rugose processes formed in part by the palatine and in part by the alisphenoid. Each process is supported by a strong, transverse, plate-like buttress of the alisphenoid, the squamosal taking no part in its formation, unlike the structure of this region in *Hegetotherium* (cf. text figs. 8 and 13). The pterygoid is a small, thin plate, terminating in upwardly curved hamular processes. Between the pterygoid and alisphenoid plate is a deep fossa. In all the specimens examined the narial border has been injured and it is not possible to ascertain whether a posterior narial spine was present or not. Two posterior palatine foramina are present, the larger perforating the maxillary opposite the posterior lobe of the fourth premolar about half way between the base of that tooth and the median suture, while a second smaller foramen perforates the maxillo-palatine suture. The basioccipital supports a median keel, which does not extend beyond the suture between this element and the basisphenoid. The pear-shaped bullæ are hollow and are more or less completely fused with the basioccipital, producing a different arrangement of the cranial foramina in this region from that characterizing *Hegetotherium*. Anteriorly, where most prolonged, the bullæ are greatly flattened in the horizontal plane. The glenoid surfaces are almost flat, presenting downward and backward. They are separated from the postglenoid process by a wide fossa, accommodating the non-articular portion of the madibular condyle when the mouth is widely open.

Owing to the fusion of the basioccipital with the tympanic bulla, the carotid foramen is shifted posteriorly, fusing with the foramen lacerum posterius at the base of the paroccipital process. Traces of a septum dividing the two foramina are observable. Large condyloid foramina are present, in addition to which one or more small foramina pierce the basioccipital on either side of the median keel in line with the carotid-lacerum posterius foramina. A single large foramen (probably vascular) is lodged in the groove between the tubular auditory meatus and the dilated mastoid, while in *Hegetotherium* three or four foramina are present in this region. Two foramina, lying side by side, perforate the suture between the meatus and the postglenoid process (postglenoid foramina). The foramen ovale and foramen lacerum medium are confluent, with vestiges of a dividing septum. Within the orbit, a deep groove leads forward to the infraorbital foramen. Posteriorly the course of this groove is backward and downward, terminating in the posterior palatine notches. Vacuities within this groove communicate with the olfactory chamber. The foramen rotundum and spheno-orbital foramen are confluent. The posterior narial canal is connected with the spheno-maxillary fossa as in the hyraces. Several smaller foramina within the orbit are probably vascular.

Complete fusion of the opposite halves of the mandible has taken place, leaving no trace of suture (Pl. IV, fig. 15). The horizontal ramus increases suddenly in depth beneath the last molar and as suddenly decreases in depth posteriorly, producing a prominent convexity in this region, which is carried to a much greater extreme in *Interatherium*. The angular portion of the mandible does not project below this convexity. Posteriorly, the angle extends far beyond the condyle. The free border is strongly curved inward, inclosing a deep submaxillary fossa. The masseteric fossa is shallow, but its boundary is well defined and almost circular in outline inferiorly. The coronoid process is high, thin and sharply pointed, projecting far above the condyle. Its anterior border is S-shaped, and strongly inclined forward inferiorly. The condyles are broadly oval in outline, wider externally than internally and almost flat both antero-posteriorly and transversely. The articular surface presents upward and forward. Posteriorly, the capitulum supports a non-articular projection, which fits into the postglenoid fossa, preventing the backward dislocation of the mandible when the mouth is widely opened. A large mental foramen is present beneath the fourth premolar or the anterior lobe of the first molar, and one or two smaller foramina are in the symphysial region beneath the canine. On the inner surface of the ramus, the inferior dental canal is circular in outline, with a more or less well defined groove leading into it from above, a structure far more strikingly developed in *Hegetotherium*.

Vertebral Column, Ribs and Sternum.—The atlas (Pl. V, figs. 18–20) is characterized by broad transverse processes, with irregularly lobate free border, but little basal constriction and no canal for the vertebral artery. The neuro-arterial foramina are large and completely inclosed anteriorly by strong bony bars. The neural arch is wide, with a large median tubercle at its anterior margin. The narrow inferior arch also supports a tubercle at its anterior margin, but a much smaller one than that on the arch above.

The axis (Pl. V, figs. 16, 17) may be readily recognized by the small size of the arterial canal perforating the base of the transverse process. The neural spine is strong and hatchet-shaped, projecting beyond the centrum posteriorly, where it terminates in a point. This has been broken off in the specimen figured. The odontoid is flattened dorso-ventrally, its superior surface being flush with the floor of the neural canal, unlike *Hegetotherium*. Inferiorly, the centrum is keeled and supports a pair of tubercles at its posterior margin.

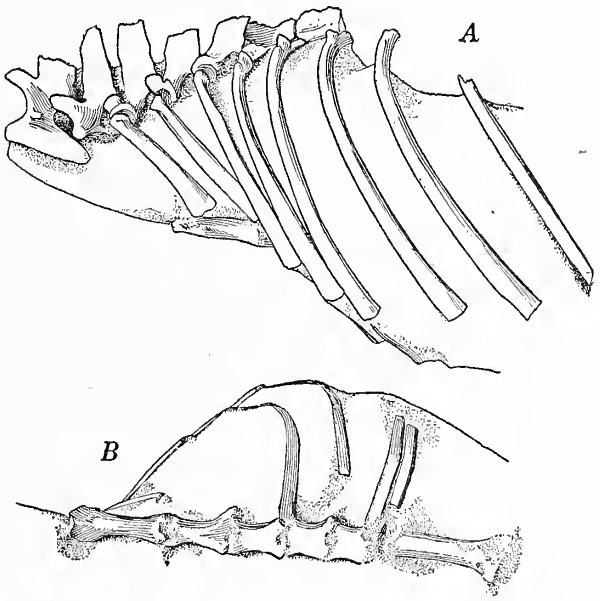
The centra of the third and fourth cervicals are also keeled, with similar inferior tubercles, but both keels and tubercles are absent from the posterior members of the series. The neural spines and transverse processes have not been preserved in the anterior cervicals available for study. In the sixth, the transverse process supports a large hatchet-shaped inferior lamina and a prominent diapophysis. The former is wanting in the seventh cervical and the diapophysis is greatly elongated.

No complete dorso-lumbar series is known, but, from analogy with the closely related *Interatherium*, it may be assumed with a high degree of probability that there were fifteen dorsals and seven lumbars. The anterior dorsals (Pl. VI, fig. 8) have high narrow spines strongly inclined backward, with the tips terminating in knob-like expansions. The spines of the posterior dorsals (Pl. VII) are wide antero-posteriorly, with obliquely truncated, dorsally flattened summits. The change from backward to forward inclination of the neural spines occurs at about the thirteenth dorsal. The spines of the anterior lumbars resemble those of the posterior dorsals, but increase in length and are more slender posteriorly. The transverse processes of the lumbars are broad flat blades, curving forward and downward. The width of these processes increases in the posterior lumbars. Prominent anapophyses are developed in the posterior dorsals and anterior lumbars, but decrease in size toward the end of the lumbar series. Large metapophyses and strongly interlocking zygapophyses are also characteristic of the posterior dorsals and lumbars (Pl. VI, figs. 10, 14, 15).

Three sacrals are in contact with the ilium and two caudals are fused with them, making five vertebræ in the sacral complex (Pl. VI, fig. 10). A dorsal intervertebral fenestra is present between the first and second sacrals. The remaining sacrals and the first and second caudals have the neural arch firmly fused, without trace of fenestræ. The neural spine of the first sacral is imperfectly preserved, but appears to have been similar to that of the posterior lumbars. The spines of the remaining members of the caudo-sacral series are solidly fused, as in *Interatherium*, forming a narrow plate, with the dorsal margin transversely expanded and flattened. The tail is known to have been long, eighteen free caudals being preserved with one specimen (No. 15,161). The proximal caudals have broad transverse processes and short, transversely compressed spines. Posteriorly, the spines rapidly decrease in height and the transverse processes elongate antero-posteriorly, but decrease in transverse diameter. Beginning with the seventh free caudal, the neural arch is greatly reduced and the transverse process limited to a small tuberosity at the anterior and posterior margins of the centrum. The distal caudals are mere cylinders, without neural arch or transverse process.

The ribs (text fig. 9) are slender, with little tendency toward flattening, even in the anterior members of the series. Distally, near the junction with the costal cartilage, the rib shaft expands slightly. The costal cartilages were calcified and are preserved in No. 15,352 (text fig. 9, *B*).

FIG. 9.



A, *Protypotherium* sp. Posterior cervicals and anterior dorsals with ribs in place, viewed from the left side, × $\frac{2}{3}$ (No. 15,352). *B*, the same from below, showing the sternum and calcified costal cartilages, × $\frac{2}{3}$.

The sternum consists of six pieces, of which four are mesosternal. The first sternal segment (figured separately in Pl. VI, fig. 7) is strongly keeled inferiorly in *P. australe*, but this keel is wanting in No. 15,352.

The mesosternal segments are hour-glass shaped, with the inferior surface flat. The xiphisternal segment is longer than any of those preceding. Its inferior surface is also flat. Posteriorly, the transverse diameter increases slightly.

Appendicular Skeleton.—Several more or less complete scapulæ of *P. australe* are in the collections, of which the best preserved is figured on Plate IV, figure 10. The coracoid border above the suprascapular notch is moderately convex throughout, the convexity continuing unbroken over the vertebral border as far as the inferior angle. The axillary border is also convex centrally, but immediately above the glenoid fossa and below the inferior angle it is concave. A high narrow spine is present, terminating in a slender acromion process and supporting a large metacromion, the distal portion of which has not been preserved. The body of the bone is very thin and has been slightly deformed by crushing, producing an undulatory surface throughout the floor of the supraspinous fossa. The infraspinous fossa is triangular in outline and deeply concave transversely. The glenoid surface (Pl. IV, fig. 11) is continued forward to the extremity of the large bicipital tubercle. Apart from this prolongation, the outline of the glenoid fossa is approximately circular. The margins are but little elevated. The fossa is slightly concave in all diameters. The coracoid process is short, with its free margins curved inward.

The proximal extremity of the humerus (Pls. IV, figs. 6, 7; VI, fig. 1) is the stoutest and heaviest portion of that bone. The head, which is hemispherical in shape, projects a considerable distance beyond the posterior margin of the shaft. The tuberosities are low, the greater tuberosity rising but little above the level of the head. It is separated from the lesser tuberosity by a broad bicipital groove. Antero-externally, the proximal surface of the shaft is flattened, supporting a broad triangular area, the apex of which is continued distally as the deltoid ridge. Some distance above the distal extremity of the deltoid ridge, on the inner surface of the shaft, is a prominent rugosity for muscular attachment, corresponding in position to the area of insertion of the coracobrachial muscle in the rabbit. The shaft is slightly curved antero-posteriorly and somewhat flattened laterally. The distal end is expanded transversely. The supinator ridge is very slightly developed, but the inner epicondyle is prominent and a large internal epicondylar foramen is present. The distal articular surface is characterized by the great prominence of the inner lip of the trochlea and the absence of any sharp demarcation between the latter and the capitellum. Posteriorly, both lips of the trochlea are sharp (Pl. IV, fig. 7), the inner exceeding the outer in elevation, but farther forward the outer lip terminates suddenly at the margin of the capitellar expansion (Pl. IV, fig. 6). No perforation unites the anconeal and coronoid fossæ.

The radius (Pls. IV, figs. 12–14; VI, fig. 2) is strongly curved antero-posteriorly. The shaft is elliptical in cross-section proximally, but distally it becomes wedge-shaped, the point of the wedge corresponding to the sharp interosseous margin, while the head of the wedge forms the convex anterior surface of the shaft. The head is oval, narrower internally than externally and slightly cupped for reception of the humeral capitellum. The inner narrower portion of the oval is occupied by a surface inclined downward and inward, slightly convex transversely and articulating with the inner portion of the humeral trochlea. A slight projection on the anterior margin of the radial head separates the margins of these two surfaces. The ulnar surface is slightly convex transversely and flattened vertically. The carpal articular surface is small in proportion to the width of the shaft at this extremity. It is irregularly oval in outline, concave in all dimensions and shows faint traces of division into two surfaces for the scaphoid and lunar respectively (Pl. IV, fig. 13.) The styloid process is quite short and inconspicuous.

The ulnar shaft (Pls. IV, figs. 16, 17; VI, fig. 3) is strongly curved laterally. The interosseous border is almost straight and strongly rugose, and the posterior border smooth and broadly sigmoid in outline. On the outer surface the shaft is excavated longitudinally for about half its length below the sigmoid cavity. The olecranon is heavy, posteriorly flattened and strongly rugose distally and projects as far forward as the coronoid process. The latter is quite sharp, the humeral and radial articular surfaces meeting at an acute angle, as in many of the rodents. Distally, the anterior margin of the shaft curves outward, leaving a flattened area above the radial facet (Pl. IV, fig. 16). The latter is convex from side to side and plane proximo-distally. In contrast with *Hegetotherium*, the styloid process is long, narrow and more sharply pointed.

The manus is tetradactyl, with interlocking carpus and metacarpus (Pl. V, figs. 3, 4, 9; text fig. 3, *A*). The second and third digits are of approximately the same size, the third slightly exceeding the second in length, with the axis of the foot passing between them. The fourth digit is much shorter and feebler and the fifth greatly reduced. No trace of the first remains. Proximally, the scaphoid presents a broad, antero-posteriorly convex surface for articulation with the radius. Distally, it is in contact with the magnum by a long, narrow process (scaphoid + centrale) supporting a small, plane, quadrangular facet, and with the trapezoid by a large crescentic facet, plane in dorso-palmar section and slightly concave transversely. Externally, it articulates with the lunar by a small, oval, proximo-distally concave facet on the outer side of the process in contact with the magnum. Internally, the palmar surface supports a heavy rugose tubercle. The lunar is a large element, wedge-shaped in dorsal view, with a broad, strongly convex proximal surface for the radius. Distally, it is in contact with the magnum and unciform. The surface for the former is divided into two portions, a small dorsal convex area, wedge-shaped in outline, and a large, irregularly quadrangular palmar tract, strongly concave in dorso-palmar section. The unciform facet is triangular, slightly concave, and but little differentiated from the surface for the cuneiform. Internally and distally, there is a small triangular concave facet for the scaphoid. Externally, contact with the cuneiform is secured by a broad surface of irregular outline, concave in dorso-palmar section and convex proximo-distally. The cuneiform is broadly grooved proximally for the styloid process of the ulna. On the palmar surface is a large oval flat facet for the pisiform, distally an oval concave facet for the unciform and internally a small, crescentic, convex surface for the lunar. Externally, the cuneiform supports a large protuberance almost half as large as the bone itself. The pisiform is a large T-shaped element, the cross bar of the T articulating with the cuneiform. The shaft is quite heavy, broadly convex in cross-section dorsally and more sharply angulate on the palmar surface. Distally, the shaft is expanded and is either abruptly truncate (*P. australe*) or terminates in a broad convexity (*P. prærutilum*). The trapezium is convex internally and slightly rugose, with no trace of an articular surface for the pollex. Externally, it articulates with the second metacarpal, which is deeply excavated for its reception, while proximally it is in contact, by a small triangular facet, with the trapezoid. The latter is a triangular element, broad dorsally, but tapering toward the palmar margin, where it supports a heavy tubercle. Proximally, there is a triangular facet for the scaphoid, concave in dorso-palmar section and slightly convex transversely, and, distally, a similar facet convex in both dimensions for the second metacarpal. Internally, there is slight lateral contact with the trapezium, while externally and distally the surface for the magnum is but little differentiated from the metacarpal facet. The magnum is narrow dorsally, but increases in proximo-distal diameter toward the palmar margin. It is in contact with the second metacarpal, the trapezoid, the scaphoid, the lunar and the unciform, and distally rests upon the third metacarpal. The surface for the second metacarpal is narrow dorsally, but increases in width toward the palmar margin. It is irregularly triangular in outline, slightly convex in dorso-palmar section and strongly concave transversely. The trapezoidal surface is narrow and broadly convex in dorso-palmar section, while the facet for the scaphoid is concave from side to side and also dorso-palmarly. The lunar surface is sigmoid in the latter direction, slightly convex palmarly, and concave dorsally. It is confluent dorsally and externally with the irregularly triangular, plane facet for the unciform. The metacarpal facet is quadrangular in outline and deeply concave in dorso-palmar section, while transversely it is plane. The unciform is a large element, irregularly tetrahedral in form, supporting proximally a large, transversely sigmoid surface for the cuneiform and proximo-internally a concave semicircular facet for the lunar. Internally, there is a large surface, slightly concave proximo-distally, for the third metacarpal and the magnum. Distally, there are two surfaces for the fourth and fifth metacarpals respectively. That for the former is triangular and concave in all dimensions, while the surface for metacarpal V is oval, concave in dorso-palmar section and slightly convex transversely. Proximally, the metacarpus is strongly interlocking. The articular surfaces are sufficiently well shown in the figure (Pl. V, fig. 9) to make detailed description unnecessary. The shafts are transversely flattened and bear well marked plantar keels, distally. The distal articular surfaces of the proximal phalanges are confined to the distal and palmar surfaces, while the proximal surfaces of the second row present upward and forward, indicating a moderate amount of angularity in the position of these elements (see restoration of the skeleton, Pl. VII). The ungual phalanges are laterally compressed hoofs, with slight, more or less well defined terminal clefts. All the digits supported terminal phalanges, but in none of the specimens studied has the terminal phalanx of digit V been preserved.

The ilia (Pl. VI, figs. 9, 10) are broadly expanded, with deeply concave gluteal fossæ and prominent anterior superior and posterior inferior spines. Between the anterior and posterior superior spines the crest of the ilium is inclined forward obliquely. Inferiorly, the iliac margin is broad, flattened and channeled longitudinally by a shallow groove. The neck is stout and the tubercle for the rectus femoris rather prominent and rugose. Ilio-pectineal eminences are practically absent. The ischium is broadly expanded posteriorly, with prominent spine and tuberosity. The ischial ramus and the pubis are slender.

The straight femoral shaft is slightly flattened transversely (Pls. IV, figs. 1–3; VI, fig. 4). The head is large and hemispherical, with a deep pit for the round ligament (not shown in the figures). The major trochanter slightly exceeds the head in elevation, from which it is separated by a shorter notch than in *Hegetotherium*. The trochanter minor is very large and sharply pointed. A prominent third trochanter is present, situated on the opposite side of the shaft and slightly farther down than the trochanter minor. The condyles are large, the inner exceeding the outer in width and posterior extension. Both are slightly convex transversely.

The patella (Pl. IV, figs. 8, 9) is quite narrow, tapering distally. Anteriorly, it is strongly convex in all directions and rugose for tendinous attachment. Posteriorly, it is divided by a median keel into two equal concave articular surfaces, occupying the entire posterior aspect of the bone except at the extreme distal end.

The tibia and fibula (Pls. IV, figs. 4, 5; VI, fig. 5) are usually unfused both proximally and distally, but in some specimens partial fusion has taken place distally. The tibial shaft is slightly arched inward and the fibular shaft outward, inclosing a large lens-shaped interosseous fossa. Of the condylar surfaces, the outer is the larger and more nearly circular. The spine is comparatively inconspicuous. The proximal fibular facet presents outward and downward, and is completely overhung by the outer condyle. It is a dumb-bell-shaped surface, sigmoid in antero-posterior section and plane transversely. The tibial shaft is triangular in cross-section proximally, becoming circular in cross-section toward the middle portion of the shaft. Externally, it is deeply excavated longitudinally, while the internal surface is quite smooth and slightly convex transversely. The cnemial crest is prominent, terminating in *P. australe* in a rugose tubercle. Distally, the tibial shaft is slightly expanded transversely, supporting externally a large rugose surface for ligamentous union with the fibula. The distal articular surface (Pl. IV, fig. 5), which is placed somewhat obliquely with respect to the median plane of the shaft, is divided by a prominent keel into two approximately equal grooves for the crests of the astragalar trochlea. The internal malleolus is quite long, supporting a plane surface for lateral articulation with the internal astragalar crest.

The fibula (Pls. IV, fig. 18; VI, fig. 5) is quite slender, slightly arched externally and greatly compressed laterally, with strongly marked interosseous ridge. Proximally, the shaft is expanded both antero-posteriorly and transversely, with the oval surface for the tibia terminal. Distally, the fibula is in lateral contact with the tibia by a broad rugose surface. Internally, the distal end articulates with the outer astragalar crest by a crescentic, plane facet, while distally a broad, antero-posteriorly concave surface is in contact with the calcaneum. The peroneal groove is quite distinct.

The pes (Pl. V, figs. 1, 2, 5–8, 10) is tetradactyl and paraxonic, the median digits are of approximately the same size and the lateral digits reduced. The hallux is wanting. The astragalar trochlea is long, moderately deep, with the crests sharp and equally developed. The neck is long and the head globular. The ectal facet is dumb-bell shaped, wider proximally than distally and strongly concave in proximo-distal section. The sustentacular facet is a flattened oval in outline, convex in all diameters and is supported largely by the neck of the astragalus. The fibular and internal malleolar facets, on the lateral surfaces of the body of the astragalus, are vertical, and the entire body is approximately symmetrical to the vertical plane, differing in this respect from *Hegetotherium* (cf. Pls. II, fig. 19; V, fig. 1). The most striking feature of the calcaneum is the large fibular facet, which is almost as large as the ectal surface. Both are strongly convex proximo-distally and slightly convex transversely. The sustentaculum is heavy and deep in the dorso-plantar diameter, with its free margin grooved. The sustentacular facet is oval in outline and concave. The cuboidal facet is much less deeply concave than in *Hegetotherium*. Unlike that genus, there is no articulation between the calcaneum and the navicular. The tuber is moderately elongated and rather heavy, supporting a large rugose area distally. The navicular is deeply cupped proximally for the head of the astragalus, while distally it supports three facets for the cuneiform bones (Pl. V, fig. 8). It may be readily distinguished from that of *Hegetotherium* (Pl. II, fig. 16) by the small size of the mesocuneiform facet and the absence of an articular surface for the calcaneum. The external cuneiform facet is subcircular in outline and almost plane, that for the mesocuneiform oval and slightly convex in all diameters, while the facet for the internal cuneiform is crescentic and convex in all diameters. Externally, the navicular is in contact with the cuboid by a large reniform facet, slightly convex in dorso-plantar section and concave proximo-distally. The internal plantar tuberosity is quite long, perhaps representing a coössified sesamoid, such as occurs in a free state in many of the hystricomorph rodents, with which it coincides in position. The proximal surface of the cuboid is strongly convex in dorso-plantar section and broadly concave transversely. Internally, it is in contact with the navicular by a large oval facet concave in dorso-plantar section and convex proximo-distally, below which are two oval facets, with their major axes at right angles, for contact with the outer cuneiform. The facet for the fourth and fifth metatarsals is a large, irregularly oval area, concave in all dimensions and not differentiated into separate articular surfaces for these two elements. The peroneal groove is deep and the overhanging tubercle very large. Of the cuneiform series, the outer is the largest. It is irregularly quadrilateral in outline dorsally, decreasing in transverse diameter toward the plantar surface, where it supports a long process terminating in a blunt tubercle. The proximal surface is semicircular in outline and almost plane. Of the two oval facets for the cuboid, the dorsal is convex in proximo-distal section and almost a plane surface at right angles to this, while the plantar surface is plane. Internally, there is a narrow, almost plane surface for the mesocuneiform proximally and two semicircular, approximately plane facets distally for the second metatarsal. The surface for the third metatarsal is reniform, wider dorsally than at the plantar margin, convex from side to side and concave in dorso-plantar section. The mesocuneiform is quite small. Its proximal surface is semicircular and almost plane. Externally and proximally, there is a narrow, plane surface for the outer cuneiform. Distally, the facet for the second metatarsal is sigmoid in dorso-plantar section and convex transversely. Internally and proximally, there is a single facet, variable in form, for the internal cuneiform. The latter is scale-like, terminating distally in a rugose tubercle without any trace of an articulation for the hallux. The third and fourth metatarsals are of approximately the same length and weight, while the second and fifth are much shorter and more slender, the fifth slightly exceeding the second in length. Proximally, the metatarsals interlock with each other and with the tarsus. The proximal surfaces are sufficiently well shown in the figure (Pl. V, fig. 10) to dispense with further description. The shafts are slightly flattened. Well developed keels are present distally. Except for their superior size, the phalanges are indistinguishable from those of the manus. The terminal phalanges are laterally compressed hoofs, without clefts.

Restoration of the Skeleton (Pl. VII).—Compared with *Interatherium* (Pl. IX), the restored skeleton of *Protypotherium* shows the proportionately greater length of the limbs. The hind feet have been given a digitigrade position because of the length, depth and sharpness of definition of the astragalar trochlea. The depth of the posterior portion of the thorax is conjectural, as are also the lengths of the spines of the median dorsals and cervicals. The tail has been drawn to scale from a much smaller specimen, probably *P. prærutilum*, in which eighteen free caudals are present. It may have been longer than is represented in the restoration.

Species.—Three species are represented in the collections at Princeton University and the American Museum of Natural History (*P. australe, prærutilum, attenuatum*). Within the limits of each there is considerable range in size, all transitions occurring between the minimum for the largest species (*P. australe*) and the maximum for the next smaller form (*P. prærutilum*), making their separation a more or less arbitrary matter. *P. attenuatum* shows less range in size and is characterized by fairly well marked cranial peculiarities, by which it may be readily recognized. In the absence of detailed stratigraphic work, with systematic collecting from definite levels, it is impossible to avoid confusing individual variations with true mutations of specific value, and this may account for the difficulty in separating *P. australe* from *P. prærutilum*.

Protypotherium australe (Moreno) Ameghino.

(Pls. III, Figs. 1–4; IV; V, Figs. 1–3, 6–10, 16–20; VI, Figs. 7–10, 14, 15; VII; Text Figs. 1*A*, 2, 3*A*, 4*A*, 8.)

Toxodontophanus australis Moreno; Patagonia, resto de un antiguo continente hoy submerjido, p. 23, 1882 (*nomen nudum*).

Protypotherium (*Toxodontophanus*) *australe* Ameghino; Observaciones generales sobre el orden de mamiferos estinguidos sud-americanos llamados Toxodontes, etc., p. 64, 1887.

Patriarchus palmidens Amegh.; Contrib. al Conoc., etc., p. 481, Pl. 15, figs. 2–3, 1889.

Patriarchus furculosus Amegh.; Revista Argent. de Hist. Nat., I, p. 292, 1891.

Patriarchus distortus Amegh.; ibid., p. 293, 1891.

Protypotherium distortum Amegh.; Énum. Syn., etc., p. 13, 1894.

Patriarchus altus Amegh.; Revista Argent. de Hist. Nat., I, p. 293, 1891.
Protypotherium altum Amegh.; Énum. Syn., p. 13, 1894.
? *Protypotherium lineare* Amegh.; Énum. Syn., etc., pp. 13–14, 1894.

This is the largest and also the most abundant species of *Protypotherium* in the Santa Cruz beds. It may be readily recognized by its large size (skull length .099–.112). There is considerable individual variation in the size of the skull and teeth, but with a sufficiently large suite of specimens it is possible to detect all transitions between the extremes in dental and cranial measurements.

Specimens in the Munich collection, determined by Ameghino as *Patriarchus palmidens* and *P. furculosus*, are old individuals of *P. australe*. The latter differs from *P. prærutilum*, a smaller and more slenderly constructed form, in the greater width of the molar crowns, which, although they may in some of the smaller individuals approach those of *P. prærutilum* in antero-posterior diameter, are always much wider.

From *P. attenuatum* the species under consideration differs in its much greater size and in the less pronounced dilatation of the parietal region of the skull.

The specimens selected for measurement and illustration represent fairly well the extremes of size variation within the limits of the species. Nos. 15,828, 15,340, 15,551, 15,598 of the Princeton collection, and Nos. 9565, 9149 and 9566 of the American Museum collection, are figured on the accompanying plates.

The following localities are represented, the figures referring to the number of individuals from each: Rio Gallegos (3), Cañon de las Vacas (2), Felton's estancia, Rio Gallegos (7), Halliday's estancia, Rio Gallegos (4), Killik Aike (7), West of Killik Aike Ranch, Rio Gallegos (1), two miles west of Killik Aike, Rio Gallegos (1), five miles south of Coy Inlet (1), ten miles south of Coy Inlet (1), seventeen miles north of Cape Fairweather (1), Mount of Observation (2).

MEASUREMENTS.

	No. 15,828.	*No. 9565.*	*No. 15,598.*	*No. 9149.*
Skull, maximum length	.112	.108		
" length, premaxillæ to condyle inclusive	.1085	.1055	.099	
" greatest width across arches	.0645	.061	.062	
" interorbital width	.032	.031	.0273	

	No. 15,828.	*No. 9565.*	*No. 15,598.*	*No. 9149*
Skull, least width of brain case	.0175	.0155	.017	
" height of occiput	.021	.020		
" width of occiput	.0425	.044		
Palate, length	.070	.067 *	.0615	
" width at $M^{\underline{3}}$	.0245	.021 *	.0235	
Mandible, length including $I_{\overline{1}}$	.100	.101		
" depth below $P_{\overline{4}}$	.0176	.016		.0166
" " " posterior margin of $M_{\overline{3}}$	.0293	.027		.0255
Upper dentition, length $I^{\underline{1}}$–$M^{\underline{3}}$	.063	.060	.0575	.058
" " " $P^{\underline{1}}$–$M^{\underline{3}}$ on alveolar border	.045	.042	.0405	.0395
Upper dentition, length $M^{\underline{1}}$–$M^{\underline{3}}$ on alveolar border	.0245	.023	.0225	.021
$I^{\underline{1}}$, width	.0056	.0067	.007	
" greatest transverse diameter	.0034	.0026	.0023	
$I^{\underline{2}}$, width	.005	.0055	.005	.005
" greatest transverse diameter	.0027	.0024	.002	.002
$I^{\underline{3}}$, width	.0055	.0055	.0053	.0052
" greatest transverse diameter	.0027	.0026	.0023	.002
C, width	.005	.005	.005	.005
" greatest transverse diameter	.003	.0022	.0022	.002
$P^{\underline{1}}$, antero-posterior diameter just above triturating surface	.005	.005	.005	.004
" transverse diameter in same plane	.003	.0027	.0028	.0025
$P^{\underline{2}}$, antero-posterior diameter just above triturating surface	.0058	.0055	.0053	.0045
" greatest transverse diameter in same plane.	.004	.0037	.0035	.0035
$P^{\underline{3}}$, antero-posterior diameter just above triturating surface	.0065	.006	.006	.0055
" transverse diameter in same plane	.0045	.0045	.004	.004
$P^{\underline{4}}$, antero-posterior diameter on triturating surface externally	.006	.006	.0055	.0048
" transverse diameter at widest part	.005	.0045	.0045	.0045
$M^{\underline{1}}$, antero-posterior diameter on triturating surface externally	.0088	.008	.008	.0075
" transverse diameter at widest part	.0058	.005	.0054	.0052
$M^{\underline{2}}$, antero-posterior diameter on triturating surface externally	.0085	.0073	.0073	.0065
" transverse diameter at widest part	.005	.005	.0045	.0048
$M^{\underline{3}}$, antero-posterior diameter on triturating surface externally	.008	.0075	.0066	.0065
" transverse diameter at widest part	.0045	.0045	.004	.004

* Approximate.

	No. *15,828.*	*No.* *9565.*	*No.* *15,598.*	*No.* *9149.*
Lower dentition, length $I_{\bar{1}}$–$M_{\bar{3}}$ . .	.059	.0565		
" " " $P_{\bar{1}}$–$M_{\bar{3}}$ on alveolar border	.044	.0415		.039
Lower dentition, length $M_{\bar{1}}$–$M_{\bar{3}}$ on alveolar border	.026	.0235		.0228
$I_{\bar{1}}$, width of crown	.002	.002		
" greatest transverse diameter . .	.0023	.0019		
$I_{\bar{2}}$, width of crown	.0027	.0025		.0026
" greatest transverse diameter . .	.0025	.002		.002
$I_{\bar{3}}$, width of crown	.004	.004		
" greatest transverse diameter . .	.0025	.002		
C, width of crown	.005	.0045		.0045
" greatest transverse diameter . .	.0027	.0026		.0023
$P_{\bar{1}}$, antero-posterior diameter on triturating surface	.0045	.0055		.005
" greatest transverse diameter . .	.003	.0022		.0025
$P_{\bar{2}}$, antero-posterior diameter on triturating surface	.005	.0045		.005
" greatest transverse diameter . .	.003	.003		.0025
$P_{\bar{3}}$, antero-posterior diameter on triturating surface	.0055	.0053		.005
" greatest transverse diameter . .	.0034	.003		.003
$P_{\bar{4}}$, antero-posterior diameter on triturating surface	.0067	.0065		.006
" greatest transverse diameter . .	.004	.0035		.0035
$M_{\bar{1}}$, antero-posterior diameter on triturating surface	.009	.008		.007 *
" greatest transverse diameter . .	.0045	.004		.0035
$M_{\bar{2}}$, antero-posterior diameter on triturating surface	.0085	.0075		.0073
" greatest transverse diameter . .	.0042	.004		.0035
$M_{\bar{3}}$, antero-posterior diameter on triturating surface	.010	.009		.0083
" greatest transverse diameter . .	.0037	.0032		.0032

	No. *15,551.*
Atlas, approximate width across transverse processes	.032
Atlas, width across anterior articular surfaces	.020
" " " posterior " "	.020
" " of neural arch	.009
Axis, length including odontoid, but exclusive of distal epiphysis	.0205

* Approximate.

	No. 15,551.		
Axis, width across condyles	.019		
Axis, height of neural spine above floor of neural canal .	.016		
	No. 15,828		
First dorsal, length of centrum	.0105		
Second " " " "	.0105		
" " " " spine measured along anterior margin	.026		
Third " " " centrum	.0105		
" " " " spine measured along anteror margin .	.029		
Fourth dorsal " " centrum	.0105		
" " " " spine measured along anterior margin	.0265		
Fifth dorsal, length of centrum	.0115		
Sixth " " " "	.0115		
First lumbar, length of centrum	.015		
" " width across transverse processes	.014		
" " " of neural spine at tip	.011		
Second lumbar, length of centrum, minus epiphyses . .	.014		
" " width across transverse processes . .	.021		
Third lumbar, length of centrum, lacking anterior epiphysis	.0165		
" " width across transverse processes . . .	.028		
			No. 9566.
Fourth lumbar, length of centrum, lacking anterior epiphysis	.015		
" " width across transverse processes . .	.032		.031
" " " of neural spine at tip	.010		.0075
Fifth lumbar, length of centrum	.017		
" " width across transverse processes	.032		.031
" " " of neural spine at tip	.0076		.006
Sixth lumbar, length of centrum	.0175		
" " width across transverse processes . .	.036		.0325
" " " of neural spine at tip	.0083		.006
Seventh lumbar, length of centrum minus epiphyses . .	.015		
" " of neural spine at tip	.0075		.0045
Scapula, length, coracoid process to inferior angle . .	.0835		
" greatest transverse width	.043		
		No. 9149.	
" antero-posterior diameter of glenoid fossa . .	.0195		
" transverse diameter of glenoid fossa	.012	.0095	
Humerus, length	.104	.094	.086
" greatest antero-posterior diameter at proximal end	.0265	.023	.022
" " transverse diameter at proximal end .	.022	.0187	
" " " " distal end . .	.027	.023	
Radius, length	.082	.075	
" antero-posterior diameter of head	.0075	.0066	
" transverse diameter of head	.0105	.0104	
" width of distal end	.0155	.013	

	No. 15,828.	*No. 9149.*	*No. 9566.*
Ulna, length	.1055	.0955	
" width at upper margin of sigmoid cavity	.0146	.014	
" " " coronoid process	.016	.015	
" antero-posterior diameter of distal end	.009	.0088	
Carpus, width, trapezium — cuneiform		.0205	
Metacarpal II, length		.030	
" " greatest width distally		.0074	
" III, length		.032	
" " greatest width distally		.007	
" IV, length		.025	
" " greatest width distally		.0062	
" V, length		.0145	
" " greatest width distally		.005	
Manus, digit II, first phalanx, length		.015	
" " " " " width proximally		.007	
" " " " " " distally		.005	
" " " second " length		.0105	
" " " " " width proximally		.006	
" " " " " " distally		.0045	
" " " ungual " length		.0105	
" " " " " width proximally		.0045	
" " III, first phalanx, length		.0145	
" " " " " width proximally		.007	
" " " " " " distally		.005	
" " " second " length		.0105	
" " " " " width proximally		.0055	
" " " " " " distally		.004	
" " " ungual " length		.010	
" " " " " width proximally		.0045	
" " IV, first phalanx, length		.0128	
" " " " " width proximally		.006	
" " " " " " distally		.0042	
" " " second " length		.009	
" " " " " width proximally		.005	
" " " " " " distally		.0035	
" " " ungual " length		.009	
" " " " " width proximally		.0038	
" " V, first phalanx, length		.010	
" " " " " width proximally		.0048	
" " " " " " distally		.003	
Pelvis, length	.120		.100
" transverse diameter at acetabulum			.050
" width of ilium at greatest expansion	.025		.0195
" width at neck of ilium	.0135		.013

	No. 15,828.	*No. 9149.*	*No. 9566.*
Pelvis, antero-posterior diameter of acetabulum	.015		.012
" transverse " " "	.0155		
	No. 15,340		
Femur, length	.1055	.0995	.0925
" transverse diameter proximally	.027	.0248	
" " " at middle of shaft.	.013	.0105	.0095
" " " distally	.025	.022	
Patella, length		.0178	.0135
" width		.0095	.010
Tibia, length	.120	.1125	.108
" transverse diameter proximally	.026	.0235	
" " " distally	.014	.011	
Fibula, length		.104	.102
	No. 15,828		
Calcaneum, length	.0365	.035	
Astragalus, length	.020	.019	
" length of trochlea	.014	.012	
" width " "	.0085	.0085	
" " " head	.008	.007	
Metatarsal II, greatest width distally		.007	
" III, length		.040	
" " greatest width distally		.009	
" IV, length		.042	
" " greatest width distally		.0085	
" V, length		.0315	
" " greatest width distally		.0065	

	No. 9149.
Pes, digit II, ungual phalanx, length	.010
" " " " " width proximally	.004
" " III, proximal " length	.019
" " " " " width proximally	.0086
" " " " " " distally	.0063
" " " second " length	.0135
" " " " " width proximally	.0072
" " " " " " distally	.0054
" " " ungual " length	.0136
" " " " " width proximally	.0055
" " IV, proximal " length	.019
" " " " " width proximally	.008
" " " " " " distally	.006
" " " second " length . . . , ...	.013

	No. 9149
Pes, digit IV, second phalanx, width proximally	.0066
" " " " " " distally	.005
" " " ungual " length	.013
" " " " " width proximally	.005
" " V, proximal " length	.015
" " " " " width proximally	.0065
" " " " " " distally	.0045
" " " second " length	.0092
" " " " " width proximally	.005
" " " " " " distally	.004
" " " ungual " length	.009
" " " " " width proximally	.004

Protypotherium præutilum Ameghino.

(Pl. V, Figs. 21, 22.)

Protypotherium præutilum Amegh.; Enumeracion Sistematica, etc., p. 15, 1887.

Protypotherium compressidens Amegh.; Revista Argentina de Hist. Nat., I, p. 292, 1891.

?*Protypotherium convexidens* Amegh.; Revista Argentina de Hist. Nat., I, p. 292, 1891.

Patriarchus leptocephalus Amegh.; Revista Argentina de Hist. Nat., I, p. 293, 1891; Énum, Syn., etc., p. 14, 1894 (listed); Segundo Censo, etc., p. 150, 1898 (listed).

Considerable hesitancy is felt in admitting this as a valid species. The only positive character of specific value seems to be the narrowness of the superior molars in proportion to their length. Although the length antero-posteriorly may be the same as in some of the smaller individuals of *P. australe*, the width is always less. The characters, apart from size, enumerated in the original descriptions (Ameghino, 1887, 15; 1889, 478) do not seem sufficient to warrant the separation of *P. præutilum* from *P. australe*. In the absence of exact stratigraphic data, the species as it stands now is a rather ill-defined assemblage of individuals intermediate in size between *P. attenuatum* and *P. australe*. Specimens in the Munich collection labelled by Ameghino *P. leptocephalum* are about the size of *P. præutilum* and might be grouped with the latter without overstepping the bounds of probability. Some do not differ greatly from medium sized individuals of *P. australe*.

Specimens referred for the present to *P. præutilum* have been obtained from the following localities: Ten miles south of Coy Inlet (4), Felton's estancia, Rio Gallegos (1), Halliday's estancia, Rio Gallegos (1), Killik Aike, Rio Gallegos (2).

MEASUREMENTS.

	No. 15,386.	*No. 15,161.*	*No. 9486.*
Skull, maximum length	.0925		
" length, premaxillæ to condyle inclusive	.088		
" greatest width across arches	.061		.0545
" interorbital width	.030		
" least width of brain case	.020		
" height of occiput	.0155		
" width of occiput	.046		
Palate, length	.054		
" width at posterior margin of M^3	.0206		.020
Mandible, length including I_1	.082		
" depth below P_4	.015		
" " " posterior margin of M_3	.023		
Upper dentition, length I^1–M^3	.0495		
" " " P^1–M^3 on alveolar border	.034		.0352
" " " M^1–M^3 " " "	.020		.0185
I^2, width	.0032		
" greatest transverse diameter	.0016		
I^3, width	.0035		
" greatest transverse diameter	.002		
C, width	.0035		
" greatest transverse diameter	.002		
P^1, antero-posterior diameter just above triturating surface	.0022		.0036
" transverse diameter in same plane	.002		.0025
P^2, antero-posterior diameter just above triturating surface	.0035		.0038
" transverse diameter in same plane	.0025		.0025
P^3, antero-posterior diameter just above triturating surface	.0045		.0046
" transverse diameter in same plane	.0032		.0035
P^4, antero-posterior diameter on triturating surface externally	.0042		.0046
" transverse diameter at widest part	.0035		.0037
M^1, antero-posterior diameter on triturating surface externally	.0062		.0066
" transverse diameter at widest part	.0045		.0045
M^2, antero-posterior diameter on triturating surface externally	.0062		.006
" transverse diameter at widest part	.004		.004
M^3, antero-posterior diameter on triturating surface externally	.0065		.0061
" transverse diameter at widest part	.0034		.0035
Lower dentition, length I_1–M_3	.046		
" " " P_1–M_3 on alveolar border	.0343		
" " " M_1–M_3 " " "	.0194		

	No. 15,386.	*No. 15,161.*	*No. 9486.*
$I_{\bar{1}}$, width of crown	.0015		
" greatest transverse diameter	.0015		
I_2, width of crown	.0018		
" greatest transverse diameter	.0016		
$_{\bar{3}}$, width of crown	.003		
" greatest transverse diameter	.002		
C, width of crown	.0035		
" greatest transverse diameter	.002		
$P_{\bar{1}}$, antero-posterior diameter on triturating surface	.003		
" greatest transverse diameter	.002		
$P_{\bar{2}}$, antero-posterior diameter on triturating surface	.0032		
" greatest transverse diameter	.002		
$P_{\bar{3}}$, antero-posterior diameter on triturating surface	.0043		
" greatest transverse diameter	.0024		
$P_{\bar{4}}$, antero-posterior diameter on triturating surface	.005		
" greatest transverse diameter	.0026		
$M_{\bar{1}}$, antero-posterior diameter on triturating surface	.0057		
" greatest transverse diameter	.003		
$M_{\bar{2}}$, antero-posterior diameter on triturating surface	.0063		
" greatest transverse diameter	.0026		
$M_{\bar{3}}$, antero-posterior diameter on triturating surface	.0075		
" greatest transverse diameter	.0025		
Atlas, width across transverse processes		.031	.0305
" " " anterior articular surfaces		.018	.0205
" " " posterior " "		.0185	.019
" " of neural arch		.007	
" " " inferior "		.005	.004
Axis, length including odontoid			.0205
" width across condyles			.018
Cervical series, length			.068
Sixth–fifteenth dorsal, length			.100
Humerus, length	.079		
" greatest transverse diameter at proximal end	.016		
" " " " " distal "	.018		
Radius, antero-posterior diameter of head	.0058		
" transverse " " "	.008		
" width of distal end	.0115		
Pelvis, width of ilium	.019	.0195	
" " " neck of ilium	.011		
" antero-posterior diameter of acetabulum	.012	.0117	
" transverse " " "	.012	.011	
Femur, length	.084	.086	
" transverse diameter at proximal end	.022		
" " " " middle of shaft	.0095		

	No. 15,386.	*No. 15,161.*	*No. 9486.*	*No. 15,742.*
Femur, transverse diameter at distal end	.020			
Tibia, length	.097	.100		
" transverse diameter proximally	.020			
" " " distally	.011			
Fibula length		.0945		
Calcaneum, length		.029	.033	
Astragalus, length		.018		
" " of trochlea		.011		
" width of head		.006		
Tarsus, width				.0165
Metatarsal II, length				.0245
" " greatest width distally				.005
" III, length				.0362
" " greatest width distally				.0073
" IV, length				.0035
" " greatest width distally				.0064
" V, length				.026
" " greatest width distally				.0046

The following measurements of the manus are from a specimen numbered 15,364, intermediate in size between *P. australe* and *P. attenuatum* and therefore referred to *P. prærutilum.*

Carpus, width, trapezium — unciform	.018
Metacarpal II, length	.029
" " greatest width distally	.0065
" III, length	.030
" " greatest width distally	.0063
" IV, length	.026
" " greatest width distally	.0055
" V, length	.015
" " greatest width distally	.0042
Digit II, proximal phalanx, length	.015
" " " " width proximally	.0065
" " " " " distally	.005
" " second " length	.011
" " " " width proximally	.0055
" " " " " distally	.004
" " ungual " length	.011
" " " " width proximally	.004
" III, proximal " length	.015
" " " " width proximally	.0065
" " " " " distally	.0046
" " second " length	.0115
" " " " width proximally	.0054
" " ungual " length	.011
" " " " width proximally	.004

Protypotherium attenuatum Ameghino.

(Pls. III, Figs. 5–7; V, Figs. 4, 5; VI, Figs. 1–6.)

Protypotherium attenuatum Amegh.; Enumeracion Sistematica, etc., p. 15, 1887.
Protypotherium globosum Amegh.; Revista Argentina, etc., p. 291, 1891.
Protypotherium icochiloides Amegh.; Énumeration Synoptique, etc., pp. 14–15, 1894.
Patriarchus rectus Amegh.; Revista Argentina de Hist. Nat., I, p. 293, 1891.

Protypotherium attenuatum may be readily distinguished from the other species by its smaller size (length of skull .08–.09 as contrasted with .099–.112 in *P. australe*), and the marked convexity of the brain-case just posterior to the fronto-parietal suture, a character used by Ameghino in defining *P. globosum*, a species here regarded as synonymous with *P. attenuatum*. A careful comparison of the skeleton, so far as known, with that of *P. australe* fails to show characters of specific value, apart from size. *P. icochiloides* was originally defined as transitional to the genus *Icochilus* (*Interatherium*). The molars and premolars are said to be like those of *Protypotherium*, but the mandible is stout, with the horizontal ramus short, low in front and very high behind. The measurements accompanying the description agree closely with the dimensions of the mandible in No. 9187 Am. Museum (Pl. III, fig. 6) which has been referred to *P. attenuatum*, and the two species are regarded as synonymous. Specimens in the Munich collection determined by Ameghino as *P. icochiloides* and *Patriarchus rectus* are certainly the same as *P. attenuatum*.

The latter is represented in the Princeton and American Museum collections by a considerable amount of material illustrating the structure of the skull and limbs. The following localities have afforded specimens: Killik Aike (4), two miles west of Killik Aike, Rio Gallegos (1), south of Santa Cruz (1), ten miles south of Coy Inlet (1), five miles south of Coy Inlet (1), Coy Inlet (1).

Nos. 15,665, 15,341, and No. 9187 American Museum, are illustrated in the accompanying plates.

MEASUREMENTS.

	No. 9187.	*No. 15,665.*	*No. 15,341.*
Skull, maximum length	.085	.0885	
" greatest width across arches	.0515		
" interorbital width	.027	.027	
" least width of brain case	.016	.0155	
" height of occiput	.0165	.020	
" width of occiput	.0355	.037 *	
Palate, length from alveolus of I^1 to palato-narial border, along median line	.049 *	.0525	
Palate, width at M^3	.0195	.0195	
Mandible, depth below P_4	.0135		
" " " posterior margin of M_3	.0216		
Upper dentition, length I^1–M^3	.0466	.048	
" " " P^1–M^3 on alveolar border	.0323	.033	
" " " M^1–M^3 " " "	.0185	.018	
I^1, width of alveolus	.0035	.0039	
I^2, width of crown	.0038		
" greatest transverse diameter	.0015		
I^3, width of crown	.0036	.004	
" greatest transverse diameter	.0016	.0022	
C, width of crown	.0036	.004	
" greatest transverse diameter	.0016	.002	
P^1, antero-posterior diameter just above triturating surface	.003	.0027	
" transverse diameter in same plane	.0023	.002	
P^2, antero-posterior diameter just above triturating surface	.0035	.0035	
" transverse diameter in same plane	.0026	.0027	
P^3, antero-posterior diameter just above triturating surface	.004	.0045	
" transverse diameter in same plane	.003	.0035	
P^4, antero-posterior diameter on triturating surface externally	.004	.0044	
" transverse diameter at widest part	.0032	.004	
M^1, antero-posterior diameter on triturating surface externally	.006	.0065	
" transverse diameter at widest part	.004	.0046	
M^2, antero-posterior diameter on triturating surface externally	.0058	.006	
" transverse diameter at widest part	.0035	.004	
M^3, antero-posterior diameter on triturating surface externally	.0057	.0055	
" transverse diameter at widest part	.003	.0033	
Lower dentition, length I_1–M_3	.043		
" " " P_1–M_3 on alveolar border	.0326		
" " " M_1–M_3 on alveolar border	.0183		
I_1, width of crown	.0014		
" greatest transverse diameter	.0012		
I_2, width of crown	.0019		
" greatest transverse diameter	.0015		

* Approximate.

	No. 9187.	*No. 15,665.*	*No. 15,341.*
$I_{\overline{3}}$, width of crown	.003		
" greatest transverse diameter	.0017		
$P_{\overline{3}}$, antero-posterior diameter on triturating surface	.0035		
" greatest transverse diameter	.0025		
$P_{\overline{4}}$, antero-posterior diameter on triturating surface	.0046		
" greatest transverse diameter	.0025		
$M_{\overline{1}}$, antero-posterior diameter on triturating surface	.0055		
" greatest transverse diameter	.0029		
$M_{\overline{2}}$, antero-posterior diameter on triturating surface	.0056		
" greatest transverse diameter	.003		
$M_{\overline{3}}$, antero-posterior diameter on triturating surface	.0075		
" greatest transverse diameter	.0025		
Humerus, length			.074
" greatest antero-posterior diameter proximally	.0175		
" greatest transverse diameter distally	.0167		.0165
Radius, length	.058		.056
" antero-posterior diameter of head	.005		.0047
" transverse diameter of head	.0072		.0066
" width of distal end	.011		.010
Ulna, antero-posterior diameter at upper margin of sigmoid cavity	.010		.0103
" " " " " lower " " " "	.009		.0096
Pelvis, width of ilium at greatest expansion			.0155
" " " " " neck			.0095
" antero-posterior diameter of acetabulum			.0109
" transverse diameter of acetabulum			.010
Femur, length	.0775		.079
" greatest width at proximal end	.0195		.019
" " " " distal end	.0185		.017
Patella, length			.011
" width			.007
Tibia, length	.091		.0905
Tibia, transverse diameter at proximal end	.0186		.0165
" " " " distal end	.011		.0095
Fibula, length			.086
" antero-posterior diameter at proximal end			.007
" " " " " distal end			.0067
Metacarpal II, length			.024
" III, "	.027		.026
" IV, "	.021		.021
" V, "			.0122
Calcaneum, length	.0285		.0265
Astragalus, length	.0165		.0145
" width of body	.007		.0062
" " " head	.0065		.0055

	No. 9187.	*No. 15,665.*	*No. 15,341.*
Metatarsal II, length	.026		.0246
" III, "			.035
" IV, "	.037		.036
" V, "			.0265
Digit, III, first phalanx, length			.016
" " second " "			.0113
" " ungual " "			.011
Digit IV, first " "			.0162
" " second " "			.011
" " ungual " "			.0105

INTERATHERIUM (Moreno) Ameghino.

(Plates VI, Figs. 11, 12, 13, 16–21; VIII, IX; Text Figs. 1*B*, 11, 12.)

Interatherium Moreno; Patagonia resto de un antiguo continente hoy submerjido, p. 23, 1882 (*nomen nudum*). Ameghino; Observ. gen. sobre los Toxodontes, etc., p. 63, 1887.

Icochilus Ameghino; Contrib. al Conoc., etc., pp. 469–474, 1889.

Tembotherium Moreno; *fide* Ameghino, Observ. gen. sobre los Toxodontes; etc., p. 65, 1887.

A large amount of material from localities near the east coast of Patagonia is referable to this genus. All parts of the skeleton are well represented.

Dentition (Pl. VIII, figs. 16, 18, 20–27). — The dental formula varies slightly, owing to the loss in some individuals of the lateral incisor and occasionally the canine, and the presence in others of supernumerary teeth. The median incisors are enlarged and functional as cropping teeth. The crown continues to grow more or less during life, but in old individuals the width of the crown rapidly decreases above the alveolar border. The enamel layer, in worn specimens, is confined to the anterior surface. If any is present on the inner side of the crown, it must extend but a short distance above the cutting edge, as none is here observable in little-worn teeth. The crown of the second incisor is smaller and lower than the first with the enamel layer also external. The margins of the cutting edges of the first and second incisors are closely applied without imbrication, forming a perfectly symmetrical crescent. The third incisor is still smaller. In certain individuals it is well developed in proportion to its size, while in others it is quite small, present on one side only or entirely absent. This character, which does not seem to be due to difference in age, has been applied to the separation of two of the species (*I. robustum* and *I. extensum*). The second and third incisors are usually separated by a slight diastema. Both $I^{\underline{3}}$ and the canine have laterally compressed pointed crowns. A supernumerary canine is sometimes present (Pl. VIII, fig. 26) or the canine may be entirely wanting (Pl. VIII, fig. 16. Age character). Between $I^{\underline{3}}$ and the canine a diastema is always present, and usually also between the latter and $P^{\underline{1}}$. The first upper premolar is a simple-crowned, cylindrical, laterally compressed tooth, strongly curving inward and backward. The remaining premolars and molars may be readily distinguished from those of *Protypotherium* by the great elongation of the antero-external angle and the strong development of the outer ridges and the intervening groove. The second premolar is incompletely molariform, while the third and fourth resemble the molars. This is a distinct advance over *Protypotherium*, in which none of the premolars have attained the molariform condition. In the second premolar of *Interatherium* the crown is deeply grooved internally, producing a pair of lobes, of which the anterior is the smaller. Antero-externally a deep groove is lodged between two ridges, as in *Protypotherium*, but the groove is proportionately much deeper and the ridges higher. The same arrangement of inner lobes and outer ridges, is observable in the third and fourth premolars and in the molars, but in the latter the inner lobes are equal in size. The antero-external portion of the crown is greatly elongated. As the crown wears down, the external groove with its bounding ridges disappears and there remains only the elongated antero-external angle (Pl. VIII, fig. 18). The triturating surfaces of the inner lobes are deeply cupped. Plate VIII, figure 20 shows the pattern of the unworn second and third premolars. The molar-pattern appears to be very similar to these, but no specimen in the collection shows an unworn tooth of this series. The crown pattern consists essentially of two internal crescents separated by a deep groove, and an ectoloph concave anteriorly and convex posteriorly. The antero-external groove lies between the anterior horn of the first inner crescent and the ectoloph. The crescentic lobes are cuspidate internally, but the cusps soon wear down. A cement layer is present as in *Protypotherium*.

In the inferior series, the incisors are pronate with the crowns of the first and second notched by a deep internal groove. These teeth are proportionately broader than in *Protypotherium* and the groove does not bifurcate the summit of the crown as in the median lower incisors of that genus (Pls. V, fig. 22; VIII, fig. 25) but notches it as in $I_{\overline{3}}$ of *Protypotherium.* The third incisor is cylindrical, with several shallow internal grooves. The canine and first premolar are simple cylindrical teeth, the former showing, in unworn specimens, a slight internal groove. The worn crowns of the second, third and fourth premolars and the first and second molars consist of a pair of triangular to oval lobes joined by a narrow isthmus like a figure 8 (Pl. VIII, fig. 25). The third molar is rendered trilobate by the elongation of the posterior lobe and its constriction by a broad groove on the outer side. In slightly worn teeth it is seen that this lobate structure is developed from a pair of crescents having parts homologous with the elements of the crown pattern in the unworn lower molars of *Protypotherium* (Pl. V, fig. 14*a*; text fig. 6, *A*). A thin layer of cement is present on the lower premolars and molars.

Milk Dentition. — The only difference between the deciduous premolars and their permanent successors is the presence of roots in the former (Pl. VIII, figs. 22, 24). On the presence or absence of this character two genera have been established, *Interatherium* with rooted premolars and *Icochilus* with these teeth hypsodont. These are merely the immature and adult stages of one and the same form. *Interatherium* has priority and must be retained as the proper designation for the genus. The order of tooth replacement is the normal one, but the milk teeth are retained in position until after the eruption of the third molar. It cannot at present be ascertained whether the first premolar has a deciduous predecessor, as it is a single-rooted tooth and has the same shape in specimens with rooted deciduous premolars as in those with hypsodont premolars.

Skull (Pl. VIII, figs. 16–19). — The skull is short and broad, with heavy arches and prominent crests. The facial region is decidedly short, the orbit lying farther forward than in *Protypotherium.* The premaxillæ are heavy, with the ascending process short or wanting (Pl. VIII, fig. 16). A prominent anterior nasal spine is present. On the palatal surface, the premaxillæ are strongly arched antero-posteriorly and deeply excavated by the anterior palatine foramina, which extend posteriorly beyond the line of the premaxillo-maxillary suture. Along the line of this suture the rostrum is constricted vertically, producing a strong upward arching of the alveolar border between the second incisor and the second premolar (Pl. VIII, fig. 16). The facial expanse of the maxillary is broadly concave both antero-posteriorly and transversely. It is continued upward as a robust, V-shaped bar inclosed in a deep notch in the frontal, widely separating the nasal from the lachrymal. The maxillary is extensively involved in the anterior and inferior margin of the orbit and in the temporal arch, where it extends as far back as the posterior margin of the glenoid cavity, forming with the malar a strong buttress preventing lateral dislocation of the mandible. A large descending maxillary process is developed beneath the orbit and the whole lower surface of the temporal process of this bone is deeply pitted for muscular attachment. The orbits are circular, quite prominent and widely open posteriorly. They are bounded anteriorly and inferiorly by the maxillary, the orbital portion of which rises above the facial tract as a vertical plate (Pl. VIII, figs. 16, 17). The lachrymal is entirely orbital, a "lachrymal" tubercle being developed from the maxillary. Almost directly beneath this tubercle, the circular infraorbital foramen perforates the maxillary at the junction of its orbital and facial portions. Posteriorly, the orbit is bounded by the anterior extremities of the malar and squamosal. These elements have the same mutual relations as in *Protypotherium*, but the malar is proportionately heavier than in the latter genus. The squamosal is distended and filled with cancellæ, the distention involving also the mastoid.

In superior view (Pl. VIII, fig. 17; text figs. 11, 12) the nasals are seen to be very broad, with square-cut tips and either straight (*I. extensum*) or curved fronto-nasal suture (*I. robustum*). They are not firmly united with the premaxillæ and maxillæ and are frequently crushed down into the narial chamber. A broad, V-shaped maxillary process widely separates the nasal from the lachrymal. The interorbital tract is flat, with persistent median suture. The postorbital processes are short and robust, with blunt points. Their posterior borders give rise to the temporal ridges, which are heavy and converge rapidly at an acute angle to form a prominent sagittal crest in *I. robustum* and *I. extensum*, while in *I. excavatum* they are lyrate, lower and converge much farther back on the parietal to form a short low crest. Back of the postorbital processes, the brain case attains its maximum constriction, but expands rapidly posteriorly. The lambdoidal and sagittal crests join at a right angle, inclosing, with the superior border of the temporal process of the squamosal, a deep temporal fossa, the floor of which is perforated by numerous foramina situated in both the parietal and the squamosal. The latter is dilated, as in *Protypotherium*, and firmly coössified with the mastoid and the auditory meatus.

The back of the skull (Pl. VIII, fig. 19) is circular in outline superiorly, with strong rugosities on the occipital surface for muscular attachment. The distended squamosal and mastoid are broadly exposed, but the suture between them can no longer be distinguished. The occipital elements are likewise completely fused, as in *Protypotherium*. As in that genus, the occipital is constricted transversely, the mastoid foramen perforating the suture between the mastoid and the occipital at the point of greatest constriction of the latter. The foramen magnum is circular in outline and the condyles obliquely directed and semicylindrical in shape.

The palate is deeply concave anteriorly, but posteriorly the concavity is about the same in degree as in *Protypotherium*. The sweep of the tooth rows is lyrate, approaching horizontality back of the first molar. The anterior palatine foramina are large, extending posteriorly beyond the premaxillo-maxillary suture. The posterior palatine foramina emerge opposite the fourth premolar on the maxillo-palatine suture, or a short distance anterior to it. The palatines extend well back of the last molar and terminate in a pair of very large, heavy, triangular processes proportionately much larger than in *Protypotherium* and similarly supported externally. The pterygoid appears to have been small and scale-like, though it is not preserved in any of the specimens available, nor can the shape of the posterior narial border be determined. The bullæ are pear-shaped and considerably flattened anteriorly, where most prolonged, as in *Protypotherium*. The auditory meatus is long, tubular and directed almost horizontally. The basi-occipital is keeled inferiorly, as in *Protypotherium*. The arrangement of the cranial foramina is the same as in the latter genus.

The mandible is short, heavy and very deep (Pl. VIII, figs. 16, 25), with the rami firmly coössified, without trace of suture. The symphysis is pronate, tapering anteriorly, as in *Protypotherium*. Back of the symphysis, the depth of the mandible rapidly increases until a maximum is reached at a point vertically below the third molar. Beyond this point, the angle rapidly decreases in depth. As in *Protypotherium*, it extends well beyond the condyle and has the inferior and posterior border inverted, inclosing a large submaxillary fossa. The coronoid process is sharp-pointed and slender, with strong posterior inclination. The coronoid margin of the ascending ramus is sigmoid in outline, as in *Protypotherium*. The sigmoid notch is broad and the condyle irregularly elliptical in outline, broader externally than internally, with its margin overhanging the neck. The groove terminating in the inferior dental canal is much longer than in *Protypotherium*. Two mental foramina are present, one beneath the canine and the other beneath the last premolar, or the anterior part of the first molar. Sometimes the latter foramen is doubled. The masseteric fossa is almost circular, as in *Protypotherium*, but less sharply defined anteriorly and with proportionately stronger transverse ridges for muscular attachment.

Vertebral Column; Ribs and Sternum.—The atlas (Pl. VIII, figs. 13–15, 28) may be readily recognized by the prominence of the neural spine, the robustness of the transverse processes and the position of the canal for the vertebral artery. The latter perforates the base of the transverse process at the margin of the posterior cotylar surface, emerging on the lower surface of the process near its anterior margin. Between the point of emergence and the neuro-arterial canal, the artery lay in a groove (sometimes enclosed as a foramen, Pl. VIII, fig. 13) between the transverse process and the anterior cotylus. The neuro-arterial canals are large and are inclosed anteriorly by robust bony bars. The transverse processes vary somewhat in shape and degree of expansion. In *I. robustum* and *I. extensum*, there is but little basal constriction, while the free border is broadly expanded, especially antero-externally. In *I. excavatum*, there is considerable basal constriction and the free border is less expanded (Pl. VIII, fig. 28). The anterior margin of the neural arch supports a large and very prominent spine-like tubercle. A smaller sharp-pointed spine projects backward from the posterior margin of the inferior arch.

The axis (Pl. VIII, figs. 11, 12) is characterized by a large, hatchet-shaped neural spine, which varies slightly in shape in specimens referred to one and the same genus. In some, it is strongly convex dorsally, with round anterior and posterior extremities. In others, the dorsal margin is horizontal or nearly so. The transverse processes are slender, sharp-pointed and directed posteriorly. Their bases are perforated by the canal for the vertebral artery. The odontoid is short and robust, its dorsal surface lying in the same plane as the floor of the neural canal. The centrum is strongly keeled inferiorly, the keel bifurcating posteriorly. The deep concavities on either side of the keel are bounded externally by the inferior edges of the transverse processes.

The slender spines of the remaining cervicals increase in length posteriorly. Anteriorly, they are directed vertically, but posteriorly they incline backward like the anterior dorsal spines. They are seldom completely preserved. Hatchet-shaped transverse processes begin on the third cervical and the differentiation into diapophysis and inferior lamina is already apparent in the fourth. The diapophysis alone is present in the seventh. Inferiorly, the centra of the anterior members of the series are strongly keeled, but the keel soon bifurcates, terminating posteriorly in a pair of tubercles. These tubercles are absent in the fifth, sixth and seventh cervicals and the centra are broadly keeled.

The dorso-lumbar vertebral formula is definitely known to be twenty-two, of which fifteen are dorsals. The anterior dorsals have long, slender, posteriorly directed spines, which, at about the sixth dorsal, begin to decrease in length, to increase in antero-posterior diameter and to expand at the tip into a dorsally flattened, triangular area. From the ninth dorsal onward, the spines are very broad antero-posteriorly, with the tips flattened and oblong in outline. The backward inclination of the neural spines changes between the tenth and eleventh dorsals. The lumbar spines are similar to those of the posterior dorsals, but in a single specimen referred to *I. extensum* (No. 15,041) the tips of the spines are broadly expanded dorsally, irregular in outline and strongly rugose. In another specimen (No. 9557 American Museum collection) which it has not been possible to determine specifically, the neural spines of the lumbars are bifid posteriorly and the dorsal flattened area is quite narrow. The transverse processes are broad, flat blades, curving forward. Prominent metapophyses and anapophyses are present on the posterior dorsals and lumbars, the anapophyses decreasing in length in the posterior members of the lumbar series. Strongly interlocking zygapophyses are a feature of the lumbar and posterior dorsal vertebræ.

Five vertebræ form the sacrum, three of which are in contact with the ilium and two belong to the caudal series (Pl. VI, fig. 11). The second and third sacrals and the caudals are firmly coössified by their neural arches, zygapophyses, transverse processes and centra, while the first sacral is free. The coössified neural spines of the sacral complex form an elongated plate, flattened dorsally.

The tail was probably long and heavy, but its exact length cannot be determined from the material available. The most complete specimen has sixteen free caudals in series (Pl. IX). The proximal caudals (Pl. VI, figs. 16, 17) have robust transverse processes, which decrease in length and increase in antero-posterior diameter posteriorly. These soon bifurcate, forming a process at either extremity of the elongated, hour-glass-shaped centrum (Pl. VI, figs. 18–20). The neural arch disappears at about the tenth caudal, a pair of processes at the anterior and posterior extremities of the centrum alone remaining. Chevrons are present (Pl. IX).

In proportion to the size of the animal, the ribs (Pl. IX) are quite robust, the first rib exceeding in width that of *Protypotherium*. It is broadly expanded antero-posteriorly at the proximal and distal ends. Farther back in the series the ribs are cylindrical.

The sternum is imperfectly known, as but three segments are present in the most complete specimen (No. 15,401). The first segment (Pl. VI, fig. 21) is dagger-shaped, with its anterior half, corresponding to the blade of the dagger, sharply keeled inferiorly. The two mesosternal segments preserved are hour-glass-shaped and doubly keeled inferiorly, the keels diverging anteriorly and posteriorly.

Appendicular Skeleton.—The scapula (Pls. VI, fig. 13; VIII, fig. 8) varies somewhat in shape with the species, but it is quite probable that a part of the difference is due to crushing. In all the specimens the coracoid border is strongly convex, the convexity continuing unbroken over the vertebral border as far as the inferior angle, which is quite prominent. The axillary border is convex in *I. robustum* and concave with elevated margin in a specimen referred to *I. extensum* (No. 15,041), but this may be due to crushing. Some slight differences in the shape of the coracoid border exist, but these can be more readily appreciated after an examination of the accompanying figures (Pls. VI, fig. 13; VIII, fig. 8) than from a description, however detailed. The surface of the supraspinous fossa is slightly undulatory in *I. robustum* and strongly convex in *I. extensum*, but just how much of the convexity is due to crushing is hard to determine. The infraspinous fossa is concave transversely in both species, but more so in the one last mentioned. The spine is high, with narrow, flattened crest and short metacromion. The neck is short and thick. The glenoid cavity is elliptical in outline, concave in all diameters, and continued forward to the extremity of the large bicipital tubercle, as in *Protypotherium*. The coracoid process is scarcely indicated.

No trace of a clavicle has been observed.

The humerus (Pl. VIII, fig. 7) is of about the same length as in *Pachyrukhos*, but may be readily identified, among other characters, by its larger head, stouter shaft, the greater transverse expansion of the distal end and the entire absence of an internal epicondylar foramen. The shaft is strongly curved antero-posteriorly, laterally compressed proximally and transversely expanded distally. The head is large, overhanging the shaft posteriorly. The tuberosities are not prominent, not exceeding the head in elevation. The deltoid ridge is broad and strong. Distally, the supinator ridge is not very well defined, resembling in this respect *Protypotherium*. The inner epicondyle is very heavy and the inner epicondylar foramen entirely wanting. The distal articular surface is similar to that of *Protypotherium*, with the exception that the inner lip of the trochlea is shorter, not so sharp and less completely separated from the inner epicondyle. A supratrochlear foramen is wanting.

The radius and ulna are short and very heavy. The radial shaft (Pl. VIII, fig. 10) is strongly arched antero-posteriorly and expanded transversely both proximally and distally. The head is oval in outline, its proximal surface concave externally for the humeral capitellum and flattened internally for contact with the inner lip of the trochlea. The articular surface for the ulna is convex transversely, plane proximo-distally, and evidently permitted considerable freedom of motion. The neck is constricted antero-posteriorly and expanded transversely. Distally, the radius is irregularly triangular in cross section, with a large oval concave facet for the scaphoid and lunar. The ulnar articulation is concealed in anterior view by a prominent flange on the outer margin of the distal end, proportionately larger than the similar structure in *Protypotherium*. The styloid process is short and the groove for the extensor tendons especially conspicuous and deep.

The ulna (Pl. VIII, fig. 9) exhibits the same decided lateral curvature as in *Protypotherium*, with strongly sigmoid posterior border. The olecranon is especially heavy, with the subcutaneous portion broad and almost flat and the area of insertion of the triceps quite rugose. The olecranon and coronoid processes have the same degree of anterior extension. Distally, the shaft decreases greatly in weight and is transversely flattened. Its anterior margin terminates in a sharp flange similar to that described in *Protypotherium*. At the level of the radial tubercle the shaft is antero-posteriorly expanded, but rapidly decreases in width distally. The styloid process is long, with a globular head. The radial articular surface is oval in outline and plane.

The manus (Pl. VIII, fig. 1) is tetradactyl. A pentadactyl manus, here reproduced as text figure 10, *A*, with large opposable thumb and separate os centrale is referred by Ameghino (1891*b*, p. 394, fig. 96) to *Interatherium* (*Icochilus*) *robustum*. No manus of *Interatherium* in the Princeton or American Museum collections has more than four digits and

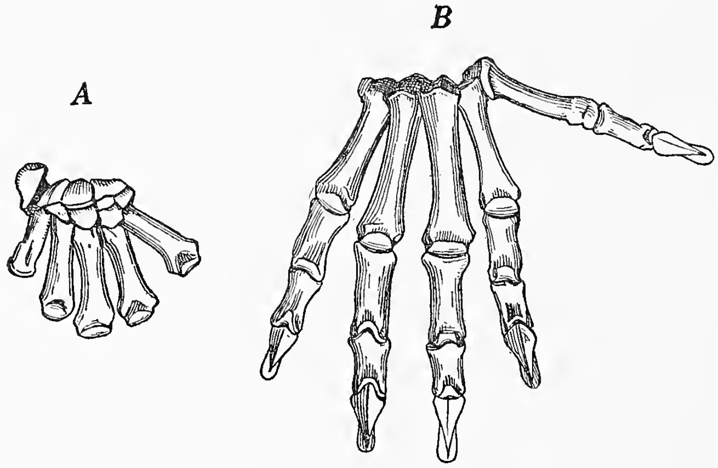


FIG. 10.

A, Right manus with opposable pollex and separate centrale, × $\frac{1}{1}$. *B*, Right pes with opposable hallux, × $\frac{1}{1}$ (after Ameghino). Both have been referred erroneously to *Interatherium robustum*.

neither in *Interatherium* nor in any of the Santa Cruz Typotheria does the centrale occur as a separate element. In shape and arrangement, there is the closest similarity between the carpal elements of *Interatherium* and *Protypotherium*. Some slight differences in the shape of the various articular surfaces are noticeable. The proximal surface of the scaphoid is deeply excavated antero-posteriorly in contrast with its even convexity in *Protypotherium*. On the lunar the facets for the unciform and cuneiform are wedge-shaped in outline and differentiated from each other, unlike *Protypotherium*. The cuneiform does not differ greatly from the corresponding element in *Protypotherium*. The ulnar surface is continued externally over the neck of the prominent external tubercle. The trapezium is a small element, laterally compressed proximally, with surfaces for the trapezoid and the second metacarpal. Distally, it is spherical and quite rugose, without the slightest trace of a surface for the pollex. The trapezoid, magnum and unciform do not differ sufficiently from those of *Protypotherium* to call for separate description. The metacarpals interlock proximally to about the same extent and in the same manner as in the latter genus. Distally, keels are present on the palmar surfaces. The phalanges resemble those of *Protypotherium*. Slight terminal clefts may or may not be present in the unguals, both conditions occurring in the same specimen.

The ilia (Pl. VI, figs. 11, 12) are long and narrow, with deeply concave gluteal fossæ, prominent superior and inferior borders and inconspicuous spines. The crest of the ilium, as in *Protypotherium*, is inclined forward obliquely. Inferiorly, the ilium is flattened, not excavated longitudinally as in the latter genus. The neck is robust, with prominent tubercle for the origin of the rectus femoris. Prominent ilio-pectineal eminences are developed. The ischia are broadly expanded and fan-like, with scarcely perceptible ischial spine. The descending ramus and the pubis are slender, inclosing a large, oval obturator foramen. The acetabulum is circular and deeply cupped, with narrow cotyloid notch.

The straight femoral shaft (Pl. VIII, figs. 3, 4) is more compressed antero-posteriorly than in *Protypotherium*. The head is large and globular, and impressed by a deep pit for the round ligament. The greater trochanter is low, not exceeding the elevation of the head. The lesser trochanter is proportionately larger than in *Protypotherium* and the third trochanter quite small and inconspicuous. The distal end is flattened transversely, with prominent condyles, of which the inner projects slightly beyond the outer. The patellar trochlea is proportionately wider and shallower than in *Protypotherium*.

The patella (Pl. VIII, figs. 29, 30) seems disproportionately large. It is almond-shaped in outline, strongly convex in all dimensions anteriorly and quite rugose. Posteriorly, the surface for contact with the femoral trochlea is slightly differentiated into two broadly concave facets.

The tibia and fibula (Pl. VIII, figs. 5, 6) are quite firmly fused proximally, but less completely so distally, where the suture remains distinct. The tibial shaft is slightly curved inwardly, the straight fibula spanning the arc. Proximally, the tibial articular surfaces are circular and slightly concave transversely, with inconspicuous spine. The shaft is triangular in cross-section proximally, but becomes oval in section toward the distal end, where it is expanded transversely. Internally and proximally, it is broad and almost a plane surface, while externally it is concave, the prominent cnemial crest forming the dividing line between the two surfaces. Distally, the articular surface closely resembles that of *Protypotherium.* The trochlea is evenly divided by a broad median keel. The internal malleolus is robust, with a large, slightly concave surface for the internal astragalar crest. Distally, the internal malleolus terminates in a hook-shaped process directed outward and downward (Pl. VIII, fig. 5).

The fibula is a slender element, firmly coössified with the tibia proximally and articulating with it distally by suture. The shaft is irregularly oval in cross-section, except at the ends, where it is transversely compressed proximally and expanded, with triangular outline, distally. The latter extremity supports a crescentic, plane surface for the outer astragalar crest and a second crescentic surface antero-posteriorly sigmoid in section for the calcaneum. The peroneal groove on the posterior surface of the distal end is quite conspicuous.

The pes is tetradactyl, with no trace of the hallux. Ameghino (1891 b, p. 393, fig. 95, reproduced as text fig. 10, *B*) refers to *Interatherium* (*Icochilus*) *robustum* a large hind foot, with strongly opposable hallux. An examination of the numerous complete hind feet in the Princeton and American Museum collections shows that this foot, like the fore foot mentioned on page 56 does not pertain to *Interatherium* or to any of the Santa Cruz Typotheria. The astragalus of *Interatherium* closely resembles that of *Protypotherium*, differing in the slightly shallower trochlea, proportionately shorter neck and the lesser degree of median constriction in the calcaneal facet. The calcaneum also is strikingly like that of *Protypotherium*, differing in the reniform shape of the astragalar facet and its sharper differentiation from the fibular facet than in the latter genus. With the exception of minor differences in the shape and proportions of the facets, the tarsus is closely similar to that of *Protypotherium* and need not be described in detail. The third and fourth metatarsals are equal in length, as are also the second and fifth, but shorter than the other two. All the metatarsals interlock proximally with each other and with the tarsus. Well developed keels are present on the distal plantar margin. The phalanges can be distinguished from those of the manus only by their greater size. They are slightly expanded transversely both proximally and distally. Those of the first row have the distal articulations confined to the distal and palmar surfaces, while in the second row the distal surface is in part dorsal, indicating some angularity in the position of the digits (Pl. IX). The terminal phalanges are laterally compressed hoofs, sometimes with slight terminal clefts.

Restoration.— The restored skeleton (Pl. IX) shows to advantage the large head, long back, heavy tail and short limbs. A digitigrade gait is inferred for the same reasons as those already given (p. 33) in discussing the gait of *Protypotherium*.

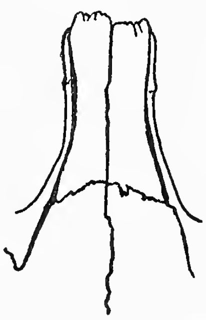
Interatherium robustum (Ameghino).

(Pls. VI, Figs. 11, 12, 16–20; VIII, Figs. 2, 5–8, 10–16, 19, 26, 29, 30; IX; Text Figs. 1*B*, 11.)

Icochilus robustus Amegh.; Revista Argentina de Hist. Nat., I, p. 393, footnote, fig. 97, but not figs. 95 and 96, 1891; Segundo Censo, etc., p. 150, fig. 17, 1898 (listed).

Characterized by the presence of a large persistent $I^{\underline{3}}$, and curved fronto-nasal suture. The temporal ridges are acutely convergent and not lyrate as in *I. excavatum*.

Fig. 11.



Interatherium robustum, showing the curved fronto-nasal suture, × $\frac{1}{1}$ (No. 15,300).

The following localities have afforded specimens of this species: Ten miles south of Coy Inlet (5), five miles south of Coy Inlet (1), eight miles south of Coy River (1), Coy Inlet (1), Killik Aike (1), seven miles south of Mt. Leone (1), Cañon de las Vacas, thirty-five miles south of Santa Cruz (nodule layer) (1), Cañon de las Vacas (2), Felton's estancia, Rio Gallegos (1), Halliday's estancia, Rio Gallegos (1), Rio Gallegos (1), Monte's Casa, seven miles south of Coy River (1).

As in the preceding lists, the figures in parentheses indicate the number of specimens from each locality.

Nos. 15,401, 15,100, 15,348 15,293, and Nos. 9129 and 9263 of the American Museum collection are illustrated in the accompanying plates.

Measurements.

	No. 9263.	*No. 15,348.*	*No. 15,100.*	*No. 15,401.*
Skull, length premaxillæ to inion	.082	.0735		.080
" greatest width across arches	.058	.0505		.0585
" interorbital width				.031*

* Approximate.

	No. 9263.	*No. 15,348.*	*No. 15,100.*	*No. 15,401.*
Skull, least width of brain case	.016	.0145		.0145
" width of occiput	.0445			.0455
" height " " above foramen magnum	.017	.014		.018
" width of palate at $P^{\underline{1}}$	.014			.014
Mandible, length including $I_{\overline{1}}$	.071	.0635	.0745	.072
" depth below $P_{\overline{1}}$	.017	.0135	.017	.016
" " " $M_{\overline{3}}$	.023	.023	.024	.024
Upper dentition, length $I^{\underline{1}}$–$M^{\underline{3}}$	.043	.0405	.0455	.0444
" " " $P^{\underline{1}}$–$M^{\underline{3}}$ on alveolar border	.029		.0285	.028
" " " $M^{\underline{1}}$–$M^{\underline{3}}$ " " "	.015		.0144	.0144
$I^{\underline{1}}$, width of crown at cutting edge	.0054	.0044	.0045	.005
$I^{\underline{2}}$ " " " " " "	.003	.002	.002	.003
$I^{\underline{3}}$ " " "	.0018	.0015	.0016	
C, antero-posterior diameter		.0017		
$P^{\underline{2}}$, antero-posterior diameter just above triturating surface			.0035	.0035
$P^{\underline{2}}$, greatest transverse diameter in same plane			.0025	.0025
$P^{\underline{3}}$, antero-posterior diameter on triturating surface externally			.0036	.004
$P^{\underline{3}}$, greatest transverse diameter on triturating surface			.0032	.0038
$P^{\underline{4}}$, antero-posterior diameter on triturating surface externally			.0042	.0046
$P^{\underline{4}}$, greatest transverse diameter on triturating surface			.0035	.004
$M^{\underline{1}}$, antero-posterior diameter on triturating surface externally			.0046	.005
$M^{\underline{1}}$, greatest transverse diameter on triturating surface			.0035	.004
$M^{\underline{2}}$, antero-posterior diameter on triturating surface externally			.0043	.0046
$M^{\underline{2}}$, greatest transverse diameter on triturating surface			.0035	.0036
$M^{\underline{3}}$, antero-posterior diameter on triturating surface externally			.005	.0045
$M^{\underline{3}}$, greatest transverse diameter on triturating surface			.003	.0034
Lower dentition, $I_{\overline{1}}$–$M_{\overline{3}}$			.043	
" " length $P_{\overline{1}}$–$M_{\overline{3}}$ on alveolar border			.027	
" " " $M_{\overline{1}}$–$M_{\overline{3}}$ " " "			.0145	
$I_{\overline{1}}$, width			.0022	.002
" greatest transverse diameter			.0016	
$I_{\overline{2}}$, width			.002	.0025
" greatest transverse diameter			.0016	
$I_{\overline{3}}$, antero-posterior "			.002	
" greatest transverse "			.0015	
C, antero-posterior "			.0015	
" greatest transverse "			.0012	

	No. 9263.	*No. 15,348.*	*No. 15,100.*	*No. 15,401.*
$P_{\overline{1}}$, antero-posterior diameter on triturating surface			.0018	
" greatest transverse diameter			.0012	
$P_{\overline{2}}$, antero-posterior diameter on triturating surface			.003	
" greatest transverse diameter			.002	
$P_{\overline{3}}$, antero-posterior diameter on triturating surface			.0035	
" greatest transverse diameter			.0025	
$P_{\overline{4}}$, antero-posterior diameter on triturating surface			.0038	
" greatest transverse diameter			.003	
$M_{\overline{1}}$, antero-posterior diameter on triturating surface .			.0045	
" greatest transverse diameter			.003	
$M_{\overline{2}}$, antero-posterior diameter on triturating surface .			.004	
" greatest transverse diameter			.003	
$M_{\overline{3}}$, antero-posterior diameter on triturating surface .			.0056	
" greatest transverse diameter			.003	
Atlas, width across transverse processes	.0305	.030		.029
" " " anterior articular surfaces . .	.0205		.019	.018
" " " posterior " " . .			.0175	.017
" " of neural arch	.009		.008	.008
" " " inferior arch			.005	.0048
Axis, length including odontoid			.017	.016
" height of spine above floor of neural canal .				.016
" length of spine		.018	.020	.018
" width across condyles			.018	.017
Vertebral column, length, atlas–sacrum		.301		
" " " first–fifteenth dorsal . .				.1385*
" " first sacral–second caudal . .				.047
" " length, third–eighteenth caudal .				.2215
Scapula, length, coracoid process to inferior angle .		.048		.052
" greatest transverse width		.0265		.028
" antero-posterior diameter of glenoid fossa .				.011
" transverse diameter of glenoid fossa . .				.007
Humerus, length	.0635	.055	.059	.0605
" antero-posterior diameter of head . .	.017	.05		
" transverse " " " . .	.0155			
" width of distal end	.0185		.016	.016
Radius, length		.0415	.043	.0415
" antero-posterior diameter of head . .				.0048
" transverse " " " . . .				.0067
" width of distal end		.0085	.0095	.0087
Ulna, length		.0525	.055	.055
" width at upper margin of sigmoid cavity .			.010	.0095
" " " coronoid process			.010	.0095

* Approximate.

	No. 9263.	*No. 15,348.*	*No. 15,100.*	*No. 15,401*
Ulna, antero-posterior diameter of distal end		.0055	.0065	.006
Metacarpal II, length		.013		.014
" " greatest width distally		.0046		.0046
" III, length		.015		.0155
" " greatest width distally		.0045		.0048
" IV, length		.013		.013
" " greatest width distally		.0045		.0046
" V, length		.0095		.009
" " greatest width distally		.004		.0035
Manus, digit II, first phalanx, length				.0086
" " " " " width proximally				.0045
" " " " " " distally				.0034
" " " second " length				.0055
" " " " " width proximally				.0038
" " " " " " distally				.0025
" " III, first phalanx, length		.009		.009
" " " " " width proximally		.0045		.0048
" " " " " " distally		.0035		.0035
" " " second " length		.0065		.0065
" " " " " width proximally		.004		.004
" " " " " " distally		.003		.003
" " " terminal phalanx, length				.008
" " " " " width proximally.				.0032
" " IV, first phalanx, length				.009
" " " " " width proximally				.0045
" " " " " " distally				.0035
" " " second phalanx, length				.0065
" " " " " width proximally				.004
" " " " " " distally				.003
" " " terminal " length				.008
" " " " " width proximally				.0033
" " V, first " length				.007
" " " " " width proximally				.004
" " " " " " distally				.0025
" " " second " length				.0048
" " " " " width proximally				.003
" " " " " " distally				.0025
Pelvis, length		.070		.074 *
" width at anterior margin of acetabulum		.028		.035
" " of ilium at greatest expansion		.011		.011
" " at neck of ilium				.0085
" acetabulum, antero-posterior diameter				.0097

* Approximate.

	No. 9263.	*No. 15,348.*	*No. 15,100.*	*No. 15,401.*
Pelvis, acetabulum, transverse diameter				.0095
Femur, length		.058		.059
" transverse diameter proximally				.0155
" " " at middle of shaft				.0075
" " " distally				.016
Patella, length			.014	
" width			.007	.007
Tibia, length			.0675	.0645
Tibia + fibula, transverse diameter proximally				.018
Tibia, transverse diameter distally		.085	.0105	.009
Fibula, length				.061
Calcaneum, length		.017		.0195
Astragalus, length		.011		.0115
" length of trochlea		.008		.0085
" width of trochlea		.005		.005
" " " body				.007
" " " head		.005		.005
Metatarsal II, length				.0165
" " greatest width distally				.0047
" III, length				.021
" " greatest width distally				.0056
" IV, length				.022
" " greatest width distally				.0055
" V, length				.0175
" " greatest width distally				.0045
Pes, digit II, first phalanx, length				.0093
" " " " " width proximally				.0047
" " " " " " distally				.0035
" " III, " " length				.0106
" " " " " width proximally				.006
" " " " " " distally				.0042
" " " second phalanx, length				.0074
" " " " " width proximally				.0045
" " " " " " distally.				.0035
" " " terminal phalanx, length				.0075
" " " " " width proximally				·003
" " IV, first phalanx, length				.011
" " " " " width proximally				.0054
" " " " " " distally				.004
" " " second phalanx, length.				.007
" " " " " width proximally.				.0045
" " " " " " distally				.0033
" " " terminal phalanx, length				.0075

	No. 15,401.
Pes, digit IV, terminal phalanx, width proximally	.003
" " V, first phalanx, length	.0099
" " " " " width proximally	.005
" " " " " " distally	.0035
" " " second phalanx, length	.006
" " " " " width proximally	.004
" " " " " " distally	.003
" " " terminal phalanx, length	.007
" " " " " width proximally	.003

INTERATHERIUM EXTENSUM (Ameghino).

(Pls. VI, Fig. 13; VIII, Figs. 3, 4, 17, 18.)

Icochilus extensus Amegh.; Contrib. al Conoc., etc., pp. 471–472, Pl. 15, figs. 4–9, 1889; Énum. Synoptique, etc., p. 15, 1894 (listed); Segundo Censo, etc., p. 150, 1898 (listed).

Icochilus hegetotheroides Amegh.; Énum. Synoptique, etc., p. 17, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Separated from *I. robustum* by characters of somewhat doubtful importance. The third upper incisor is frequently entirely wanting, or may be present on one side and absent on the other, and is much smaller than the corresponding tooth in *I. robustum*, which persists even in aged individuals. In the best preserved specimen referred to *I. extensum* the fronto-nasal suture is straight, while in *I. robustum* it is curved. The absence of lyrate temporal ridges separates it from *I. excavatum*.

Represented by two specimens in the Princeton collection No. 15,041 from a locality ten miles south of Coy Inlet and No. 15,666 from Coy Inlet.

MEASUREMENTS.

	No. 15,041.	No. 15,666.
Skull, length premaxillæ to inion	.0815	
" greatest width across arches	.058	
" interorbital width	.034	
" least width of brain case	.0145	
" width of palate at P^1	.0135	.014
" width of palate at M^3	.019	.0185
Upper dentition, length I^1–M^3	.0435	.0446
" " " P^1–M^3	.029	.0295
" " " M^1–M^3	.015	.0155

			No. 15,041.	*No. 15,666.*
$I^{\underline{1}}$ width of crown at cutting edge			.005	.005
$I^{\underline{2}}$ " " " " " "			.003	.003
C, antero-posterior diameter				.0017
" transverse	"			.001
$P^{\underline{1}}$, antero-posterior	"	just above triturating surface	.0024	.0021
" transverse	"	in same plane	.0015	.0015
$P^{\underline{2}}$, antero-posterior	"	just above triturating surface	.0035	.003
" transverse	"	in same plane	.0025	.0025
$P^{\underline{3}}$, antero-posterior	"	on triturating surface externally	.004	.004
" transverse	"	at widest part	.0035	.0032
$P^{\underline{4}}$, antero-posterior	"	on triturating surface externally	.0043	.0045
" transverse	"	at widest part	.004	.004
$M^{\underline{1}}$, antero-posterior	"	on triturating surface externally	.0048	.0052
" transverse	"	at widest part	.0045	.0045
$M^{\underline{2}}$, antero-posterior	"	on triturating surface externally	.0045	.0048
" transverse	"	at widest part	.004	.0042
$M^{\underline{3}}$, antero-posterior	"	on triturating surface externally	.005	.0055
" transverse	"	at widest part	.0035	.0035
Atlas, greatest width across transverse processes.			.028	
" width across anterior articular surfaces			.017	
" " of neural arch			.0073	
" " " inferior arch			.0055	
Axis, length including odontoid			.017	
Pelvis, length			.081	
Femur, length			.063	
Tibia, length			.068	
Astragalus, length			.0115	
Calcaneum, length			.0195	
Metacarpal II, greatest length			.0135	
" III, length			.0158	
" IV, "			.013	
Metatarsal II, " dorsally			.017	
" III, " "			.0208	
" IV, " "			.0202	
" V, " "			.016	

INTERATHERIUM EXCAVATUM (Ameghino).

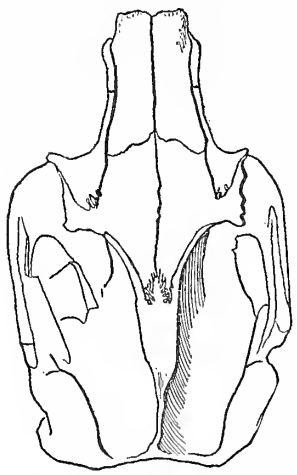
(Pls. VIII, Fig. 28, Text Fig. 12.)

Icochilus excavatus Amegh.; Contrib. al Conoc., etc., pp. 472–473, Pl. 15, figs. 10–13, 1889.

This species may be readily recognized by the lyrate temporal ridges (text fig. 12). A photograph of a specimen in the collection of Dr.

Ameghino, determined by him as *I. excavatum*, shows this feature plainly. The dental characters given in the original description (Ameghino, 1889, pp. 472–473) have not been found to be of specific value. The third upper incisor is about as large as in *I. extensum*. The posterior border of the nasals is curved, as in *I. robustum*. Characters of specific importance are exhibited by the atlas (Pl. VIII, fig. 28) in which the transverse processes are more sharply constricted proximally and less widely expanded distally.

Fig. 12.



Interatherium excavatum, showing the lyrate crest, ×¾ (No. 15,043). Slightly diagrammatic.

Represented by a crushed skull and mandible associated with the atlas and axis, the posterior portion of the vertebral column, the pelvis and portions of both hind limbs, No. 15,043, from a locality ten miles south of Coy Inlet. Several immature skulls also showing the lyrate crest are probably to be referred to this species. These are No. 9750 Am. Museum, No. 15,291 and No. 15,146 from the same locality as No. 15,043.

The adult individual (No. 15,043) is considerably crushed, so that only approximate dimensions can be given.

Measurements.

	No. 15,043.
Length of skull	.080
Interorbital width	.0305
Length of mandible including incisors	.0665
Atlas, width across transverse processes	.025
" width across anterior articular surface	.0185
" " of neural arch	.007
" " " inferior arch	.0045
Axis, " across condyles	.017
" length of odontoid	.004
Fourteenth dorsal, length of centrum	.0105
Fifteenth " " " "	.0105
First lumbar " " "	.011
Second " " " "	.0105
Third " " " "	.0115
Fourth " " " "	.0115
Fifth " " " "	.012

	No. 15,043.
Sixth lumbar, length of centrum	.0115
Seventh " " " "	.011
Pelvis, length	.069
" greatest width of ilium	.0093
" width of neck of ilium	.008
" antero-posterior diameter of acetabulum	.0094
" transverse " "	.0095
Femur, transverse diameter proximally	.015
" " " across minor and third trochanters	.0135
Patella, length	.012
" width	.0065

HEGETOTHERIIDÆ.

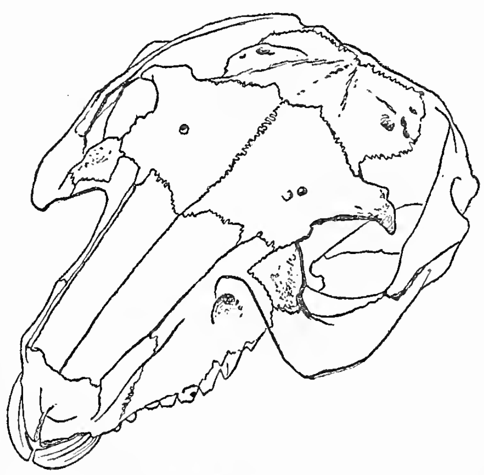
HEGETOTHERIUM Ameghino.

(Plates I, II; Text Figs. 1, *D*; 4, *A*; 13–16.)

Hegetotherium Amegh.; Enumeracion Sistematica, etc., p. 14, 1887.
Selatherium Amegh.; Énumeration Synoptique, etc., p. 19, 1894.

This genus is represented in the collections by a single species, *Hegetotherium mirabile.* With the exception of the vertebral column and ribs, pelvis, scapula and fore foot, the skeleton is fairly well known.

Fig. 13.



Hegetotherium mirabile, skull from in front, × ¾ (No. 15,542).

Dentition (Pl. I, figs. 1, 3, 5–5 *b*).—In *Hegetotherium,* the median upper incisors are enlarged, cropping teeth, growing from persistent pulps, with the enamel layer confined, as in the Rodentia, to the outer side of the crown. The enamel is marked by a large number of minute, longitudinal, parallel flutings, occasionally crossed by growth lines. These teeth are implanted obliquely and converge anteriorly (text fig. 13).

The remaining incisors and the canine are cylindrical, single-rooted teeth, separated from each other and from the median incisor by short diastemata. The canine may be close to the first premolar, or slightly spaced from it, and is implanted entirely in the maxillary. The true shape of the crowns of these teeth cannot be ascertained, as the enamel-covered portions have been worn away, leaving merely cylinders of dentine. In all the specimens examined the teeth are well worn, but the patterns developed by attrition in the molars and premolars and the outlines of the crowns are characteristic, and cannot be confused with those of any other genus. The first premolar is more or less cylindrical in shape, depending on the amount of wear to which it has been subjected. The crown is slightly curved, with the convexity of the curve directed anteriorly; the buccal surface is convex; the lingual surface is sometimes slightly grooved. The worn area on the occlusal surface varies in different individuals from a deep notch to a slight, postero-internally directed concavity. The second premolar is triangular, with the base of the triangle directed postero-internally. Externally, the anterior portion of the crown is channeled by a groove between two ridges (Pl. I, fig. 1). The third and fourth premolars are molariform and may be described together with the molars. Externally, the crowns are convex, the convexity flattening out anteriorly and posteriorly. An antero-external groove is present in each, but its depth and distinctness decrease with the age of the individual and the amount of wear to which any particular tooth has been subjected. Internally, the crowns are convex except in the third molar, which is slightly grooved on the inner side posteriorly, the depth of the groove decreasing as the tooth wears down. The antero-external angle of the molars and molariform premolars is slightly elongated. Posteriorly, these teeth are rectangular in outline except in the third molar, where the postero-external angle is considerably elongated. The degree of elongation of this portion of the third molar varies somewhat in different individuals. The triturating surface of the crown of each tooth ($P^{\underline{2}}$–$M^{\underline{3}}$) is traversed by two ridges of dentine trending inward from two serrate cusps in the enamel of the buccal face. These serrations interlock with the external crescents of the lower molars. The molars and molariform premolars are invested externally with a thin layer of cement. All are hypsodont. The first molar is the largest, the remaining members of the series decreasing anteriorly and posteriorly. The primary crown pattern must have been quite superficial, as the surfaces developed by attrition show no traces of enamel lakes or other indications of a deeply indented crown. From $P^{\underline{2}}$ to $M^{\underline{3}}$ all the teeth are implanted obliquely, the antero-external portion of each projecting beyond the postero-external angle of the tooth next preceding. As in all the Santa Cruz Typotheria, the crowns of the upper molars and premolars curve inward.

In the inferior series (Pl. I, fig. 5), the median and second pair of incisors are greatly enlarged, with the enamel confined to the outer surface. These teeth are inclined forward obliquely, both shearing against the tips of the median upper incisors, and like the latter growing from persistent pulps. The third incisor and the canine are cylindrical in shape and are directed forward. The first premolar is also cylindrical, is slightly larger than the teeth preceding it and differs from them in its erect position. As in the case of the vestigial members of the superior series, the enamel-covered portions of the crowns have been entirely worn away, leaving cylinders of dentine. The third incisor, canine and first premolar are separated from each other and from the second incisor and second premolar by short diastemata. In some specimens in which the vestigial teeth are less worn, the third incisor is close to the second, and owing to its oblique position, overhangs the posterior border of the latter. The absence of the lower canine has been used by Ameghino to separate the genus *Selatherium* from *Hegetotherium*. All the specimens on which this determination is based are more or less broken in the region of the lower canine, and even admitting the correctness of this diagnosis, it is a question whether the loss of such a minute vestigial tooth would justify a generic distinction. In the opinion of the writer, *Selatherium* is invalid and should be united with *Hegetotherium*. As in the upper series, the premolars become increasingly molariform posteriorly. The shape of the second premolar varies with the amount of wear to which it has been subjected. In less worn teeth, it is triangular with the apex of the triangle directed forward. Externally, the crown is impressed with a narrow groove. Internally, it is broadly grooved. As the tooth wears down, the outer groove disappears and the angularity of the crown decreases, until finally it assumes a cordate outline in cross-section (Pl. I, figs. 5*a*, 5*b*). The third and fourth premolars are fully molariform and may be described with the first and second molars. Externally, the crown is divided by a deep V-shaped notch into two crescents, while internally the tooth wall is smooth and broadly convex, differing markedly in this respect from *Protypotherium*. In the fourth premolar and first and second molars the postero-internal corner is elongated. The third molar is trilobate externally, the second groove being much shallower than the first. Internally, the crown is marked by a broad shallow concavity opposite the second external groove. The crowns of the lower molars and molariform premolars curve outward, and, as in the superior series, are invested with a thin layer of cement.

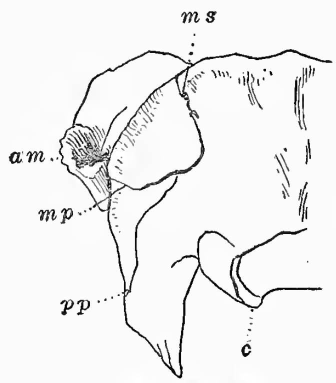
The milk dentition is unknown.

Skull (Pl. I, figs. 1–4, 6; text fig. 13).—The skulls in the collection at Princeton University and the American Museum of Natural History belong to individuals of approximately the same age and show but a small amount of variation in size, so that the measurements given in the description of *H. mirabile* may be regarded as a fair average.

In side view (Pl. I, fig. 1) the upper profile of the skull is broadly convex, the surface sloping gradually forward and rather rapidly backward from the parietal eminences. The orbit is approximately central and almost entirely inclosed posteriorly by the strong postorbital frontal process and the abruptly truncated anterior extremity of the zygomatic process of the squamosal. Unlike *Protypotherium* and *Interatherium*, the maxillary is entirely excluded from taking any part in the orbital border by the malar, the free border of which is produced anteriorly as a broad plate overhanging the preorbital expanse of the maxillary (text fig. 13), bounding externally a deep fossa and, in side view, almost concealing the infraorbital foramen, which lies above the anterior margin of the first molar. Anterior to the lachrymal, a small portion of the maxillary enters into the lateral surface of this plate. The lachrymal is about equally divided into orbital and extraorbital moieties, with the tear duct double, one canal opening within the orbit behind the rather large lachrymal tubercle and the other on the orbital margin below the tubercle. The maxillary is in contact with the frontal by a small process extending between the nasal and lachrymal (Pl. I, fig. 2). This process has less posterior extension than in either *Protypotherium* or *Interatherium*, in which it is produced well beyond the anterior margin of the orbit, while in *Hegetotherium* it does not extend much beyond the fronto-nasal suture. A small process of the frontal is received between it and the nasal. Anteriorly, the nasal and maxillary are in broad contact, preventing the premaxillary from touching the frontal. Posteriorly, the maxillary gives rise to a long narrow process applied to the inferior inner surface of the zygoma and terminating a short distance anterior to the glenoid cavity. The posterior border of this zygomatic process of the maxilla originates opposite the posterior margin of $M^{\underline{3}}$. In

Protypotherium it arises farther forward opposite the posterior border of M^2, while in *Pachyrukhos* its origin lies a considerable distance posterior to the last molar. The premaxillæ are heavy, increasing in width superiorly, with the ascending process proportionately shorter than in *Protypotherium*. On the palatal surface the premaxillæ almost entirely inclose the incisive foramina. The arches are heavy, their lateral surface being formed entirely by the squamosal and malar in contrast with the structure in *Protypotherium* and *Interatherium*, in which the maxillary enters largely into the lateral surface of the arch. In *Hegetotherium* the maxillary enters into the inferior inner surface of the arch, sending a narrow process applied to the malar almost as far posteriorly as the glenoid cavity. The deep, narrow zygomatic process of the squamosal terminates abruptly at the orbital rim and, with the postorbital process of the frontal, almost closes the orbit posteriorly. The malar terminates a short distance anterior to the glenoid cavity, while in *Protypotherium* it bounds the glenoid cavity laterally. The latter presents posteriorly as well as inferiorly. It is much wider than long, concave in section from side to side and convex antero-posteriorly. The postglenoid process, which is closely fused with the spout-like, posteriorly directed auditory meatus, is separated from the glenoid cavity by a deep fossa for accommodation of the non-articular portion of the mandibular condyle when the mouth is widely opened. The mastoid is dilated, inclosing a large oval chamber (Pl. I, fig. 6) connected by a canal with the tympanic cavity. The sutures between the mastoid and the squamosal have been completely obliterated by fusion. This is usually also the case with the suture between the squamosal and the auditory meatus, but in No. 9223 American Museum (text figs. 14, 16) the latter is clearly apparent, as is also the mastoideo-posttympanic suture.

FIG. 14.

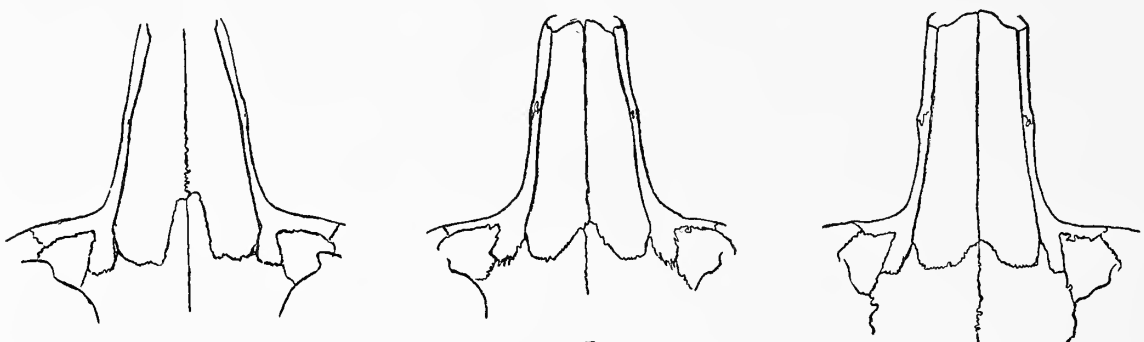


Hegetotherium mirabile, occiput showing the sutures between the cranial elements, × 1/1 (No. 9223, American Museum).

am, auditory meatus; *c*, condyle; *mp*, mastoideo-posttympanic suture; *ms*, mastoideo-supraoccipital suture; *pp*, posttympanic-paroccipital suture. Terminology after Roth (1903)

Superiorly (Pl. I, fig. 2), the nasals are seen to be broad and slightly arched, increasing in width posteriorly, and extending as far back as the anterior margin of the orbit. The relation existing between frontals and nasals has been made a basis for specific distinction, *Hegetotherium cuneatum* being founded on an individual in which a tongue of the frontals is produced between the nasals (text fig. 15, *A*), but as transitions may be observed between this extreme and the normal in *Hegetotherium mirabile* (text fig. 15, *B*, *C*), it seems probable that these are merely individual

FIG. 15.



A B C

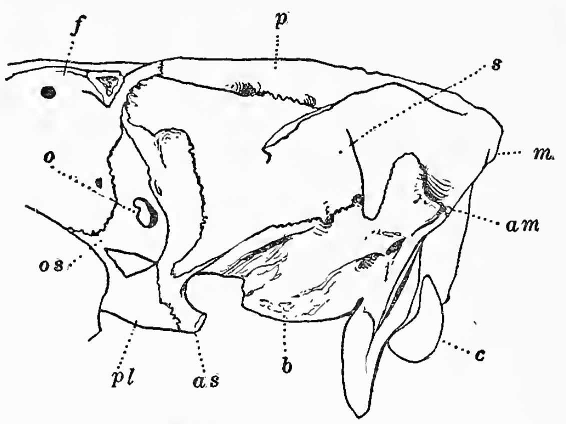
Hegetotherium mirabile, showing variation in the shape of the fronto-nasal suture, × $\frac{3}{4}$. *A*, No. 9156 American Museum collection; *B*, No. 15,341; *C*, No. 15,542.

variations. The interorbital tract is quite broad, plane in some individuals, slightly concave in others, and is perforated by one or more supraorbital foramina. The interfrontal suture persists. The postorbital processes are large and bilobate. Their posterior borders are confluent with the slight temporal ridges, which converge far back on the parietal, giving rise to a low sagittal crest. The brain case is proportionately wider than in *Protypotherium* or *Interatherium*, but not as wide proportionately as in *Pachyrukhos*. Numerous foramina perforate the parietal tract. The outer margin of the temporal fossa is sharply defined by the elevated border of the zygomatic process. This crest terminates a short distance anterior to the inion, from which it is separated by the mammilated surface of the squamosal, inclosing a deep groove continuous anteriorly with the temporal fossa. In *Protypotherium* and *Interatherium* it is produced to the inion, joining the lambdoidal crest. In some individuals the interparietal suture remains distinct; in others it is entirely obliterated. The suture between parietal and supraoccipital lies a short distance anterior to the lambdoidal crest, exposing a narrow tract of the supraoccipital in superior view (Pl. I, fig. 2).

On the back of the skull (Pl. I, fig. 4; text fig. 14) the mastoid is broadly exposed. The occipital elements are fused to such an extent that it is impossible to differentiate between supra- and exoccipitals. Dorsally, the occipital is broad, a wing-like expansion overlapping the mastoid dilatation. About midway between the lambdoidal crest and the foramen magnum the width of the occipital decreases sharply. This constriction lodges the mastoid foramen, which perforates the occipito-mastoid suture. When not obliterated by fusion, the mastoideo-posttympanic suture trends outward and downward from this point (text fig. 14) for about two-thirds of its course, thence rising toward the border of the occiput at a point opposite the lower margin of the auditory meatus. Opposite the condyles the occipital attains its maximum expansion, but does no reach the border of the occiput, where the post-tympanic area is exposed. Inferiorly, the exoccipital portion is greatly elongated, forming the fang-shaped paroccipital process. The occiput is divided by a slight ridge extending from the lambdoidal crest to the foramen magnum. The latter is elliptical in outline, with the condyles obliquely placed. The condylar surfaces are divided into posterior and inferior moieties by a low but perfectly distinct ridge, coinciding with the inferior border of the condylar surface as seen in posterior view (Pl. I, figs. 3, 4). These surfaces are convex in all dimensions, but are comparatively flat when contrasted with the semi-cylindrical condyles of *Protypotherium*.

The palate (Pl. I, fig. 3) is moderately concave. The tooth-rows are straight posteriorly, converging rather sharply anterior to the second premolar and again becoming straight or nearly so. The palatine extends as far forward as the middle of the first molar. Opposite the middle of the second molar the maxillo-palatine suture is perforated by the posterior palatine foramina. The narial border is emarginated by a strong spine. Posteriorly, the palate resembles that of *Protypotherium*, terminating in a pair of processes with knob-like extremities, which are partly developed from the palatines and partly from the alisphenoids. Each process is supported externally by a plate-like buttress (text fig. 16, *as*) developed from the alisphenoid and squamosal, directed outward and backward and coinciding with the line of suture between the alisphenoid and the squamosal, while in *Protypotherium* it is directed mainly outward. The pterygoid is not preserved in any of the skulls examined, but, with the alisphenoid plate, incloses a deep fossa as in *Protypotherium*. The squamosal is peculiar in that it sends a long process upward and forward to contact with the frontal (text fig. 16), from which it is excluded in *Protypotherium* by the alisphenoid and parietal, and a second process forward and downward, forming the postero-external margin of the alisphenoid plate. The bullæ are large, heart-shaped, hollow structures, convex in all dimensions and tapering to a point anteriorly. The auditory meatus is long and tubular, with its orifice opening posteriorly. It is frequently fused with the squamosal. The basioccipital is sharply keeled for a short distance anterior to the foramen magnum.

Fig. 16.



Hegetotherium mirabile, arch removed to show the arrangement of the cranial elements in the temporal fossa, $\times \frac{1}{1}$ (No. 9223, American Museum). *am*, auditory meatus, *as*, alisphenoid; *b*, bulla; *c*, condyle; *f*, frontal; *m*, mastoid; *o*, optic foramen; *os*, orbitosphenoid; *p*, parietal; *pl*, palatine; *s*, squamosal. The pterygoid has been broken off.

The distribution of the cranial foramina differs in several essential particulars from their arrangement in *Protypotherium* and *Interatherium* (cf. Pls. I, fig. 3; III, fig. 3). The carotid foramen perforates the suture between the basioccipital and the tympanic opposite the middle of the bulla and is widely separated from the foramen lacerum posterius, with which it is confluent in *Protypotherium* and *Interatherium*. The latter foramen is situated between the basioccipital and the tympanic at the inner anterior margin of the base of the paroccipital process. On the external side of this process is a deep pit for the tip of the stylohyal. Between the auditory meatus and the mastoid are three or four foramina apparently opening into lateral vascular sinuses (text fig. 16). A large postglenoid foramen perforates the suture between the squamosal and the auditory meatus at the margin of the postglenoid fossa. The foramen ovale and the foramen lacerum medium are confluent. The Eustachian canal opens on the suture between the tympanic and the basisphenoid at the elongated anterior extremity of the bulla. Within the orbit a large, elongated orbito-nasal vacuity, communicating with the infraorbital foramen, opens into the olfactory chamber. Several smaller foramina (text fig. 16) are probably vascular. The foramen rotundum and spheno-orbital foramen are confluent. A large spheno-palatine foramen connects the spheno-maxillary fossa with the posterior narial cavity.

The mandibular rami (Pl. I, figs. 1, 5) are firmly coössified at the symphysis, producing a long, spout-like depression, the slope of which is continued forward by the pronate incisors. The horizontal ramus is somewhat thicker than in *Protypotherium* and increases more gradually in depth posteriorly. The masseteric fossa extends to the angular margin, limited anteriorly and inferiorly by a strong everted flange, with hook-shaped anterior extremity. The angular portion of the mandible is deep, projecting posteriorly beyond the condyle and inferiorly below the lower border of the horizontal ramus, with sharply convex outline. The coronoid process is imperfectly preserved in all the specimens examined. It is thin and narrow, projecting well above the condyle, from which it is separated by a narrow sigmoid notch. Anteriorly, the coronoid border is slightly convex, rising almost vertically from the alveolar margin, in striking contrast with its strong forward inclination in *Protypotherium*. The condylar surface is a flattened oval in outline, wider externally than internally, convex in all dimensions and presenting forward. The posterior portion of the capitulum is not occupied by an articular surface, but by a roughened area of irregular outline fitting into the postglenoid fossa, as in *Protypotherium*. The neck is far less sharply differentiated than in the last named genus. Externally, on either side, there is always a large mental foramen (sometimes double) in the symphysial region, and several small foramina varying in number and position on the external surface of the horizontal ramus. Internally, the opening of the inferior dental canal is large and is rendered doubly conspicuous by a long, deep groove, leading into it from above.

Vertebral column (Pl. II, figs. 22–27). — The vertebral column is very incompletely known. The atlas (Pl. II, figs. 25–27) differs from that of *Protypotherium* in the shape of the transverse processes and the arrangement of the vertebral foramina. The transverse processes are fan-shaped expansions, with lobate free border, and are rather sharply constricted at the base. The posterior third of the base of the process is thickened, the arterial canal entering at the margin of the posterior constriction and emerging on the lower surface of the process. Anterior to the point of emergence of the canal, the thickness of the basal portion of the process greatly decreases. In the atlas of *Protypotherium* this canal is not present. The neuro-arterial canal sometimes lacks the anterior bony bridge, appearing as a deep groove. Both conditions occur in the same specimen. In *Pachyrukhos*, the anterior bar is apparently regularly wanting. The inferior arch supports a strong median tubercle.

The axis (Pl. II, figs. 23, 24) is not sufficiently well preserved in any of the specimens examined to show the shape of the spine. Unlike *Protypotherium*, the odontoid is strongly curved upward and the transverse processes are perforated by a large arterial foramen, which is quite small in *Protypotherium*. The centrum is keeled inferiorly and supports a pair of large tubercles at its posterior margin.

Little can be said regarding the remaining cervicals, as in all the specimens available the transverse processes have been broken off, and in the majority of cases the neural spines also. In the third cervical (Pl. II, fig. 22) the neural spine is low, broad and directed vertically. The centra of the third to the fifth cervicals inclusive are keeled inferiorly, the keel becoming bifid posteriorly and terminating in a pair of tubercles. The transverse processes are perforated by a large arterial canal.

A single lumbar vertebra, from which the transverse processes and the neural spine are missing (Pl. I, fig. 7), is interesting in that it shows the strongly interlocking character of the zygapophysial articulations. Rather prominent metapophyses are present. Anapophyses are but slightly developed. The centrum is hour-glass-shaped, with prominent median keel.

Appendicular Skeleton. — The scapula has not been preserved with sufficient completeness to warrant an attempt at extended description. Enough remains in one specimen to show the presence of a high spine and prominent metacromion.

The humerus (Pl. II, fig. 13) is of about the same size as the corresponding element in the larger individuals of *Protypotherium australe*, but differs structurally in several important details. The shaft is strongly compressed laterally. The head is of about the same shape as in *Protypotherium*, the greater tuberosity rising farther above the level of the head than in the latter genus. The lesser tuberosity is comparatively insignificant and is separated from the greater tuberosity by a wide bicipital groove. The area of insertion of the deltoid is broad and flat, the margins of this area converging distally to form a sharp ridge. Distally, the shaft expands transversely. The supinator ridge is somewhat better defined than in *Protypotherium* and the inner epicondyle heavier. Capitellum and trochlea are differentiated to about the same extent as in *Pro-*

typotherium, with the inner lip exceedingly prominent. In fact the whole distal articular surface of the humerus is hardly to be distinguished from that of *Protypotherium*. The olecranon and coronoid fossæ are separated by a very thin lamina of bone, which is sometimes perforated by a supratrochlear foramen. An inner epicondylar foramen is always present.

The head of the radius (Pl. II, figs. 3, 4) is irregular in outline, much wider in transverse diameter than antero-posteriorly. The ulnar surface is almost plane transversely. The anterior margin supports a strong median convexity, unlike the smooth, evenly convex, anterior margin of the radial head in *Protypotherium*. The outer two thirds of the head is cupped for articulation with the humeral capitellum. The inner third is concave antero-posteriorly, slightly convex transversely and slopes sharply inward. It articulates with the inner lip of the trochlea. The neck is transversely flattened, especially on the anterior side, where it is overhung by the head of the radius. The shaft is almost straight, while in *Protypotherium* it is strongly arched forward (cf. Pl. IV, fig. 14). It is circular in cross-section proximally, but becomes triangular distally and at the extreme distal end irregularly quadrangular, owing to the development of grooves to accommodate the extensor tendons. The carpal articular surface covers almost the entire distal end. The facets for the scaphoid and lunar are undifferentiated. The entire surface is deeply concave antero-posteriorly and more broadly concave transversely. The facet for the ulna is a small crescentic, antero-posteriorly concave surface on the ulnar side of the distal end.

The ulnar shaft (Pl. II, figs. 6, 7) is much straighter than in *Protypotherium*, exhibiting none of the lateral curvature characteristic of that genus. The olecranon process is proportionately about as long and wide as in *Protypotherium* — but is much narrower transversely. Anteriorly, it projects slightly beyond the coronoid process. The greater sigmoid cavity is narrower transversely than in *Protypotherium*. Its coronoid portion meets the lesser sigmoid cavity at a right angle, resembling closely the arrangement of these parts in many rodents. Both are approximately plane surfaces. The shaft is flattened laterally, lacking the strongly developed interosseous ridge and the deep concavity on the inner face which are present in *Protypotherium*. Toward the distal end the shaft is expanded antero-externally, giving rise to a narrow, sharp ridge trending downward and outward. The inferior extremity of the ulna is heavier than in *Protypotherium*. The radial articulation is an almost plane surface. The styloid process is proportionately shorter and the articular surface for the cuneiform flatter than in *Protypotherium*.

The manus is unknown.

The pelvis is known from several fragments, the best preserved specimen (No. 15,093, Pl. II, fig. 14) being an incomplete right half, retaining portions of the ilium and ischium, with the pubis broken off at the inferior margin of the acetabular cavity. Compared with the pelvis of one of the larger individuals of *Protypotherium australe*, the gluteal surface of the ilium is seen to be less deeply excavated and the posterior inferior spine less prominent. The inferior iliac margin is broad and flat, separated from the gluteal fossa by a sharp ridge trending forward from the origin of the rectus femoris muscle. In *Protypotherium* the area thus inclosed is rendered concave by a median groove. The ischial spine is large and the ilio-pectineal eminence quite prominent, while in *Protypotherium* it is scarcely indicated. The acetabulum is larger than in the latter genus and the cotyloid notch somewhat wider. Internally, the surface for articulation with the auricular process of the sacrum seems to extend farther forward than in *Protypotherium*.

The femur (Pl. II, figs. 8–10) differs from that of *Protypotherium* in proportion rather than in detail. The head is globular, with a well-marked pit for the ligamentum teres (not shown in the figures), which varies in distinctness and depth in different individuals. The great trochanter rises above the head about as far as in *Protypotherium*, but is separated from it by a somewhat wider notch. The digital fossa is much wider than in the last named genus. The trochanter minor and third trochanter occupy the the same relative positions as in *Protypotherium*, but the third trochanter is proportionately larger. Distally, there is scarcely any difference between the two genera in the details of the condylar surfaces.

The patella (Pl. II, figs. 11, 12) is an elongated element of oval shape, tapering gradually to a rounded apex. The anterior surface, which is strongly convex in all diameters, is quite rugose. The posterior surface is divided by a median ridge into two approximately equal, concave articular surfaces, extending to the apical extremity, but separated from the upper edge by a narrow, roughened area.

The tibia and fibula (Pl. II, figs. 1, 2) are firmly coössified both proximally and distally. The two condylic surfaces for articulation with the femur are approximately equal. Both are circular in outline. The inner is strongly concave from side to side and very slightly convex antero-posteriorly; the outer is strongly convex from before backwards and plane transversely. The spine is inconspicuous. The shaft is irregularly triangular proximally, but in its central portion becomes laterally flattened, in contrast with *Protypotherium*, in which this portion of the shaft is circular in cross-section. A strong cnemial crest terminating in a prominent tubercle extends about one-third the length of the shaft. The shaft is strongly arched inward, the straight, slender fibula forming the chord of the arc. The shaft of this element is semi-circular in section, with the inner surface flat. Distally, both bones are firmly welded, the laterally expanded distal end of the tibia forming with the fibula a broad flat area on the anterior side of the symphysis and a deeply excavated depression on the posterior side. The internal malleolus is very long and deeply grooved postero-internally for the lodgement of tendons. The fibula is also produced distally, but does not extend so far as the internal malleolus. The surface for articulation with the astragalar trochlea (Pl. II, fig. 2) is deeply sunk between them. The outer lip of the trochlea is lodged in a deep, V-shaped notch along the line of suture between tibia and fibula. The groove for the inner trochlear lip is U-shaped in transverse section and extends down the outer surface of the internal malleolus. The fibula supports three facets distally, a large, flat facet for articulation with the lateral surface of the body of the astragalus, an almost flat, trapezoidal facet in contact with the lateral process of the astragalar body, when the foot is in the position of extreme flexion, and a small, lemniscus-shaped facet for contact with the calcaneum. The groove for the peroneal tendons is well defined and the external malleolus prominent.

No complete specimen of the pes is preserved, but by putting together parts of two specimens (Nos. 15,392 and 15,298) it has been possible to reconstruct an almost complete tarsus and the entire metatarsus (Pl. II, fig. 19). The astragalar trochlea is wider than in *Protypotherium*, but the margins are unequally developed, the external being high and sharp and the internal low and round. The former fits into the deep groove between the distal ends of the tibia and fibula. The trochlear surface is short and not produced as far backward as in *Protypotherium*. The astragalar body supports two processes, as in *Pachyrukhos*. The external process rises from the distal outer corner of the body of the astragalus. Its dorsal surface supports a facet, confluent with the crescent-shaped facet for articulation with the inner side of the fibula, which is in contact with the small, trapezoidal fibular facet, already described, when the foot is in extreme flexion. The inner process rises from the plantar margin of the astragalar body. Internally, the inner margin of the trochlea articulates with the tibial malleolus. The neck is long and directed rather more obliquely than in *Protypotherium*. The head is spherical, fitting into a cup-shaped depression in the navicular. On the plantar surface (Pl. II, fig. 20) the sustentacular facet is reniform in outline, but is wider distally than proximally. Transversely, it is almost a plane surface, but in proximo-distal section is broadly S-shaped. The astragalar facet is dumbbell-shaped, constricted at the middle and wider at the ends. It is concave in proximo-distal section and plane transversely.

The calcaneum (Pl. II, figs. 15, 19) may be readily distinguished from that of *Protypotherium* by the small size of the fibular facet, which is hardly differentiated from the ectal facet, and by its extensive articulation with the navicular. The ectal facet is much longer and wider than in *Protypotherium*. It is convex in proximo-distal section, approximately plane transversely and presents forward and inward. The sustentaculum is wedge-shaped, decreasing in width toward the free border, while in *Protypotherium* it is slightly wider at the free border than at the base. The sustentacular facet is circular and concave in all dimensions, but especially proximo-distally. The surface for the cuboid (Pl. II, fig. 15) is concave in dorso-plantar section, more so than in *Protypotherium*. Internally, it is confluent with a small, almost plane facet for the navicular, which is entirely wanting in *Protypotherium*. The tuber has much the same shape in both genera, but the rugosities at the free end are proportionately smaller in *Hegetotherium*.

The navicular is deeply cupped proximally for articulation with the round head of the astragalus, while distally (Pl. II, fig. 16) it supports two heart-shaped facets for the ecto- and mesocuneiforms. The facet for the ectocuneiform is plane in both dimensions; that for the mesocuneiform is concave transversely and convex in the direction at right angles to this. On the inner side a small, semicircular, almost plane facet supports the extremity of the internal cuneiform. An oval, plane facet on the outer side articulates with the cuboid. Another, for contact with the calcaneum, lies between the cuboidal facet and that for the head of the astragalus on the dorsal surface of the navicular. At the proximal internal extremity a strong tubercle is developed, as in all the Santa Cruz Typotheria. The most striking difference by which the navicular of *Hegetotherium* may be differentiated from the corresponding element in *Protypotherium* is in the large size and characteristic shape of the mesocuneiform facet.

The cuboid is much longer than in *Protypotherium*, but the calcaneal facet is smaller. Distally, it supports a large concavity common to the fourth and fifth metatarsals. Proximally, there is a single oval facet for the calcaneum, convex in dorso-plantar section and slightly concave transversely. Internally, there are a large, oval, almost plane surface for the navicular, two small, oval, approximately plane surfaces for contact with the external cuneiform, and a small crescentic, plane facet for the third metatarsal. The plantar surface supports a heavy tubercle overhanging the peroneal groove.

The inner cuneiform is an elongated, scale-like element, articulating proximally with the navicular and applied to the inner side of the mesocuneiform and the second metatarsal. The mesocuneiform is unknown. The outer cuneiform differs greatly from that of *Protypotherium* in the extent of its articulation with the second metatarsal. Proximally, it supports an almost plane, oval surface for the navicular; distally, a dumb-bell-shaped facet concave in both diameters for the head of the third metatarsal; on the outer side, two small, oval facets for the cuboid and internally, three facets, a large oval facet, deeply concave proximo-distally, for articulation dorsally with the head of the second metatarsal, a circular plantar facet, concave in proximo-distal section and plane transversely, for the plantar process of the same metatarsal, and a narrow, B-shaped surface for the mesocuneiform. The plantar surface supports a prominent, pedunculate knob.

The metatarsus is tetradactyl, the axis of the foot passing through the third digit, which is much the longest. The first digit is entirely wanting; the second and third are large, the third exceeding the second in length; the fourth is much smaller and the fifth greatly reduced, but supporting phalanges. Proximally, the metatarsals overlap, the amount of imbrication increasing toward the inner side of the foot, until the second attains the extreme degree of overlap on the outer cuneiform just described. Proximally, the articulations between the third and fourth metatarsals interlock, as in *Protypotherium* (Pls. II, fig. 18; V, fig. 2). Distally, strongly developed keels are present on the plantar surfaces.

No associated series of phalanges are preserved. Such representatives of the first and second rows as are known are scarcely distinguishable, except in point of size, from those of *Protypotherium*, except that the phalanges of digit V in *Hegetotherium* are extremely slender. The terminal phalanges (Pl. II, fig. 21) may be readily recognized by their broad, hoof-like character and terminal clefts.

Hegetotherium mirabile Ameghino.

(Plates I, II; Text Figs. 1, *D*; 4, *A*; 13–16.)

Hegetotherium mirabile Amegh.; Enum. Sistematica, etc., p. 14, 1887.
Hegetotherium strigatum Amegh.; ibid., p. 14, 1887. Lydekker, Anales del Museo de La Plata, Palæontologia Argentina II, article 3, p. 8, Pl. I, figs. 3, 4, 1893.
Hegetotherium cuneatum Amegh.; Revista Argentina de Hist. Nat., I, p. 291, 1891.
Hegetotherium costatum Amegh.; ibid., p. 291, 1891.
Selatherium pachymorphum Amegh.; Énum. Synoptique, etc., p. 20, 1894.
Selatherium remissum Amegh.; ibid., p. 20, 1894.

The preceding account of the osteology of *Hegetotherium* is based entirely on remains of this species, which is represented in the collections at Princeton University and the American Museum of Natural History by a large suite of specimens from localities as follows: Killik Aike (5), two miles west of Killik Aike (1), Cañon de Palo (1), ten miles south of Coy Inlet (7), five miles south of Coy Inlet (3), Coy Inlet (1), seventeen miles north of Cape Fairweather (1), ten miles north of Cape Fairweather (1), Cape Fairweather (2), Felton's estancia, Rio Gallegos (2), Halliday's estancia, Rio Gallegos (1), seven miles south of Monte Leone (1), fifteen miles south of Monte Leone (1), forty miles south of Santa Cruz (1), ten miles north of Coy Inlet (1).

In each case the figures in parentheses refer to the number of individuals from the locality mentioned.

As but one species is represented, the generic and specific characters cannot be separated. Nos. 15,542, 15,432, 15,505, 15,093, 15,298, 15,431, 15,176, 15,392, and Nos. 9223 and 9156, American Museum, are figured on Plates I and II.

Measurements.

	No. 15,542.
Skull, maximum length	.118
" greatest width across arches just anterior to glenoid fossa	.070
Skull, interorbital width	.037
" least width of brain case	.0275
" height of occiput	.021
" width of occiput	.045
Palate, length from alveolus of I^1 to palato-narial border, along median line	.0675
Palate, width at M^3	.0245
Mandible, approximate length including I_1	.104
" depth at P_4	.0165
" " " posterior margin of M_3	.0255
" " below condyle	.055
Upper dentition, length I^1–M^3	.062
" " " P^1–M^3 on alveolar border	.041
" " " M^1–M^3 " " "	.0225
I^1, width at alveolar border	.008
I^2, antero-posterior diameter	.002
" transverse "	.0019
I^3, antero-posterior "	.0018
" transverse "	.0016
C, antero-posterior "	.0021
" transverse "	.0022
P^1, antero-posterior "	.003
" transverse "	.0025
P^2, antero-posterior "	.0041
" transverse "	.0034
P^3, antero-posterior " on triturating surface	.006
" transverse " " " "	.004
P^4, antero-posterior " " " "	.0065
" transverse " " " "	.0042
M^1, antero-posterior " " " "	.008
" transverse " " " "	.005
M^2, antero-posterior " " " "	.007
" transverse " " " "	.0049
M^3, antero-posterior " " " "	.0079
" transverse " " " "	.0044
Lower dentition, length I_1–M_3	.0595
" " " P_1–M_3 on alveolar border	.0386
" " " M_1–M_3 " " "	.023
I_1, width of crown at alveolar border	.005
I_2, " " " " " "	.0044

	No. 15,542.	*No. 15,431.*	*No. 15,298.*	*No. 15,176.*
$I_{\bar{3}}$, antero-posterior diameter	.0015			
“ transverse “	.0017			
C, antero-posterior “	.002			
“ transverse “	.002			
$P_{\bar{1}}$, antero-posterior “	.0025			
“ transverse “	.0022			
$P_{\bar{2}}$, antero-posterior diameter on triturating surface	.0035			
“ greatest transverse “ “ “ “	.002			
$P_{\bar{3}}$, antero-posterior “ “ “ “	.006			
“ greatest transverse “ “ “ “	.0035			
$P_{\bar{4}}$, antero-posterior “ “ “ “	.0066			
“ greatest transverse “ “ “ “	.0035			
$M_{\bar{1}}$, antero-posterior “ “ “ “	.0072			
“ greatest transverse “ “ “ “	.0035			
$M_{\bar{2}}$, antero-posterior “ “ “ “	.007			
“ greatest transverse “ “ “ “	.0035			
$M_{\bar{3}}$, antero-posterior “ “ “ “	.009			
“ greatest transverse “ “ “ “	.003			
Atlas, transverse breadth	.042			
“ breadth between anterior articular surfaces	.228			
“ width of neural arch	.007			
“ “ “ inferior “	.006			
Axis, length including odontoid	.024			
“ width across anterior articular surfaces	.022			
“ length of odontoid	.0072			
Humerus, length				.103
“ width of distal end	.025			.026
Radius, length	.0765			
“ width of proximal end	.0118			
“ “ “ distal “	.014			
Ulna, length	.099			
“ greatest width of olecranon	.0156			
“ “ at coronoid process	.0147			
Femur, length		.112		
“ width of proximal end		.029		
“ “ distal “		.027		
Patella, length			.0225	
“ width			.012	
Tibia, length		.115	.128	

	No. 15,431.	No. 15,298.	No. 15,392.
Tibia + fibula, greatest transverse diameter proximally.	.029	.029	
" " " " distally	.0245	.026	
Calcaneum, length	.038		.038
Astragalus, length	.0195		.020
" greatest width of body	.0165		.016
" width of head	.008		.0085
Metatarsal II, length			.0395
" width of proximal end			.0077
" " distal "			.009
Metatarsal III, length			.0426
" width of proximal end			.0075
" " distal "			.008
Metatarsal IV, length			.038
" width of proximal end			.0065
" " distal "			.0065
Metatarsal V, length			.0273
" width of distal end			.003

PACHYRUKHOS Ameghino.

(Plates X, XI; Text Fig. 1, *C*.)

Pachyrukhos Amegh.; Nuevos restos de mam. fos., etc., Bol. Acad. Nac. Cien. Cordoba, VIII, entr. 1, pp. 160–162, footnote, 1885.

Pachyrucos Amegh.; Contrib. al Conoc., etc., pp. 422–436, 918, 1889.

Pædotherium Burmeister; Anales del Mus. Nac. de Buenos Aires, T. III, p. 179, 1888 (*fide* Ameghino).

This genus includes the smallest representatives of the Typotheria in the Santa Cruz beds. Like *Hegetotherium*, to which it is closely related, but one recognizable species appears to be present. Three almost complete individuals are preserved in the American Museum collection, illustrating all parts of the skeleton except the anterior dorsal region, and on these the following description is based, supplemented wherever possible by the less complete material in the Princeton collection.

Dentition (Pl. X, figs. 1, 3, 13). — As in *Hegetotherium*, the median upper incisors are greatly enlarged, cropping teeth, growing persistently, and supported entirely by the premaxillæ. In the moderately worn specimens studied the enamel is confined entirely to the anterior surface of the crown. The remaining incisors, the canine and the first premolar are entirely wanting, producing a long diastema between the median incisor and the second premolar. The remaining upper teeth are in close series. All are rootless, with long, inwardly curving crowns and in all the crown pattern has been modified by wear, producing a structure closely similar to that developed in *Hegetotherium*. The second premolar is triangular in cross-section, decreasing in width anteriorly. Antero-externally, there is a shallow groove bounded by ridges and on the lingual side of the crown a broad groove situated somewhat farther back than the external one. The margin of the ectoloph is serrate, two or three cusps being developed, of which the first and second mark the position of the external ridges just mentioned, while the third is not located with respect to any ridge and corresponds in position with the posterior serration on the margin of the ectoloph already described in *Protypotherium*. The third and fourth premolars are molariform and may be described with the molars. In these teeth the ectoloph is almost plane externally, except for the slight antero-external groove with its bounding ridges. In the molars, another slight ridge is present, terminating at the apex of the notch between the two most prominent points on the margin of the ectoloph. Internally, the crown is evenly convex. The posterior margin is almost at right angles to the ectoloph except in $M^{\underline{3}}$, while the anterior margin meets it at an acute angle. Two cross-crests are developed as a result of wear, terminating externally in sharp serrations at the margin of the tooth-crown. The first molar is the largest, the series decreasing in size posteriorly. $M^{\underline{3}}$ is narrower posteriorly than anteriorly, with the postero-external angle produced as in *Hegetotherium*, but the degree to which this is developed varies somewhat with the state of wear. The premolars and molars are arranged in an imbricating series, each overlapping externally the tooth just preceding. A layer of cement is usually present.

In the inferior series (Pl. X, fig. 13) the first and second incisors are pronate, growing persistently, like those of *Hegetotherium*, which they further resemble in having the enamel limited to the anterior surface. The third incisor, canine and first premolar are absent, producing a long diastema similar to that in the superior series. The remaining teeth are unspaced. $P_{\overline{2}}$ is incompletely molariform, $P_{\overline{3}}$ and $P_{\overline{4}}$ completely so. The first mentioned tooth is triangular in cross-section, tapering anteriorly. The inner wall is convex posteriorly and broadly grooved anteriorly, while externally the crown is divided by a deep groove into two crescentic lobes, of which the posterior is the larger. The third and fourth premolars and the first and second molars are convex internally, while externally they are divided by a deep groove into two crescentic lobes. $M_{\overline{3}}$ differs from the teeth preceding in the greater antero-posterior diameter of the crown, which is externally trilobate and broadly concave postero-internally. A layer of cement is present as in the superior series.

The milk dentition is unknown.

Skull (Pl. X, figs. 1–4; text fig. 1, *C*).—The skull is most rabbit-like in appearance, due to the convexity of the dorsal profile, the slender rostrum, long diastema, large prominent orbits, slender zygomatic arches and great posterior depth of the mandible. Dorsally, the upper profile slopes forward sharply from the region of the mastoid dilatation, where it meets the plane of the occiput at an acute angle. The slender rostrum is grooved longitudinally from the region of the infraorbital foramen to the margin of the premaxillary above the alveolus of the median incisor. The premaxilla is long and heavy, without ascending process. Laterally, it is broadly grooved and perforated by numerous foramina. Dorsally, it is in contact with the nasal, but not firmly united therewith. Inferiorly, the long incisive foramina extend beyond the premaxillo-maxillary suture, unlike *Hegetotherium* (*cf.* Pls. I, fig. 3; X, fig. 3). The facial portion of the maxillary is also excavated longitudinally. Its thin walls are perforated by a net-work of foramina, recalling this region in the rabbit. The maxillary is excluded from the orbital margin by the lachrymal and malar, as in *Hegetotherium*. It forms the larger part of the orbital floor and appears as a narrow zone in front of the lachrymal at the margin of the plate-like elevation formed from the maxillary, lachrymal and malar, which bounds the orbit anteriorly. A thin vertical lamina developed from the maxillary incloses a groove, at the lower extremity of which the infraorbital foramen lies. The zygomatic process of the maxillary extends almost to the glenoid cavity, its posterior border originating some distance back of the last molar. The facial expansion of the lachrymal is large, but, owing to the number of foramina perforating it, this portion of the bone is usually more or less broken. A prominent tubercle is developed on its orbital margin, concealing in external view the lachrymal duct. Contact between frontal and lachrymal is reduced by a narrow bar of the maxillary. The orbits are almost circular, very large and prominent and but slightly constricted posteriorly by the slender styliform postorbital processes. The zygomatic arches are slight, resembling those of *Hegetotherium* in the arrangement of the several elements. The delicate zygomatic process of the squamosal is not dilated, as in *Hegetotherium*, but the inflation of the mastoid is proportionately much greater than in any of the other genera, lodging a large spherical cavity communicating by a canal with the tympanic chamber (Pl. X, fig. 4).

In superior view (Pl. X, fig. 2) the long, blunt-pointed nasals are seen to increase greatly in width posteriorly, receiving a broad tongue of the frontals between them. They are separated from contact with the lachrymal by a long, narrow bar of the maxillary. The nasals are convex in cross-section anteriorly, but flatten out posteriorly. The interorbital tract is approximately plane transversely, the interfrontal suture persisting. Unlike *Hegetotherium*, the postorbital processes are slender and spine-like. No marked constriction of the brain-case succeeds them. The temporal ridges are exceedingly slight, appearing as faint lyrate crests, originating just back of the postorbital processes and converging posteriorly, but not uniting.

The most prominent feature of the back of the skull is the greatly distended mastoid bulla, which projects posteriorly beyond the condyles. These bullæ show but slight contact with the squamosal anteriorly and are separated from the parietal by a groove opening into the cerebral chamber. Internally, they are hollow and, as in *Hegetotherium*, are connected by a canal with the tympanic cavity (Pl. X, fig. 4). The sutures between the various occipital elements can no longer be distinguished. Dorsally, the supraoccipital appears on the upper surface of the skull between the mastoid bullæ. Posteriorly, there is a strong median convexity for lodgment of the vermis of the cerebellum, bounded on either side by a broad longitudinal concavity. The degree of transverse constriction of the occipital in the region of the mastoid foramen is proportionately much less than in *Hegetotherium*. The foramen magnum and occipital condyles are similar to those of the last named genus. The paroccipital processes are quite long, increasing greatly in antero-posterior diameter a short distance below their bases, where they form a thin plate, from the posterior margin of which a narrow, transversely compressed process is continued downward, gradually curving forward toward the tip (Pl. X, figs. 3, 4).

The palatal surface of the skull recalls that of *Hegetotherium*. The tooth-rows are slightly arched, inclosing an area deeply concave both antero-posteriorly and transversely, but decreasing in concavity anteriorly, so that the palatal floor of the rostrum is practically flat. The anterior palatine foramina, as already described, are proportionately longer than in *Hegetotherium*, extending posteriorly beyond the premaxillo-maxillary suture. The posterior palatine foramina are in advance of the maxillo-palatine suture, perforating the maxillary opposite the anterior part of $M^{\underline{1}}$. The posterior narial border is divided by a strong median spine, as in *Hegetotherium*. In structure, the pterygoid region is practically the same in both genera, the only difference of importance appearing in the absence of the squamosal process, which in *Hegetotherium* is applied externally to the external alisphenoid plate (text fig. 16, page 74). The bullæ are heart shaped, pointed anteriorly, but considerably flatter inferiorly than in *Hegetotherium*. The meatus is long, tubular and directed posteriorly, opening on a level with the postglenoid fossa.

The distribution of the cranial foramina is similar to that in *Hegetotherium*. The infraorbital foramen opens into a deep fissure within the orbit connected by various vacuities with the olfactory chamber. Owing to the rupture of the thin interorbital septum in all the specimens in which this region is exposed, it is impossible to locate the position of the foramina opening at this point, but it is probable that a confluent foramen rotundum and spheno-orbital foramen and a large spheno-palatine foramen would be found to be present, as in *Hegetotherium*. An irregular opening at the anterior margin of the bulla marks the position of the foramen ovale and lacerum medius. The internal carotid enters the skull between the basi-occipital and the bulla near the suture between the basioccipital and the basisphenoid. The condylar foramina are rather large and are situated close to the condyle, while farther forward several additional foramina on either side perforate the basioccipital. The foramen lacerum posterius is inconspicuous, lying back of the bulla near the base of the paroccipital process. The presence of a postglenoid foramen cannot be definitely ascertained, owing to fracture in all specimens in which this region is exposed. Above the fossa for the tip of the stylohyal a pair of foramina, probably vascular, emerge at the edge of the auditory meatus. On the occipital surface the mastoid foramen occupies its usual position at the point of greatest transverse constriction of the occipital plate.

The mandible (Pl. X, figs. 1, 13) differs from that of any other genus of Santa Cruz Typotheria in transmitting an external branch of the inferior dental canal, which opens into the masseteric fossa close to the anterior border of the latter (Pl. X, fig. 1). The symphysis is firmly coössified and spout-like. The horizontal ramus increases rapidly in depth posteriorly, the coronoid border is strongly inclined backward, and the angle broadly rounded. The coronoid process is small, sharp-pointed and quite delicate and is accordingly broken in the majority of specimens. The condyle is approximately circular in outline and almost flat, presenting upward and forward. The inferior margin of the angle has an outwardly directed, sharp ridge as in *Hegetotherium*.

Vertebral Column and Ribs.—The atlas (Pl. X, figs. 24–26) is peculiar in having the neuro-arterial foramina reduced to notches and in the irregularly lobate outline of the free borders of the transverse processes. Each arch supports a single, prominent, median tubercle. Owing to the broken condition of the superior arch and the absence of good contacts, it is not possible to be certain whether the tubercle is at the anterior or posterior border, but, judging from the structure of this region in *Protypotherium* and *Hegetotherium*, it was probably anterior. The posterior third of the base of the transverse process is perforated by the vertebral artery, as in the last named genus.

The axis is incompletely preserved in one specimen (No. 15,744). As in *Hegetotherium*, the odontoid curves upward sharply. The neural spine is almost complete, differing considerably in shape from that of *Protypotherium* (cf. Pls. V, fig. 16; X, fig. 23). Anteriorly and posteriorly, it has about the same degree of extension and is evenly convex above. Its posterior margin is grooved below to receive the tip of the neural spine of the third cervical, when the neck is flexed upward. This spine is short, broad and directed vertically. The spines of the fourth, fifth and sixth cervicals are delicate, sharp-pointed, and incline forward. The transverse processes are heavy, with prominent anterior and posterior tubercles. The differentiation of the diapophysis from the inferior lamella is first observable in the fifth cervical. The centra are keeled inferiorly.

The number of dorsal vertebræ is not positively known, but probably is not more than fifteen, as in *Interatherium*. Eight lumbars are present (seven in *Interatherium*) and five vertebræ are coössified in the sacral complex, three true sacrals and two caudals. The anterior dorsals are either crushed or concealed by other bones which cannot be removed without injury to the specimens. The anticlinal vertebra appears to be the thirteenth dorsal, and has a broad, vertically directed spine. It is followed by two dorsals, in which the spines are similar in shape to those of the anterior lumbars and are directed forward. The spines of the posterior lumbars are very heavy, strongly inclined forward and deeply grooved posteriorly, with a prominent tubercle developed on either side of the groove about half way between the posterior zygapophyses and the tip of the spine (Pl. X, fig. 31). The transverse processes are broad, flat blades, with truncated extremities, curving outward and forward. Prominent anapophyses are developed on the posterior dorsals and anterior lumbars, decreasing in size posteriorly. The zygapophyses in the posterior dorsals and in the lumbar series interlock as strongly as in *Hegetotherium*.

Five vertebræ are coössified in the sacrum, of which three are in contact with the ilium and two are referable to the caudal series. In all the specimens (Nos. 9242, 9283, 9481 of the American Museum collection) the neural spines of the anterior sacrals have been broken off. Those of the posterior sacral and the coössified caudals are very heavy, with flat summits (Pl. X, fig. 18). Little can be said regarding the tail, as but four free caudals close to the sacrum are preserved in No. 9242. These are elongated, with little indication of transverse processes, and suggest a short tail.

Appendicular Skeleton.—The scapula is so imperfectly preserved in all the specimens available that its shape cannot be determined. In the restored skeleton of *Pachyrukhos* (Pl. XI) it has been given approximately the same shape as in *Protypotherium*. The spine is high and the metacromion robust. The clavicle is a slender rib-like element compressed laterally and gently arched longitudinally (Pl. X, fig. 5). At the distal end it expands, but has been so damaged by fracture that its exact shape cannot be ascertained.

The humerus (Pl. X, fig. 11) is almost a miniature of that of *Hegetotherium*. The head is large, overhanging the shaft posteriorly. The greater tuberosity is prominent, rising above the level of the head, as in *Hegetotherium*, while the lesser tuberosity is inconspicuous. Distally, the correspondence with *Hegetotherium* is very close. There is the same well-defined separation of the articular surface into trochlea and capitellum, the same elongation of the inner lip of the trochlea, strong development of the inner epicondyle and short, but sharply defined, supinator ridge. An internal epicondylar foramen is present and in all the specimens available the septum separating the olecranon and coronoid fossæ is perforated.

So far as it is possible to make comparison, the radius and ulna (Pl. X, figs. 9, 10, 12) closely resemble the corresponding elements in *Megetotherium*, and do not call for separate description. The only difference of importance appears in the shape of the styloid process of the ulna, which is slightly inclined internally, while in *Megetotherium* it is straighter.

The mutual relationships of the carpal and metacarpal elements is much the same as in *Protypotherium* (cf. Pls. V, fig. 3; X, fig. 14) except that metacarpal II apparently articulates with the scaphoid. But two specimens of the carpus are available for study (Nos. 9551 and 9481, American Museum) and in both of these the proximal end of the second metacarpal projects some distance above the magnum, excluding the latter from contact with the trapezoid. Owing to the partial relief employed in mounting the only specimen with this portion of the carpus complete (No. 9481 of the American Museum collection), it is not possible to verify this observation by an examination of the articular surfaces of the carpal elements.

Ameghino (1889, Pl. 13, fig. 14) figures a slender pollex in *Pachyrukhos typicus* from the Monte Hermoso beds. No trace of a pollex is preserved in the otherwise almost complete fore foot of No. 9481 of the American Museum collection, but this cannot be regarded as conclusive, as the trapezium is also wanting. The metacarpals decrease in strength externally, as in *Protypotherium*. The third is the longest. Well developed keels are present on the distal palmar surfaces. The proximal phalanges are slightly arched and taper towards the distal end. The proximal articular surface is almost at a right angle to the shaft, is crescentic in outline and slightly concave. Distally, the articulation is c
to the distal and palmar surface, while the distal articulation of the second phalanx is about equally developed on both dorsal and plantar surfaces. Distally, the terminal phalanges are flattened transversely and hoof-like, without trace of terminal clefts, differing in this respect from *Pachyrukhos typicus*.

The pelvis (Pl. X, figs. 17, 18) is well preserved in one of the specimens in the American Museum collection (No. 9242). The gluteal surface of the ilium is slightly concave in all dimensions, in contrast with its deep concavity in *Protypotherium* and *Interatherium*. Anteriorly, it is obliquely truncated from above forward, with prominent anterior and posterior superior spines. The posterior inferior spine, and the ischial spine and tuberosity are also prominent. The symphysial portion of the pubis and the ischial ramus are broad, and the superior ramus of the pubis slender.

The patella (Pl. X, figs. 19, 20) is an almond-shaped element, convex in all dimensions anteriorly, while posteriorly it supports two equal concave facets for the femoral condyles.

The femur (Pl. X, fig. 8) is stout, with the shaft slightly arched anteriorly, prominent minor, major and third trochanters, and heavy condyles. Except for the straighter shaft in *Hegetotherium* and the greater size, there is little or no difference between the femora of the two genera, the description of that of *Hegetotherium* already given applying equally well to *Pachyrukhos*.

Compared with the length of the femur, the tibia (Pl. X, fig. 7) is proportionately much longer in *Pachyrukhos* than in *Hegetotherium*. This fact, correlated with the length and strength of the inner digits of the pes, the comparatively short fore limb and other structural peculiarities presently to be mentioned, demonstrates in the writer's opinion that *Pachyrukhos* was a jumping animal. Tibia and fibula are firmly fused, both proximally and distally, the fusion at the distal end extending up the shaft for a distance somewhat greater than one third its total length. The tibial shaft is laterally compressed, with short, but sharp, cnémial crest. Internally, the proximal portion of the shaft is convex and externally concave, and is slightly curved inward longitudinally, the nearly straight fibula forming the chord of the arc. The distal third of the shaft, formed by the fusion of tibia and fibula, is elliptical in cross-section. The proximal articular surfaces resemble closely the corresponding region in *Hegetotherium*. They are approximately circular in outline, the inner transversely concave and antero-posteriorly slightly convex, and the outer convex in both directions. The spine is inconspicuous. The distal end closely parallels in structure the fused tibia and fibula of the rabbit. Both external and internal malleoli are long, the latter exceeding the former in this respect. Both are grooved posteriorly for transmission of tendons, the peroneal grooves being especially deep. The surface for the astragalar trochlea is similar in every respect to that in *Hegetotherium* and does not call for for separate description (see p. 79, and Pls. II, fig. 2; X, fig. 16).

The American Museum is especially fortunate in possessing two skeletons with the hind limbs complete and the elements of the pes in their natural positions. Here also, correspondence with *Hegetotherium* is exceedingly close. The astragalar trochlea (Pl. X, fig. 15) is wide, shallow and bilaterally symmetrical, with the outer crest sharper and higher than the inner. The trochlear surface is confined to the dorsal aspect of the bone, but is not produced as far backward as in *Protypotherium*. The shallowness of the trochlea and its small posterior extension suggest a plantigrade position for the foot as indicated in the restoration (Pl. XI). The proximal and distal corners of the astragalar body on the inner and outer sides respectively are prolonged as in *Hegetotherium*. The fibular facet is a vertical crescentic plane surface; that for the internal malleolus a convex surface sloping inward. The neck is long and obliquely directed toward the inner side of the foot, and the head hemispherical. The calcaneum is almost a replica on a smaller scale of that of *Hegetotherium*, the shape and arrangement of the facets being practically the same in each (see description p. 80 and Pls. II, fig. 15, X, fig. 27). Slight differences appear in the top-shaped rather than circular sustentacular facet, the more oblique position of the navicular facet and the slightly shorter and more convex astragalar facet in *Pachyrukhos* as compared with *Hegetotherium*. The tarsals have not been disturbed from their original position in No. 9481 of the American Museum collection (Pl. X, fig. 15) and, so far as it is possible from the type of mounting employed, to compare them, they are exactly the same in shape and position as in the last named genus (pages 80, 81 and Pls. II, fig. 19, X, fig. 15). No trace of a hallux remains. The inner cuneiform, although not present, seems, from its articular surfaces, to have been scale-like as in *Hegetotherium*. The metatarsals interlock strongly proximally, the second articulating with the middle of the outer cuneiform and the third with the cuboid. The second and third are the most robust, the latter exceeding the former in length. The fourth is more slender than the second and slightly shorter, and the fifth quite slender and shorter than the fourth. Well developed keels are present on the plantar surfaces. The phalanges closely resemble those of the fore foot, differing only in size and greater robustness. Their natural position is probably more strongly angulate than is represented in the restoration (Pl. XI). The terminal phalanges (Pl. X, fig. 15) are transversely expanded distally as minute hoofs without trace of median cleft.

Restoration (Pl. XI). — The restored skeleton shows effectively the much greater length and strength of the hind limb as compared with the fore limb. If the pes were placed in a digitigrade position the spinal column would incline obliquely upward. The approximate correctness of the position of the hind feet in the restoration receives additional confirmation from specimen No. 9481 of the American Museum collection, which shows the death pose of an animal smothered by a fall of the volcanic ash of which the Santa Cruz formation is largely composed. The back is strongly arched, more so than is shown in the restoration, and the long hind feet project forward between the fore feet, and are strongly flexed, more so than seems probable in a digitigrade form. The evidence furnished by the astragalar trochlea in favor of a plantigrade position for the hind foot has already been mentioned (p. 94). The great length and strength of the hind limb, the shortness of the fore limb and the plantigrade pes are regarded as indicative of a saltatorial gait. The fore foot may have been as digitigrade as in the rabbit. The shape of the scapula is largely hypothetical. It has been given the same shape as in *Protypotherium*. The tail may have been longer, but the small size of the proximal caudals does not seem to justify such an inference.

Pachyrukhos moyani Ameghino.

(Plates X, XI, Text Fig. 1, *C*.)

Pachyrukhos moyani Amegh.; Nuevos restos de mamif. fos. oligocenos, recogidos por el Prof. Pedro Scalibrini, etc., p. 160, 1885.

Pachyrucos moyani Amegh.; Contrib. al Conoc., etc., pp. 430–431, Pl. 13, figs. 28, 29, 34, 35, 1889.

Pachyrucos nævius Amegh.; Contrib. al Conoc., etc., p. 430, Pl. 13, fig. 30, 1889.

Pachyrucos absis Amegh.; Contrib. al Conoc., etc., pp. 429–430, Pl. 13, figs. 32–33, 1889.

But one species of *Pachyrukhos* is represented in the collections studied. It may be distinguished from *Pachyrukhos typicus* of the Monte Hermoso horizon by the different shape of the postorbital process which is exceedingly slender in the Santa Cruz form and large, triangular and perforated by a foramen in the later species, by the shallower lower jaw, less heavy rostrum and the possession of pointed, uncleft, terminal phalanges. Doubtless other characters of specific importance would appear if it were possible to make comparison directly with the type. A specimen in the

Munich collection labelled by Ameghino *P. nævius* has the mandible less thick transversely and the teeth somewhat smaller than in the typical *P. moyani.* Possibly *P. nævius* is to be regarded as a distinct species but for the present it may be included with *P. moyani.*

The following Santa Cruz localities have afforded specimens of the latter species, the figures referring in each case to the number of individuals: Halliday's estancia, Rio Gallegos (2), Felton's estancia, Rio Gallegos (10), Rio Gallegos (1), Killik Aike, Rio Gallegos (6), four miles east of Killik Aike (1).

Nos. 15,743, 15,744 and Nos. 9283, 9481, 9242 and 9219 of the American Museum collection are figured on the accompanying plates.

MEASUREMENTS.

	No. 15,743.	*No. 9283.*	*No. 9481.*
Skull, maximum length	.0825	.0765	
" greatest width across arches	.0485	.0455	
" interorbital width	.021	.0195	
" height of occiput	.0135		
" width " "	.030	.0265	
Palate, length along median line from alveolus of I^1 to palato-narial border	.049		
Palate, width at M^3	.0165		
Mandible, length including median incisors	.0665	.061	.0666
" depth at P_2	.0105	.0105	.010
" " " M_3	.015	.0135	.0135
Upper dentition, length I^1–M^3	.0425	.039	
" " " P^2–M^3 on alveolar border	.0244	.0227	
" " " M^1–M^3 " " "	.014	.0126	
I^1, width at alveolar border	.0065		
P^2, antero-posterior diameter	.0036		
" transverse "	.0022		
P^3, antero-posterior "	.004		
" transverse "	.0025		
P^4, antero-posterior "	.0042		
" transverse "	.0028		
M^1, antero-posterior "	.0052		
" transverse "	.003		
M^2, antero-posterior "	.0045		
" transverse "	.003		
M^3, antero-posterior "	.0045		
" transverse "	.0025		

	No. 15,743.	*No. 9283.*	*No. 9481.*
Lower dentition, length $I_{\overline{1}}$–$M_{\overline{3}}$	.0395		
“ “ “ $P_{\overline{1}}$–$M_{\overline{3}}$ on alveolar border .	.0245		
“ “ “ $M_{\overline{1}}$–$M_{\overline{3}}$ “ “ “ .	.0145		
$I_{\overline{1}}$, width of crown at alveolar border . . .	.0044		
$I_{\overline{2}}$ “ “ “ “ “ “	.0023		
$P_{\overline{2}}$, antero-posterior diameter	.003		
“ transverse “	.0015		
$P_{\overline{3}}$, antero-posterior “	.0035		
“ transverse “	.0022		
$P_{\overline{4}}$, antero-posterior “	.0038		
“ transverse “	.0022		
$M_{\overline{1}}$, antero-posterior “	.0045		
“ transverse “	.0025		
$M_{\overline{2}}$, antero-posterior “	.0045		
“ transverse “	.0025		
$M_{\overline{3}}$, antero-posterior “	.0055		
“ transverse “	.002		
Humerus, length		.055	.056
“ antero-posterior diameter of proximal end.			.0118
“ transverse diameter of distal end . .	.012		
Radius, length	.053		.050
“ width of proximal end			.005
“ “ “ distal “	.0075		.0075
Ulna, length			.059
“ greatest width of olecranon			.0066
“ “ “ at coronoid process . .			.0065
Manus, metacarpal II, length			.020
“ “ “ width proximally . . .			.004
“ “ III, length			.0225
“ “ “ width proximally . . .			.0032
“ “ “ “ distally . . .			.0035
“ “ IV, length			.0185
“ “ “ width proximally . . .			.0034
“ “ V, length			.0145
“ “ “ width proximally . . .			.002
Proximal phalanx, digit II, length . . .			.0104
“ “ “ III, “ . . .			.010
Second “ “ “ “ . . .			.006
Proximal phalanx, digit IV, length . . .			.0095
Second “ “ “ “ . . .			.0055
Terminal “ “ “ “ . . .			.0055
Proximal “ “ V, “ . . .			.0085
Second “ “ “ “ . . .			.0042

	No. 15,743.	*No. 9283.*	*No. 9481.*	*No. 9242.*
Pelvis, length				.0665
" width at anterior margin of acetabulum .				.032
" " of ilium at greatest expansion . .				.013
" " at neck of ilium			.0062	.007
Femur, length				.070
" transverse diameter proximally . . .				.015
" " " through minor and third trochanter				.014
Femur transverse diameter distally . . .				.0145
Patella, length				.011
" width				.0055
Tibia + fibula, length			.082	.090
" transverse diameter proximally .	.016			.0155
" " " distally . .	.012			.0118
Calcaneum, length			.021	.022
Astragalus, length			.0105	.0105
" width of body				.008
" " " head				.0045
Metatarsal II, length	.030		.0265	.029
" " width proximally	.0042			.004
" " " distally	.005			.0048
Metatarsal III, length	.033		.030	.031
" " width proximally	.0035		.003	.004
" " " distally	.0045			.0045
" IV, length			.0266	.029
" " width proximally			.003	.005
" V, length			.0214	.023
" " width proximally				.004
Proximal phalanx, digit II, length . . .			.0135	.0142
Second " " " " . . .			.009	
Proximal " " III, " . . .			.0133	
Second " " " " . . .			.0095	
Terminal " " " " . . .			.0072	
Second " " " " . . .			.0075	
Terminal " " " " . . .			.0055	
Proximal " " V, " . . .				.0105
Second " " " " . . .				.005

TYPOTHERIA INCERTÆ SEDIS.

A large number of Typotheria have been described by Dr. Ameghino from the Santa Cruz Beds, which it has not been possible to recognize in the collections studied. It does not follow that these are necessarily invalid species, although some may be individual variants of species described in the present memoir. The collections studied, although extensive, are not sufficient to settle this point. It therefore seems best to list these forms separately, quoting for each the full bibliography and a translation of the most complete description, with some of the characteristic measurements given by the author.

PROTYPOTHERIUM.

PROTYPOTHERIUM DIVERSIDENS Ameghino.

Protypotherium diversidens Amegh.; Revista de Hist. Nat., I, p. 292, 1891; Énum. Syn., etc., p. 13, 1894 (listed); Segundo Censo, etc., p. 150, 1898 (listed).

Of relatively small size. Is easily distinguished by the upper premolars which have an external vertical groove, broad on the crown but narrowing and suddenly disappearing toward the base, instead of running the whole length of the tooth as in the other species. Length P^2–M^2 .024 ('91, 292).

PROTYPOTHERIUM DIASTEMATUM (Ameghino).

Patriarchus diastematus Amegh.; Revista Argentina de Hist. Nat., I, p. 293, 1898, Énum. Syn., etc., p. 14, 1894 (listed); Segundo Censo, etc., p. 150, 1898 (listed).

Of the same size as *Patriarchus rectus* (synon. *Protypotherium prærutilum*) or slightly larger, from which it is distinguished by the first upper premolar which is small, cylindrical and separated from the second premolar by a short diastema. The upper dental series is a little more arched. Length P^2–M^3 .029; breadth of palate at M^3 .018; at M^1 .0205; at P^2 .013 ('91, 293).

PROTYPOTHERIUM CLAUDUM Ameghino.

Protypotherium claudum Amegh.; Contribucion al Conocimiento de los Mamiferos Fosiles de la Republica Argentina, p. 480, 1889; Énum. Syn., p. 13, 1894 (listed); Segundo Censo, etc., p. 150, 1898 (listed).

This species, of quite small size, intermediate between *P. prærutilum* and *P. attenuatum*, is removed from all the others by some characters of importance. I (*i. e.*, Ameghino) know of it a fragment of the right ramus of the mandible with the two last premolars and the first two true molars.

$P_{\overline{3}}$ is entirely different from the shape seen in all the other species. The inner side is almost plane, presenting a notable analogy to that of *P. obstructum**; however it displays three faintly marked vertical crests which bound two broad but entirely superficial depressions. The outer side is distinguished by a broad and shallow perpendicular depression which does not form a reëntering fold, a depression which replaces the deep and narrow groove that the other species have in the hinder part of the outer side, forming a sharp entering fold. The perpendicular posterior face, instead of being narrow and rounded as in the other species, is of the same width as the rest of the tooth and grooved perpendicularly in the middle. The grinding surface is of regularly elongate or elliptical shape, somewhat flattened on the inner side but not divided into unequal lobes as in the other species. It measures .0035 by .0025

$P_{\overline{4}}$ has an internal vertical groove and another external, opposite, as in almost all of the other species, but the two lobes are of nearly equal size, the anterior slightly the larger. It measures .004 by .0026.

The first and second molars are bilobate by opposite vertical grooves as in the other species, with the anterior lobe considerably smaller than the posterior. On the inner side the former is convex, ending behind in a broad and rounded column, but the posterior lobe is depressed and somewhat excavated in its anterior part. Each molar measures .0065 by .003. Length $P_{\overline{3}}$–$M_{\overline{2}}$ inclusive .021. Two mental foramina are present, a larger one under $P_{\overline{3}}$ and a smaller one beneath $P_{\overline{4}}$. Depth of horizontal ramus at $M_{\overline{1}}$ .016 ('89, 480).

INTERATHERIUM.

INTERATHERIUM TRILINEATUM (Ameghino).

Icochilus trilineatus Amegh.; Énum. Synoptique, etc., p. 16, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

This species is of the same size as *I. extensum*, from which it is easily distinguished, as well as from the other species, by the form of the upper molars and premolars. Each of these teeth has on the external face a broad and deep groove which divides it into two lobes and on each lobe there is a narrow and deep groove which divides it into two vertical columns. On the external face there are thus four columns separated by

* A Monte Hermoso species.

three grooves of which the median one is much broader and the other two very narrow ('94, 16).

Interatherium anguliferum Ameghino.

Interatherium anguliferum Amegh.; Énum. Synoptique, etc., p. 18, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Size intermediate between *I. rodens* and *I. supernum* from which it is distinguished by the absence of the first upper premolar. The upper canine is well developed and isolated by diastemata in front and behind. $P^{\underline{2}}-^{\underline{4}}$ have the two perpendicular columns of the antero-external angle very strong. Length from the anterior border of the canine to the posterior border of the first upper true molar .017 ('94, 18).

Interatherium anomalum (Ameghino).

Icochilus anomalus Amegh.; Énum. Synoptique, etc., p. 16, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Of the same size as *Icochilus extensus*. This species is easily distinguished by the atrophy and disappearance of many teeth. The external lower incisor is very small. The lower canine is extremely small and isolated before and behind by diastemata of considerable length, while in almost all the other species of this genus this tooth is, on the contrary, well developed and recumbent on the incisors of which it has the form. The first lower premolar is well developed, with two opposite perpendicular grooves, one internal and the other external ('94, 16).

Interatherium truncum (Ameghino).

Icochilus truncus Amegh.; Énum. Synoptique, etc., p. 16, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Almost of the same size as *Icochilus extensus*. It is distinguished by the presence of a very small first lower premolar, and by the absence of the lower canine. In the place of the canine there is quite a long diastema which separates the external incisor from the first premolar ('94, 16).

Interatherium undulatum (Ameghino).

Icochilus undulatus Amegh.; Contrib. al Conoc., etc., p. 473, Pl. 15, fig. 14, 1889; Énum. Synoptique, etc., p. 15, 1894 (listed); Segundo Censo, etc., p. 150, 1898 (listed).

Intermediate in size between *I. extensum* and *I. excavatum* from which it is distinguished by the quite different conformation of the molars and premolars, especially on the outer side. The premolars have the two antero-external crests a little broader but lower, without projecting beyond the plane of the outer face, separated by a shallow groove and followed by a groove identical with the preceding one, whence it results that the external side of these teeth has three low vertical elevations separated by two shallow grooves which produce a gently undulating appearance very different from that seen in *I. extensum* and *I. excavatum*. The true molars are even more different, since the two antero-external crests are completely fused into a single convex column which is quite broad. Each molar has thus externally two low columns corresponding to the two internal lobes, separated by a shallow depression opposite to the deep furrow of the inner side. The posterior upper molars, and especially $M^{\underline{3}}$, have much compressed crowns. The dental series is almost straight. Diameters of $P^{\underline{3}}$ .0035 × .0025; $P^{\underline{4}}$ .0037 × .003; $M^{\underline{1}}$ .004 × .0027; $M^{\underline{2}}$ .004 × .0024; $M^{\underline{3}}$ .004 × .002; length of space occupied by the five last upper molars .0185 ('89, 473).

Interatherium lamellosum (Ameghino).

Icochilus lamellosus Amegh.; Énum. Synoptique, etc., p. 15, 1894; Segundo Censo, etc., p. 150, 1898.

Species of small size. The superior canine is well developed, of the same size and almost of the same form as the external incisor. They are separated the one from the other by a small diastema. These two teeth are laterally compressed and have the form of trenchant blades. The external incisor, or third, is separated from the second by a considerable diastema. Another diastema, a little longer, separates the first premolar from the canine. $P^{\underline{1}}$ is placed opposite $P^{\underline{2}}$ and carries a vertical groove with its angle antero-external. Length from anterior border of $I^{\underline{1}}$ to posterior border of $M^{\underline{3}}$ .037 ('94, 15–16).

Interatherium multidentatum (Ameghino).

Icochilus multidentatus Amegh.; Énum. Synoptique, etc., p. 17, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Quite small. It is distinguished in having eight molars above and below on each side, of which the five anterior teeth are premolars. In the upper jaw, the canine and the first two premolars are very small and in continuous series with the other teeth. In the lower jaw, the first two premolars have the form of small canines and the second is separated from the third by a small diastema. The first two lower premolars and the canine are unspaced. Length of space occupied by the eight upper molars .028 ('94, 17).

INTERATHERIUM INTERRUPTUM Ameghino.

Interatherium interruptum Amegh.; Énum. Synoptique, etc., p. 18, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Size of *I. supernum*. Distinguished easily by the presence of the first upper premolar which is placed against the anterior part of P^2, and by the complete absence of the canine. There is a long diastema which separates the first premolar from the external incisor. The margin of this diastema carries a deep longitudinal groove which has the same direction as the dental series. Length of the seven upper molars .025 ('94, 18).

INTERATHERIUM CURTUM (Ameghino).

Icochilus curtus Amegh.; Énum. Synoptique, etc., p. 17, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Of the same size as *I. extensum*. This species is easily distinguished by the great shortening of the last lower molar which is hardly longer than $M_{\overline{2}}$ and by its posterior lobe which is convex on the external side without vestige of the perpendicular groove seen on the same tooth in the other species. $M_{\overline{3}}$ is nearly .005 long. The last two molars occupy a space of .009 ('94, 17).

INTERATHERIUM CRASSIRAME (Ameghino).

Icochilus crassiramis Amegh.; Énum. Synoptique, etc., pp. 16–17, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Of the same size as *I. extensus*. Distinguished very well by the first lower premolar which has the form of a well-developed canine, being isolated in front and behind by fairly large diastemata. The lower canine has the form of an incisor, resting anteriorly on the external incisor. The second lower premolar is elliptical, without perpendicular internal groove. Of the outer groove only traces are visible ('94, 16–17).

INTERATHERIUM DENTATUM Ameghino.

Interatherium dentatum Amegh.; Énum. Synoptique, etc., p. 18, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Approaching *I. supernum* in size. Distinguished by possessing an extra premolar in the upper jaw, that is to say five instead of four. The first two premolars are conic, the first or anterior being separated from the second. Complete upper dental series measures .041 ('94, 18).

INTERATHERIUM SENILE (Ameghino).

Icochilus senilus Amegh.; Énum. Synoptique, etc., p. 15, 1894; Segundo Censo, etc., p. 150, 1898 (listed).

This species is of the size of *I. extensus*, but a little more robust. It is easily distinguished by the second lower premolar which is not bilobate but elliptical in contour and consequently without vertical groove either on the internal or the external face. The third and fourth lower premolars as well as the true molars are larger than in the other species. The second upper premolar is also of elliptical contour and without groove. There is a diastema of considerable length between the lower canine and the first premolar. Length of the seven lower molars .032 ('94, 15).

INTERATHERIUM ROTUNDATUM (Ameghino).

Icochilus rotundatus Amegh.; Contrib. al Conoc., etc., pp. 473–474, Pl. 15, figs. 15–16*a*, 1889; Énum. Synoptique, etc., p. 15, 1984; Segundo Censo, etc., p. 150, 1898 (listed).

This species is separated by very marked characters. The skull is more prolonged anteriorly. $I^{\underline{1}}$ very large, $I^{\underline{2}}$ much smaller and $I^{\underline{3}}$ still smaller. The upper incisors are closely crowded. $P^{\underline{1}}$ is placed against the anterior part of $P^{\underline{2}}$. There is no upper canine, and there is a long diastema between the external upper incisor and the first premolar. Length, anterior part of $I^{\underline{1}}$ to posterior part of $M^{\underline{3}}$ .046; length of diastema between $I^{\underline{3}}$ and $P^{\underline{1}}$ .008 ('94, 15).

INTERATHERIUM BREVIFRONS Ameghino.

Interatherium brevifrons Amegh.; Énum. Synoptique, etc., p. 18, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

Species much smaller in size than *I. rodens* and with all the dentition in continuous series without diastemata. The anterior part of the skull is very short. $I^{\underline{1}}$ is very large and $I^{\underline{2}}$ and $I^{\underline{3}}$ very small. The canine is well developed. Length from the anterior part of $I^{\underline{1}}$ to the posterior part of $M^{\underline{3}}$ .027 ('94, p. 18).

Interatherium rodens (Moreno) Ameghino.

Interatherium rodens Moreno; Patagonia, resto de un antiguo continente hoy submerjido, p. 23, 1882 (*nomen nudum*). Ameghino; Observaciones generales sobre el orden de mamiferos estinguidos sud-americanos llamados Toxodontes, etc., p. 63, 1887; Enumeracion Sistematica, etc., p. 15, 1887; Contrib. al Conoc., etc., pp. 467–468, Pl. 15, figs. 20–26, 1889; Énum. Synoptique, etc., p. 18, 1894 (listed); Segundo Censo, etc., p. 151, 1898 (listed).

Size of a rabbit. Represented by numerous fragments of mandibles and the anterior part of a skull with almost all the dentition. The premaxilla is short and thick. $I^{\underline{1}}$ is three millimeters wide at the base of the crown. The base of $I^{\underline{2}}$ is two millimeters and that of $I^{\underline{3}}$ less than one millimeter. The base of the crown of the canine is also less than one millimeter. $P^{\underline{1}}$ is very small, almost rudimentary and of an acutely conical shape; it is closely appressed to $P^{\underline{2}}$. $P^{\underline{2}}$ has a more elongate crown. It has a small internal groove which dies away on the base of the crown before reaching the root, dividing the crown into two internal lobes, the anterior much smaller than the posterior. On the anterior part of the outer side is a deep and narrow groove which hardly extends to the base and divides the crown into two external lobes, the anterior very narrow and ridge-like, the posterior much broader. $P^{\underline{3}}$ and $P^{\underline{4}}$, successively larger, have the same general form but with the inner lobes more equal. The three premolars with very long crowns have the bases divided into separate but very short roots. The true molars have an internal groove like the premolars, which extends to the base, dividing the crown into two equal lobes. The antero-external groove also extends to the base, but near the middle of the anterior face there is a second broader groove forming three well-marked external columns. The three true molars are completely open at the base. The seven molars form a much more pronounced arc of a circle than in the following species. The symphysial part of the mandible, much compressed laterally, has the incisors and canine in continuous series and inclined forward. Only $I_{\overline{1}}$ is placed in the anterior narrowest part of the symphysis, with its crown transverse.

The others are placed on the sides with the principal diameter in the direction of the dental series. The anterior part of the crown is a little broader than the root, with the apex bilobate by an internal groove which gradually disappears on wear, but the canine, which has not the groove, has an acutely conical crown. $P_{\overline{1}}$, which is separated from the canine by a short diastema, is similarly shaped but implanted vertically. $P_{\overline{2}}$ is low and bilobate by two opposite grooves, each lobe elliptico-triangular, and the two of almost equal size, the base divided into two separate and quite long roots. $P_{\overline{3}}$ and $P_{\overline{4}}$ and $M_{\overline{1}}$ and $M_{\overline{2}}$ are composed of two elliptico-triangular, almost equal prisms separated by two opposite grooves which extend to the completely open base. Each prism is a little narrower on the inner than on the outer side, without reëntering folds or salient ridges. $M_{\overline{3}}$ is composed of three unequal subprismatic parts, the median twice as large as the anterior and the last one half smaller but on the inner side fused with the second. Length of space occupied by the seven upper molars .021; length of space occupied by the seven lower molars .023 ('89, 467–468). Founded on an immature individual with the milk dentition. A photograph by Professor Scott of the anterior part of the skull referred to above shows very clearly by the texture of the bone that the individual is far from adult.

Interatherium supernum Ameghino.

Interatherium supernum Amegh.; Enumeracion Sistematica, etc., p. 15, 1887; Contrib. al Conoc., etc., pp. 468–469, Pl. 15, figs. 17–19*b*, 1889; Énum. Synoptique, etc., p. 18, 1894 (listed); Segundo Censo, etc., p. 151, 1898 (listed).

This species is one-third larger than *I. rodens*, from which it is easily distinguished by the molars which are shorter and broader, the intermediate molars being of almost equal length and width, while in *I. rodens* the antero-posterior diameter of the crown always considerably exceeds the breadth. Further, in the premolars, the internal reëntering fold is deeper than in *I. rodens* but is not extended into a vertical groove, whence the inner side is not bilobate but of vertically convex surface and notably narrower than the external surface. $P^{\underline{2}}$ differs from $P^{\underline{3}}$ and $P^{\underline{4}}$ in being more compressed, with crown much longer than wide, resembling the corresponding tooth in *I. rodens*, but without the internal groove of the latter. All the upper premolars and molars have the same antero-external ridge as in *I. rodens*, but less accentuated in the molars and with the second depression broader, already well-marked in P^3 and P^4. All the upper teeth except P^3 have the anterior part considerably broader than the posterior. P^2 measures .0045 × .002. P^3 and P^4 are .004 long on the outer side but only .0025 on the inner; maximum breadth .0035. The true molars are somewhat broader on the inner side and diminish slightly in size from M^1 to M^3. Length, P^1 to M^3 .028 following the curve of the series and only .026 in a straight line. A small fragment of the anterior part of the skull with the premaxilla shows that behind the first incisor, in the palate, were two large incisive foramina as in *Pachyrukhos*, instead of the incisive notch of *Typotherium*. The lower dentition presents nothing peculiar except for the slightly larger size, but the teeth are in a more continuous series, the short diastema between the canine and P_1 having disappeared. Length P_1 to M_3 .027; depth of jaw at M_1 .015. The symphysis measured on the outer side is .014 long. There are three mental foramina, the anterior and largest below the canine, the second and smallest below P_2 and the third beneath P_4. I have of this species the two rami somewhat broken with three molars of the first dentition still but little worn and the first true molar. The deciduous molars, bilobate by two opposite grooves, have separate roots. These teeth, deciduous molars and true molars, have the peculiarity of a small notch or cavity on the inner side of each lobe, very superficial and soon disappearing on wear, but which evidently córrespond to the two inner folds of *Toxodon*, *Protoxodon*, *Colpodon*, etc., as also of many pachyderms, such as *Homalodontotherium*, *Macrauchenia*, etc. ('89, 468–469).

PACHYRUKHOS.

Pachyrukhos teres Ameghino.

Pachyrucos teres Amegh.; Contrib. al Conoc., etc., p. 429, Pl. 13, figs. 25–27, 1889; Énum. Synoptique, etc., p. 19, 1894 (listed); Segundo Censo, etc., p. 151, 1898 (listed).

One half smaller than *P. typicus*,* but is very similar in general conformation. P^2 is not so disproportionately smaller than P^3 as in the latter, but is only slightly so. Its anterior part is also less compressed than in the other species and is of perfectly elliptical section. P^3, is slightly larger, is of the same shape as P^2 and both are inserted obliquely.

* A Monte Hermoso species.

M^3 is somewhat smaller than M^2, narrower behind and without the third posterior cusp which distinguishes this tooth in *P. typicus*. The palate is more concave in its posterior part, opposite P^4, M^1 and M^2, ascending rapidly between M^3. $P_{\overline{2}}$ is considerably smaller than $P_{\overline{3}}$, but divided equally into two lobes by a perpendicular external groove as is not the case in *P. typicus*. The anterior lobe is notably narrower than the posterior and the inner side slightly grooved in its anterior part. The symphysis is very little shorter than in *P. typicus*, its posterior part extending beneath the anterior lobe of $P_{\overline{4}}$, but is much more horizontal. The mental foramina are two, both quite small. The first is a little forward of the anterior part of $P_{\overline{2}}$, and the second below the space between $P_{\overline{2}}$ and $P_{\overline{3}}$, considerably more forward than in *P. typicus*. Length of space occupied by the six upper molars .019; width of palate at P^2 .010; width of palate at M^3 .0135; length of space occupied by the six lower molars .019; width of $I_{\overline{1}}$ .0037; width of $I_{\overline{2}}$ .002; length of symphysis inferiorly .0125; length of inferior diastema .006; depth of ramus below $M_{\overline{1}}$ .011 ('89, 429).

PACHYRUKHOS TRIVIUS Ameghino.

Pachyrucos trivius Amegh.; Contrib. al Conoc., etc., p. 429, Pl. 13, fig. 31, 1889; Énum. Synoptique, etc., p. 19, 1894 (listed); Segundo Censo, etc., p. 151, 1898 (listed).

A little smaller than the preceding species, although the dental series is of the same length, but the bones are more delicate, the mandible is lower and thinner and the molars, especially $P_{\overline{2}}$ of very different shape. This tooth is triangular and might be described as formed by a single lobe with anterior appendix, which ends forward in a thin vertical crest. This appendix is well demarcated from the lobe by a small external groove, but on the inner side is united with it into a single smooth plane. The mandible is distinguished by the almost uniform depth of the horizontal ramus below the teeth. On the most complete fragment of the mandible at my disposal there is no sign of the first mental foramen since the fragment is broken at this point. The second foramen, quite small, is below the anterior part of $P_{\overline{4}}$, somewhat farther back than in the preceding species. The six lower molars occupy a space .018 in length; depth of jaw at $M_{\overline{1}}$ .0095 ('89, 429).

HEGETOTHERIUM.

Hegetotherium convexum Ameghino.

Hegetotherium convexum Amegh.; Revista Argentina de Historia Natural, I, pp. 133–134, fig. 30, 1891; Énum. Synoptique, etc., p. 19, 1894 (listed); Segundo Censo, etc., p. 151, 1898 (listed).

Size comparable to *Hegetotherium mirabile* or slightly smaller. M^{3} considerably smaller than M^{2}, with postero-external angle not pronounced and with the inner face very convex. Antero-posterior diameter of M^{2} .007; of M^{3} .005; width of palate between the third molars .020 ('91, 134).

Hegetotherium minum Ameghino.

Hegetotherium minum Amegh.; Énum. Synoptique, etc., p. 19, 1894; Segundo Censo, etc., p. 151, 1898 (listed).

This species is distinguished by its size, a little smaller than *H. strigatum* (synon. *H. mirabile*) and by the horizontal ramus of the mandible being very low and shortened in front. Length, anterior border of $I_{\overline{1}}$ to posterior border of $M_{\overline{2}}$ .041; depth of mandible below $M_{\overline{1}}$ .014 ('94, 19).

Hegetotherium anceps Ameghino.

Hegetotherium anceps Ameghino; Revista Argentina de Hist. Nat., I, p. 242, 1891, Énum. Syn., etc., p. 19, 1894 (listed); Segundo Censo, etc., p. 151, 1898 (listed).

Size of *Hegetotherium convexum;* M^{3} much smaller than M^{2} but with inner face depressed and more or less grooved perpendicularly. Antero-posterior diameter of M^{2} .007; the same for M^{3} .004; length of space occupied by the second and third molars .012 ('91, 242).

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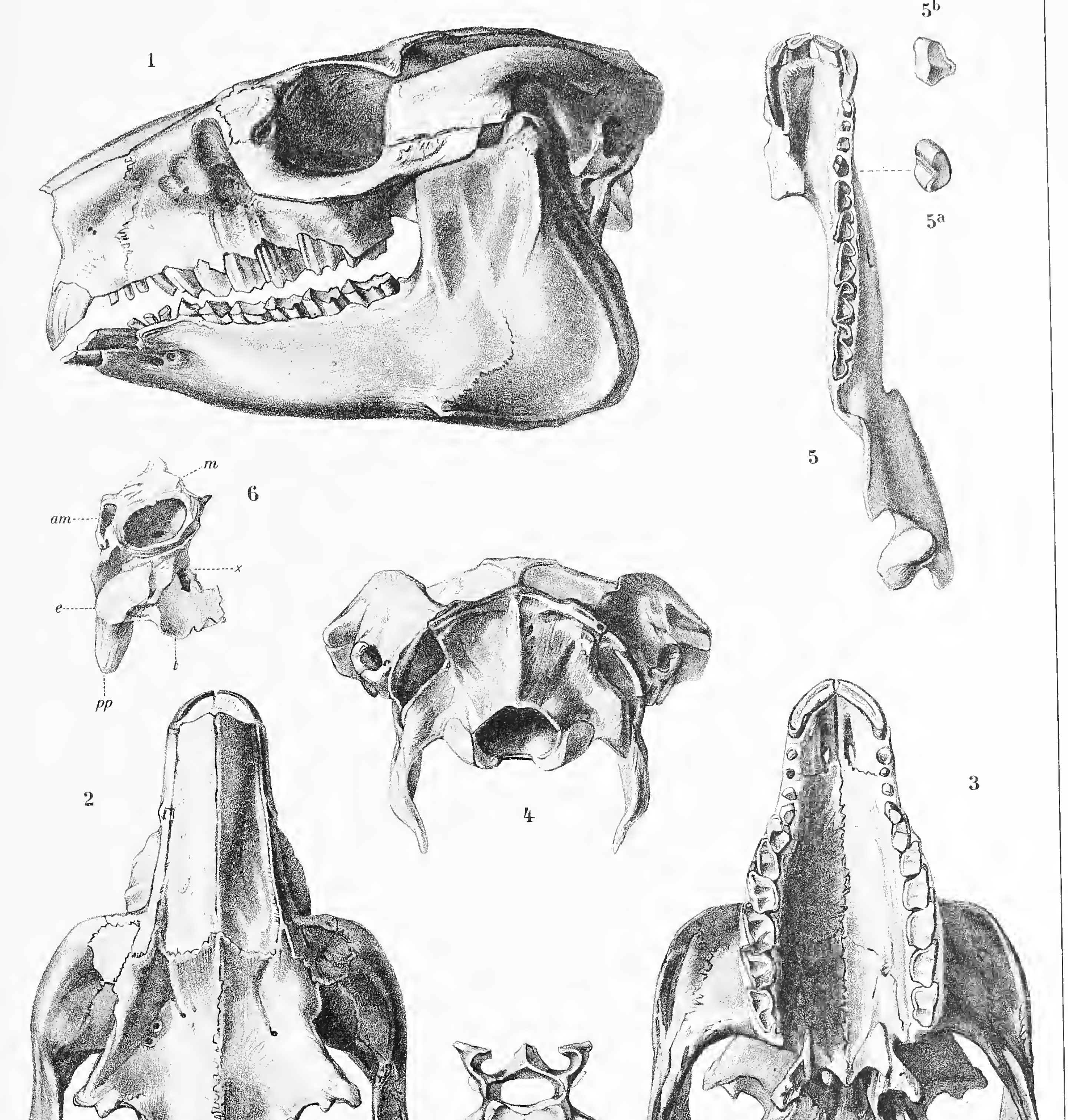

Bruce Horsfall del. Werner & Winter Frankfort a/M. lith.

HEGETOTHERIUM.

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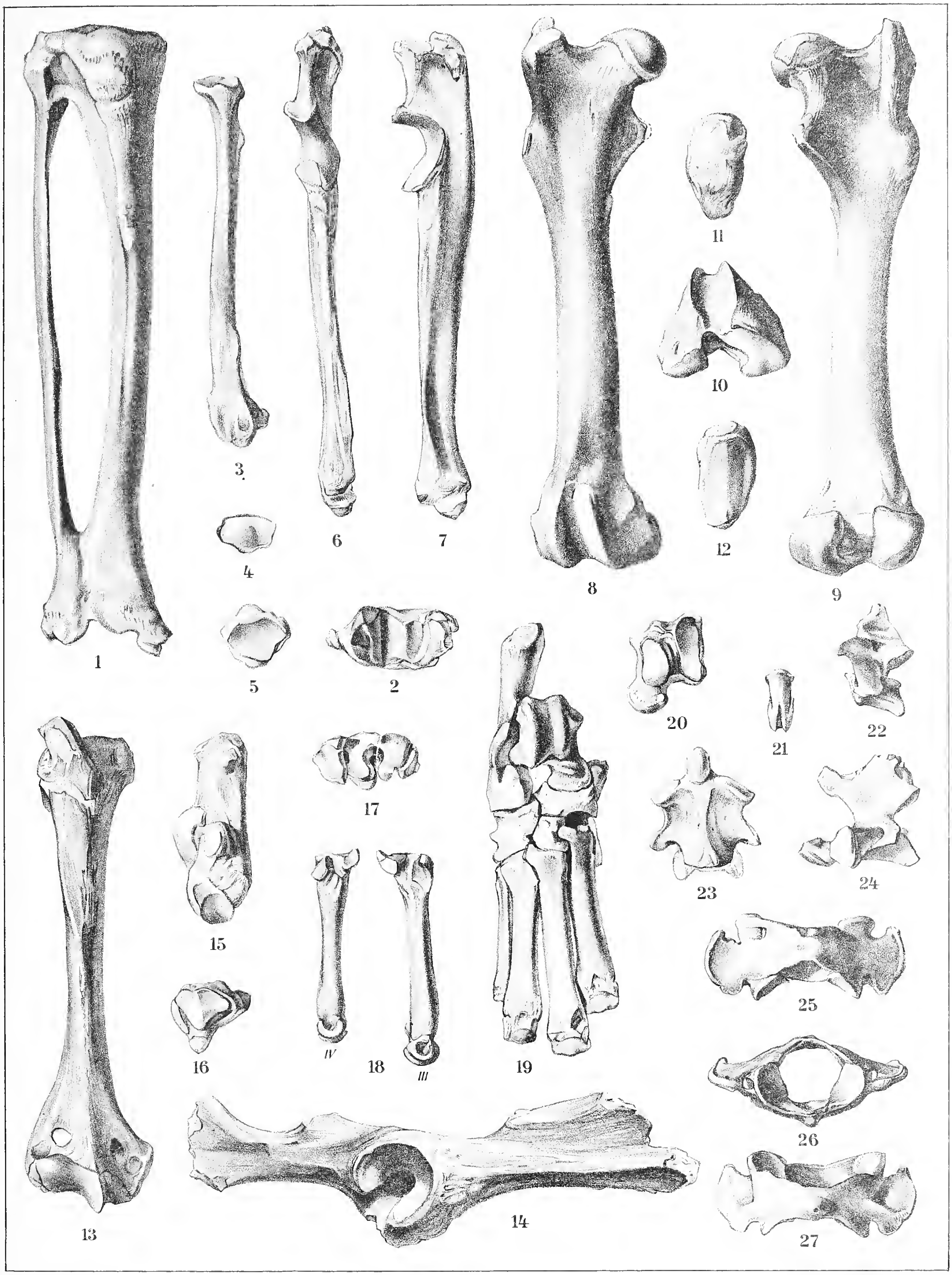

Bruce Horsfall del

HEGETOTHERIUM

All the figures are natural size.

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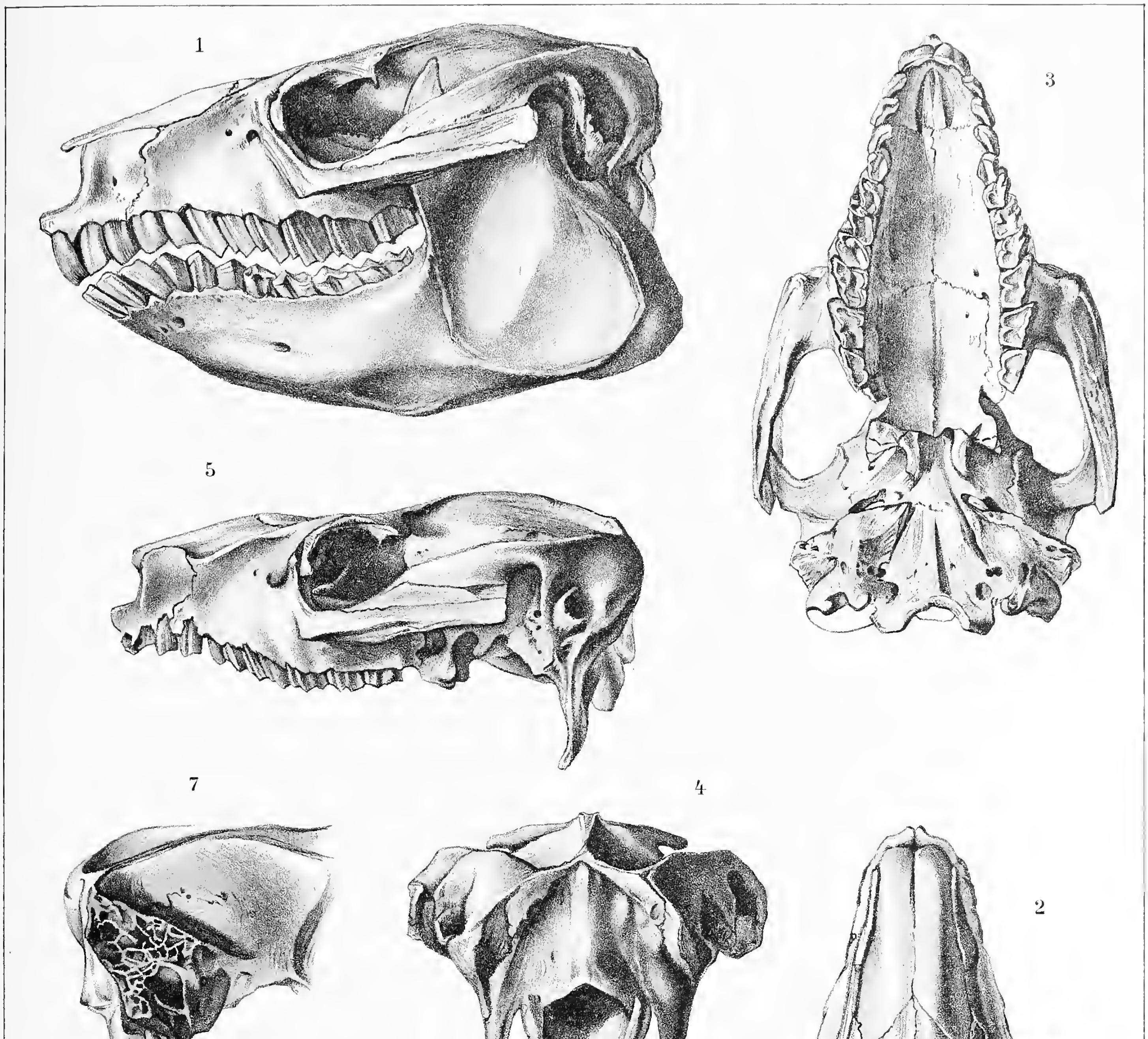

Bruce Horsfall del

Werner & Winter Frankfort a/M.

PROTYPOTHERIUM

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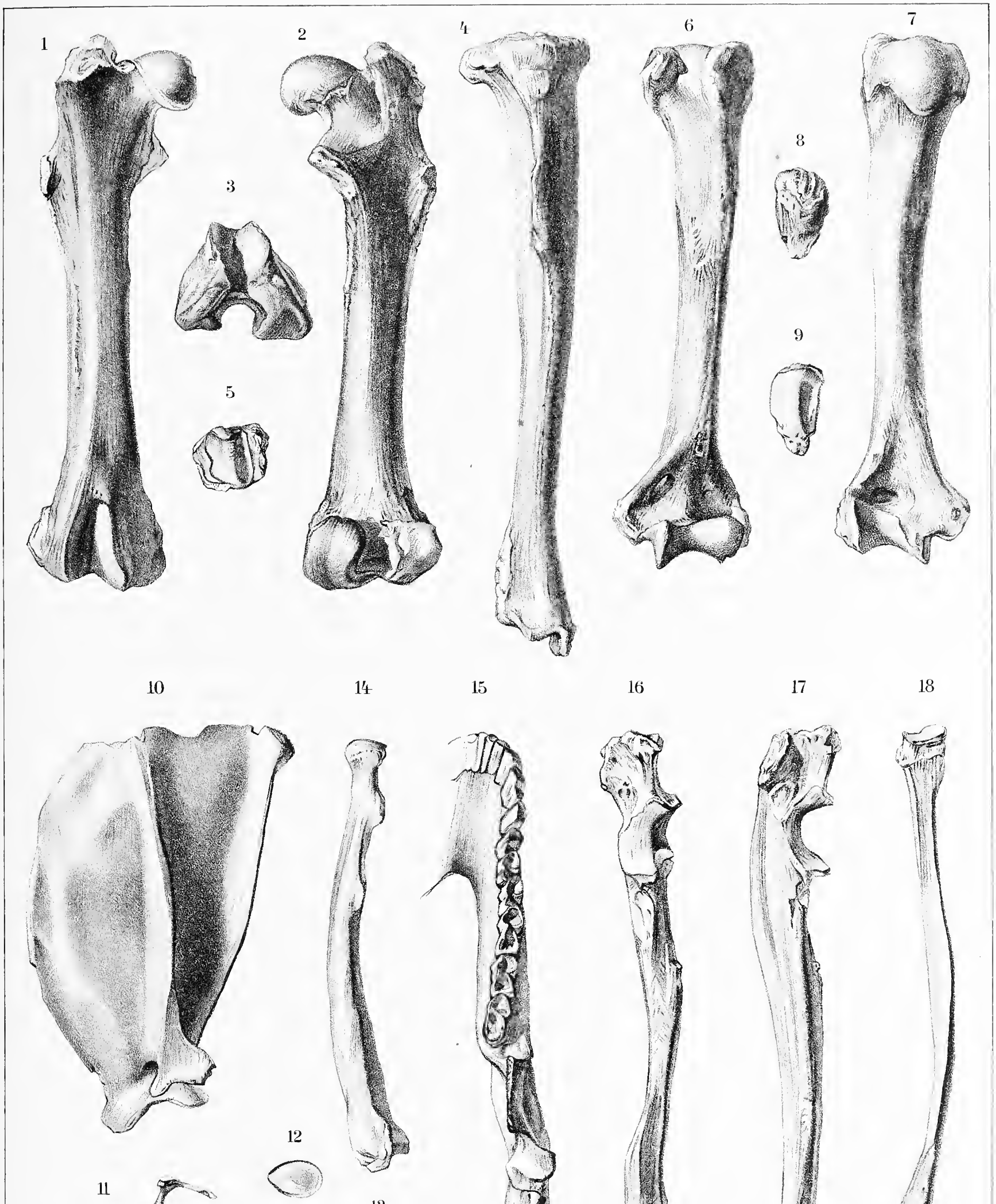

Bruce Horsfall del. Werner & Winter Frankfort ᵃ M.

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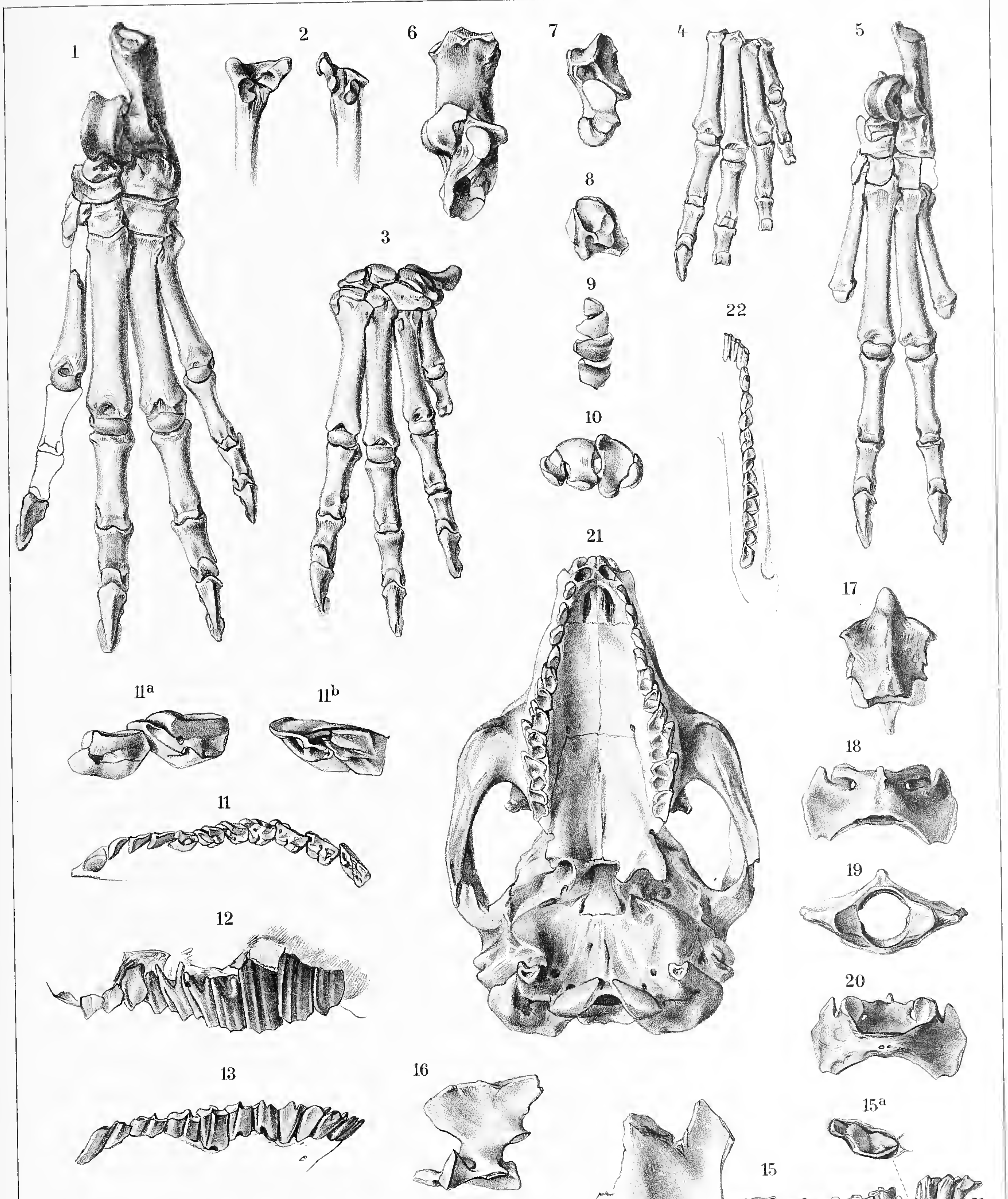

Bruce Horsfall del.

Werner & Winter Frankfort a M.

PROTYPOTHERIUM

All the figures except 11*a*, 11*b*, 14*a* and 15*a* are natural size.

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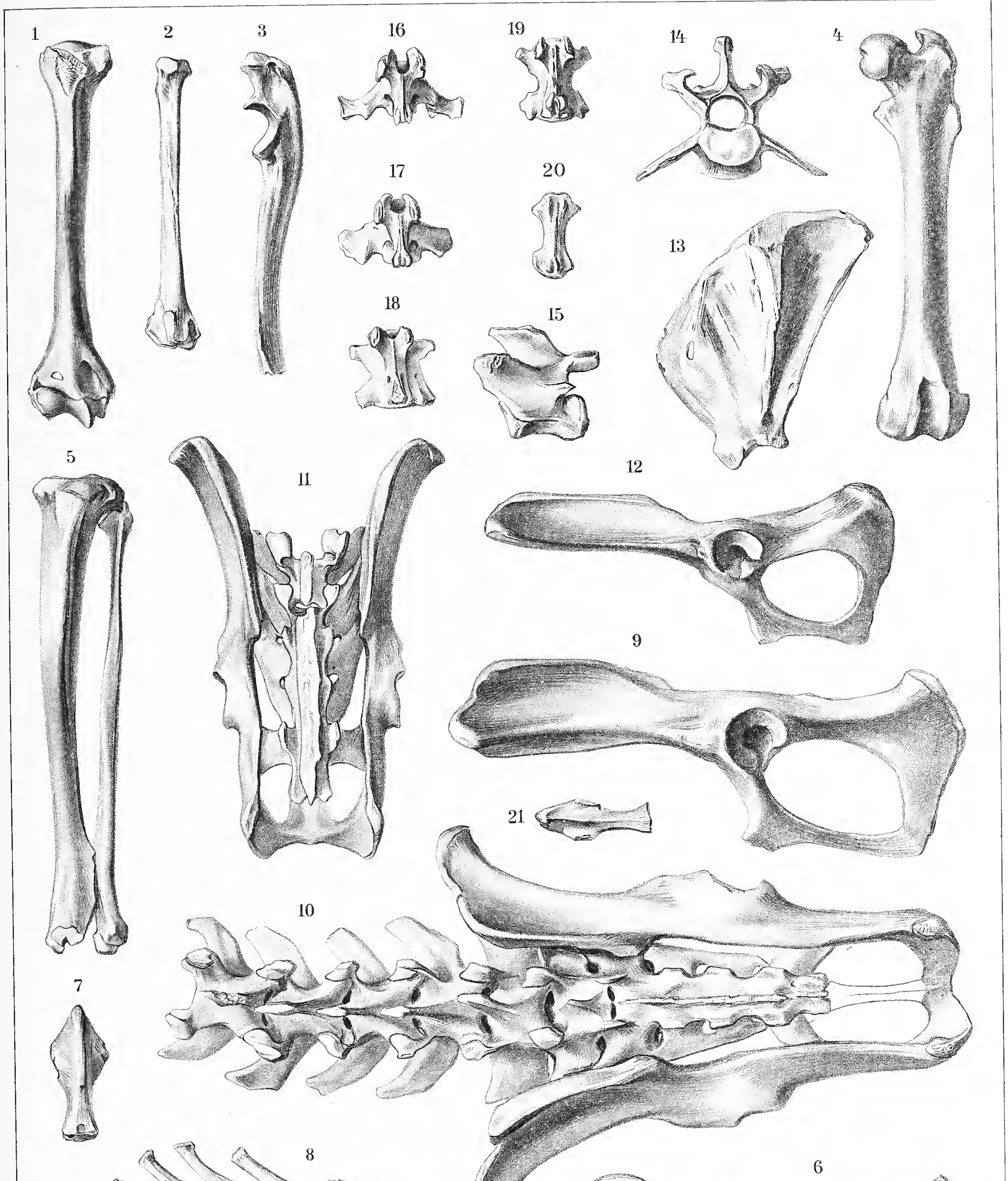

Bruce Horsfall del. Werner & Winter, Frankfort ºM.

PROTYPOTHERIUM, INTERATHERIUM

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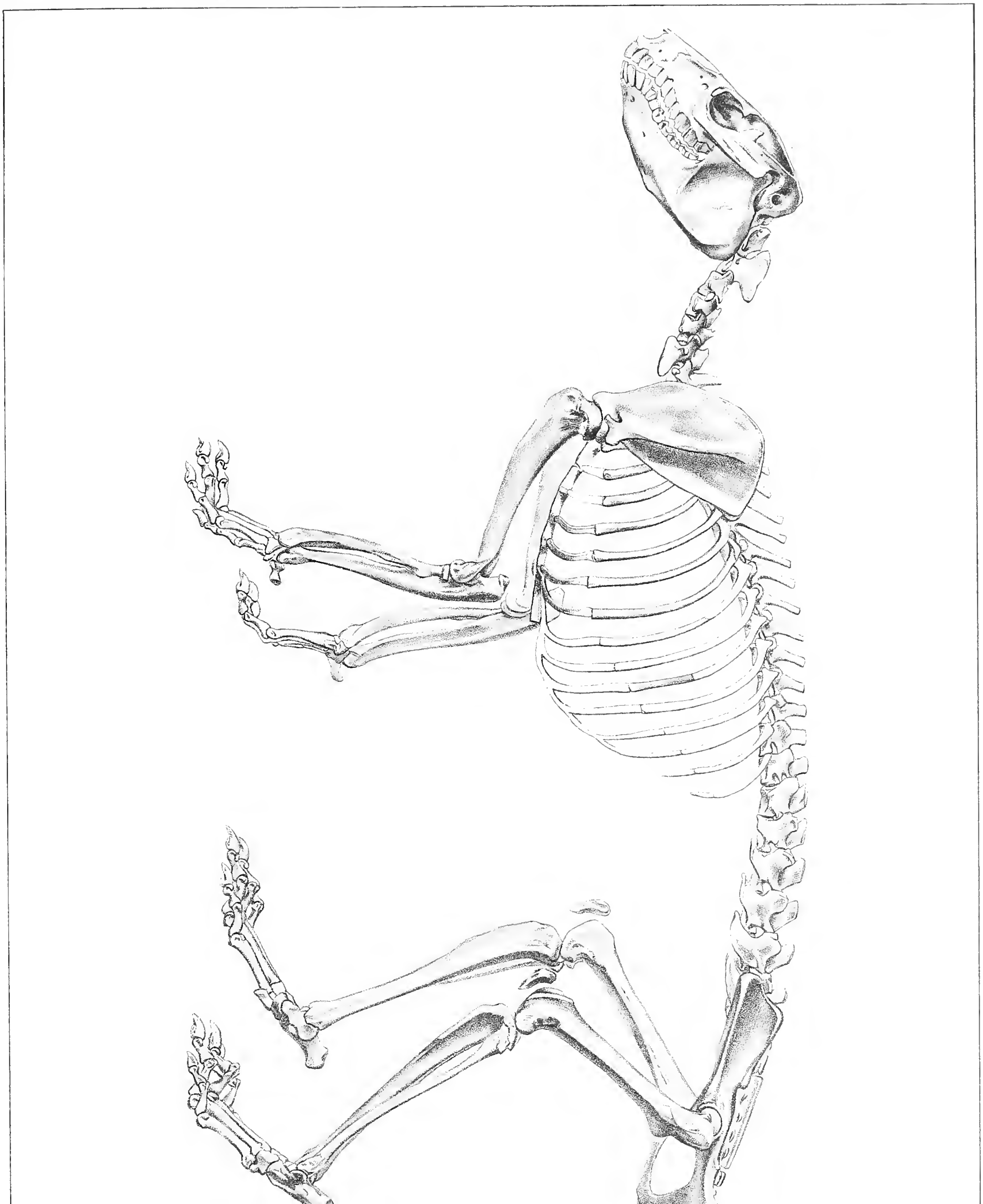

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PROTYPOTHERIUM

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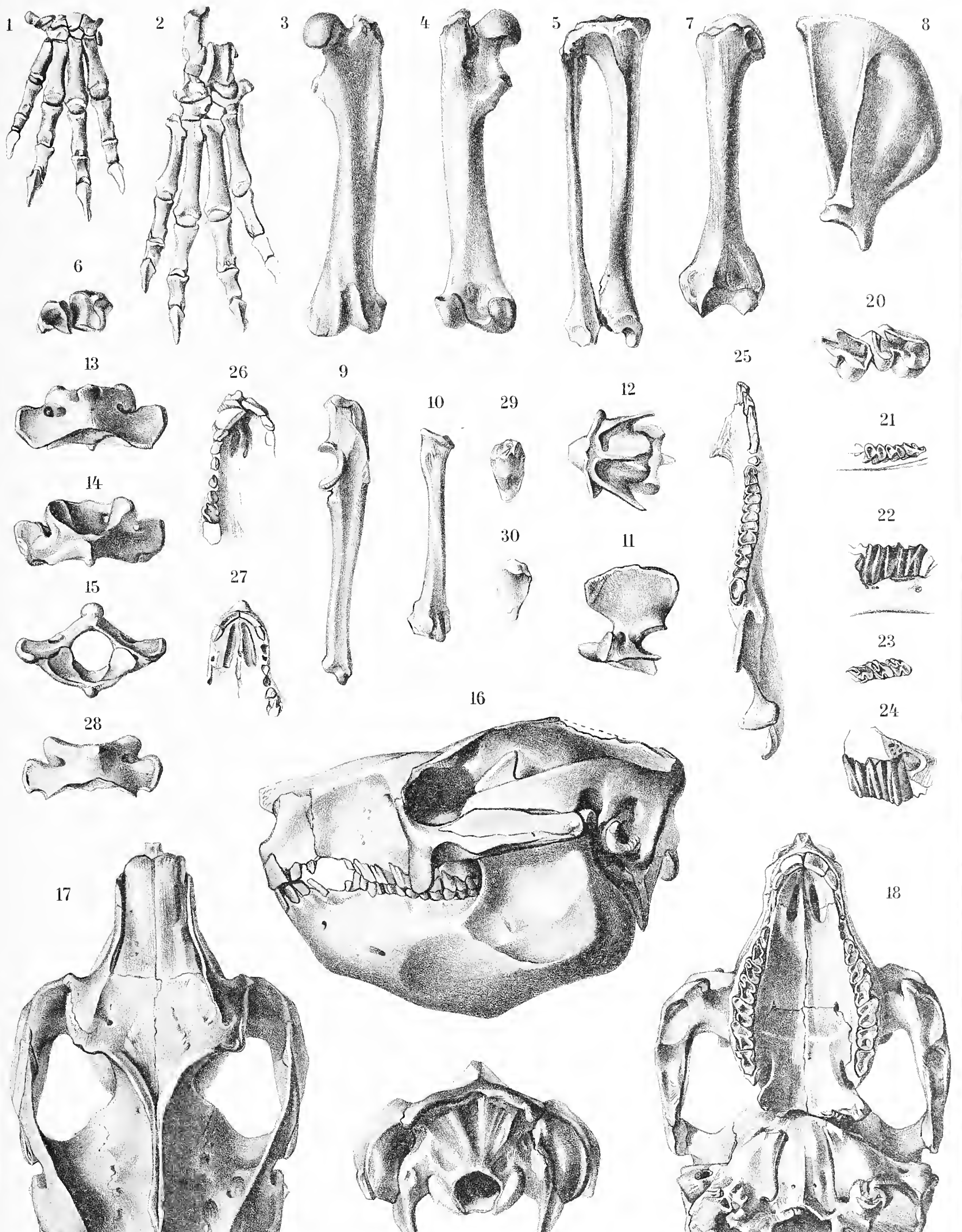

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INTERATHERIUM

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All the figures except 20 are natural size.

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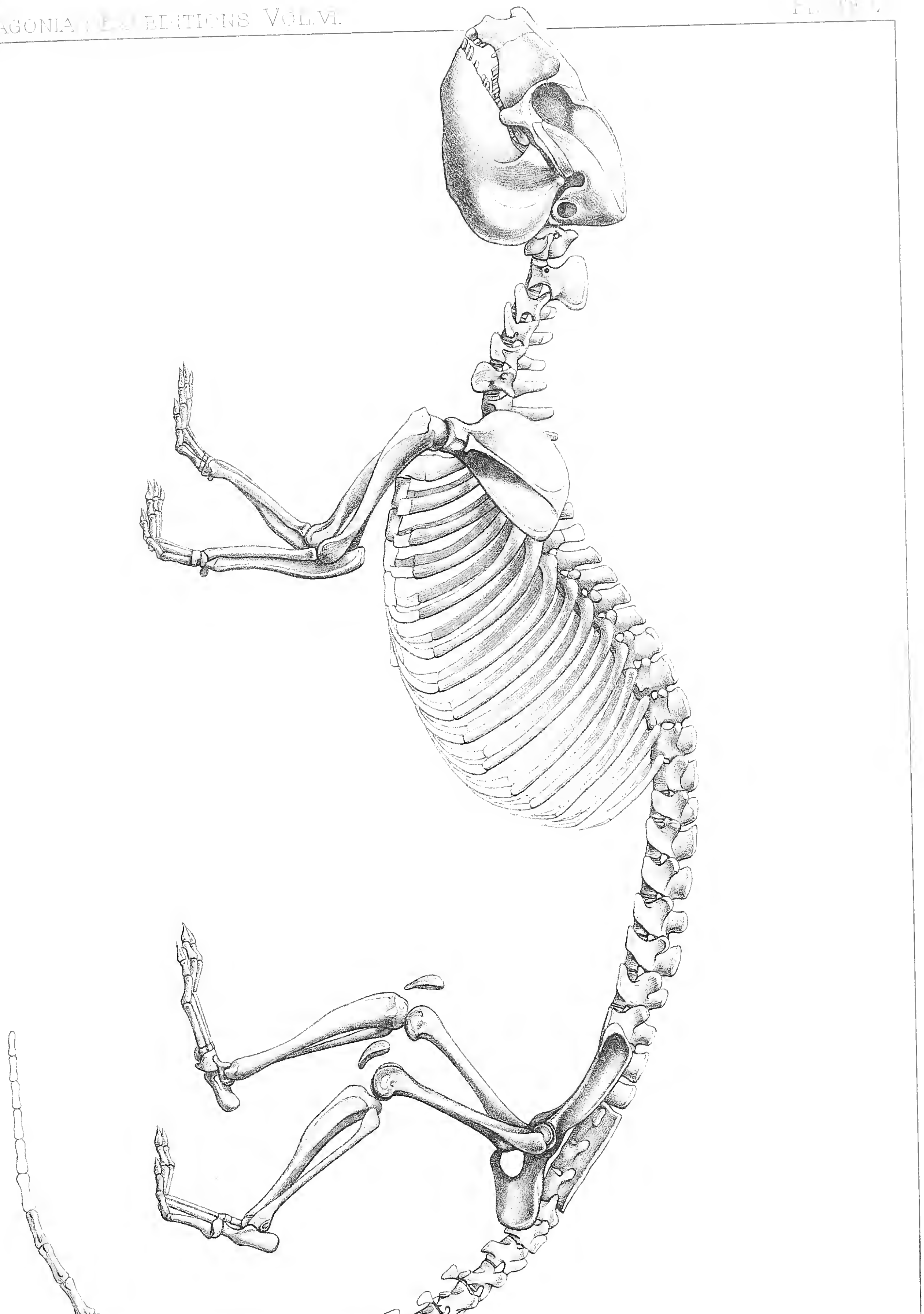
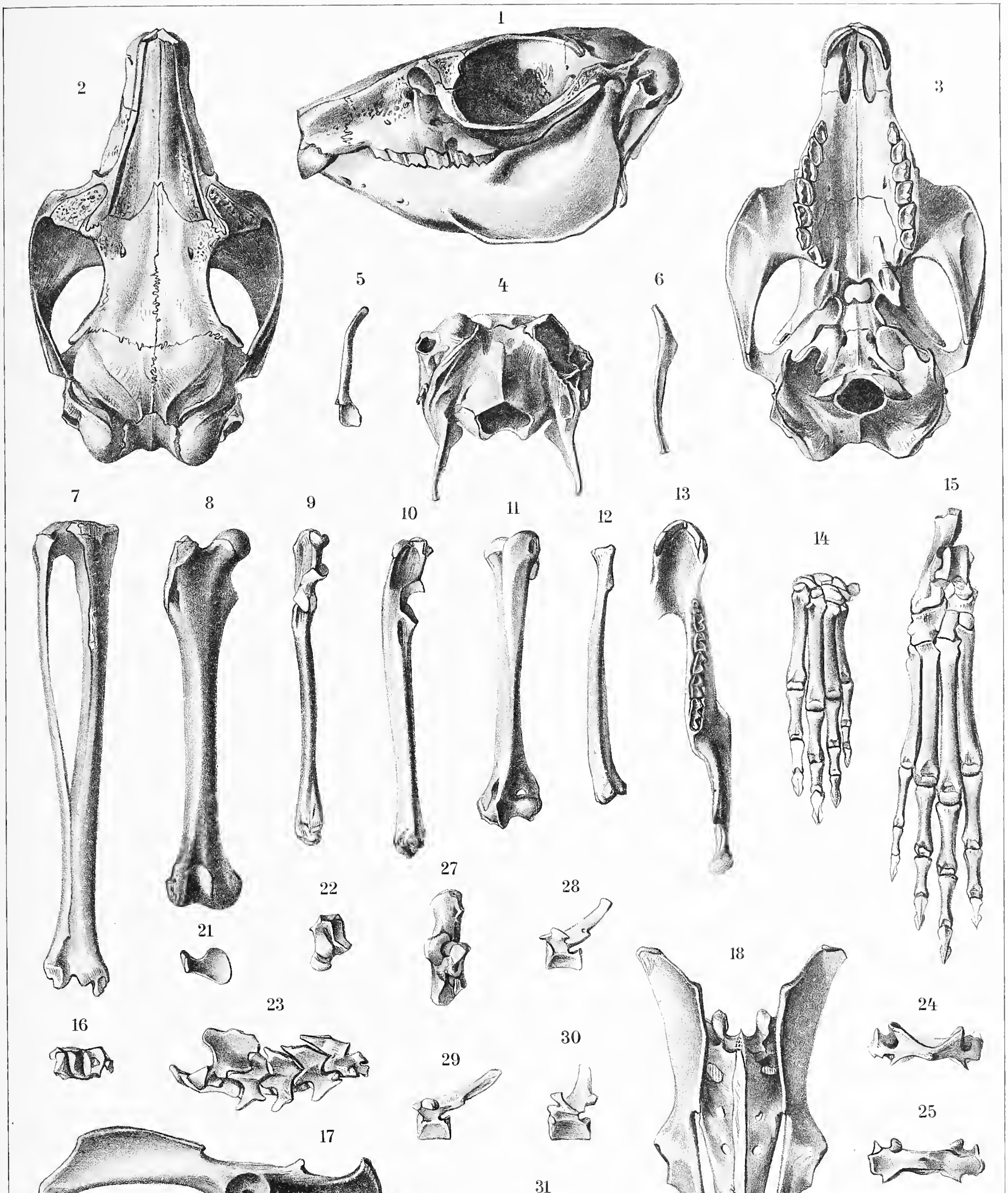


W. J. S. & F. v. I. del.

Werner & Winter, Frankfort ⁰/M. lith.

INTERATHERIUM

EXPLANATION OF PLATE X.



Bruce Horsfall del.

Werner & Winter Frankfort a/M.

PACHYRUKHOS

All the figures are natural size.

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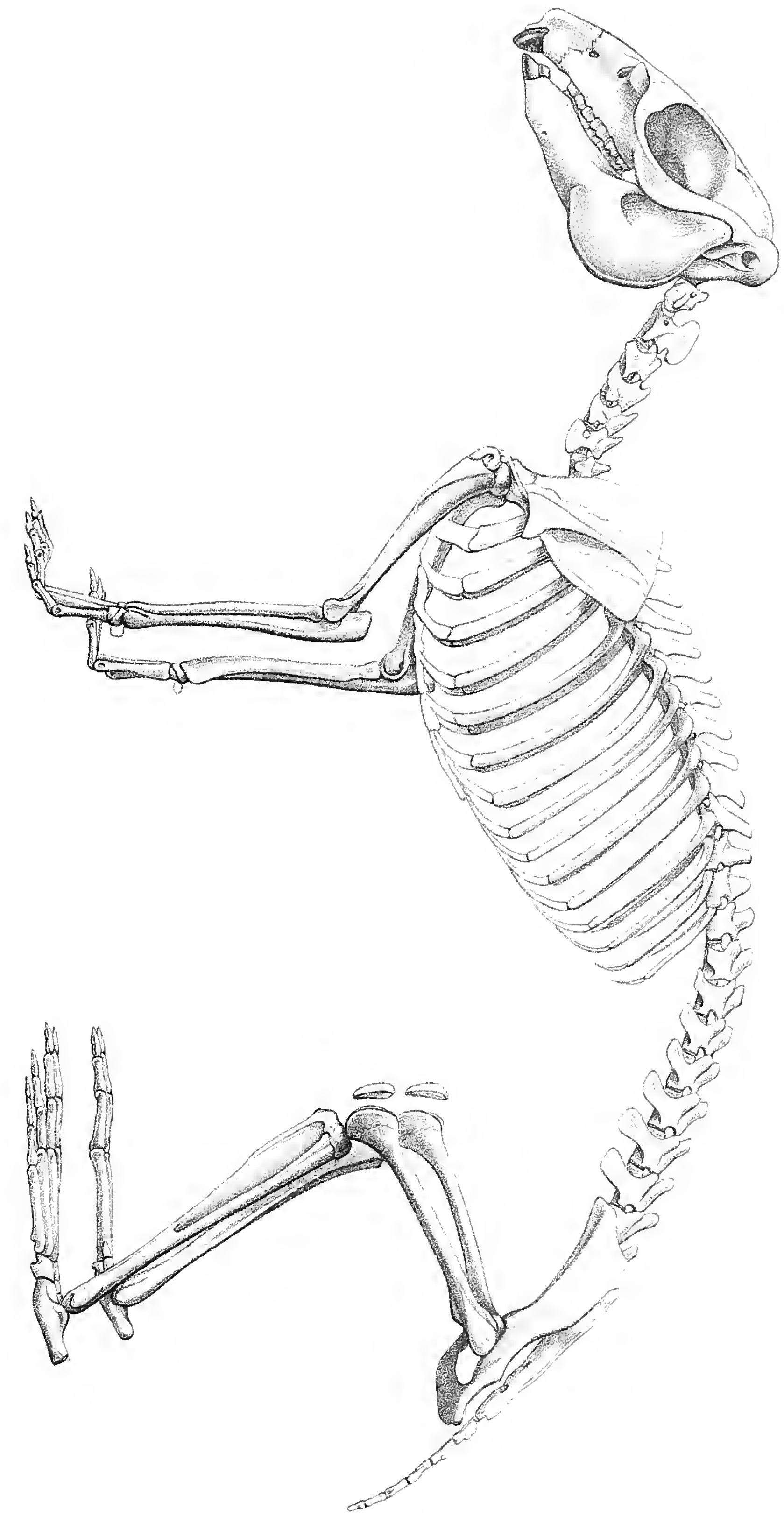

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PACHYRUKHOS

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J. B. HATCHER, IN CHARGE

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VOLUME VI—PALÆONTOLOGY

PART II. TOXODONTA OF THE SANTA CRUZ BEDS

PART III. ENTELONYCHIA OF THE SANTA CRUZ BEDS

BY

WILLIAM B. SCOTT
PRINCETON UNIVERSITY

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MAMMALIA OF THE SANTA CRUZ BEDS

PART II. TOXODONTA.

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THE known representatives of this suborder range from rather small to very large and massive animals, always much exceeding in bulk and stature the contemporary Typotheria, but, in Santa Cruz times, equalled or even surpassed by the Entelonychia, not to mention the Astrapotheria, some species of which are the largest mammals known from the Santa Cruz beds.

In this group the dental formula is very generally unreduced: $I\frac{3}{3}$ $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$, though there is some individual variability in the number of small and functionally unimportant teeth between the incisor tusks (i^2 and $_3$) and the cheek-teeth. Only in *Phobereotherium* is there a significant difference from the usual formula in the absence of the upper median incisors. A highly characteristic feature of the suborder is the arrangement of the incisors and the remarkable changes in appearance and relative size which these teeth undergo during the lifetime of the individual animal. The second upper and third lower incisors (i^2 and $_3$) are much enlarged and grow throughout life, or, at least, to very advanced age, and form moderately large tusks, such as are found in no other subdivision of the order. Indeed, this arrangement occurs in no other known group of Santa Cruz ungulates except in the family Proterotheriidæ of the Litopterna (see Vol. VII, p. 8) in which, however, these tusks are relatively small. The very large tusks, of the Astrapotheria are canines. The teeth, especially the tusks and the true molars, display a strong tendency to hypsodontism, the former growing from persistent pulps and the latter forming their roots at an advanced stage of wear. The crowns are incompletely covered with enamel, which forms broad vertical bands. In the post-Santa Cruzian genera complete hypsodontism is attained.

Except in *Phobereotherium*, the median upper incisor ($i^{\underline{1}}$) is broad, antero-posteriorly compressed and somewhat chisel-shaped; it early develops a root, toward which the crown contracts and is thus steadily reduced in size by abrasion. The second upper incisor ($i^{\underline{2}}$) is the tusk and is placed in the same transverse line as $i^{\underline{1}}$; it is of D-shaped cross-section, terminating in a sharp point, and somewhat resembles the bayonet-like canine tusk of the peccaries, but is abraded on the *posterior* face. The third upper incisor ($i^{\underline{3}}$) is very small, hardly more than vestigial, and can have had little functional importance. The same is true of the canines in both jaws, which may even be absent, though probably only as an individual abnormality. The two median lower incisors ($i_{\overline{1}}$ and $_{\overline{2}}$) are broad, chisel-shaped and rooted and diminish in size with age and wear. The inferior tusk ($i_{\overline{3}}$) is laterally compressed and inclined forward, more or less procumbent, and is obliquely truncated by the abrasion of the upper tusk. In the Pampean *Toxodon* all the teeth are hypsodont and the lower incisors are all strongly procumbent, so that the appearance of the anterior teeth is quite different from that seen in the Santa Cruz toxodonts.

The premolars are all of simpler pattern than the molars and, though having very high crowns, they early form roots in the Santa Cruz representatives of the suborder, which distinguishes them from those of the contemporary Typotheria. In toxodonts from the Pampean beds the premolars are completely hypsodont. The upper molars are all strongly curved, with the convexity outward, those of the opposite sides almost meeting in the middle line of the palate; they also are partially hypsodont in the Santa Cruz genera, completely so in the later forms. As Sinclair has pointed out (p. 8), the molars are constructed on the same plan as those of the Typotheria and have some resemblance, though not a close one, to the rhinocerotic pattern, with broad external wall and two oblique transverse crests. The grinding surface is much complicated by spurs and crotchets given off from the outer wall and transverse crests, though in the genera of the post-Santa-Cruzian formations the molar-pattern is greatly simplified.

The lower molars are composed of two crescents, each with an internal pillar. The posterior pillar appears to be common to all of the groups of the Santa Cruz ungulates, though in some of the genera of the Litopterna it is much reduced or even absent. This pillar divides the valley of the posterior crescent into two parts and does not close it internally, as it does in the Santa Cruz Typotheria. Like the upper molars, the lower ones are incompletely hypsodont and form roots at a comparatively late stage.

The milk-dentition differs in several respects from the permanent one. The incisors, which are rooted before eruption, are all more or less chisel-shaped, not forming tusks, and thus the appearance of the young skull with milk-teeth is very different from that of the adult and has led to great confusion in the nomenclature. The grinding teeth are quite similar to their permanent successors, but are more brachyodont and dp4 is molariform.

Ameghino has reported the very extraordinary fact that in *Nesodon* and *Adinotherium* there is a complete and functional pre-lacteal dentition, which is not known to be the case in any other mammal, although the same author has shown that pre-lacteal grinding teeth are present in the tapir.

The skull, though of very much larger size and quite different appearance and proportions, is yet constructed upon essentially the same plan as that of the Typotheria, the toxodont skull having much less resemblance to that of the Rodentia. The cranium is relatively narrow and the facial region broad, without such a long and slender rostrum as characterizes the Typotheria. On the other hand, the skull and mandible are deeper dorso-ventrally, which gives a peculiar appearance to the head. The occiput, which differs considerably in the various genera and species of the group, is proportionately narrower and higher than in the Typotheria. The auditory apparatus is of the same exceptional structure as is found throughout the order and in the Toxodonta has few special peculiarities. The post-tympanic portion of the squamosal (or perhaps, as Roth maintains, the mastoid) contains a large, oval cavity, which communicates with the cavity of the tympanic bulla, but it is not so inflated as to form an external protuberance on the surface of the skull, as it is in such Typotheria as *Pachyrukhos* and *Hegetotherium*. On the other hand, this part of the squamosal forms a larger proportion of the occipital surface than in the Typotheria or Entelonychia and the external auditory meatus has a more elevated position than in the other suborders, owing to the extensive union of the post-tympanic and postglenoid processes with the intervening mastoid portion of the periotic (the protuberancia petrosa of Roth). This position of the mastoid between the two processes of the squamosal is an altogether exceptional one, the normal place, when it appears on the surface of the skull, being between the exoccipital and the squamosal. Inward, the process is extended to a contact with the tympanic bulla, with which it may coössify.

The hyoid apparatus possesses the peculiarity (unique among mammals, so far as is now known) of being attached to the *anterior*, instead of the posterior, end of the tympanic bulla and in the adult skull the stylohyal is firmly ankylosed in that position. In the Santa Cruz Typotheria the hyoid is loosely connected with the skull and is very rarely found in position, but its point of attachment is different from that of the Toxodonta, though likewise very exceptional. In this group the junction of the paroccipital process with the tympanic leaves no room for the hyoid in its usual position and it is displaced to the external side of the bulla, near the posterior end, where a cylindrical fossa may be seen in some of the genera.

The neck is short and thick and the trunk is very long, with long and deep thorax. The development of the neural spines is quite different in the various genera. In the comparatively small *Adinotherium* the spines of the back and loins have their tips in nearly the same horizontal plane, making the profile an almost straight line, while in *Nesodon* the spines of the anterior thoracic vertebræ are greatly elongated and form a decided hump at the shoulders, an arrangement which is exaggerated in *Toxodon*. The thoracic vertebræ have the pedicles of the neural arch perforated by large foramina for the passage of the spinal nerves. The sacrum is long, broad and depressed. Caudal vertebræ are not yet known in the Santa Cruz representatives of the suborder, but from the character of the sacrum it may be inferred that the tail, as in *Toxodon*, was heavy and of moderate length, in contrast to the long and slender tail of most of the contemporary Typotheria.

The limbs are in all cases relatively short and heavy and the feet surprisingly small in proportion to the size of the animal; the limb-bones differ greatly in size and massiveness in the various genera of the suborder, but agree quite closely in structure among all the forms in which these elements are known. One striking difference between the earlier and the later genera is in the shape of the scapula, which in the Santa Cruz animals is relatively much broader than in the Pampean types and bears two very prominent metacromia, given off from the spine, of which only the proximal one is retained and in greatly reduced form in *Toxodon*. This double metacromion does not occur in the Typotheria; there is merely a small, well-defined process near the distal end of the spine.

The clavicle, which is retained in some at least of the Typotheria (see p. 91), has not been found in any member of the present suborder, yet it is not at all unlikely that it may have persisted as late as Santa Cruz times, as is suggested by the prominent acromion. The unexpected discovery of a vestigial clavicle in an artiodactyl of the upper Oligocene (Scott, '94, 136) shows that only a rare and fortunate accident could bring to light so small and loosely attached an element.

The pelvis is quite different from that of the Typotheria, in which the ilium is elongate, slender and more or less trihedral. In the Toxodonta the ilium has lost the trihedral form and its anterior plate is greatly expanded and everted, in a degree which varies with the size of the animal and reaches its maximum in the large Pampean species, in which the pelvis has quite an elephantine appearance.

In the Santa Cruz genera the fore and hind limbs are of approximately equal length, but in the Pampean *Toxodon* the hind limb is much longer, which results in the elevation of the rump and depression of the shoulders, neck and head and gives a very curious appearance to the skeleton. The humerus is short and quite stout, becoming very massive in the later and larger representatives of the suborder. The fore-arm bones are separate in all of the known genera and the ulna remains large and heavy throughout the series, while the radius is relatively slender. The femur is the longest of the limb-bones and in the Santa Cruz genera retains a prominent third trochanter, which is lost in the Pampean forms, in which also the femoral shaft is much compressed and flattened antero-posteriorly, which gives the bone a decided resemblance to that of the elephants. In all of the known genera of the suborder the leg-bones are ankylosed at the proximal, but not at the distal end, a very peculiar arrangement; the tibia has the shaft strongly compressed laterally, but has a very broad proximal end, so that the interosseous space is very wide. The fibula is heavy and unreduced and retains throughout the series a large articulation with the calcaneum.

As already noted, the feet are curiously small in proportion to the size of the skeleton. Though assuredly derived from five-toed ancestors, all of the known genera are tridactyl, but always retain a vestige of the fifth metacarpal, and are of mesaxonic symmetry, which is thus more constant and definite than in the Santa Cruz Typotheria, which have tetradactyl feet with either paraxonic or mesaxonic symmetry. The carpus is of the completely interlocking type, the scaphoid articulating with the magnum and the lunar with the unciform, thus closely resembling the structure of the perissodactyls, notably the early rhinoceroses. On the other hand, the tarsus retains a highly primitive character; the astragalus has a trochlea with very shallow groove, a short neck and convex head, which rests exclusively upon the navicular, being widely removed from the short cuboid, while the calcaneum bears a very large and prominent facet for the fibula; the ento- and mesocuneiforms are coössified. The ungual phalanges, especially that of the median digit, are broad and heavy and quite like those of such perissodactyls as *Palæosyops* in the Santa Cruz genera, and in the Pampean are more rhinocerotic in form.

Classification of the Toxodonta.

Ameghino has divided the Toxodonta into several family groups, the Toxodontidæ, Xotodontidæ, Haplodontheriidæ, Nesodontidæ, but, as he has predicted, this example will not be followed here. He complains that South America fossils are treated differently from those of other continents, saying: "Comme les faunes éteintes sudaméricaines et celles des autres continents sont toujours jugées avec un critérium distinct, on prétend qu'il n'y a pas de raison pour séparer les *Nesodontidæ* des *Toxodontidæ;* on en dira certainement autant des *Haplodontheriidæ*, et on en fera probablement trois sous-familles de celle de *Toxodontidæ*" ('07, 89).

This complaint necessitates some remarks upon the significance of the family as applied to extinct organisms. Broadly speaking, there are among palæontologists two contrasted methods of using the family group. One method, that of Cope, for example, is to apply the Linnæan conception to the fossil forms and to treat the family purely as a matter of definition, the fauna of each horizon being classified without reference to preceding or succeeding groups. The other method, first suggested, I believe, by Schlosser ('86) is to regard the family as a *phylogenetic series* and to include in it not merely the main stem of the series, but also such side-branches as are not themselves so distinct and so widely ramified as to constitute other families. Just how large and important a side-branch shall be to demand recognition as a distinct family is, of course, largely a matter of individual judgment, and perfect agreement on this point is hardly to be expected. If classification is to be the concrete expression of genetic relationship, the second method is clearly the better and more logical one. For example, all of the horses, from the lower Eocene to the present, are by this method included in the Equidæ, both the genera which can be placed in the main line of descent and such side-branches as *Anchitherium*, *Hippidium*, etc., as are given off at different levels from the principal stem. On the other hand, if, as is probably true, the Palæotheriidæ are derivatives of the same stock, they diverge and ramify so much as to form a separate family.

An even more instructive example is that of the rhinoceroses, of which Osborn ('10, 557–8) recognizes two families, the Hyracodontidæ and Rhinocerotidæ, and divides the latter into four subfamilies. Personally, I prefer the classification which includes all of the rhinoceroses in one family, dividing this into three subfamilies, for the true rhinoceroses, the cursorial Hyracodonts and the presumably aquatic Amynodonts respectively, but Osborn's arrangement will suffice for the comparison. The family of the Rhinocerotidæ includes much more diversified forms than are known among the Toxodonta. Whether we consider the dentition, the skull, or the feet, we find far greater differences between such genera as the Oligocene *Trigonias*, the Miocene *Teleoceras* and the Pleistocene *Elasmotherium* than can be found among the known Toxodonta. To this single family are referred animals with and without horns, with single and with paired nasal horns, with frontal horns present or absent, with and without incisors and canines, with grinding teeth brachyodont and comparatively simple; or hypsodont, cement-covered and highly complex, with tetradactyl or tridactyl feet, which are either long or slender, or short and extremely heavy. Comparing the rhinoceroses with the toxodonts, I can see no valid reason for making more than one family for the Santa Cruzian and later members of the suborder.

From the foregoing considerations the Notohippidæ have been excluded, because I have had but little opportunity to examine the animals of this group and they are still incompletely known, but they are doubtless entitled to separate family rank. The same is true of the Leontiniidæ of the *Pyrotherium* beds, which are so aberrant that they are usually included in the Entelonychia. I am confident, however, that this reference is erroneous.

NESODON Owen.

(Plates XII–XXVI.)

Nesodon Owen; Rep't Brit. Ass. Adv. Science, 1846, p. 67.
Toxodon Moreno (*non* Owen); Patagonia, resto de un continente hoy submerjido, Buenos Aires, 1882.
Colpodon Burmeister (in part); Anales del Mus. Nac. de Buenos Aires, T. III, Entr., XIV, 1885, p. 161.
Astrapotherium Burmeister (in part); Descr. Phys. Rèpub. Argent., T. III, 1879, p. 517.
Protoxodon Ameghino; Observ. gener. sobre el orden de mamíferos esting. sud-amer. llamados Toxodontes, p. 62. La Plata, 1887.
Atryptherium Ameghino; Enumeracion sistemática, etc., 1887, p. 18.
Scopotherium Ameghino; Ibid.
Adelphotherium Ameghino; Ibid., p. 16.
Gronotherium Ameghino; Ibid., p. 17.
Acrotherium Ameghino (in part); Ibid.
Nesotherium Mercerat; Rev. del Museo de La Plata, T. I, 1891, p. 386.

Among the Santa Cruz ungulates by far the commonest is the genus *Nesodon*, the remains of which occur in remarkable abundance. Almost all parts of the skeleton are fully represented in the collections, sacral and caudal vertebræ alone excepted, and even the successive stages of development, from earliest youth to extreme age, may be readily followed. As Ameghino has well shown ('91, 357; '94[b], 230), the animal undergoes remarkable changes of appearance during the course of development, and to these changes are largely attributable the many names which have been applied to it. Though not the largest of Santa Cruz mammals, none of which are gigantic, the species of *Nesodon* are among the larger and heavier forms and there is no great range of variation in size.

Dentition (Pls. XIII, XVI–XIX).—Attention has repeatedly been called, especially by Ameghino and Lydekker, to the extraordinary changes in the character and appearance of the dentition, which in this genus take place in the course of individual development. Without a continuous series of skulls, representing all the steps of the transformation, one would hardly venture to suggest that the earlier and later stages were of the same animal. Normally, the number of teeth is still unreduced and the formula is that common to all the early groups of placentals, viz., $I\frac{3}{3}$, $C\frac{1}{1}$,

$P\frac{4}{4}$, $M\frac{3}{3}$. Supernumerary teeth occasionally appear among the premolars, and, in certain cases, some of the smaller teeth may be suppressed, but these appear to be abnormalities.

A. Upper Jaw (Pls. XIII, XV, XVI, XVII, figs. 2, 3; XX, fig. 5).— The median incisor (i^1) is a large tooth, which greatly changes in shape and appearance with age. When freshly erupted and unworn (Pl. XVI, fig. 1) it is very broad and massive and the exposed portion is of uniform width; the masticating surface has an enamel-pit, or "mark" which, however, is quite shallow, and its floor is irregularly pitted with numerous depressions, while the anterior and posterior borders are trenchant edges. On the anterior face the medial border is raised into a more or less prominent ridge and, external to this, is a broad, shallow concavity, while the outer moiety of the face is convex. Wear speedily obliterates the pit on the masticating surface and the concavity and convexity of the anterior face also soon disappear, for they have no great vertical extension, leaving that face gently convex, or nearly plane (Pl. XVII, fig. 2). For some time the base of this incisor remains open and the tooth continues to grow, the crown, in front view, having much the appearance of the scalpriform incisor of the rodents. Thick enamel covers the anterior face and is reflected around the medial and external borders, but leaves the posterior face uncovered. With the formation of the root, which takes place when the animal is in early adult life, i^1 assumes quite a different appearance (Pl. XVI, figs. 3–6), narrowing to the base and having a more or less triangular anterior surface. As growth has now ceased, the tooth becomes smaller with advancing age, as the crown is worn down by use.

When the first incisor is erupted and for some time after it has come into use, there is still no visible trace of i^2, di^2 being still in place, and for a considerable period after its eruption i^2 is much smaller and less conspicuous than i^1 (Pl. XVI, fig. 3) but it grows from a persistent pulp and throughout the whole life of the animal, or, at least, to extreme old age, eventually far surpassing i^1 in size and especially in length. (Cf. Pl. XVI, figs. 4–6.) It is these changes in the relative size of the median and second incisors which are the chief factor in the surprisingly altered appearance of the dentition in the successive stages of the animal's development. I^2, which thus becomes a formidable tusk, with considerable resemblance in shape to the lower canine of the boar, is recurved and sharply pointed and of trihedral cross-section, with the apex formed by the rounded anterior border. Enamel is not present on the posterior face, which is bevelled by the abrasion of i_3, but covers the front and sides in a thick layer. Apparently, there is a sexual difference to be noted in the development of the tusk-like i^2, which is heavier and more robust in some individuals than in others of similar age, and there is nothing in the skull-structure to indicate that this difference is specific rather than sexual.

The first and second incisors are implanted in the same transverse line and form the front of the broad muzzle, but i^3 is inserted in the same fore-and-aft line as the premolars and is quite invisible from the front. This tooth is very much smaller than i^1 or i^2 and of simple, irregularly style-like form, but, in the unworn condition, with enamel-pit on the cutting surface; it cannot have had much functional importance. To a varying degree, the enamel is absent from more or less of the inner face. A short diastema in front of and behind it gives to this small tooth an isolated position.

The canine is slightly larger than i^3, which it resembles in form and in the presence of an enamel pit on the masticating surface, while still unworn; it stands quite near p^1 and, at first sight, appears to be one of the premolar series. This tooth also must have been functionally insignificant.

The seven cheek-teeth (Pls. XIII, XV, XVII, figs 1–5) form a continuous series, progressively increasing in size from p^1 to m^3, though all the premolars are of simpler pattern than the molars. These teeth are all strongly curved, with the convexity turned outward, as in *Toxodon*, and almost meet those of the opposite side in the median line of the palate. When first erupted, they have open bases and no roots, which are developed later, first in the premolars and then successively in the molars, m^3 remaining rootless till a very advanced period. In freshly erupted and unabraded condition, the premolars all have a very deep central pit, or valley, completely enclosed by the external wall and a continuous ridge, which joins the outer wall in front and behind and bounds the valley anteriorly, internally and posteriorly. This valley is much complicated by spurs and pillars given off from the enclosing wall, their number and prominence differing in the successive teeth. In the first premolar, p^1, which is the smallest and simplest of the series and is implanted by a single root, there is no spur, but the valley is in two portions, an anterior and much deeper part and a posterior, shallower part. When the tooth has been moderately abraded, the two portions of the valley are converted into two separate enamel lakes, of which the anterior one is the larger and deeper, and the posterior one speedily disappears altogether. In the fully adult animal the anterior lake is also worn away, leaving a smooth surface of dentine partially enclosed in a wall of enamel.

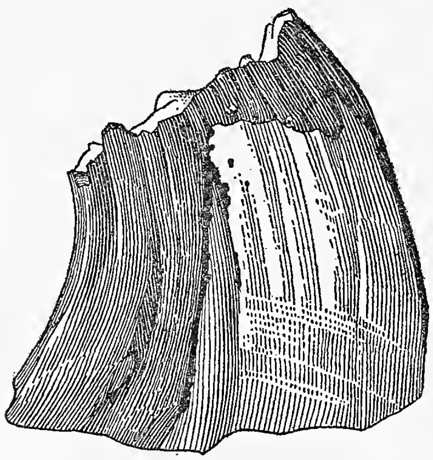
The second premolar is considerably larger than $p^{\underline{1}}$ and is inserted by two roots; it has a prominent spur from the external wall, which divides the valley into two parts, and a second and much smaller spur projects into the valley from the posterior part of the enclosing ridge. Behind this ridge is a second valley, which is smaller and much shallower than the principal one and has several small, circular enamel-pits in its floor, and at the antero-internal angle of the crown is an enamel-lined pocket. The third premolar resembles the second, but is somewhat larger, and the spur which projects forward from the posterior ridge is better developed. After a short period of wear, in both $p^{\underline{2}}$ and $p^{\underline{3}}$, the principal valley becomes a narrow, antero-posteriorly directed, enamel-lined slit, and the posterior, shallower valley is obliterated, but the pits remain for a time as four or five very small enamel-lakes, and the antero-internal pocket persists as a lake. The minute lakes of the posterior border soon disappear, but the central valley and the anterior lake remain until the animal may be called old.

The fourth premolar, which is the last of the permanent teeth to come into use, is of a pattern similar to that of $p^{\underline{2}}$ and $p^{\underline{3}}$, but slightly more complicated; the crista or spur from the external wall is more prominent, and that from the posterior crest is divided into three or more ridges, while the posterior valley is divided into two well-defined parts, each with two or more pits in its floor; the antero-internal pocket is smaller than in $p^{\underline{3}}$. In quite an advanced state of wear, $p^{\underline{4}}$ differs from the preceding premolars and has a certain resemblance to a worn molar in the retention of the crista and the consequent Y-shaped valley. There is, however, no real difference of structure and the dissimilar appearance is largely due to the very late eruption of $p^{\underline{4}}$, so that, at a given stage, it has suffered less abrasion than the other premolars.

The first of the premolar series has an irregularly oval grinding surface, while in the others this surface is approximately square, but, as the crowns contract toward the base, these teeth become smaller through abrasion, as age advances. The external wall of $p^{\underline{2}}$–$p^{\underline{4}}$ shows, more or less obscurely, a division into two nearly equal lobes by a shallow median groove.

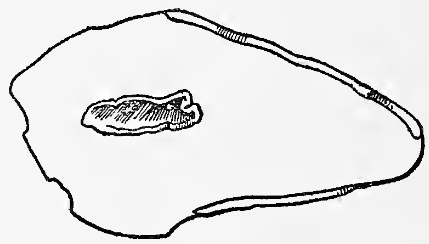
The upper molars are entirely different from the premolars both in shape and pattern, being, in the fresh or little worn state, elongate antero-posteriorly and narrow transversely and having an incompletely lozenge-shaped masticating surface. The angle between the anterior and external walls is quite acute and overlaps and projects prominently external to the tooth in front, giving to the molars the appearance of being set *en échelon*, while the outer faces of the premolars all lie in nearly the same vertical plane. The relative proportions of the three molars and the shape of their crowns change much with age and wear. When first brought into use, $m^{\underline{3}}$ appears to be much smaller than $m^{\underline{2}}$, which, in turn, is considerably larger than $m^{\underline{1}}$, but, as $m^{\underline{3}}$ greatly enlarges in antero-posterior diameter toward the base, this tooth becomes both relatively and absolutely

Fig. 17.



Nesodon imbricatus: Last upper molar ($m^{\underline{3}}$) of the right side, much worn, external view, $\times\frac{1}{1}$. E mel band white, dentine dark.

Fig. 18.



The same, crown view, $\times\frac{1}{1}$. Enamel bands with double contour.

larger with advancing age, until it is much the largest of all the grinding teeth, though in very old animals, when $m^{\underline{3}}$ begins to develop roots, the crown grows smaller toward the base and diminishes in size with abrasion. The external wall in the molars shows no division into lobes and is quite smooth, but there is reason to think that the posterior lobe is considerably larger than the anterior.

The enamel does not cover the entire crown, but is restricted to vertical bands, the extent of which varies in the different teeth and also changes with the degree of abrasion. In nearly all of the grinding teeth the enamel covers the external wall and is reflected over upon the anterior and posterior faces, but covers them only partially. On the inner side the band of enamel is narrower. The much abraded m^3, shown in Text-figs. 17, 18, has the posterior half of the crown bare of enamel and in $m_{\overline{2}}$ and $m_{\overline{3}}$ there is none on the inner side.

In the unworn condition, the essential pattern of the molars may be readily made out, but the homologies of some of the elements are far from satisfactory determination. From the external wall run two principal transverse crests, of which the anterior one forms the front wall of the crown and the posterior one arises about midway in the fore-and-aft length of the outer wall. These two crests are separated by a broad valley, which narrows upward along the inner face of the tooth, until the two crests meet and coalesce, closing the entrance to the valley. From the external wall, nearly half-way between the two transverse crests, arises a very prominent spur or crista, which divides the valley into two parts and is much thicker and more prominent than in the premolars. Another spur projects from the outer wall behind the posterior crest, which it joins, enclosing a deep pocket, partially open on the inner side. It might, however, be more accurate to regard this second spur as the posterior crest and to say that the valley is divided into three parts by two parallel spurs. There is a difference between various teeth in this respect; in some, the third of the transverse ridges appears to be the posterior crest, or metaloph, in others the fourth. Still a third spur arises much higher up on the inner face of the external wall and encloses a second posterior pocket.

With the progress of abrasion, the appearance of the molars becomes greatly changed; the cross-crests, which in early stages are nearly transverse, grow more and more oblique, the principal valley is closed on the inner side by the junction of the transverse crests, but long retains its Y-shape, owing to the prominence of the spur which divides it, while the two pockets are converted into lakes, of which the posterior, being larger and deeper, persists longer, but is eventually obliterated; in very old teeth it even disappears in $m^{\underline{3}}$. In the fully adult animal, with moderately worn teeth, there is a certain resemblance to the molar pattern of the perissodactyls, especially of the rhinoceroses, but the unworn teeth show that this resemblance is entirely superficial and without taxonomic significance.

B. Lower Jaw (Pls. XIII, XVIII, fig. 4).—As in the case of the upper incisors, those of the mandible greatly change their shape and appearance with age, though the changes are hardly so striking. All of the lower incisors are more or less strongly procumbent, but there is a considerable variation in the degree of procumbency among the individuals of the same species, though it never approximates the condition seen in *Toxodon.* When first erupted, $i_{\overline{1}}$ is a broad, much depressed, scalpriform tooth, contracting gradually to the base and of trihedral cross-section, with thickened medial border, which forms the base of a narrow triangle, and thinning toward the external border, the apex of the triangle. When the root has been formed and growth ceases, abrasion causes the tooth to become narrower and thicker and assume a more definitely trihedral form.

The second incisor is similar, but somewhat broader, and undergoes much the same changes of form. The third, on the other hand, grows throughout life from a persistent pulp and in the adult is a large and characteristic tusk, which bites behind the upper tusk and abrades its posterior surface, while $i_{\overline{3}}$ itself is obliquely truncated by the wear. In this stage of development the tooth points obliquely upward and forward and its principal diameter is antero-posterior; in shape, it is trihedral, with the base of the triangle formed by the antero-inferior border and the apex by the postero-superior. $I_{\overline{3}}$ is not erupted until after $i_{\overline{1}}$ and $\mathbf{i}_{\overline{2}}$ have been in use for some time, and at first appears as a thin, depressed and flattened tooth, with rounded cutting edge and smaller in every dimension than $i_{\overline{2}}$; its principal diameter is transverse. It is the persistent growth of the tusk-like incisors ($i^{\underline{2}}$ and $i_{\overline{3}}$) with the diminution of the others by abrasion, that so remarkably changes the appearance of the animal in passing from the youthful to the fully adult condition. In the stage in which $i_{\overline{3}}$ is just erupted, all the incisors are closely crowded together and are arranged in imbricating fashion, each tooth being extensively overlapped by the one external to it. In older stages this overlapping is much reduced, partly by the growth of the jaw and widening of the symphysis, partly by the narrowing of $i_{\overline{1}}$ and $_{\overline{2}}$, as they are worn down.

The canine is a small tooth, of little or no functional importance, which is inserted somewhat internal to $i_{\overline{3}}$ and is usually in contact with the first premolar; it has a narrow, compressed crown, with irregularly rounded, trenchant edge, convex on both internal and external sides, except that there is a shallow depression on the anterior portion of the inner surface.

The first premolar is a small, single-rooted tooth, with compressed-conical crown, but is complicated by a narrow valley on the posterior side, enclosed between two ridges which run down from the apex of the crown. The remaining lower premolars ($p_{\overline{2}}$, $_{\overline{3}}$, $_{\overline{4}}$) have essentially the pattern of the molars, with some differences, but develop roots at a much earlier stage and therefore have less decidedly hypsodont crowns. On the external side is a vertical groove, running down to the base of the crown and dividing it into two lobes, which are of crescentic form, with valleys on the inner side, giving the bicrescentic pattern so very frequent among primitive ungulates of many different groups. These internal valleys, however, are shallow and have but small vertical extension and are soon obliterated by wear. The second premolar, the simplest of the last three, has imperfectly formed crescents, especially the anterior one, and there is no spur, or pillar, in the posterior crescent. On the external face, the groove is broad and open and the two lobes are of nearly equal size. In the third premolar the external valley is a narrow groove, and the posterior lobe is distinctly larger than the anterior; the posterior horn of the anterior crescent projects obliquely backward as a spur and encloses a deep fossa with a prominent spur in the valley of the posterior crescent, and there is also a deep pit in the posterior valley. At a very early stage of wear, even before the eruption of $p_{\overline{4}}$, the inner opening of both these pits is obliterated and the pits are converted into small enamel lakes. The fourth premolar is like the third, but the posterior lobe exceeds the anterior in size to a greater degree, though much less than in the molars.

The lower molars increase progressively in size from $m_{\overline{1}}$ to $m_{\overline{3}}$, the predominance of the latter growing more marked with age, as in the case of the corresponding upper tooth, but even more strikingly. These teeth are all decidedly hypsodont and do not form roots until the animal is beginning to grow old. They have the bicrescentic pattern already described in the premolars, but the difference in size between the two lobes is much greater than in the premolars, the posterior crescent being far larger than the anterior, and the disproportion attains its maximum in $m_{\overline{3}}$. The valleys on the inner side of the crescents have a much greater vertical extent than in the premolars and the posterior valley much more than the anterior. The spur in the posterior valley is separated by a deep cleft from the hinder horn of the anterior crescent and is itself marked by a deep pit and there is a similar, but larger and deeper, pit in the floor of the posterior valley. At a certain stage in the abrasion of each molar, but not more than one at the same time, there are three enamel-lakes in the masticating surface; of these, the anterior one is formed by the isolation of the slit between the posterior horn of the anterior crescent and the spur of the posterior valley, the second by the fossa in that spur itself, and the third by the pit in the floor of the posterior valley. The small differences of structure between the molars and premolars thus become clear, only when several stages of growth and abrasion are available for comparison. The last molar ($m_{\overline{3}}$) is remarkable for the great antero-posterior extension and transverse narrowness of the hinder lobe. As the posterior border of the tooth slopes strongly backward and downward, the antero-posterior length of the crown increases as the tooth is worn down and begins to decrease only in old individuals.

Milk Dentition (Pls. XVII, fig. 1; XVIII, fig. 6; XIX, figs. 1–3, 7–8; XXI, figs. 1–2).—This temporary series of teeth is complete, all of the antemolars having predecessors in it, and there are some striking differences between the corresponding teeth of the two series, especially among the incisors, where the absence of tusks from the milk-teeth makes a great difference in the appearance of the skull and jaws, a difference which has led to the creation of many synonyms.

A. Upper Jaw.—The first incisor ($di^{\underline{1}}$) is much the largest of the series and, while still quite unworn, considerably resembles the permanent $i^{\underline{1}}$, but is, of course, actually smaller and proportionally thinner antero-posteriorly. When the root has been formed and the crown considerably worn, the appearance of the tooth is much changed, as it then has a low and very broad crown, contracting abruptly into the long and slender root. The second incisor ($di^{\underline{2}}$) is not placed in the same transverse line with $di^{\underline{1}}$, as are $i^{\underline{1}}$ and $i^{\underline{2}}$, but behind it and in line with the cheek-teeth. It is at first much smaller than $di^{\underline{1}}$ and of quite a different shape, being trihedral with rounded angles, except the postero-external one, which is a sharp ridge. In the more advanced and rooted stage the crown has become much broader, resembling that of $di^{\underline{1}}$, but smaller. The third incisor ($di^{\underline{3}}$) is the smallest of the series and has a simple, laterally compressed crown, the principal diameter of which is antero-posterior. The canine resembles $di^{\underline{3}}$ in form, but is somewhat larger; the temporary incisors and canine all have a shallow enamel-pit, or mark, on the cutting surface, but this is soon obliterated by wear.

The milk-premolars are, generally speaking, molariform, with some differences, especially in the anterior ones. The first ($dp^{\underline{1}}$) is so early shed and replaced, that it is difficult to find examples of it and I have seen no unworn specimens. As ordinarily found, it has a small subquadrate crown, with two external lobes, and an enamel-lake on the grinding surface, the remnant of the internal valley. The second ($dp^{\underline{2}}$) is much larger in both diameters and has two equal external lobes, each with a prominent median rib. The valley is T-shaped, directed longitudinally, with a narrow, slit-like opening on the inner side; three small spurs invade the valley, two from the posterior and one from the external wall. Posterior to the main valley is a fossette, with three small, circular pits in its floor, which, on abrasion, give rise to three minute lakes, a character of the permanent premolars. The special peculiarity of this tooth, in addition to the presence of the posterior fossette and its pits, is the large size and anterior prolongation of the postero-internal cusp (tetartocone), which extends forward almost to a contact with the antero-internal (deuterocone).

The third milk-premolar ($dp^{\underline{3}}$) is still larger than $dp^{\underline{2}}$, especially in the antero-posterior diameter, and is almost exactly like a molar, except for the presence of a prominent median rib on the antero-external lobe. The fourth ($dp^{\underline{4}}$) is the largest of the temporary series and, like $dp^{\underline{3}}$, has a median rib on the antero-external lobe, but it is less prominent; otherwise it is like a molar. $Dp^{\underline{3}}$ and $^{\underline{4}}$ are set *en échelon*, like the true molars, the antero-external angle of each overlapping the preceding tooth.

B. Lower Jaw.—The incisors are broad, scalpriform teeth, which increase in size from $di_{\overline{1}}$ to $di_{\overline{3}}$ and, when freshly erupted, with a median ridge on the postero-superior face; when worn and rooted, $di_{\overline{1}}$ has considerable resemblance to a human incisor. These teeth are thin and antero-posteriorly compressed and $di_{\overline{1}}$ and $_{\overline{2}}$ are much less distinctly trihedral than their permanent successors: $di_{\overline{3}}$ does not become a tusk, but develops a root and ceases growth very early, and is abraded at the tip like the other incisors, not obliquely truncated as is $i_{\overline{3}}$. All the milk-incisors are somewhat procumbent, but less decidedly so than the permanent ones, and each one at first extensively overlaps the tooth in front of and internal to it, but in older stages this overlapping is much reduced, as the crowns are narrowed by wear. The canine is in close juxtaposition to $di_{\overline{3}}$, which it somewhat resembles in form, but is very much smaller.

Owing to the very early replacement of $dp_{\overline{1}}$ by $p_{\overline{1}}$, I have seen no example of the former. The second milk-premolar resembles $p_{\overline{2}}$, but in *N. imbricatus* a small separate pillar stands at the entrance of the anterior valley and a spur from the anterior crescent almost closes the posterior valley, which, when well-worn, becomes a lake in the grinding surface of the posterior crescent. The third and fourth of the series ($dp_{\overline{3}}$ and $_{\overline{4}}$) resemble molars except in their lower crowns and the earlier formation of roots.

Pre-lacteal Dentition.—Ameghino has announced ('02, 80; '04, 10) the exceedingly surprising discovery that in *Nesodon* and *Adinotherium* a third functional dentition, the pre-lacteal, is present. Traces of such a dentition had already been observed in the embryos of certain mammals, but no case was known in which these teeth were fully developed and functional, and to find them in so advanced and specialized a group as the toxodonts and at so late a geological date as the Santa Cruz epoch, is indeed most extraordinary. According to Ameghino's latest account: "L'avant-première série des Nésodontidés est constituée par trois incisives, une canine et trois molaires de chaque côté, qui sont remplacées par les mêmes dents de la première série" ('04, 11). "Chez *Nesodon* et *Adinotherium* la denture définitive comprend le nombre complet de sept molaires, dont les quatres antérieures sont des remplaçantes et les trois dernières des persistantes de la première série. La première série est constituée par les quatre caduques antérieures et les trois persistantes postériures, les sept molaires, restant en fonction en même temps durant une certaine période de la vie de ces animaux. A un âge moins avancé, avant d'entrer en fonction la première persistante, la série n'était constituée que par les quatre caduques. Les caduques, à leur tour, ont été les remplacantes d'une série antérieure, l'avant-première série qui ne comprenait que trois molaires correspondantes à la première, deuxième et troisième molaires. Donc, les caduques 1 à 3 étaient précédées par les avant-caduques correspondantes mais la quatrième caduque n'était pas précédée d'une avant-caduque" (l. c., pp. 14–15).

To this description I can add but little, as the material in the Princeton and New York collections exhibits hardly any remnant of the pre-lacteal series, but in one specimen each of *Nesodon* and *Adinotherium* (see text-fig. 39, p. 202) the pre-lacteal upper tusk has persisted alongside of the permanent i^2 and is much smaller than di^2 and of entirely different shape, being a cylindrical, quill-like tooth. During my visit to La Plata, however, I was convinced by the study of the materials in Dr. Ameghino's collection that, so far at least as the mandibular incisors and canines are concerned, there were actually functional teeth of the pre-lacteal series in *Nesodon*. One mandible (Pl. XIX, fig. 6), in particular, was especially instructive, as it showed the milk-incisors and canines in process of eruption and entirely unworn, with the roots of the pre-lacteal series still in place. Unfortunately, the photographs which I made of this and other specimens in a corresponding stage of development are not satisfactory for reproduction, but apparently the same individual is figured by Ameghino (op. cit., fig. 1, p. 12).

This remarkable phenomenon loses something of its entirely exceptional character through Ameghino's recently published observation of a pre-lacteal premolar in the tapir.

The succession of the teeth in *Nesodon* may be followed out in much detail. The first of the permanent teeth to appear is m1, in both jaws, which becomes functional before any of the milk-teeth are shed. This is followed by p1, dp1 being shed so early that it is rare to find an individual retaining it and, in some cases at least, the replacement takes place before m1 comes into use. Next follows m2 and then di1 is shed and replaced by i1, while di2 still continues in function. The second and third incisors, the canines, second and third premolars are replaced in rapid succession and before the last molar is erupted; m3 then comes into use, and, last of all, dp4 is replaced.

This account, which is drawn chiefly from the material in the Princeton collection, does not exactly agree with the description given by Ameghino ('94^b, 233) according to which p1 is not erupted until after m3 has appeared. No doubt, there is some individual variability in the order of succession.

Ameghino ('91, 357 ff.; '94^b, 231–234) has summed up the individual changes in the dentition of *Nesodon*, dividing them into twelve stages, which are here reproduced in abbreviated form, with the addition of a stage for the prelacteal dentition.

Stage A.—Prelacteal dentition of three incisors, a canine and three premolars, $i\frac{2}{}$ small, simple and styliform.

Stage 1.—Milk-dentition of di$\frac{3}{3}$; dc$\frac{1}{1}$; dp$\frac{4}{4}$. The dp are the first teeth erupted and the last are the external incisors and canines; all the teeth in continuous series.

Stage 2.—Milk-teeth in function and no permanent tooth yet visible. In the mandible the four internal incisors are of equal size and the two external ones a little larger, and all the teeth have open roots. The two rami of the mandible are in contact, but have not yet begun to ankylose.

Stage 3.—M$\frac{1}{1}$ in function, but m$\frac{2}{2}$ not visible. The anterior part of the skull is elongated, producing short diastemata on each side of the upper canine, and the first upper incisors, diminished by wear, are separated by a space. Lower teeth still in continuous series; roots are closed in di$_{\overline{1}}$–dp$_{\overline{1}}$ and roots begin to appear in dp$_{\overline{2}}$ and $_{\overline{3}}$: the germs of most of the permanent ante-molars are clearly visible, the two rami of the mandible are ankylosed, and the sagittal crest begins to appear.

Stage 4.—M$\frac{1}{1}$ considerably worn and m$\frac{2}{2}$ coming into use; milk-teeth much abraded and dp$\frac{3}{3}$ and $\frac{4}{4}$ with four separate roots; germs of the permanent incisors well developed and visible in the sides of the jaws. Germs of p$\frac{1}{1}$ quite large and placed above dp$^{\underline{1}}$ and below dp$_{\overline{1}}$. The masticating surface of all the teeth in use has the appearance of that belonging to an adult animal. The mandible described and figured by Owen as *N. imbricatus* is in this stage of dental development and was mistakenly believed by him to be an adult individual.

Stage 5.—M$\frac{2}{2}$ well abraded; none of the milk-teeth yet replaced. Germ of m$^{\underline{3}}$ small and placed in the upper part of the maxillary against the base of m$^{\underline{2}}$; that of m$_{\overline{3}}$, also small, is placed in the base of the ascending ramus; germs of p$\frac{4}{4}$ very small and hardly visible. This stage corresponds to *Nesodon* as defined by Mercerat.

Stage 6.—Germs of m$\frac{3}{3}$ quite large, but not yet erupted; replacement of incisors begins: germs of p$\frac{4}{4}$ very small.

Stage 7.—M$\frac{3}{3}$ erupted, but not yet worn; germs of p$\frac{4}{4}$ larger, dc, dp$\frac{1}{1}$–$\frac{3}{3}$ shed and replaced.

Stage 8.—M$\frac{3}{3}$ enters into use; dp$\frac{4}{4}$ replaced by p$\frac{4}{4}$.

Stage 9.—All the permanent cheek-teeth in use and have open bases. I$^{\underline{1}}$ much broader and thicker than i$^{\underline{2}}$, which is thin and pointed and has its tip nearly on a level with that of i$^{\underline{1}}$. Cheek-teeth gradually increasing in size; m$^{\underline{3}}$ with relatively small grinding surface, and m$_{\overline{3}}$ but slightly larger than m$_{\overline{2}}$; upper molars with cross-section a parallelogram. This stage corresponds to *Adelphotherium* Mercerat.

Stage 10.—Animal has attained its full development. I^{1} has decreased in size by abrasion, while i^{2}, growing from a persistent pulp, is longer and much heavier than i^{1}. $M_{\overline{3}}$ is a little larger than $m_{\overline{2}}$, a much more marked difference than in the preceding stage. Upper molars decreased in antero-posterior diameter through abrasion and of more square shape; roots begin to appear on the molars and those of the premolars to close. Sagittal crest high and thin. This stage corresponds to the genus *Nesotherium* of Mercerat.

Stage 11.—This stage is well distinguished by the relatively enormous size of m^{3} in proportion to the other teeth; all the molars have the antero-posterior diameter reduced by abrasion and the upper molars have a cross-section of trapezium-shape; all the molars, except m^{3}, have well-formed roots; $m_{\overline{3}}$ has one long root, but open and undivided. Sagittal crest very high and compressed. This stage corresponds to the genus *Protoxodon* as defined by Mercerat.

Stage 12.—$M_{\overline{3}}$ is proportionally very large and the other teeth much smaller; at a still more advanced age m^{3} forms several roots.

The Pampean genus *Toxodon* has a dentition which may be described as that of *Nesodon* somewhat reduced in number and considerably simplified in pattern, but thoroughly hypsodont, all the teeth growing from persistent pulps. Lydekker's brief statement may be here quoted with advantage: "This genus . . . is characterized by a somewhat Rodent like dentition, in which all the teeth grow from persistent pulps, the normal dental formula in the adult being $i\frac{2}{3}$, $c\frac{0}{1}$, $p\frac{4}{3}$,* $m\frac{3}{3}$. The first upper premolar may, however, frequently be wanting in the adult, and occasionally the corresponding lower tooth is present. The upper molars are characterized by their height and decidedly triangular form, the middle lobe being but slightly developed and almost disappearing in an advanced state of wear, while the main cleft on the inner side continues to the base of the crown even in the most advanced state of wear and there is no posterior valley. The lower molars are very narrow, with three internal folds, the third tooth of this series being much larger than either of the others. In both jaws the premolars are much simpler than the molars. Both pairs of upper incisors are scalpriform, and while the first and second

* Lydekker has $\frac{3}{4}$, an obvious misprint, as is shown by the statement immediately following.

lower incisors are flattened and proclivous, the third is triangular and raised above the level of the other two. All three are however worn to nearly the same transverse line by the upper teeth and their alveoli are nearly in the plane of the inferior border of the jaw" ('93, 13, 14).

While in general character the dentition of *Toxodon* is thus of the same type as that of *Nesodon*, there are several significant differences which should be emphasized. (1) The teeth are all conspicuously hypsodont and grow throughout life. (2) I^1 is thin antero-posteriorly, broad and scalpriform, while i^2 is more trihedral and tusk-like. There is a marked difference in the relative size of these teeth in the different species; in *T. platensis*, for example, i^2 is much longer and more tusk-like than i^1, but in *T. burmeisteri* these proportions are reversed. (3) The third upper incisor and the canine have disappeared, and there is a long diastema between the incisors and the cheek-teeth. (4) The lower incisors are much more strongly procumbent than in *Nesodon*, pointing almost directly forward and with their inferior faces in nearly the same plane as the ventral side of the symphysis. $I_{\overline{1}}$ and $_{\overline{2}}$ are much broader and more flattened than in *Nesodon*, but $i_{\overline{3}}$ retains something of its trihedral and tusk-like form, though worn to the same transverse line as the others. (5) The premolars are reduced in number and in relative size and importance, and are even less molariform than in *Nesodon*. (6) The upper molars are more triangular and have a much simpler pattern than those of *Nesodon;* the posterior valley has disappeared and only the principal spur, which projects into the main valley from the external wall, is retained. In the genus *Xotodon* even this spur has been lost.

The Skull of *Nesodon* (Pls. XIII–XV; XVIII, fig. 1) is remarkable in many ways and strikingly different from the typical ungulate skull, but closely similar to that of *Toxodon;* its most characteristic peculiarity is in the remarkable structure of the auditory region, which Roth ('03) was the first to point out and has so strongly emphasized. The upper profile of the skull may be nearly straight from the occiput to the end of the nasals, or may rise quite steeply from the forehead to the occiput, a difference which does not appear to be of specific value. The orbits are well forward, the anterior rim being in advance of the middle of the skull, making the cranial region considerably longer than the facial, but the brain-case proper is short, narrow and of small capacity. The great development and spread of the zygomatic arches give to the cranium a width which is deceptive as to its actual capacity. The sagittal crest is thin and sharp and is often divided by a deep, narrow groove into two closely approximated parallel ridges. Though much longer proportionately than in *Toxodon*, the crest is yet quite short and divides anteriorly into the supraciliary ridges, which die away upon the forehead without reaching the orbital border.

The orbit has a more inferior, as well as a more anterior, position than in *Toxodon*, the roof not forming a protuberance above the level of the forehead. The facial region is short, but very deep dorso-ventrally, especially when the mandible is in position; in fact, the whole skull is curiously short, deep and massive in proportion to the size of the animal. The anterior nares are rather small and terminal in position, presenting almost directly forward, though with a slight inclination upward and backward, one of the most marked differences from the skull of *Toxodon*.

The posterior surface of the skull, which can hardly, with propriety, be called the occiput, as it is so largely made up of elements which are not occipital, is low, very broad and almost D-shaped, with lateral and superior borders describing a continuous and nearly semicircular curve. The occiput proper is of quite a different shape; it is very broad at the base, forming here nearly the whole width of the posterior surface of the skull, but above the foramen magnum it is sharply constricted, expanding again, though but moderately, to the summit of the inion. The large area on each side which is thus left open, is filled by the element which Roth calls ('03) the pars mastoidea of the petrosal, but for reasons which will be explained in a subsequent section, is here regarded as being more probably the post-tympanic portion of the squamosal; the relations of the parts are apparently much as in the pig.

The upper view of the skull (Pl. XIV) is very peculiar. From this point of view the outline is that of a somewhat irregular, truncated triangle, with the occiput forming the base, though the greatest width is over the zygomatic arches. The downward and backward slope of the occipital surface makes much of that surface visible and even the sessile condyles are prominently conspicuous. A highly characteristic feature is the great prominence of the auditory meatus and post-tympanic process at the supero-external angles of the occiput, and the elevated position of the zygomatic arches where their dorsal borders pass into the lambdoidal crest.

The brain-case is very narrow, making the temporal openings very large, giving the skull an almost reptilian appearance and allowing the pterygoid processes of the alisphenoids to be plainly visible. The forehead broadens greatly and abruptly in front of the postorbital constriction, and the face narrows very gradually forward from the orbits, though widening again very slightly at the muzzle. Another very characteristic feature of this skull is the manner in which the facial region narrows dorsally, the narrow and convex nasals forming the whole upper surface in front of the orbits. The solid and massive premaxillaries project for a considerable distance in front of the nasals, but much less than in *Toxodon*, in which the nasals are greatly reduced in length.

The base-view (Pl. XV) of course corresponds closely with the upper view in the form of the outline, but shows somewhat more distinctly that the widening of the muzzle, which is very slight, and, indeed, hardly perceptible, begins at the anterior end of the maxillaries, at the insertion of the canines. This widening is very much greater and more abrupt in *Toxodon*, and even in the Santa Cruz genus *Adinotherium* it is much more decided than in *Nesodon*. This view also shows clearly the peculiar form of the posterior nares, the prominent lateral projection of the pterygoid processes of the alisphenoids and the great breadth of the auditory region, on each side, external to the paroccipital process. The mammillate tympanic bullæ appear unduly small, as their principal diameter is dorsoventral. The broken stylo-hyals are also visible, attached to the *anterior* side of the bullæ, a highly exceptional arrangement.

The basi-occipital is quite long and stout, though narrowing between the tympanic bullæ and expanding again behind them, and bears a moderately prominent median keel; it takes no part in the formation of the condyles, which are confined to the exoccipitals. The latter are very low and wide, but form relatively little of the occipital surface, except at the base, and having no crest. The foramen magnum is low and very broad, of transversly oval shape. The condyles also are low and broad, quite closely approximated ventrally, very widely separated dorsally. Though they are almost sessile, they project quite strongly backward, owing to the slope of the exoccipitals, and are fully visible when the skull is seen in side-view. Each exoccipital bears a very long paroccipital process which is heavy and trihedral proximally, becoming much more slender and rounded distally. The supra-occipital is very large and forms the greater part of the occiput proper; its dorsal border is a heavy and prominent crest, which is relatively short from side to side, as the supra-occipital does not expand greatly above the constriction of the exoccipitals. In the young skull the exposed surface of the supra-occipital is nearly plane, but in the adult animal it becomes quite deeply concave, in which stage the bone is very thick and massive, with cancellous interior, but without any distinct sinus.

The basisphenoid is also long, passing forward into the posterior nares and tapering anteriorly; near the middle of its course, on each side, is a massive projection for the attachment of the alisphenoid. Very little of the presphenoid is visible, as it is mostly covered and concealed by the pterygoids. The alisphenoid is very narrow antero-posteriorly, but has a very considerable dorso-ventral extent and sends down a long, narrow descending process, or pterygoid plate, which ends distally in a prominent knob. The limits of the orbitosphenoid are not distinctly shown in any skull that I have examined.

The parietals are relatively small and especially narrow, forming but little of the side-walls of the cranium; posteriorly, at the junction with the supraoccipital, they are very thick and massive, thinning forward, and have a diploëtic structure, but I have seen no sinus in them. For most of their length, they carry the sagittal crest, but anteriorly the ends diverge, to receive between them the posterior extensions of the frontals. The cranial cavity, as seen in a longitudinally bisected skull, is enclosed almost entirely by the occipitals, sphenoids, parietals and squamosals, the frontals being but little involved. The cerebral fossa is small and apparently does not extend back over the cerebellar fossa; the olfactory fossæ are surprisingly small in view of the otherwise primitive character of the brain. Nothing can be learned from the material at my disposal regarding the number and course of the cerebral convolutions.

The squamosals are very large, forming much the greater portion of the side-walls of the cranium and even part of the floor, where the bone is incurved internal to the glenoid cavity. This cavity is a saddle-shaped surface, narrow and convex antero-posteriorly, broad and slightly concave transversely; its outer end forms a prominent protuberance, much as in the horse, but larger and more conspicuous. Separated from the cavity by a notch, which is very broad externally and narrows inward, is the large and swollen-looking postglenoid process, which is filled with spongy bone, and, so far as I have observed, does not contain a sinus. This process is closely applied to a high thin plate of bone, which is the element usually called the mastoid portion of the periotic (the *protuberancia petrosa* of Roth) and is interposed between the postglenoid and the post-tympanic processes, an altogether exceptional position. The post-tympanic portion, or *pars Serrialis* is a very remarkable and anomalous structure; it is extensively exposed on the posterior surface of the skull, of which it makes up a large part, larger than in the Typotheria or the pig. Its dorsal portion is inflated and contains a large, oval cavity, lying above the long, tubular auditory meatus; at the antero-internal corner of this cavity is a small, tubular passage, which communicates with the cavity of the tympanic bulla through the inner end of the auditory meatus.

The surface exposure of the post-tympanic varies considerably with the age of the animal; in the very young skull it is relatively much less extensive and forms a smaller proportion of the posterior surface of the skull; along the base, or ventral side, of the occiput it is completely overlapped by the exoccipital and the paroccipital processes form the infero-external angles of the posterior surface, since, at this stage, there are no mastoid processes. In the adult skull, on the other hand, the post-tympanic is much increased in relative size and, along the base of the occiput, projects well externally to the exoccipital; the paroccipital processes are no longer at the infero-external angles of the occiput, the development of the mastoid processes displacing them from this position.

The periotic, or petrosal, is relatively large and of the usual dense, shining texture. The internal surface has a very small and shallow fossa for the flocculus of the cerebellum and from the anterior end is given off a blunt, inwardly projecting and recurved hook. The internal auditory meatus is large and conspicuous and deep within it may be seen the division into two canals for the seventh and eighth cranial nerves respectively. On the external face the periotic is concave and is closely applied, but not ankylosed, to the large, hollow capsule of the post-tympanic, which it partially encloses. The mastoid portion (as it is here called, without discussion of the general homologies of this element, the *protuberancia petrosa* of Roth) is, in the very young animal, very small and inconspicuous, for the postglenoid and post-tympanic processes are in contact distally and but very little of the mastoid is visible between them. As the skull grows, however, the mastoid portion increases rapidly, becoming a large plate in the adult, completely separating the postglenoid and post-tympanic processes and projecting freely below them, ending in a conspicuous, bluntly pointed mastoid process, of which there is no trace in the very young stage. Toward the mesial side it reaches and is closely applied to the tympanic bulla with which it may become fused.

The tympanic, in the very young skull, is a large, oval, thin-walled and moderately inflated bulla, with long axis directed antero-posteriorly, in striking contrast to the small, scale-like tympanic of the Litopterna. In the adult skull the bulla has a different form, being more mamillate in shape, with the principal diameter dorso-ventral, somewhat as in the pig, but not in such an exaggerated degree, and throughout life it remains hollow and free from cancellous bone. The external auditory meatus is a very long tube, only the outer end of which is visible in the intact skull, and which passes upward, outward and backward to a very elevated termination, which has nearly the same relative position as in *Sus*.

This auditory region of the skull is, in *Nesodon*, quite different in its details from that seen in the small Typotheria of the Santa Cruz. Disregarding the extraordinary specialization of this region in *Pachyrukhos*, the other and less extremely modified genera, such as *Hegetotherium* and *Protypotherium*, have a less extensively developed post-tympanic process, which occupies much less of the occipital surface and its cavity is filled with coarsely cancellous bone. The postglenoid and post-tympanic processes are more widely separated than in *Nesodon* and the space between them is filled by the tubular auditory meatus; the mastoid is not visible externally and there is, of course, no mastoid process.

The zygomatic process of the squamosal in *Nesodon* is moderately elongate, very deep dorso-ventrally, plate-like, thin and compressed laterally; its dorsal border is continuous with the lambdoidal crest and rises steeply upward and backward. The anterior end of the process is abruptly truncated and slightly convex, and forms little or none of the orbital boundary. The jugal is very large, especially in dorso-ventral diameter, but thin and laterally compressed; the posterior border is excavated to receive the rounded anterior end of the zygomatic process and it extends far back beneath the latter, but not reaching to the glenoid cavity, as it does in the Santa Cruz Typotheria. Anteriorly, it rests upon the zygomatic process of the maxillary, extending upward to a contact with the lachrymal and excluding the maxillary from the rim of the orbit, of which the jugal forms the whole inferior and most of the anterior border; it has no postorbital process, or even angulation. As a whole, the zygomatic arch is long and heavy, though laterally compressed, somewhat as in the rhinoceros, and curves out boldly from the side of the skull, enclosing a large temporal opening and forming a very high external border for the temporal fossa. A characteristic feature of the arch is the steep rise upward and backward to the junction with the occipital crest.

The lachrymal, though not very large, is a very conspicuous bone, of elongate oval shape, ending above and below in a point. It forms the dorsal moiety of the anterior border of the orbit and bears a heavy, prominent spine; the foramen is within the rim of the orbit.

The frontals are short antero-posteriorly, but broad; their hinder ends are sharply contracted into narrow processes, which pass between the divergent anterior ends of the parietals and bear low, inconspicuous temporal ridges, which die away before reaching the orbital border. The forehead is broad and is usually plane longitudinally, but may have a short, abrupt descent over the orbits (see Lydekker, '93, Pl. XIV, fig. 1). The postorbital processes are prominent and the frontals extend well outward to form a roof over the deeply set orbits. Anteriorly, the frontals usually have short, triangular nasal processes between the hinder ends of the nasal bones, but these processes may be absent (*N. marmoratus*). At the postorbital constriction a cross-section shows that the frontals are very thick and filled with a dense mass of cancellous bone, but anteriorly sinuses appear, extending over the orbits, though these sinuses are comparatively small and cause no protuberance of the forehead.

The nasals are long, quite broad and strongly convex from side to side, curving downward laterally, so that the suture with the maxillary and premaxillary is well below the upper contour. In the most abundant species, *N. imbricatus*, the nasals diverge posteriorly and their hinder ends are separated by the triangular processes of the frontals, each nasal terminating in a sharp point. In the much less common *N. marmoratus*, admitting that to be a distinct species, the nasals are in contact throughout their length and their hinder ends together form a convex curve, which is received into a corresponding emargination of the frontals. Anteriorly, the nasals have broad, regularly rounded tips and project for a very short distance in advance of the premaxillaries.

The premaxillaries are relatively very large; the ascending ramus is a broad, thin plate, which forms an appreciable portion of the face and has a suture with the nasal of 4–6 cm. in length. Thus, the nasals and premaxillaries completely enclose the anterior nares and exclude the maxillaries. The narial opening is large, especially in dorso-ventral diameter, of cordate shape and presenting almost directly forward, though having a slight obliquity, due to the inclination of the ascending rami. The two premaxillæ are in contact in quite a long median symphysis, but, so far as I have been able to observe, even in aged skulls, they are never coössified. At the antero-superior angle of this symphysis each bone has a blunt, rugose prominence of no great length or height, though together they form a conspicuous keel, which is much larger in *Toxodon*. The alveolar portion is broad and deep, to carry the great incisors, and the palatine processes are also large, especially in length, narrowing behind to triangular plates, which separate the palatine processes of the maxillaries. The incisive foramina, which are relatively very small, are completely separated from each other by the heavy spines.

The maxillaries are very large and make up the greater part of the facial region; the pre-orbital portion has great dorso-ventral depth and slopes upward and inward toward the median line, thus causing the dorsal narrowing of the face, which is so striking and characteristic a feature of this skull. In undistorted specimens this facial portion, above the alveolar process, is often quite deeply concave, especially in the antero-posterior direction. The alveolar portion is also very large, in correlation with the great size of the teeth, and forms a large mass beneath the orbit; posteriorly, this mass ends in a rounded, prominent border, which projects freely and is not continued backward by the palatines. The infraorbital canal is very short and its anterior opening is placed near the orbit over $m^{\underline{1}}$. The palatine processes of the maxillaries are long and rather narrow, though broadening posteriorly, and deeply concave, following the remarkable curvature of the grinding teeth.

The palatines are short and take but little share in forming the bony palate, hardly extending to the line of $m^{\underline{2}}$; they are composed of two quite distinct portions, a broad anterior part, which forms the hindmost region of the bony palate, and the part which encloses the posterior nares. The two portions are demarcated by a very sharp constriction a little behind the last molars. On the sides of the posterior nares the palatines have unusually broad ventral surfaces and each ends behind in a prominent, everted and rugose knob, part of which is formed by the pterygoid process of the alisphenoid. The posterior border of the palatines is also very broad and is deeply impressed by the large pterygoid fossa. The pterygoids are narrow slips of bone, which proximally almost conceal the presphenoid and end distally in recurved and very prominent hamular processes. The posterior nares, which are entirely behind the teeth, form a small opening, remarkably so in proportion to the size of the skull.

The whole posterior palatine region is highly characteristic in *Nesodon* and differs in several respects from that seen in the Santa Cruz Typotheria, as figured by Sinclair. (Cf. this volume, Pls. I, fig. 3; III, fig. 3; V, fig. 21; VIII, fig. 18; X, fig. 3.) In the latter the palatines take a much larger share in the formation of the bony palate, to a degree which varies in the different genera, and the posterior nares are displaced farther backward by the production of the median suture between the two palatines, so that the opening presents more backward and less ventrally.

The hard palate is thus one of the most curious features in the skull of *Nesodon;* it is broadest behind, narrowing forward to $p^{\underline{1}}$, thence widening slightly to the space behind the anterior incisors ($i^{\underline{1}}$, $^{\underline{2}}$), and is remarkably concave transversely, which is chiefly due to the great prominence of the alveolar processes of the maxillaries and is much more strongly marked in the adult than in the young animal with brachyodont milk-teeth.

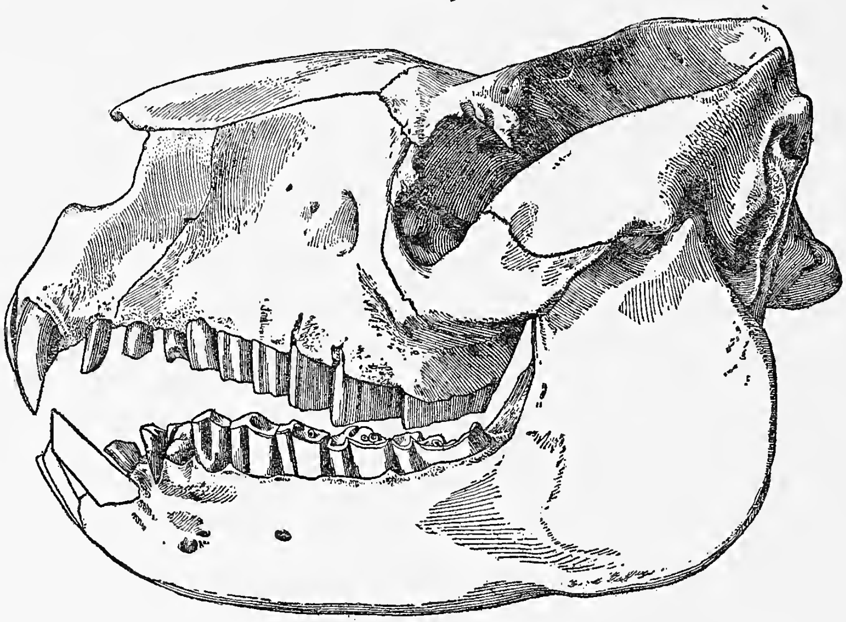
The cranial foramina are, in several respects, like those of the suillines and also those of the Litopterna. (See Vol. VII, p. 3.) There is a large and conspicuous sphenorbital foramen, a small optic foramen and a large foramen lacerum anterius, the two latter in close juxtaposition, but no alisphenoid canal, foramen ovale or rotundum. There is thus no opening visible between the foramen lacerum anterius and the foramen lacerum medium, the latter a very large opening, which no doubt transmitted both the second and third branches of the trigeminal nerve, as well as the eustachian canal and the internal carotid canal; there is no other carotid canal on the inner side of the tympanic bulla, such as occurs in the Santa Cruz Typotheria. The foramen lacerum posterius is likewise a large and irregular opening and the stylo-mastoid foramen is of unusual size. The glenoid foramen is a conspicuous opening between the postglenoid process and the mastoid portion of the periotic. The condylar foramen, which is rather small, is placed near the foramen lacerum posterius.

The mandible is large and heavy. The ascending ramus is high and rather broad, with regularly curved and rounded angle, the free border of which is not thickened, as it is in the rhinoceroses, nor yet especially thin, as it is in the tapirs, and is quite flat on both sides. The condyle is sessile, broad transversely, narrow antero-posteriorly and convex in both directions; on the posterior face of the internal half is a well-defined articular surface for the postglenoid process and from the inner end depends a broad, hook-like plate of bone, a very exceptional feature, the purpose of which is not obvious. The sigmoid notch is shallow and the coronoid process quite low, but yet rises above the level of the condyle; the masseteric fossa is very obscurely marked. On the anterior border of the ascending ramus the linea obliqua externa is not well defined, but the internal one is very prominent distally and encloses a deep fossa behind $m_{\overline{3}}$. The horizontal ramus is long, deep dorso-ventrally and stout, though laterally compressed. In the very young animal the two rami are separate, but they early become indistinguishably fused in a long, deeply concave symphysis, which extends back nearly to the middle of $p_{\overline{4}}$. The chin is narrow, rounded and inclined, rising steeply forward from the posterior end of the symphysis and thus very different from the flattened, procumbent chin of *Toxodon*. There are two mental foramina, one beneath $p_{\overline{4}}$ and the other under $m_{\overline{1}}$, while the inferior dental foramen has quite a low position.

Little of the *hyoid apparatus* is preserved in connection with any of the skulls, but enough to show some very unusual features. The hyoid is attached to the *antero-internal* corner of the tympanic bulla. How very exceptional this arrangement is, may be made clear by the statement of Flower ('85, 144), who says, in speaking of the tympano-hyal: "it is always in relation to the hinder edge of the tympanic bone, generally more or less surrounded by it." In *Nesodon*, on the contrary, a style-like bone is attached to the anterior edge and, in the adult, is ankylosed with it and seems to represent the coalesced tympano- and stylo-hyals. In one very young skull, with the milk-dentition still in use, a very small, cylindrical tympano-hyal is firmly attached to the antero-internal corner of the bulla, but is so extremely short that it cannot possibly represent the long and prominent bone, which is unfortunately broken in all of the adult skulls. (See Pl. XV.) In the young skull mentioned there is also a separate stylo-hyal, which is long, slender, laterally compressed and moderately curved, with convexity behind; the proximal end is simple, without expansion or process, but on the posterior side, near the distal end, is a low, roughened ridge. No other hyoid element has yet been found.

It is not practicable for me to make any detailed comparison between the skulls of *Nesodon* and *Toxodon*, for of the latter only a cast is at my

Fig. 19.

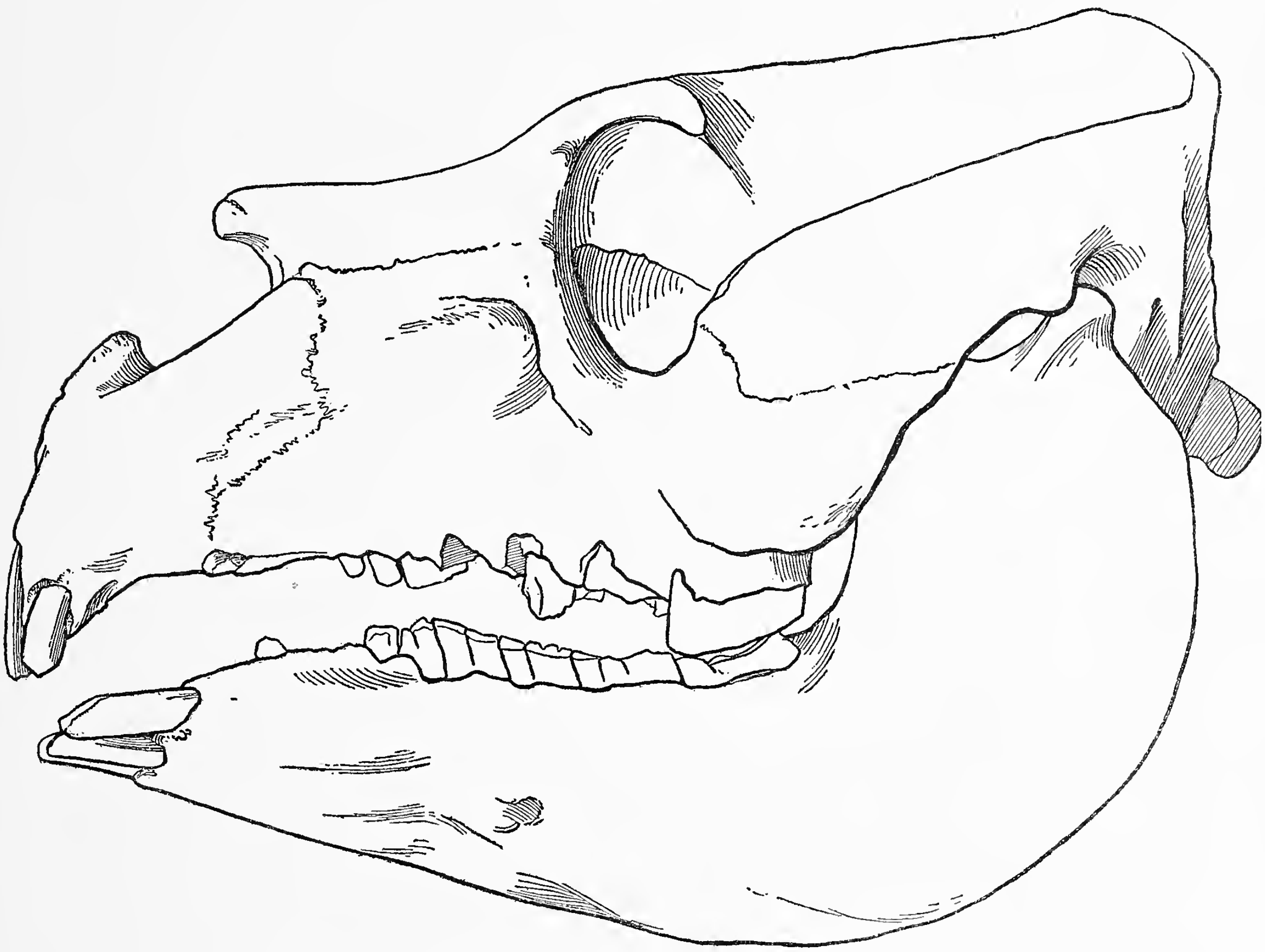


Nesodon conspurcatus?: Skull, left side, × ¼. American Museum of Natural History.

disposal, and in this cast but few of the sutures are shown. Nevertheless, instructive results may be obtained from a general comparison. The skull of *Toxodon* is manifestly of the same type as that of *Nesodon*, but has undergone considerable modification and exhibits many differences. The pre-orbital or facial region of the skull is somewhat longer in proportion to the cranial region than in the Santa Cruz genus. The occiput is much higher in relation to its width, and is more deeply and uniformly concave, with the lambdoid crest projecting prominently backward; the foramen magnum is less depressed and the occipital condyles are much more widely separated, especially ventrally. The auditory region is very different in being less specialized and more as in *Protypotherium* than in *Nesodon* and more like the young skull than the adult of the latter genus, but in this respect there is considerable variation in the Pampean genus.

The tubular auditory meatus, the aperture of which has the same elevated position as in *Nesodon*, is much more extensively exposed between the postglenoid and post-tympanic processes than in the latter. No part of the mastoid portion of the periotic would appear to be visible and, of

FIG. 20.



Toxodon burmeisteri: Skull, left side, × $\frac{1}{4}$. La Plata Museum.

course, there is no mastoid process, the paroccipital processes forming the infero-external angles of the occipital surface, as in *Protypotherium* and the immature *Nesodon*.

The sagittal crest is much shorter and widens very gradually into the broad forehead, which has a sudden, though short, descent to the nasals; The orbits have a more elevated position, their roof rising a little above the level of the forehead. The postorbital processes of the frontals are not so prominent, but there is a distinct postorbital angulation of the jugals. The zygomatic arches are of similar plate-like and laterally compressed character, but have a relatively greater dorso-ventral depth, especially the jugal portion; posteriorly, the arches do not rise so high upon the lambdoid crest.

The nasals are much shorter, giving an entirely different shape to the anterior nares, which are no longer terminal, but very oblique, presenting dorsally as much as forward. The two premaxillæ are firmly coössified and the dorsal portion of their symphysis is raised into a prominent, massive and rugose crest, which is much longer and more conspicuous than in *Nesodon*. The muzzle broadens anteriorly very much more strongly than in the latter, but the face, especially the edentulous part, is proportionately shallower dorso-ventrally. The hard palate is very much alike in the two genera, but in *Toxodon* it is narrower at the facial constriction and widens more posteriorly, and anteriorly much more. The posterior nares are placed farther back, as the palatines remain in contact in the median line for a greater distance.

The mandible has a very different appearance in the two genera. In *Toxodon* the symphysis is much longer, extending back as far as $m_{\overline{2}}$ and, though deeply concave, is shallower anteriorly and has no anterior wall, owing to the complete procumbency of the incisors. The jaw narrows forward to $p_{\overline{4}}$, and thence expands strongly, becoming very broad at the incisive alveolus, and there is no rise at the chin, the whole anterior region of the mandible being broad, depressed and with nearly flat ventral surface. The ascending ramus is very high and rather narrow and the curve of the angle rises more than in *Nesodon*, without the downward curvature seen in the latter. The sigmoid notch is almost obsolete and the coronoid low and weak, not rising to the level of the condyle. The latter projects internally more than in *Nesodon*, but has no such dependent, plate-like process from the inner end.

Vertebral Column, Ribs and Sternum (Pl. XII, fig. 2).—The vertebral formula is not definitely known, since no individual has yet been obtained with completely preserved back-bone. A careful examination of the available material leads me to the conclusion that the formula was nearly the same as in *Toxodon*, viz., C. 7, Th. 16–17, L. 4–5, though there is some reason to think that the lumbar region was relatively longer than in the Pampean genus, at least in certain individuals.

The neck is short and heavy, considerably shorter than the skull. The atlas (Pl. XXIV, figs. 5, 6) is very short antero-posteriorly, but extremely wide transversely, owing to the great development of the transverse processes, and quite depressed dorso-ventrally, and even aside from the processes, the width is the greatest of the three diameters. The anterior cotyles are very broad, deeply concave, quite widely separated ventrally and even more so dorsally. The neural arch is stout and shows only a moderate transverse convexity and, on each side, it bears a large and deep depression, the inner end of which opens into the foramen for the first spinal nerve and extends to the atlanteo-diapophysial foramen for the ventral branch of the same nerve. The neural spine is quite prominent, thick and rugose. The inferior arch is very like the neural, but smoother and less convex, and on the hinder border has a hypapophysis which varies much in size, though the difference may be specific rather than individual; in some specimens it is very prominent and heavy, in others it is much reduced. The neural canal is low and wide, of transversely oval shape and has prominent rugosities for the attachment of the transverse ligament; ventral to these is the large, semicylindrical concavity for the odontoid process of the axis. The posterior cotyles are low, very wide, of irregularly oval shape and with outer margins raised and projecting quite prominently. The transverse processes are very long, but rather narrow from before backward and posteriorly are quite thick, being strengthened by a broad bar, which runs out from the inferior arch over the processes. The large vertebrarterial canal perforates the transverse process and opens anteriorly into a large fossa, into which also opens the atlanteo-diapophysial foramen.

In *Toxodon* the atlas is very much like that of *Nesodon*, but is relatively longer antero-posteriorly and less depressed, with more strongly convex neural arch. The neural spine is rather more prominent and is bifid, and the transverse processes are broader antero-posteriorly and have more curved free borders. The foramina are the same, except that the posterior opening of the vertebrarterial canal is much smaller and has been displaced toward the median line. The posterior cotyles have a greater dorso-ventral diameter and a more irregular surface, with depressions at the mesial ends, which are hardly indicated in *Nesodon*.

The axis (Pls. XXIII, fig. 8; XXIV, fig. 4) has a short centrum, which anteriorly is very broad and depressed, but grows narrower and thicker behind the transverse processes, so that the posterior face is subcircular and slightly concave; the ventral keel is very obscurely marked and the anterior cotyles for the atlas are very wide and low and feebly convex. The odontoid process is rather long, very stout and somewhat compressed laterally, giving a vertically oval section. The pedicles of the neural arch are narrow antero-posteriorly, but thick and heavy, and the neural canal is rather small. The neural spine is hatchet-shaped and not very large, projecting forward but little in advance of the pedicles of the arch; the free border of the spine is thick and rugose, especially behind, where it forms quite a massive tuber. The postzygapophyses are large and prominent, presenting almost laterally, and are somewhat convex dorso-ventrally. The transverse processes are short, slender and thin, but diverge strongly from the sides of the centrum; they are perforated by the very large canal for the vertebral artery.

In *Toxodon* the axis differs from that of *Nesodon* in only a few details, except, of course, its very much greater size and massiveness. The anterior cotyles are more saddle-shaped; the odontoid process is relatively shorter and heavier; the neural canal is higher dorso-ventrally and the spine more massive; the postzygapophyses are of a different shape, with the long diameter directed antero-posteriorly instead of dorso-ventrally, and presenting more obliquely downward; the vertebrarterial canal is decidedly smaller.

The third cervical has a short, heavy centrum and long, slender, depressed transverse processes, which are quite simple, showing no indication of the inferior lamella, and are perforated at the base by the very large canal for the vertebral artery. The neural canal is quite small and the arch is broad and nearly flat on the dorsal surface. In all of the available specimens the neural spine is broken and its full height cannot be determined, but it evidently was unusually prominent. The prezygapophyses are large and present internally, with almost vertical faces, while the postzygapophyses present obliquely downward.

The succeeding cervical vertebræ have short, heavy and slightly opisthocœlous centra and prominent transverse processes. The inferior lamella first appears on the fourth vertebra, is considerably larger on the fifth and on the sixth becomes a great, hatchet-shaped plate, which is produced far posteriorly (Pl. XXIV, fig. 3). In all, including the sixth, the vertebrarterial canal is very large and conspicuous; the transverse processes of the seventh are short, heavy and imperforate, but have distinct inferior lamellæ. The neural arches are quite broad antero-posteriorly, so that the intervertebral spaces are very narrow. The neural spines vary much in height, but, unfortunately, it is not practicable to determine whether these differences are to be regarded as specific. In some individuals the spines are short and weak, in others very much stouter and better developed; they increase in length posteriorly and that of the seventh cervical is, in some instances, almost as long and heavy as that of the first thoracic.

In *Toxodon* the cervical vertebræ posterior to the axis do not differ in any significant manner from those of *Nesodon*. They are considerably shorter proportionately and have very heavy centra; the transverse processes resemble those of the Santa Cruz genus, but on the third vertebra they are broader, more compressed antero-posteriorly, curving more backward and less downward, and on the sixth the inferior lamella has no such antero-posterior extension as in *Nesodon*. The neural arches are much narrower, having considerable intervertebral spaces, and the neural canal is relatively much larger. The neural spines are shorter and much more slender than in some specimens of *Nesodon*, but in others there is not so great a difference from *Toxodon* in this respect.

While not definitely known, the number of thoracic vertebræ in *Nesodon* could not have varied much from 16–17, forming a very long thorax. The first thoracic in some respects resembles the seventh cervical; the centrum is somewhat longer and has a less decidedly convex anterior face than in the latter and its shape is changed by the addition of the very large anterior rib-facets; the transverse processes are very prominent and massive and bear very large and deeply concave facets for the tubercles of the first pair of ribs; behind each process is a deep groove for the passage of the spinal nerve. The prezygapophyses are, as usual, of the cervical type and the postzygapophyses, which are on the hinder part of the neural arch, present laterally, not ventrally, and are somewhat convex. The neural canal is of triangular shape and notably small and the spine, the exact length of which cannot be determined from the material before me, is relatively much stouter and presumably much longer than in *Toxodon*.

The succeeding vertebræ of the anterior thoracic region (Pl. XXI, fig. 11) have short, heavy and slightly opisthocœlous centra, with large facets for the rib-heads, which extend upward upon the base of the transverse processes; the latter are very prominent and heavy and carry large, deeply concave facets for the rib-tubercles. The second thoracic vertebra has prezygapophyses of the cervical type, arising from the dorsal side of the transverse processes, but the postzygapophyses occupy the normal position on the ventral face of the overhanging neural arch, the pedicles of which are deeply incised for the passage of the spinal nerves, while the third and succeeding thoracic vertebræ have thc pedicles perforated by foramina for the transmission of the nerves. The neural spines of the first four or five thoracics are exceedingly elongate and have a strong backward inclination. The rapid diminution posteriorly in the length of the spines produces a decided hump at the shoulders, though this feature is less strongly marked than in *Toxodon*, in which it is very striking.

In the middle thoracic region the vertebræ have centra which in size and form differ but little from those of the anterior region, though the facets for the heads of the ribs become smaller and less concave and have a more inferior position. It is perhaps unnecessary to say that the change is a gradual one. The transverse processes are shorter, but still massive, and bear much smaller and nearly plane facets for the rib tubercles, and prominent metapophyses arise from the dorsal border. The neural canal is remarkably small and the pedicles of the arch are perforated by foramina for the nerves; the spines become much shorter and more slender and have a less decided backward inclination than in the anterior region.

In the posterior thoracic region (Pl. XXIII, fig. 9) the vertebræ gradually take on the lumbar type; the neural spines are short, broad and plate-like, with thickened and rugose tips. The anticlinal vertebra appears to be the antepenultimate thoracic and on the last two the spines have a slight forward inclination. The small neural canal and the perforated pedicles of the arch are retained throughout the region. Only on the last two vertebræ are the zygapophyses like those of the lumbars and only imperfectly so, and the metapophyses are very prominent.

There must have been at least four lumbar vertebræ (Pl. XXIV, fig. 2) and in some individuals probably five; the centra become broader and more depressed posteriorly and that of the last lumbar is very broad and low and is traversed by a pair of vascular canals, which open upon the dorsal and ventral sides. The transverse processes are long, broad and depressed and extend straight out from the sides of the neural arch, without anterior or downward curvature, except on the last vertebra, which has quite peculiar transverse processes; they are narrow and thick at the base, becoming wider and thinner toward the extremities and with a concave anterior border, which gives an appearance of a forward curvature; on the posterior border of each process is a small facet for articulation with corresponding facets on the sacrum. The zygapophyses are of the cylindrical, interlocking kind, found in the Litopterna and Artiodactyla, the posterior pair being convex and the anterior strongly concave. From the outer margin of the latter arise the metapophyses, which are much more prominent than in the thoracic region. The neural canal remains small and the pedicles of the arch are not perforated for the nerves, which pass out through deep and narrow slits. The neural spines are rather short and weak and have a slight forward inclination.

So far as I am aware, no sacral or caudal vertebræ of *Nesodon* have yet been found, but the sacrum is known in the very closely allied genus, *Adinotherium*, in which it consists of six vertebræ and the centrum of the last one is so large as to make it very probable that the tail was moderately elongate and stout. There is every reason to assume that the relations were similar in *Nesodon*.

The trunk-vertebræ of *Toxodon* differ in a number of details from those of *Nesodon*, differences which are for the most part referable to the greatly increased size and body weight of the Pampean genus. The vertebræ are of nearly the same relative length as in the Santa Cruz genus, but are much more massive. The first thoracic has a much shorter and more slender spine, but those of the four succeeding vertebræ are far longer and heavier than in *Nesodon* and the descent from them to the middle region is much more abrupt, making the hump at the shoulders far more prominent and conspicuous. In the posterior thoracic and lumbar regions the spines are low, but very broad antero-posteriorly and have greatly thickened and very rugose tips. All the neural spines of the trunk-vertebræ have a backward inclination, somewhat as in the Proboscidea, although those of the last three thoracics are nearly erect. Throughout, the transverse processes are relatively shorter and the metapophyses somewhat less prominent than in *Nesodon*.

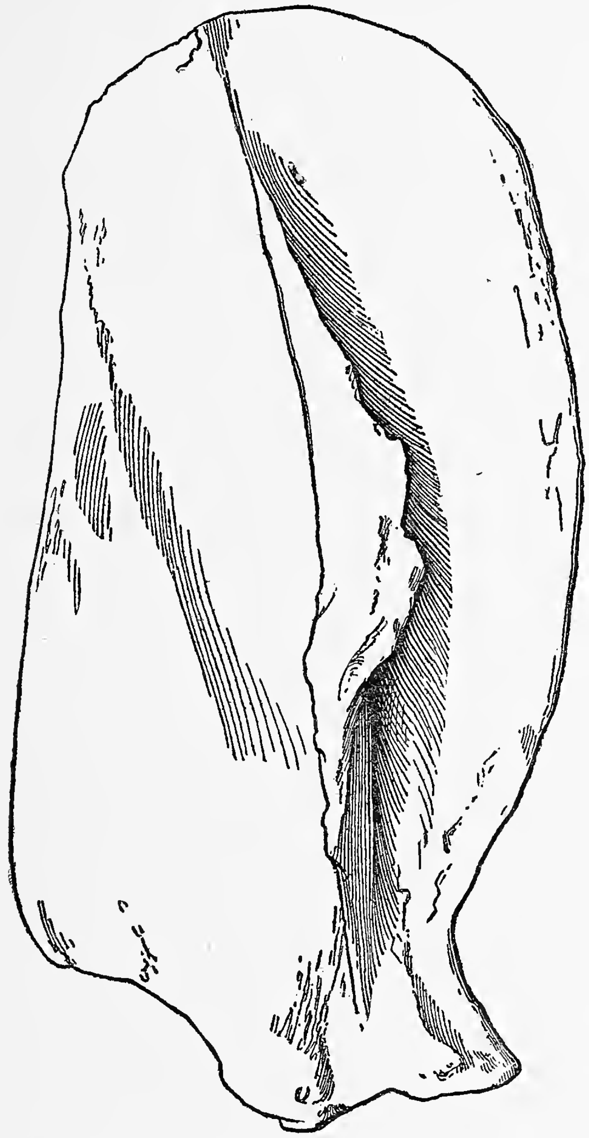
The ribs of *Nesodon* are not especially characteristic, but resemble those of the medium-sized ungulates generally. The anterior ribs have larger heads, larger and more prominent tubercles, straighter, broader and more compressed shafts. In the middle region of the thorax the ribs are longer and thicker and have a stronger outward curvature, while the tubercles are smaller and much less prominent. Posteriorly, the ribs become much more slender and rod-like and all of the ribs are conspicuously more slender than those of *Toxodon.* As a whole, the thorax is long, deep and capacious.

The sternum (Pl. XXII, figs. 3, 4) is not completely preserved in any of the specimens, but what remains is very peculiar. The presternum, or manubrium, is long, narrow and laterally compressed ; the facets for the first pair of ribs form prominent projections and in front of these is a long, much compressed and keel-like process, somewhat as in the horses and tapirs, but more pointed and having a downward direction. Behind the rib-facets, the presternum is much broader on the dorsal face, narrowing ventrally to an edge or keel. Four of the mesosternal segments are preserved, of which the first three are depressed and flattened, though very broad, the width and dorso-ventral thickness being nearly equal. The fourth segment is much narrower and more compressed, contracting toward the hinder end, and in this segment the thickness greatly exceeds the breadth.

In *Toxodon* the sternum is of similar type, but with considerable differences of form; the manubrium is relatively longer and the rib-facets are not prominences, but deep, irregular concavities. All of the presternum is more depressed and flattened than in *Nesodon* and the anterior process is broad and low, ending in a blunt point, and quite different from the sharply compressed and keel-like process of the Santa Cruz genus. The mesosternal segments are broader and more massive than in the latter and the fourth segment is not contracted.

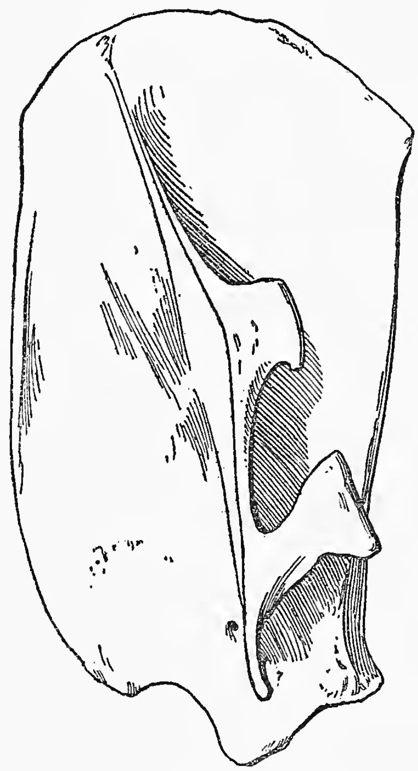
Appendicular Skeleton.—The scapula (Pl. XXII, figs. 1, 2) is very large, of high, narrow and subquadrate shape ; the spine pursues a somewhat oblique course, from above downward and backward, making the postscapular fossa much wider than the prescapular proximally, while distally these proportions are reversed. The glenoid cavity is large and broadly oval in form and the neck is very wide, made so by the coracoid, which, when seen from the outer side, appears to be merely a portion of the scapula, but in distal or internal view is shown to be a massive incurved hook of unusual size. There is a distinct coraco-scapular notch, above which the blade widens abruptly. The coracoid border is gently convex and curves uninterruptedly into the suprascapular border, which

FIG. 21.



Toxodon burmeisteri: Left scapula, outer side, $\times \frac{1}{4}$. La Plata Museum.

FIG. 22.



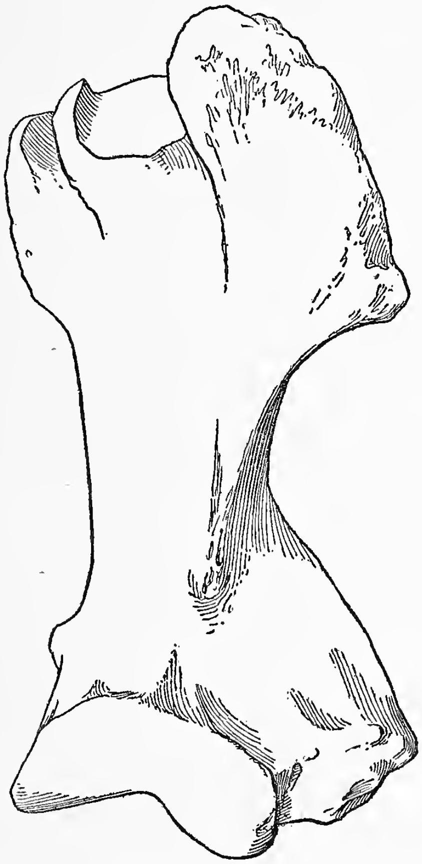
Nesodon imbricatus: Left scapula, outer side, $\times \frac{1}{4}$.

is arched and joins the glenoid border by a pronounced angulation. The glenoid border, though slightly sinuous, is nearly straight and, above the neck, the blade is not far from being of uniform width throughout. The spine begins a little below the suprascapular border, rising gradually to its full height, and is strongly recurved, so that the anterior surface is convex and the posterior concave. Distally, it ends in a short but distinct, overhanging acromion, the spine here reaching its maximum height and prominence. There are two very large metacromial processes, which project prominently backward from the spine. Of these the upper, proximal one is smaller and the lower or distal one is much longer and is expanded at the free end; both are quite thin and plate-like.

In *Toxodon* the scapula differs from that of *Nesodon* in many respects; the blade is somewhat narrower in proportion to its height and the coraco-scapular notch is less definitely marked; the coracoid is reduced to a rugose nodule, which forms no incurved hook. The widening of the blade above the neck is more abrupt than in the Santa Cruz genus and the coracoid border is nearly straight, while the glenoid border is convexly curved. The spine has no acromion, but dies away gradually upon the neck, and the metacromion is a broad, massive, roughened area, which projects backward but little behind the plane of the spine and is very obscurely divided into two parts. It is the change in the character of the spine and its processes which, more than any other single feature, makes the striking difference in the appearance of the scapula in the two genera.

The humerus (Pl. XXIII, figs. 3–5) is short and moderately heavy. The head is hemispherical and sessile and projects but little behind the plane of the shaft; the external tuberosity is very large, rising high above the level of the head, but rather narrow, not extending across the entire proximal end and leaving the head partially visible from the front; the internal tuberosity is broken away in all of the available specimens, but, judging from the analogy of the nearly allied *Adinotherium*, it was doubtless very small. The division of the bicipital groove and the development of the bicipital tubercle appear to have already begun, part of the bicipital tubercle being plainly visible in one individual. The deltoid area is a mere roughened line and forms no process or hook. The shaft has the form common to nearly all of the heavier ungulates; the proximal portion is laterally compressed and very thick antero-posteriorly, while the distal portion is antero-posteriorly compressed and broad transversely, and the middle region is subcylindrical. The supinator ridge is not strongly developed, but the external epicondyle is massive and rugose; the internal one is much smaller. The supratrochlear fossa is large and well-defined, though not very deep, while the anconeal fossa is small and profound. In some individuals the two fossæ communicate through a large perforation, but in others they are completely separated by a thin bony wall. The trochlea is wide and low and is divided into an external convexity for the head of the radius and a broad, saddle-shaped area for the ulna, which is bounded internally by a prominent flange.

Fig. 23.



Toxodon burmeisteri: Left humerus, dorsum, $\times \frac{1}{4}$. La Plata Museum.

Fig. 24.

Nesodon imbricatus: Left humerus, dorsum, $\times \frac{1}{4}$.

In *Toxodon* the humerus has become enormously massive and is relatively very short; the external tuberosity is proportionately lower than in *Nesodon* and is shifted more toward the outer side. The bicipital groove is divided into a very broad external and narrower internal portion and the former is again subdivided by a low, median bicipital tubercle. The deltoid area develops a low, but very massive and rugose, external hook. The supinator ridge is prominent and the external epicondyle very large and heavy; the radial portion of the trochlea is high and narrow and more strongly convex than in *Nesodon*. In brief, the humerus of the Pampean genus is a far more massive bone and its processes for muscular and ligamentous attachment are better developed, heavier and more prominent than in the Santa Cruz animal, a change which corresponds to the general increase in size and bulk of the former.

The fore-arm bones are always separate, not displaying the slightest tendency to coössification, and are crossed, the radius passing from the external to the internal side of the arm; the two bones are in contact, not only at the proximal and distal ends, but also for some distance along the middle portion of the shafts, by means of interosseous crests. Thus, the radio-cubital arcade is divided into a shorter proximal portion, which is very narrow and slit-like, and a longer, wider distal portion.

Relatively, the radius (Pl. XXV, figs. 5–8) is elongate and quite slender; the head is very small, and transversely oval in form and covers but a small part of the humeral trochlea; the shape of the articular surface varies somewhat in different individuals, though possibly these differences should be regarded as specific rather than individual. In some specimens the surface is simply concave; in others it is divided into a larger external concavity and a smaller, internal, saddle-shaped portion. The proximal facet for the ulna is a narrow band on the inner side of the head. On the external side of the head is an articular surface, to which is attached a large sesamoid bone, shaped like a small patella and apparently developed in one of the extensor tendons of the digits. No bicipital tubercle is visible on the radius. The shaft is slender, irregular and with a forward curvature, increasing in size toward the distal end; the interosseous crest is distinct and very rough, though of no great prominence, and runs for nearly the whole length of the shaft. The distal end is quite massive, both broad and thick; the styloid process is long and prominent and continues distally the facet for the scaphoid, which conspicuously notches the dorsal border of the distal end of the radius. The lunar surface is concave and is considerably deeper palmo-dorsally than that for the scaphoid. The distal facet for the ulna is very small and oblique, presenting proximally almost as much as laterally.

The ulna (Pl. XXV, figs. 4, 5) is much heavier than the radius, except near the distal end. The olecranon, though long, projects but little behind the plane of the shaft, from which it slopes up very gradually, and the free end is only moderately thickened and rugose. The facets of the elbow-joint are very peculiar; the sigmoid notch is deep, describing nearly a semicircle, and the coronoid process is prominent. Aside from the facet for the anconeal fossa, the humeral surface is altogether internal—there is no trace of any external facet, such as is found in almost all other ungulates. Thus, when viewed from the front or dorsal

FIG. 25.

Toxodon burmeisteri: Left fore-arm bones, dorsum, × $\frac{1}{4}$. La Plata Museum.

FIG. 26.

Nesodon imbricatus: Left fore-arm bones, outer side, × $\frac{1}{4}$.

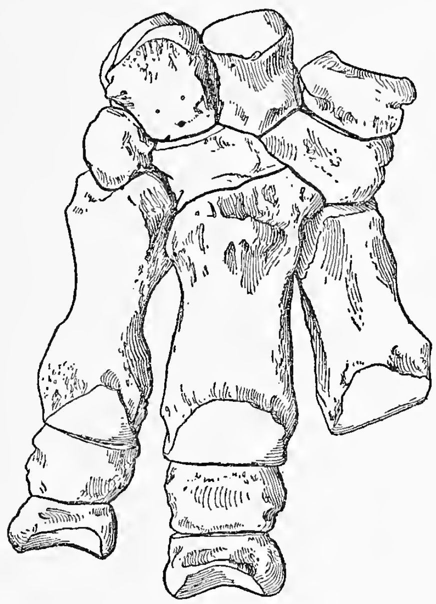
side, the articular surface pursues a very oblique course, from above downward and inward, and does not embrace the head of the radius, but merely touches it on the internal side. The shaft is heavy and of trihedral shape, with prominent interosseous crest on the anterior face, and tapers but slightly toward the distal end, though the very conspicuous styloid process is abruptly contracted; it has a strongly convex facet for the pyramidal, which passes uninterruptedly on the palmar side into the surface for the pisiform.

In *Toxodon* the fore-arm bones are relatively shorter and very much more massive than in *Nesodon*, though of similar construction. The disproportion between the ulna and radius is even greater than in the Santa Cruz genus, the ulna having increased in thickness and weight more than the radius. The radius resembles that of *Nesodon* in form, but is proportionately shorter and stouter; the distal end is especially massive and the scaphoid facet emarginates the dorsal border more deeply and in a more conspicuous way. The ulna is extraordinarily heavy; the olecranon projects much more strongly behind the plane of the shaft and is far thicker at the free end than in *Nesodon*. The sigmoid notch is much the same in both genera, but the short shaft in *Toxodon* is not only very much heavier, but has acquired a subquadrate shape, somewhat as in the Proboscidea. The styloid process is relatively decidedly shorter than in *Nesodon* and is displaced to the extreme outer side of the distal end, which extends far internally, or radially, from it and thus gives quite a different appearance to the distal end.

The manus (Pls. XXII, fig. 5; XXVI, figs. 4–6) is surprisingly small and weak in proportion to the size and weight of the animal. The carpus is very broad transversely and short proximo-distally and is already of completely interlocking type, as much so as in the Perissodactyla, the scaphoid articulating extensively with the magnum and the lunar resting almost equally upon the magnum and unciform. Aside from its much smaller size and lighter construction, this carpus is very similar to that of *Toxodon*, though there are many differences of detail, no doubt due to the readjustment necessitated by the greatly increased size and weight of the Pampean genus.

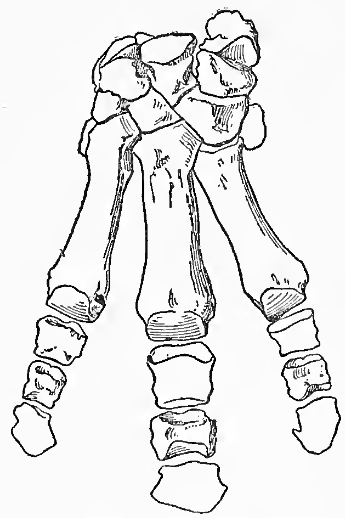
The scaphoid is low, broad and irregular in form; the dorsal face has the shape of an irregular, inverted and truncated triangle, broad proximally and narrowing distally; the palmar face is narrow, strongly convex and rugose. Proximally, the articular surface for the radius is almost plane transversely and is made slightly concave palmo-dorsally by the elevation of the posterior or palmar border; the whole proximal end is not covered by the radial facet, but a broad, rugose area extends around the palmar and internal sides. On the ulnar side is a facet for the lunar, which is continuous with that for the radius; this lunar surface is very narrow proximo-distally, but extends for nearly the whole dorso-palmar diameter of the scaphoid and is slightly convex in that dimension. This is the only articulation between the scaphoid and lunar, for distally the two bones are not in contact at all. Distally, there are only two facets, for the trapezoid and magnum respectively, there is none for the trapezium;

FIG. 27.



Toxodon burmeisteri: Left manus, dorsum, × ¼. La Plata Museum.

FIG. 28.



Nesodon imbricatus: Left manus, dorsum, × ¼.

the trapezoid surface is quite large and deeply concave, while that for the magnum is narrow, oblique, nearly plane transversely and slightly concave palmo-dorsally. At this point the raised ulnar border of the magnum is wedged in between the scaphoid and lunar, quite separating them.

In *Toxodon* the scaphoid differs in several respects from that of *Nesodon;* being proportionately narrower transversely, more elongate proximo-distally and having a less oblique position in the carpus; the dorsal face forms an irregular pentagon and the palmar protuberance has become much larger and more prominent. The proximal facet for the radius is more saddle-shaped, much more deeply concave palmo-dorsally, more convex transversely and covers the entire proximal end, which, as above mentioned, is not the case in *Nesodon.* The magnum facet is relatively wider and more directly distal and the trapezoid facet, which is very similar in form, does not extend quite so far proximally upon the radial side.

The lunar is very massive and larger than the scaphoid in almost every dimension, articulating with the latter only by a narrow band near the proximal end, a facet which is moderately concave in the dorso-palmar direction. The radial surface is in two connected portions, a broad anterior area, which is strongly convex palmo-dorsally and is reflected far over upon the dorsal face, and a very much narrower, oblique and somewhat concave posterior portion; the palmar face is very low proximo-distally, very broad and much roughened. On the ulnar side there is no facet for the pyramidal, except a very small one at the palmo-distal angle; dorsally there is no contact between the two carpals. Distally, the almost equal facets for the magnum and unciform meet at an acute angle and form a sharp, ridge-like portion between the two carpals last mentioned. However, this ridge-shaped portion is confined to the dorsal moiety of the lunar and the facet for the magnum is in two quite distinct parts, though there is no break in the continuity of the articular surface; the dorsal portion, which is on the wedge-like projection, is convex and obliquely lateral, rather than distal in position, while the palmar portion presents distally and is concave. Much the same description may be given of the facet for the unciform, except that the dorsal is more concave and distal and the palmar portion is considerably narrower than the corresponding part for the magnum and is more oblique, less completely distal.

In *Toxodon* the lunar differs in a number of particulars from that of *Nesodon*. The radial surface has a more decidedly convex anterior portion, which is reflected farther down upon the dorsal face, while the palmar portion is very much reduced in size. On the ulnar side, the lunar has a distinct contact with the pyramidal, a contact which is both dorsal and palmar, and on the distal end the faces for the magnum and unciform meet at a much more obtuse angle and, even dorsally, these facets are much more distal than lateral, so that there is hardly any ridge-like prolongation.

The pyramidal is broad transversely and very low proximo-distally. On the dorsal face, near the radial border, is a prominent tubercle for ligamentous attachment. The articular surface for the ulna is large, transversely oval and deeply concave, and on the palmar side is quite an extensive facet for the pisiform, of irregularly semicircular shape. The distal end is covered by the large, somewhat saddle-shaped facet for the unciform and on the ulnar side is another facet, no doubt for the vestigial fifth metacarpal.

In *Toxodon* the pyramidal is very similar to that of *Nesodon*, but is relatively broader and shorter, so that its proximal end is at a much lower level than that of the lunar and scaphoid, a difference which is much greater than in the Santa Cruz genus. On the ulnar side there is no facet for the rudiment of the fifth metacarpal.

The pisiform is a short and heavy bone, not unlike a calcaneum in shape. The proximal end is transversely expanded and bears two irregularly triangular facets, for the pyramidal and ulna respectively; the latter is considerably the larger of the two and more concave. The body of the bone is short, heavy, laterally compressed, and has a strongly convex ventral border, while the distal or free end is much thickened and rugose.

In *Toxodon* the pisiform is of quite a different shape, being much deeper dorso-ventrally, thinner and more compressed laterally, and is not nearly so much expanded at the proximal end.

The trapezium is very small and has no direct articulation with the scaphoid or even with the trapezoid. It is an irregular, nodular bone, with the principal diameter in the proximo-distal direction, and having roughened ends. On the ulnar side is a relatively large, subcircular and concave facet for mc. II and on the palmar side is a very small facet, the purpose of which is doubtful, but may have been for the attachment of a sesamoid. Ameghino ('94^b, 246, fig. 1) regards this bone as the vestigial mc. I and it is quite possible that this is the correct interpretation, as is suggested by the absence of any articulation with the scaphoid. In that case, the minute facet on the palmar side might be for an even more reduced trapezium. From the analogy of other ungulates, however, it seems much more probable that the bone in question is the trapezium, which almost invariably persists as a relatively large element long after all trace of the pollex has disappeared and is itself suppressed only in a few highly specialized types with monodactyl or didactyl feet. So far as can be judged from the cast of the La Plata skeleton, this problematical element, whether trapezium or first metacarpal, would seem to be lacking in *Toxodon*.

The trapezoid is a relatively large and important bone, with subquadrate dorsal face. Toward the palmar side the bone narrows much and is thus wedge-shaped. Its position in the carpus is somewhat oblique, as it faces nearly as much toward the radial as toward the dorsal side of the manus. The proximal end forms a convex head, which fits into the concavity on the distal end of the scaphoid. The only other carpal with which the trapezoid articulates is the magnum, for which there are two incompletely separated facets on the ulnar side, one proximal and the other distal. Distally, the large surface for mc. II is saddle-shaped, concave palmo-dorsally and convex transversely. The trapezoid of *Toxodon* is very similar to that of the Santa Cruz genus, but proportionately larger and heavier.

The magnum is quite large, especially in the proximo-distal dimension, exceeding the trapezoid in size, but is much smaller than the unciform. It has a very oblique position in the carpus, being inclined distally and toward the ulnar side. The ulnar face, which articulates with the lunar and unciform, is nearly plane and from the scaphoid to the head of mc. IV there is a long, straight, oblique joint, between the magnum and mc. III on the radial, and the lunar and unciform on the ulnar side. A somewhat similar arrangement may be observed in the carpus of *Cœnopus*, a tridactyl rhinoceros from the Oligocene of North America. The magnum has a very complex arrangement of facets, articulating with all the other carpal elements except the trapezium, pyramidal and pisiform. The dorsal and palmar faces are strongly rugose and on the latter is a rough protuberance, but not the long hook so frequently seen in ungulates.

As is usual, the magnum is much lower proximo-distally on the dorsal than on the palmar side, but the rise of the proximal surface is gradual and there is no well-defined head. On the radial side is the very large and complex surface which articulates with the process from the head of mc. II; this facet is quite strongly convex palmo-dorsally, except the much smaller palmar extension, which is concave. Above this facet is the small oblique, L-shaped surface for the trapezoid; that for the scaphoid is large, transversely concave and dorsally occupies the whole width of the magnum, but toward the palmar side this facet becomes narrower and more oblique. The lunar surface is quite distinctly divided into two parts; the dorsal portion, which is slightly concave, is obliquely lateral in position and is continuous with the facet for the unciform, the two surfaces lying in nearly the same plane. The palmar portion of the lunar facet is convex and much more nearly proximal in position than the dorsal portion. The unciform surface is quite small dorsally and is continued as a very narrow band almost to the palmar border. Distally, the facet for mc. III is large and very simple, almost plane transversely and concave palmo-dorsally.

In *Toxodon* the magnum is of quite a different shape, being proportionately shorter proximo-distally and very much broader. The articulations are nearly the same as in *Nesodon*, except that the dorsal portion of the lunar facet is less lateral and more proximal and that, when the carpus is seen from the front, the facets for the lunar and unciform meet at a very obtuse, though distinct angle, while in *Nesodon*, as above described, they form a continuous line.

The unciform is a very large bone, decidedly the largest of the carpals; it is low and broad and has an irregularly pentagonal dorsal face. The proximal end is unequally divided between a narrow surface for the lunar and a very broad one for the pyramidal; the former is oblique, dorsally concave, becoming convex toward the palmar side, while the pyramidal facet is more proximal and irregularly saddle-shaped. On the radial side the unciform extends over the magnum, upon which it rests, and the facet for the magnum and that for the lunar meet at an acute angle. Below the magnum facet and in nearly the same plane with it, indeed continuous with it, is a large, crescentic articular surface for the projection from the ulnar side of the head of mc. III. On the distal end is the large, subquadrate and palmo-dorsally concave facet for mc. IV, and on the ulnar side is the relatively large, triangular, concave surface for the vestigial mc. V. In *Toxodon* the unciform is proportionately broader and more massive; the proximal end is wider than the distal and on the ulnar side projects considerably beyond the head of mc. IV. The facet for the rudiment of mc. V is relatively smaller than in *Nesodon* and is displaced toward the palmar side.

The metacarpus consists of three functional members, the second, third and fourth and a rudiment of the fifth. The symmetry is nearly, but not perfectly mesaxonic, for though mc. III is symmetrical, mc. II and IV do not quite form a pair. The three functional metacarpals are quite strongly divergent toward the distal ends, almost like the sticks of a fan, causing a wide separation of the digits. As was noted above, Ameghino believes that a vestige of mc. I is also present and in support of this view it may be urged that the bone in question does not articulate with the scaphoid or trapezoid, but only with mc. II. On the other hand, it would be most exceptional for the trapezium to be suppressed while any part of the pollex remained.

Metacarpal II is short and stout, with moderately expanded head, which overlaps that of mc. III. On the radial side is a small, irregular, convex facet for the trapezium and the proximal end is occupied by the large, transversely concave surface for the trapezoid. The prominence from the ulnar side, which overlaps the head of mc. III, abuts against the magnum by a very large facet, and on its distal side is a narrow, concave, articular band for mc. III. The large facet for the magnum is extended for nearly the whole dorso-palmar diameter of the bone; most of this surface is deeply concave, but near the palmar side is a small convex area, which fits into a corresponding concavity on the side of the magnum. The shaft is quite heavy and of irregularly trihedral form, with rounded angles, and has large rugose tuberosities upon it, notably on the ulnar side below the head (see Pl. XXII, fig. 5) and on the palmar face somewhat below the middle; it is moderately curved, with decidedly concave radial border, and from a point a little below the head increases in breadth toward the distal end. The distal trochlea is narrow and not very strongly convex, but is extended well upward upon the dorsal face; the carina is low and inconspicuous and is confined to the palmar aspect of the bone, being quite invisible in front-view.

Metacarpal III is the longest and heaviest of the series, though it does not much exceed mc. II in length. The head, which is but little wider than the shaft, though of great dorso-palmar thickness, carries four articular surfaces, for mc. II and III and the magnum and unciform respectively. The facet for mc. II is very narrow and presents proximally; that for the magnum, which is obscurely demarcated from the latter, is very large and quite strongly convex palmo-dorsally. The unciform surface, which is borne on a massive projection from the ulnar side of the head, is large, oblique and of crescentic shape, narrowing toward the palmar side. The surface for mc. IV is divided into two almost separate facets, which are large and concave and placed, one near the dorsal and the other near the palmar border; they are connected proximally by a very narrow band of articular surface. The shaft is heavy, antero-posteriorly compressed and broadening toward the distal end. Near the proximal end, on the anterior face, is a median pit, which probably served for the insertion of one of the extensor tendons. Distally, the trochlea is low and wide and of compressed semicylindrical form; the carina is entirely palmar and is even less prominent than that of mc. II. (Pl. XXVI, fig. 5.)

Metacarpal IV is not an exact counterpart of mc. II, even disregarding the different shape of the proximal ends, being shorter, heavier and straighter, but the difference of length is compensated for by the fact that the head of mc. II rises much higher into the carpus than does that of mc. IV, while their distal ends are in nearly the same horizontal line. In mc. IV, the proximal end is overlapped by the head of mc. III, with which it articulates by two convexities which fit into the concave, oval facets on the ulnar side of mc. III already described and by a large, convex surface proximal to these. On the ulnar side of the head is quite a large facet for the vestigial mc. V. The shaft is rather heavier and straighter than that of mc. II, but is of similar trihedral cross-section, and the distal trochlea is narrower and its proximal border on the dorsal face is less regularly curved, being higher on the mesial and lower on the external side. Metacarpal V is not represented in any of the collections, but that it was normally present is demonstrated by the facets on the pyramidal, unciform and mc. IV. Ameghino has figured it in the closely allied, if not identical, genus *Xotoprodon* ('94[b], 246, fig. 1) as a small, irregular nodule, articulating with the three bones just mentioned.

In *Toxodon* the metacarpals have assumed elephantine proportions, being relatively shorter and very much broader than those of *Nesodon*. Metacarpal II articulates extensively with the magnum, but does not overlap the head of mc. III so much as in the Santa Cruz genus. The keel of the distal trochlea is much reduced and in mc. III is hardly distinguishable. The presence of the rudimentary mc. V is indicated by the facets for it upon the adjoining bones, and, as in *Nesodon*, it is extended proximally to a contact with the pyramidal, but is shifted more to the palmar side than in that genus.

The phalanges of the manus of *Nesodon* are very incompletely known and the few specimens which the collections contain may be most advantageously described in connection with those of the pes.

The pelvis (Pl. XXIV, fig. 1) is broad and heavy, but of no great antero-posterior length. The ilium is relatively rather small; the neck is short and laterally compressed and has obscurely marked borders, so that the usual trihedral shape of the peduncle is hardly apparent; there is no ilio-pectineal process. The anterior expansion or plate of the ilium is of only moderate width and is but slightly everted. The shape of the crista is not satisfactorily shown in any of the specimens, but apparently there was no definite division of the plate into dorsal and ventral processes. The acetabulum is large, of nearly circular shape and has prominently projecting borders and is deeply invaded by the very large ligamentous sulcus, which is out of all proportion to the size of the pit for the round ligament on the head of the femur.

The ischium is proportionately elongate and, for most of its length, is slender and shallow dorso-ventrally, but quite thick transversely; posteriorly, it expands into a thin and laterally compressed area, which has no definite tuberosity, but merely a low, rugose area. The pubis is quite broad, depressed and flattened and the symphysis is long. The large obturator foramen forms an almost regular oval, with the long axis directed antero-posteriorly.

In *Toxodon* the pelvis is remarkably different from that of *Nesodon* and has acquired considerable resemblance to the pelvis of the elephants. The iliac plate is immensely expanded and very strongly everted and the crista has become very massive and rugose, especially near the antero-dorsal and postero-ventral angles. The large, circular acetabulum has a less prominent border and is not invaded by a sulcus for the round ligament; there is merely a notch of the posterior border. All the post-acetabular region of the pelvis has been much reduced in length; the ischium is relatively much shorter and thicker than in *Nesodon* and the tuberosity is a distinct ridge, though not at all prominent. The pubis is very heavy and the symphysis is short,— actually but little longer than in *Nesodon* and therefore very much shorter proportionately.

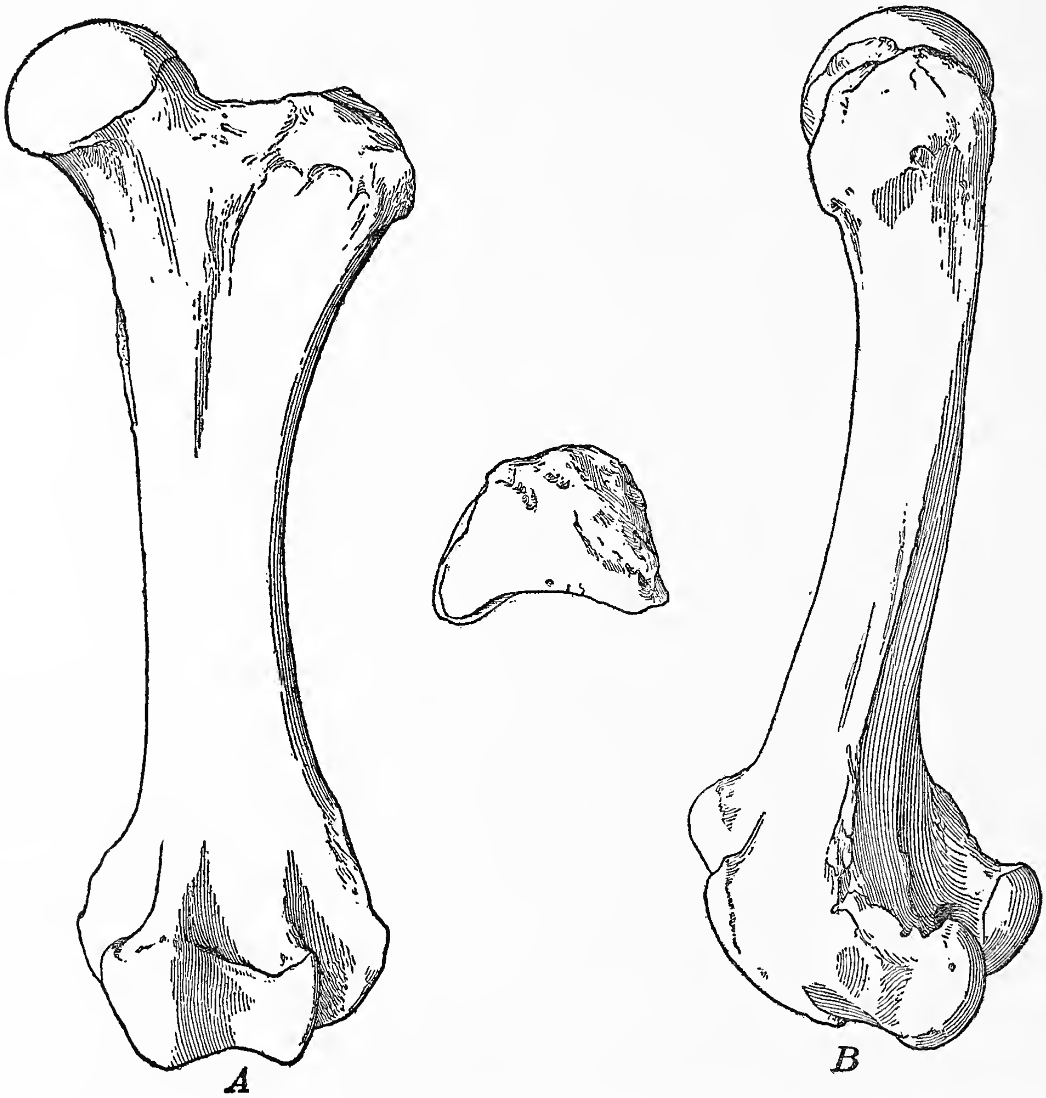
The very striking changes which the pelvis of *Toxodon* has undergone are all to be correlated with the great increase in stature and body-weight and in the mass and bulk of the viscera. Similar changes in the form of the pelvis, accompanying great increase in the size and bulk of the body, may be observed in several other ungulate phyla. Besides the Proboscidea, they are to be found in the Amblypoda and in the perissodactyl family of the Titanotheriidæ and, in a less marked degree, in the larger rhinoceroses. In several of these groups the changes in the pelvis may be followed in successive stages, where they are plainly correlated with increasing body-weight and, as plainly, they are seen to be independently acquired in each phylum. To this list should now be added the Toxodonta, the later and larger representatives of which have taken on many skeletal resemblances to the elephants, but, as the phylogenetic history shows, these likenesses are due merely to the mechanical readjustments necessitated by the greatly augmented bulk and weight.

The femur of *Nesodon* (Pl. XXIII, figs. 1, 2) is much more perissodactyl in character than is that of *Toxodon;* it is of moderate length, a little shorter than the humerus, though the effective length, measured from the head to the condyles, is slightly greater than that of the humerus. The head is oval, with the long axis transverse, and is set upon a distinct neck; the moderately large, though shallow, pit for the round ligament is placed upon the posterior aspect of the head, so as to be invisible in front view. A deep notch separates the head from the great trochanter, which is thick, massive and rugose, but low, not rising quite to the level of the head; the digital fossa is fairly deep, but small, and the prominent linea intertrochanterica is short, not extending to the second trochanter. The latter is a long and moderately prominent ridge, which arises a short distance below the head. The third trochanter is very conspicuous and is placed a little above the middle of the shaft.

The proximal portion of the shaft is broad and antero-posteriorly compressed, becoming more rounded and transversely oval in section downward; the posterior surface of the shaft is nearly smooth, owing to the absence of any distinct lineæ asperæ, but near the distal end there is a well-defined pit for the plantaris muscle, though the depth and distinctness of this pit vary much in different individuals. The rotular groove, which projects prominently in front of the shaft, is broad, shallow and asymmetrical, which is due to the greater thickness and prominence of the internal portion. Distally, its articular surface is continuous with the inner condyle, but separated by a narrow space from the outer; there is no definite suprapatellar fossa. The condyles are rather small and do not project strongly behind the plane of the shaft; there is considerable inequality in size between them, the inner one being broader and flatter, the outer one narrower and more convex. The external epicondyle is quite prominent and heavy, the internal one very much smaller.

Like the pelvis, the femur of *Toxodon* is greatly modified from the condition in *Nesodon* and bears considerable resemblance to that of the elephant. It is relatively elongate and is much the longest of all the limb-bones; the head is more hemispherical than in the Santa Cruz genus and the pit for the round ligament is merely a vestige, a shallow, triangular area, which emarginates the articular surface on the posterior side of the head. There is no such notch between the head and the great trochanter as there is in *Nesodon*, and the trochanter itself, though very heavy, is low, the head projecting considerably above it, while the digital fossa is smaller and deeper. The second trochanter is much reduced and

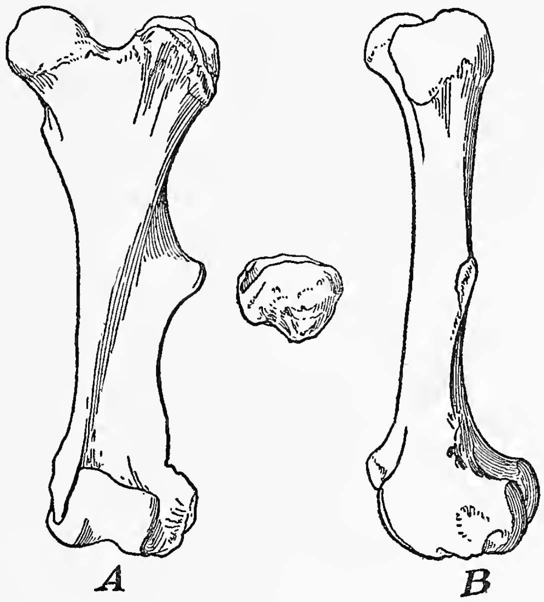
FIG. 29.



Toxodon burmeisteri: A, left femur, dorsum; *B*, the same, external view. Also left patella, dorsum. All figures $\times \frac{1}{4}$. La Plata Museum.

forms a mere rugose line, while the third trochanter has disappeared altogether. The shaft is long, broad and antero-posteriorly compressed, though not as strongly as in the elephants; the posterior surface is quite flat and there is no pit for the plantaris muscle. The rotular trochlea differs from that of *Nesodon* in being broader, shallower and more asymmetrical, owing to the greater thickness of the internal portion, which is very broad and prominent and has the articular surface reflected over

FIG. 30.



Nesodon imbricatus: A, left femur, dorsum; *B*, the same, external view. Also left patella, dorsum. All figures × $\frac{1}{4}$.

upon the internal side. The condyles are of more nearly equal size and similar shape than in *Nesodon* and are more nearly approximated, making the intercondylar fossa much narrower. Both condyles are separated by narrow spaces from the articular surface of the rotular groove.

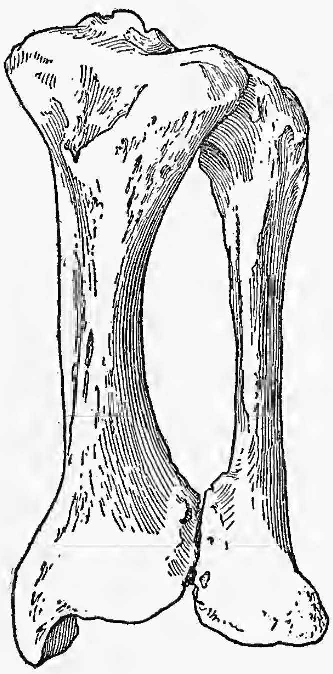
That the great changes in the character of the femur between the Santa Cruz and the Pampean genus should be chiefly ascribed to the great increase in the weight of the latter animal, is made probable by the same considerations as in the case of the pelvis. Similar changes may be followed out in other phyla, notably in the Titanotheriidæ and the Amblypoda. In the late and well-nigh gigantic species of the latter group the femur has become most deceptively proboscidean in character. In each of the four phyla the modifications of the femur are as follows: (1) The pit for the round ligament is greatly diminished in size or altogether lost; (2) the great trochanter becomes very thick and heavy, but its proximodistal height is diminished; (3) the third trochanter is greatly reduced or entirely suppressed; (4) the shaft loses its rounded form and becomes much compressed antero-posteriorly and very flat on the posterior face; (5) the medullary cavity disappears and its place is taken by cancellous bone; (6) the condyles become less prominent and more nearly alike in size and shape.

The patella of *Nesodon* (Pl. XXIII, figs. 6, 7) is a curious and characteristic bone and quite different from that of *Toxodon*. It is very short proximo-distally, quite broad and very thick, especially on the proximal and internal sides, thinning much to the external border. The distal border is concave and its internal portion is slightly produced downward. The anterior surface is very irregular and rugose and the posterior surface is obscurely divided by a low ridge into a narrow external, and much broader internal facet for the rotular groove of the femur. In *Toxodon*, on the other hand, the patella is short, of no great thickness, but immensely broad; the internal portion is greatly extended and recurved, so as to cover the inner face of the rotular prominence, while the distal border is deeply notched in a very characteristic fashion.

In *Nesodon* the leg-bones (Pl. XXV, figs. 1–3) are ankylosed at the proximal, but not at the distal end, a very peculiar arrangement. Except at the ends, the two bones are separated by a very wide interosseous space. The tibia is a little shorter than the femur and has a broad thick head, which projects far external to the shaft. The outer condyle is oblique and nearly plane transversely, very slightly concave antero-posteriorly, while the inner condyle is more concave and its portion of the bifid spine is decidedly more prominent. The shaft is surprisingly slender and its proximal portion is so strongly compressed laterally as to lose the trihedral shape common to almost all terrestrial mammals. The cnemial crest is prominent and heavy, but short, and its proximal end is deeply impressed for the insertion of the patellar ligament. On the external face of the shaft is a long interosseous crest, which, however, is prominent and rugose only for a short distance about the middle of its course. The distal half of the shaft is less compressed and more rounded than the proximal moiety and the distal end is moderately expanded and heavy. The surface for the astragalus is nearly square and is obscurely divided into a broader and shallower external, and a narrower, deeper internal facet. The intercondylar ridge is very low, but forms a tongue on each border, that on the dorsal side being the narrower and more prominent of the two; the internal malleolus is long, heavy and bluntly pointed and bears on its fibular side a facet for the inner side and neck of the astragalus.

The proximal end of the fibula, which is indistinguishably fused with the tibia, is heavy, especially in the antero-posterior direction. The shaft is stout, of roughly trihedral shape, and strongly arched outward and forward, which gives it a very irregular appearance; on the distal half of the shaft there is a prominent interosseous crest. The distal end is very large, both broad and thick, and forms a massive external malleolus, which bears two facets, one internal and slightly oblique for the astragalus, the other for the calcaneum, entirely distal in position, large and concave.

FIG. 31.



Toxodon burmeisteri: Left tibia and fibula, dorsum, × $\frac{1}{4}$. La Plata Museum.

FIG. 32.

Nesodon imbricatus: Left tibia and fibula, dorsum, × $\frac{1}{4}$.

The leg-bones of *Toxodon* are very similar in type to those of *Nesodon*, but relatively much shorter and far more massive; they are ankylosed in the same peculiar manner, that is, at the proximal end, but not at the distal. The tibia has an enormous proximal end and its condyles are very closely approximated, but the spine is formed only by the internal one; the cnemial crest also is much more prominent and massive than in the

Santa Cruz genus. The shaft has a similar, laterally compressed shape, though it has no distal interosseous crest, but the distal expansion is proportionately much greater. The division of the astragalar surface is even more faintly marked, the intercondylar ridge lower, and there is no tongue on either the anterior or the posterior border; the internal malleolus is less prominent, but more extended antero-posteriorly. The fibula has a very large head and a short, heavy shaft, which differs from that of *Nesodon* in being nearly straight and laterally compressed, rather than trihedral in form, and is without an interosseous crest. The wide space between the tibia and fibula is due to the great expansion of the ends of the former, especially of the proximal end of the tibia and the distal ends of both bones. The distal end of the fibula is relatively very much heavier than in *Nesodon*, but otherwise of similar shape, though the facets for the calcaneum and astragalus, which in the Santa Cruz genus are connected only near the dorsal angle, are continuous throughout in *Toxodon*.

The pes (Pl. XXV, figs. 9–12) is remarkably small in proportion to the length of the limb-bones and the size of the animal generally; it is even much smaller than the manus. The tarsus is not interlocking, thus retaining a more primitive character than the carpus.

The astragalus is both short and narrow and has but a feebly grooved trochlea, which is asymmetrical, the external condyle being higher and narrower and having a sharper and more angular border than the internal. On the outer condyle the articular surface passes uninterruptedly into the facet for the fibula and that of the inner condyle passes in the same way into the facet for the internal malleolus of the tibia, this latter facet extending into a shallow concavity on the neck, into which the malleolus is received, when the foot is strongly flexed upon the leg. The neck is extremely short and extends obliquely inward, allowing the outer portion of the trochlea to overhang the distal end of the calcaneum, though without any contact with the latter. The head is moderately convex in both directions and articulates with the navicular only, being widely separated from the cuboid. The external facet for the calcaneum is long, narrow and concave; for most of its length it is separate from the fibular facet, but becomes confluent with it distally; separated from the external calcaneal facet by a broad and very deep sulcus is the surface for the sustentaculum, which is nearly plane and is broad proximally, narrowing distally to its junction with the navicular facet on the head.

The calcaneum is short and massive. The tuber, which is very heavy, broadens gradually to the free end, which is roughened and has on the plantar surface a shallow tendinal sulcus, somewhat as in the Artiodactyla, though the groove is not median, as it is in the latter, but near the internal side. The fibular facet is very large and forms a broad, heavy prominence, on the tibial side of which is an oblique, convex facet for the astragalus; this latter surface is produced proximally considerably beyond that for the fibula. While of only moderate size, the sustentaculum is very thick and prominent; its astragalar facet is of irregularly oval shape and nearly plane. The distal end of the calcaneum is also very heavy and bears a broad, slightly saddle-shaped surface for the cuboid, which is concave planto-dorsally and convex transversely; internal to this is a small facet for the navicular.

The navicular is low proximo-distally and of subcircular shape; its greatest proximo-distal height is through the facet for the large ectocuneiform, while the internal portion is hardly half as high. From the plantar side is given off a very low tuberosity, which appears to be the remnant of the usual navicular hook. On the proximal end, the astragalar surface is simply concave in both directions, narrowing toward the plantar side, and on the fibular side is a small, articular projection, formed by the conjoined surfaces for the calcaneum and cuboid, the former presenting laterally and the latter obliquely distally. The distal end is occupied chiefly by the large facet for the ectocuneiform, which is oblique, sloping down toward the tibial side and contracting much toward the plantar side. The facet for the mesocuneiform, which is much smaller, is also oblique, sloping in the opposite direction and forming an obtuse angle with the ectocuneiform facet.

The meso- and entocuneiforms are fused together, though the limits of each element may still be made out. The entocuneiform is a small, irregular, nodular bone, which has no contact with the navicular and carries only one facet, a small, oblique surface on the distal end for the head of the second metatarsal. The mesocuneiform is much larger and bears a large, slightly convex surface for the navicular and interlocks with the ectocuneiform in a curiously intimate and complicated manner. Dorsally, there is a large concavity, into which fits a convexity on the tibial side of the ectocuneiform and on the plantar side the mesocuneiform sends a small shelf-like projection underneath the ectocuneiform and this shelf has a small, concave, obliquely proximal facet for the latter.

The ectocuneiform is very much larger and has much the same shape as in the perissodactyls, other than the horses. Its proximal surface meets that of the mesocuneiform at an open angle, the two bones together forming a shallow depression, into which the navicular fits. On the fibular side, in addition to the facets for the mesocuneiform already described, are two quite large and widely separated ones for the head of mt. II, of which that near the dorsal border is of complex shape, convex distally and concave proximally, while that near the plantar border is plane. On the fibular side is a large plane surface for the cuboid and the distal end is covered by the very large facet for mt. III.

The cuboid is very short proximo-distally, but broad, thick and heavy; it has no plantar hook, merely a low rugosity. There are four articular surfaces, a large, saddle-shaped, proximal one for the calcaneum; an almost equally large, plane facet on the distal end for mt. IV, and on the tibial side an obliquely proximal surface for the navicular and, below this, a large, plane, lateral surface for the ectocuneiform.

The metatarsus consists of three members, without any remaining vestiges of mt. I or V. The metatarsals are so arranged as to be strongly divergent distally, as is also the case in the metacarpals, and the mesaxonic symmetry is less complete than in the manus, since digits II and IV do not form an entirely symmetrical pair and even the symmetry of digit III is not perfect. Metatarsal II is the shortest and lightest of the series; the head is narrow, but thick planto-dorsally and bears a transversely concave facet for the mesocuneiform, and on the tibial side is a small oblique surface for the entocuneiform, the head appearing to notch the compound cuneiform in a very characteristic way. This metatarsal rises above the head of mt. III and abuts laterally against the ectocuneiform, with which it articulates by means of two large facets, but no distinct surface for mt. III is visible. The shaft is stout and of trihedral section, becoming broad and more flattened toward the distal end. The trochlea is rather oblique and asymmetrical and the carina is very low and inconspicuous.

Metatarsal III is somewhat longer and much heavier than mt. II; the head bears an oblique facet for the ectocuneiform, which is convex planto-dorsally and is incompletely divided by a constriction from each side into a larger dorsal and smaller plantar portion; the latter is wider than the corresponding surface on the ectocuneiform. On the fibular side are two facets for mt. IV, a large, deeply concave pit near the dorsal border and a much smaller, nearly plane surface on the plantar extension of the head. The shaft is short and heavy, broad and much compressed planto-dorsally, widening distally. A slight degree of asymmetry is shown in the difference between the two lateral borders of the shaft, that on the tibial side being straight, while the fibular border is slightly concave. In the same way, the tuberosity above the pit for the lateral ligament is distinctly more prominent on the fibular than on the tibial side. The trochlea, which is low and wide, is strongly compressed planto-dorsally and the carina, though inconspicuous, is yet more prominent than that of mt. II.

Metatarsal IV is nearly as long as mt. III and heavier, and is somewhat longer and decidedly stouter than mt. II. The proximal end has a large, nearly plane surface for the cuboid, which is somewhat pear-shaped, contracting toward the postero-internal angle. On the tibial side of the head, near the dorsal border, is a very prominent convexity, which fits into the concavity on the fibular side of mt. III, already described; the other facet for mt. III near the plantar side is very much smaller and slightly concave; these two facets are separated by a deep sulcus. The shaft is rather narrow, but thicker planto-dorsally than that of mt. III and having a more rounded dorsal face; the tibial border is nearly straight, while the fibular border is quite strongly concave. This form of asymmetry and the broader, heavier shaft distinguish this metatarsal decidedly from mt. II, of which it is not so nearly a counterpart as it is in the Perissodactyla. The tuberosity on the fibular side of the distal end is much larger and more prominent than that on the tibial side. The distal trochlea is much broader and more symmetrical, but lower, than that of mt. II, and the carina, which divides the plantar side of the trochlea into a broader and more concave external portion and a narrow, flatter internal part, is more distinct.

The phalanges of the three digits are all different from one another; those of digit III are the largest and those of digit II much the smallest of the series, as is also true of the manus, though the phalanges of each digit of the latter are considerably larger than those of the corresponding digit of the pes. In the hind foot the first phalanx of digit II is short, narrow and thick planto-dorsally and nearly symmetrical in form. The proximal surface, for articulation with the metatarsal trochlea, is slightly concave and very shallow and is not grooved for the carina, but has merely a slight notch on the plantar border. Distally, the phalanx becomes somewhat narrower and thinner and the distal trochlea is nearly plane, with only a shallow emargination of the plantar border to indicate the usual division into two facets. The second phalanx is very small, especially in proximo-distal length, but is quite broad and thick in proportion to the length. The proximal articular surface is nearly plane, but the distal one is divided by a shallow, median groove into two parts and is reflected upon the dorsal side of the bone. The ungual is a small, asymmetrical hoof, not unlike that of the tapir; the proximal trochlea is a very shallow concavity, divided by an obscurely marked, median ridge into two depressions. There is no subungual process.

In the manus, the first phalanx of digit II is larger than that of the pes and broader relatively to its length; the proximal trochlea is rather more concave, with plantar margin more distinctly notched for the metacarpal carina; the distal trochlea is a little more convex and a very small area of it appears on the dorsal face. The second phalanx is very like that in the hind foot, except for its larger size and slightly more concave proximal articular surface. I have seen no example of the ungual phalanx.

In the pes, the first phalanx of the third digit is very much larger than the corresponding one of the second digit and is proportionately broader and more depressed, and is also slightly asymmetrical. The very shallow concavity of the proximal end is not grooved for the carina, but the notch for it on the plantar margin is much more distinct and is continued distally as a median depression between two rugose eminences on the plantar face. The distal trochlea is very nearly plane, but is a trifle more convex than in digit II. The second phalanx is likewise much larger than in digit II and proportionately broader and more depressed; the distal articular surface is decidedly saddle-shaped and is reflected upon the dorsal side of the bone, but in a more symmetrical manner than in digit II. The ungual phalanx is large and quite symmetrical, and much depressed, with thin, rugose free border, but without any trace of the median cleft, which is replaced by a low ridge. In appearance, there is considerable resemblance to the median ungual of such Eocene Perissodactyla as *Palæosyops*. The trochlea has two continuous facets, of which that on the tibial side is distinctly the more concave.

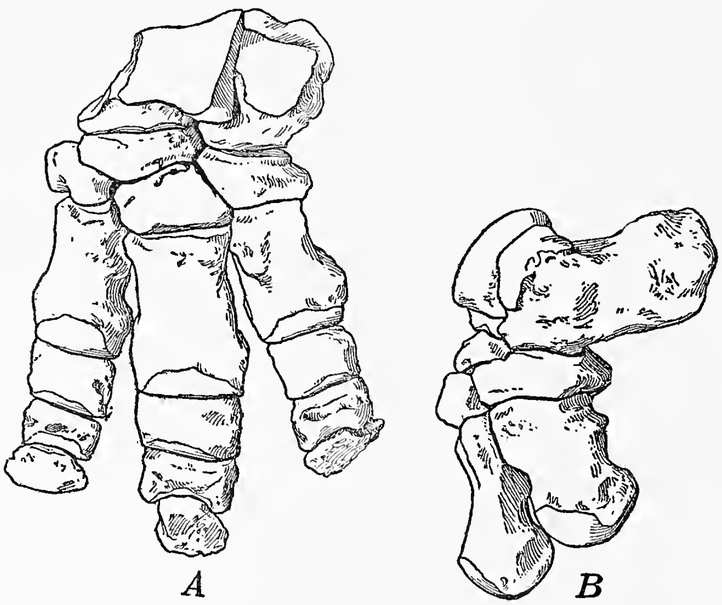
Of digit III in the manus, I have only the second phalanx. This is relatively shorter and much broader than in the pes and has a more concave proximal surface and a similarly saddle-shaped distal trochlea, which is likewise more concave transversely.

When the phalanges of the fourth digit of the pes are put together and in connection with the metatarsal, it is seen that they curve toward the median line in a peculiar and characteristic fashion, which is better shown in Sinclair's figure (see p. 8, text-fig. 4, B) than in Pl. XXV, fig. 9, because in the latter the phalanges are drawn as separated from one another. In this digit the phalanges resemble those of digit II in form, but are considerably larger and somewhat asymmetrical. The distal trochlea of the first phalanx is much more oblique to the long axis of the bone than in digit II or III and is slightly reflected upon the dorsal face, which is not true of the other digits. The ungual is relatively shorter and heavier than in digit II and has a more truncate free border, but is otherwise similar in form.

I have before me only the second phalanx of digit IV in the fore foot and this, except for its larger size, is closely similar to the corresponding bone in the pes, but is not of itself sufficient to show whether the phalanges of this digit had the same medial curvature as in the pes, or not. In both fore and hind foot a long and narrow sesamoid is attached to the metapodials on each side of the distal carina, but there appears to have been none between the second and third phalanges.

In *Toxodon* the pes has undergone some remarkable modifications, most of which are obviously due to the great increase in the size and weight of the animal. The astragalus has an even more flattened trochlea than in *Nesodon* and a somewhat longer and more obliquely directed neck and, on the fibular side, the trochlea projects over and rests upon the distal end of the calcaneum, an additional articulation of an altogether exceptional character, though perhaps an incipient stage of it is present in *Nesodon*. The tuber calcis is very broad and massive, while the portion of the calcaneum distal to the fibular facet is very short; the fibular facet itself is very large, though not so prominent as in the Santa Cruz genus. A very extraordinary feature of this calcaneum is *the position of the cuboid facet, which is on the plantar side, at right angles to its normal position;* the tuber thus projects directly backward, nearly at a right angle with the long axis of the foot. No indication of this most unusual arrangement is to be seen in *Nesodon*, in which the calcaneo-cuboid articulation is of the usual kind. The other tarsal bones resemble those of the Santa Cruz genus in character and arrangement, except that they are relatively shorter proximo-distally and much broader and more massive, a change which is particularly evident in the shape of the ectocuneiform, and in the overlapping of the latter by the cuboid. The metatarsals also are proportion-

FIG. 33.



Toxodon burmeisteri: A, left pes, dorsum, $\times \frac{1}{4}$; *B*, the same, external view. La Plata Museum.

FIG. 34.

Nesodon imbricatus: Left pes, dorsum, $\times \frac{1}{4}$.

ately shorter and much heavier and are of more nearly equal size, though mt. III is somewhat longer, broader and more compressed planto-dorsally than II and IV. The phalanges are shorter, broader and heavier than those of *Nesodon* and the unguals have more the appearance of those of the rhinoceroses.

Restoration. (Pl. XII, fig. 2.) The Santa Cruz fauna is largely made up of mammals which, from our modern standpoint, have a very curious and bizarre appearance. Among the more striking of these is *Nesodon*, which bears but a distant resemblance to any known ungulate of the northern hemisphere, recent or extinct. The short, deep and massive head has a decided suggestion of likeness to the rodent skull, though this likeness is not so strong as in the Typotheria. The neck is short and heavy and most of its vertebræ have neural spines of unusual height.

The thoracic region of the vertebral column is long and, anteriorly, its spines are very high, descending rapidly backward, so as to form a prominent hump at the withers, while the lumbar region is rather short and not very stout. The sacral and caudal vertebræ are not known, but the former may be restored from those of *Adinotherium*, in which the sacrum is long and composed of no less than six vertebræ. The thorax is long, deep and very capacious.

The limbs are short and moderately stout and the anterior pair are somewhat shorter than the posterior, though the difference in length is, to a great degree, compensated by the very large scapula, which has a highly characteristic form, with broad blade and prominent spine, which terminates in a distinct acromion and bears two very large and conspicuous metacromia. The humerus, which is short and heavy, is not especially characteristic, but the fore-arm is remarkable for the great size of the ulna, which, for most of its length, is heavier than the radius. In contrast with this, the tridactyl manus is extremely small in proportion to the size of the animal and the unguals of the lateral digits are almost claw-like.

The pelvis is rather short and heavy, but the iliac plate is only moderately expanded and everted. The femur is relatively long and stout and has a small though very distinct third trochanter, and the patella is very thick and massive. Tibia and fibula are ankylosed at the proximal, but not at the distal end, and the fibula, though much compressed laterally, is still very thick antero-posteriorly. The pes is even smaller and weaker than the manus; the calcaneum has a short and very heavy tuber and articulates in the normal manner with the cuboid. In one of his latest papers, Gaudry figures and describes the pes of *Nesodon* as thoroughly plantigrade and he gives certain reasons, the force of which must be admitted, for this conclusion ('06, 28, fig. 53). A study of all the articulations involved, however, together with the shape of the ungual phalanges, renders the digitigrade attitude more probable, in my judgment. The question is a notoriously difficult one in the case of animals which have no near analogues in the modern world. In size, *N. imbricatus*, which is the abundant Santa Cruz species, does not greatly exceed the American tapirs, though it is decidedly a heavier and stouter animal, with proportions not unlike those of the early rhinoceroses.

A comparison of the skeletons of *Nesodon* and *Toxodon* (cf. Pl. XII, fig. 2, with Lydekker's plate, '93) reveals many differences between the Santa

Cruz and the Pampean genus, not only in innumerable matters of detail, but also in the general proportions and whole appearance of the two animals. *Toxodon* is a far larger and, in particular, a much more massive animal and all the bones of its skeleton are very much heavier, not only actually, but proportionately as well. A very peculiar appearance is given to the skeleton by the relative shortness of the fore-legs, depressing the whole anterior portion of the vertebral column and bringing the head much below the level of the back and loins. This peculiarity is especially striking and remarkable when the skeleton is seen from the front end. Something of the same sort is to be seen in *Nesodon*, but in no such pronounced degree, and this constitutes one of the principal differences in the appearance of the two skeletons.

In *Toxodon* the skull is relatively longer and shallower dorso-ventrally and tapers more to the anterior end; several minor modifications combine to alter its appearance very materially. Of these may be mentioned the more elevated orbits, the much shortened nasals, with the more elongated and sloping anterior nares, the more prominent crest on the dorsal side of the premaxillaries, and the long diastema behind the functional incisors. Even more characteristic is the shape of the mandible, which, with its completely procumbent incisors, depressed and flattened chin, broad and shallow symphysis, and very high, narrow ascending ramus, differs widely from that of *Nesodon*. The neck is relatively short and heavy, and has much less prominent spines than those of the Santa Cruz genus, while in the anterior thoracic region the spines are far higher and heavier and form a more prominent shoulder-hump. In the remainder of the thoracic and the lumbar regions the spines are lower, broader and more plate-like and all have a backward inclination, much as in the Proboscidea. The trunk is relatively shorter, not only having one or two less vertebræ, but the centra of most of the trunk-vertebræ are proportionately shorter and much heavier. The backbone, disregarding the spines, forms a regular arch, curving upward from the neck to the loins. The ribs are very long and broad and are strongly curved outward, forming a very capacious thorax. The sternum has quite a different appearance from that of *Nesodon*, owing to the depressed form of the manubrium, though the two are fundamentally similar.

The scapula has proportions altogether different from that of the Santa Cruz genus, being much longer proximo-distally and narrower transversely.

The prominent spine has no acromion and dies away gradually upon the neck; there is only a remnant of the proximal metacromion about mid-way in the course of the spine, but no trace remains of the distal one, which is so very conspicuous in *Nesodon*. The pelvis is set at a more obtuse angle with the vertebral column than in the latter genus and is relatively shorter, but very much broader. The ilium has a short peduncle, but an immensely expanded and everted plate, causing a decided resemblance to the pelvis of the elephant.

As already noted, the fore-limb is very short and heavy; the humerus is extremely massive and has a greatly developed external tuberosity. The fore-arm bones, which are separate, are also very stout, especially the ulna, which much exceeds the radius in diameter. The hind-limb is much longer and the femur is by far the longest of all the limb-bones and, with its low, massive great trochanter, the antero-posterior compression and flattening of the shaft and the suppression of the third trochanter, has considerable resemblance to that of the elephants. The leg-bones are ankylosed in the same exceptional manner as those of *Nesodon*, that is, fused at the proximal, but not at the distal end. They are relatively much shorter and far heavier than in *Nesodon*, but have a similar laterally compressed shape.

The tridactyl feet resemble those of the Santa Cruz genus in structure and in the mutual relations of the various elements, but the metapodials are remarkably short and extremely stout and tend to an isodactyl arrangement, in which the three metapodials of each foot are of nearly equal weight. The phalanges also are very short, broad and thick. The altogether exceptional character of the calcaneo-cuboid articulation gives a peculiar position to the calcaneum and modifies the appearance of the pes, when seen from the side.

Systematic Position of Nesodon.—That *Nesodon* is nearly related to *Toxodon*, and should be referred to the same suborder, is obvious from the most superficial comparison, but the exact relationship between the two genera offers a much more difficult problem. This problem can receive a definitive solution only when the ancestry of *Toxodon* can be traced back step by step to Santa Cruz times, for our knowledge of the evolutionary process is still too vague for us to determine positively the relation between two genera so widely separated in time and so different in structure. Not unnaturally, therefore, the question has been answered differently by different writers. Lydekker says of *Nesodon:* "It may, indeed, be regarded as the most generalized representative of the group with which we are at present acquainted, although it does not appear to have been the direct ancestor of *Toxodon*" ('93, 25). If my memory does not deceive me, Dr. Roth expressed the same opinion to me in conversation, taking the ground that the more complex grinding teeth of *Nesodon* could not have given rise to the simpler molar-pattern of *Toxodon.* On the other hand, Ameghino ('89[b], 402; '04, 219) appears to hold that the Pampean is directly descended from the Santa Cruz form.

My own opinion is still undecided, though I am somewhat inclined to agree with the position taken by Ameghino. Dental evolution is not, as is often assumed to be the fact, always in the direction of increased complexity of pattern, but may result in simplification. Not to mention such groups as the Edentata and the Cetacea, we find among the Rodentia several clearly demonstrable instances, in which the acquisition or increase of hypsodontism is accompanied by a marked simplification of the molar-pattern, and I can see no insuperable difficulty in deriving the teeth of *Toxodon* from those of *Nesodon.* At all events, *Nesodon* very nearly represents the ancestor sought and may be used for all practical purposes of the comparison. Should it prove to be true that *Nesodon* is not the ancestor, it will, in all probability, be eventually shown that the ancestral and as yet unknown toxodont of Santa Cruz times very closely resembled *Nesodon,* differing from it chiefly in having a less developed post-tympanic region and possibly also in having simpler grinding teeth. In other regards, *Nesodon* is just what we should expect the ancestor of *Toxodon* to be.

Species.—Though remains of *Nesodon* are individually among the most abundant of Santa Cruz fossils, the number of species represented is small. Indeed, only two species, of those hitherto described, can be definitely recognized, *N. imbricatus* and *N. conspurcatus* (i. e. *andium*), and these only by a constant difference of size. Many other names have been proposed, but they are either obvious synonyms, or of very doubtful propriety and until more abundant material has been gathered and especially until the exact stratigraphic succession has been determined, it will hardly be practicable to make a satisfactory decision regarding some of these supposed species.

Nesodon imbricatus Owen.

(Plates XII, Fig. 2; XIII–XVI; XVII, Figs 2, 3; XVIII, Figs. 1, 4, 6, 7; XIX; XX, Fig. 5; XXI, Figs. 1, 2, 11; XXII–XXV; XXVI, Figs. 4–6.)

Nesodon imbricatus Ow.; Rept. Brit. Ass. Adv. Science, 1846, p. 66.
Nesodon Sulivani Ow.; Ibid., p. 67.
?*Toxodon patagonensis* Moreno (*nomen nudum*); Patagonia, resto de un continente hoy submerjido, 1882, p. 22.
Colpodon propinquus Burm. (in part); Anales del Mus. Nac. de Buenos Aires, T. III, 1885, p. 161.
?*Protoxodon patagonensis* (Mor.) Amegh.; Observ. gen. sobre el orden . . . Toxodontes, 1887, p. 62.
Protoxodon marmoratus Amegh.; Enum. sistem., etc., 1887, p. 16.
Protoxodon obliteratus Amegh.; Ibid.
Adelphotherium ligatum Amegh.; Ibid.
Acrotherium rusticum Amegh.; Ibid., p. 17.
?*Gronotherium decrepitum* Amegh.; Ibid.
Scopotherium cyclops Amegh.; Ibid., p. 18.
Protoxodon Sulivani (Owen) Amegh.; Cont. al conoc. de Mam. fos. de la Repúb. Argent., 1889, p. 443.
Acrotherium australe Mercerat; Rev. del Mus. de La Plata, T. I, 1891, p. 391.
Acrotherium intermedium Merc.; Ibid., p. 392.
Acrotherium variagatum [sic] Merc.; Ibid.
Nesodon Oweni Merc.; Ibid., p. 399.
Nesodon cyclops (Amegh.) Merc.; Ibid., p. 400.
Nesodon typicus Merc.; Ibid., p. 402.
Nesotherium Studeri Merc.; Ibid., p. 413.
Nesotherium rufum Merc.; Ibid., p. 416.
?*Nesotherium patagonense* (Moreno) Merc.; Ibid., p. 417.
Nesotherium turgidum Merc.; Ibid., p. 419.
Nesotherium rutilum Merc.; Ibid., p. 420.
Nesotherium argentinum Merc.; Ibid., p. 421.
Nesotherium Nehringi Merc.; Ibid., p. 423.
Nesotherium Burmeisteri Merc.; Ibid., p. 425.
Protoxodon demens Merc.; Ibid., p. 429.
Protoxodon Trouessarti Merc.; Ibid., p. 430.

Protoxodon americanus Merc.; Ibid., p. 431.
Protoxodon decrepitus (Amegh.) Merc.; Ibid., p. 432.
Protoxodon Henseli Merc.; Ibid., p. 435.
Protoxodon speciosus Merc.; Ibid., p. 436.
Adelphotherium lutarium Merc.; Ibid., p. 438.
Adelphotherium trivium Merc.; Ibid., p. 438.
Adelphotherium repandum Merc.; Ibid., p. 439.
Adelphotherium Rothi Merc.; Ibid., p. 440.
Adelphotherium pumilum Merc.; Ibid., p. 440.
Nesodon marmoratus Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 377.
Nesodon obliteratus Amegh.; Ibid., p. 377.
Nesodon cavifrons Amegh.; Énum. synopt., etc., 1894, p. 23.
Nesodon brachycephalus Amegh.; Ibid., p. 24.

"In the whole course of zoological literature there is, I think, nothing to compare with the appalling synonymy of this and the following species [*N. ovinus*]" (Lydekker, '93, 26). While this is true, the reason for the great multiplication of names is not far to seek; it lies in the extraordinary changes in the character of the dentition during the course of individual development, which alter the whole appearance of the animal. This was first pointed out by Ameghino ('91[h]), who showed that the initial confusion arose from the fact that the type of the species, which is an immature animal with the milk-dentition, was described by Owen as an adult. In the long list of synonyms given above, it may well eventually prove that several of the names refer to species distinct from *N. imbricatus;* all that their inclusion in the list implies is, that their claim to separation has not been proved. In his revised lists of the species of *Nesodon* Ameghino ('94[a], 23–24; '94[b], 244–5; '98, 156) retains five, of which only two can be regarded as well established. Of the others, one or more may be distinct, but the available specimens are insufficient to demonstrate this. Both in this genus and in *Adinotherium* Ameghino employs the character of the fronto-nasal suture as a means of specific distinction, referring to *N. imbricatus* most of those skulls in which the posterior ends of the nasals are separated by large triangular processes of the frontals and to *N. marmoratus* those in which the nasal processes of the frontals are absent, the nasals are in contact with each other throughout their length and are received into a deep emargination of the frontals, as in *Adinotherium.*

He adds that 95 per cent. of the specimens from the Santa Cruz beds are referable to *N. imbricatus* ('94[b], 244). While it is perfectly true that differences in the form of the cranial bones may often be used for the distinction of species, yet this criterion is practicable only when the difference is relatively constant. In the present instance, not only is the character a fluctuating one, but the two extremes are connected by intermediate gradations, the nasal processes of the frontals varying much in size to complete disappearance. On the other hand, it may be said that, as a whole, the genus *Nesodon* is characterized by the presence of large nasal processes of the frontals and *Adinotherium* by their absence, though in both genera exceptions are not rare.

Much the same reasoning applies to the supposed species, *N. obliteratus*, which is defined by the absence of the lower canine, the crowded condition of the lower teeth, the less procumbent inferior incisors and the more steeply inclined symphysis. (Ameghino, '94[b], 245.) If they were constant, these characteristics would be quite sufficient to distinguish the species, but, as a matter of fact, they are fluctuating.

Between the two species of *Nesodon* which are here recognized, the only trustworthy distinction is that of size, *N. imbricatus* being the larger and *N. conspurcatus* the smaller. There is, of course, considerable variation in size in both of these species, but they do not seem to intergrade, although there is as great a difference of size between the largest and the smallest individuals of *N. imbricatus* as between the latter and the larger examples of *N. conspurcatus*. In many cases these variations in size are due to differences of age and sex, but there are also marked differences between individuals of corresponding ages. In *N. imbricatus* the upper profile of the skull is typically of a moderate convexity in the anteroposterior direction, but not infrequently there is quite a steep ascent from the forehead to the occipital crest, as in the skull figured in Plate XIII. The forehead itself is nearly plane in the fore-and-aft dimension and is usually a little depressed below the level of the nasals.

In the following table the measurements of a representative series of individuals are given and they bring out clearly the changes in the form and size of the teeth with advancing age, the columns being arranged with the younger individuals on the left and the older on the right, though Nos. 15,135 and 15,252 are of nearly the same age and the former is probably a female.

Measurements.

	No. 15,252.	*No. 15,135.*	*No. 15,000.*	*No. 15,336.*	*No. 15,969.*	*No. 15,256.*
Upper dentition, length	.268	?.250	.272	.296	.279	.275
I^{1}, length (i. e. ant.-post. diam.)	.016		.0175	.017	.021	.018
" width (i. e. transv. diam.)	.031		.028	.029	.0285	.025
I^{2}, length	.017	.016	.0155	.019	.0235	.020
" width	.0165	.015	.016	.020	.026	.025
I^{3}, length	.015		.014	.015	.015	.0135
" width	.0073		.0095	.0105	.010	.011
Upper canine, length	.017		.017		.017	.015
" " width	.0083		.009		.0125	.012
Upper cheek-teeth series, length	.182*	.179	.190		.191	.191
" premolar series, length	.0825*	.082	.082		.080	.080
P^{1}, length	.017	.015	.0165		.0155	.015
" width	.0125	.0125	.013		.014	.019
P^{2}, length	.018	.018	.022	.020	.021	.0195
" width	.016	.019	.0205	.020	.024	.025
P^{3}, length	.019	.0235	.022	.025	.021	.0215
" width	.018	.022	.022	.023	.027	.027
P^{4}, length	.027*	.023	.024	.0245	.025	.024
" width	.029*	.026	.024	.024	.032	.034
Upper molar series, length	.108	.104	.112	.104	.118	.119
M^{1}, length	.036	.031	.036	.030	.032	.031
" width	.028	.025	.027	.029	.036	.037
M^{2}, length	.046	.042	.045	.045	.040	.041
" width	.029	.026	.027	.033	.042	.045
M^{3}, length	.038	.038	.046	.040	.060	.060
" width	.0235	.021	.023	.028	.038	.046

	No. 15,492.						*No. 15,487.*
Lower dentition, length			.262	.255	.262	.251	.269
I_{1}, length			.014	.012	.012	.013	.015
" width			.015	.017	.017	.013	.011
I_{2}, length			.013	.012	.010	.013	
" width			.0215	.020	.021	.014	
I_{3}, length	.023		.028	.025	.028	.026	.021
I_{3}, width	.014		.019	.012	.016	.016	.014
Lower canine, length				.020	.018	.017	
" " width				.0085	.009	.010	

* Dp^{4} still in place.

	No. 15,492.	*No. 15,000.*	*No. 15,336.*	*No. 15,969.*	*No. 15,256.*	*No. 15,487.*
Lower cheek-teeth series, length	.180		.200	.198	.203	
" premolar series, length	.069		.086	.0795	.074	
$P_{\bar{1}}$, length	.0135		.017	.0155	.013	
" width	.009		.0105	.011	.0095	
$P_{\bar{2}}$, length	.015	.017	.020	.019	.017	
" width	.013	.013	.013	.015	.014	
$_{\bar{3}}$, length	.018	.021	.023	.0215	.022	.017
" width	.015	.0145	.0125	.016	.016	.014
$P_{\bar{4}}$, length	.021	.025	.025	.026	.023	.019
" width	.016	.017	.014	.018	.018	.0155
Lower molar series, length	.110	.127	.112	.120	.129	
$M_{\bar{1}}$, length	.027	.031	.031	.029	.029	
" width	.015	.0165	.015	.0185	.018	
$M_{\bar{2}}$, length	.034	.038	.034	.036	.0385	.032
" width	.0165	.017	.015	.016	.0195	.020
$M_{\bar{3}}$, length	.052	.060	.049	.055	.066	.073
" width	.0175	.017	.014	.015	.020	.016

In the foregoing table No. 15,252 is the skull of a young animal, with dp^{4} still in place. No. 15,135 is much the smallest adult skull in the collection, so that I was inclined to refer it to *N. conspurcatus*, but it is rather too large to be referable to that species; it is a little older than the preceding individual and p^{4} was already erupted, but not yet in use, as the crown is still much shorter than that of p^{3} or m^{1}. Though the total length of the upper dentition is so much less than in No. 15,252, it will be observed that the difference is chiefly in the anterior region and that the grinding teeth are of nearly the same size in the two skulls. No. 15,000 is a fully adult skull, but still in early maturity, and Nos. 15,969 and 15,256, which are of almost the same size, are beginning to show signs of age, while No. 15,487 is the mandible of a very old animal. The table brings out clearly the changes in the relative dimensions of the teeth, and especially of the last molar, which accompany increasing age.

In the next table are given the measurements of the milk-teeth, taken from two individuals differing considerably in age and size.

MEASUREMENTS.

	No. 15,001.	*No. 16,010.*
Upper milk-dentition, length	?.133	
Di^{2}, length (i. e. ant.-post. diameter)	.010	
" width (i. e. transverse diameter)	.011	

	No. 15,001.	*No. 16,010.*
Di^3, length	.013	
" width	.006	
Upper milk-canine, length	.014	
" " " width	.006	
Upper milk-premolar series, length	.087	
Dp^1, length	.017	
" width	.009	
Dp^2, length	.019	
" width	.017	
Dp^3, length	.0265	
" width	.018	
Dp^4, length	.033	
" width	.018	
Lower milk-dentition, length	.108	.118
Di_1, length	.009	.007
" width		.011
Di_2, length		.006
" width	.013	.013
Di_3, length	.005	.008
" width	.014	.016
Lower milk-canine, length	.015	.017
" " " width	.0045	.006
Lower milk-premolar series, length	.079	.084
Dp_1, length	.017	.018
" width	.009	.009
Dp_2, length	.019	.019
" width	.009	.0095
Dp_3, length	.021	.023
" width		.010
Dp_4, length	.026	.026
" width	.012	.011
M_1, length		.030

No. 15,001 is the skull of a very young animal, in which the first upper true molar (m^1) is just beginning to erupt and shows no sign of abrasion, while the first lower molar (m_1) was already in partial use, the anterior crescent being slightly worn. No. 16,010 is the left ramus mandibuli of an older and larger animal, in which m_1 is quite fully erupted and both crescents are worn, indicating that the corresponding upper tooth was in function. Curiously enough, no traces of the germs of the permanent premolars are yet visible. Doubtless, the germs were present in the living jaw, but not calcified.

So far as can be determined at present, there are no very marked skull-characters which are diagnostic of the present species. In the great majority of the skulls found the frontals have large, triangular nasal processes, but these processes vary in size and not infrequently are absent. Normally, the upper profile of the skull is nearly straight, or slightly convex antero-posteriorly, but in several specimens the sagittal crest rises quite steeply from the forehead to the occipital crest. In no individual of this species have I observed a descent at the forehead, such as is characteristic, though not invariable, in *N. conspurcatus.* There is considerable variation in the form of the chin and symphysis of the mandible, a variation which does not appear to be correlated with age. In some individuals the symphysial region is much more depressed, in others more erect and abruptly rounded.

MEASUREMENTS.

	No. 15,252.	*No. 15,135.*	*No. 15,000.*	*No. 15,336.*	*No. 15,141.*	*No. 15,256.*	*No. 15,001.*
Skull, length in median base line	.420	?.361	.425	.448	.451	.423	.258
" " fr. occ. condyles	.447		.437	.472	.478	.442	
" length fr. occ. crest to end of nasals	.354	.330	.366			.389	.227
Cranium, length fr. cond. to orbit.	.242		.242	.245		.228	?.155
Face, length orbit to prmx.	.219	.202	.215	.246		.230	.123
Occiput, height	.161		.155			.146	.076
" width at base			.216	.217			
" " over condyles			.098	.110	.127	.096	
Sagittal crest, length	.090	.066	.085			.101	
Zygomatic arch, length fr. glen. cav.	.164	.153	.168	.165	.172	.167	.103
" " width	.075		.078	.087		.106	.0355
Cranium, width at constriction		.055	.059	.062		.060	.055
" zygomatic width			.251	.258		.225	
" depth at tymp. bulla	.144		.121			.136	.068
Face, width over lachrymals		.112	.132	.127		.133	.091
" " " prmx.		.065	.075	.084		.074	.048
" depth at m^1	.173	.153	.166			.188	
" " " p^1	.145	.124	.136	.129		.140	.079
Nasals, length	.184	.180	.202			.204	.095
Palate, length in med. line	.260	.229	.269	.293		.263	.150
" width at p^1	.032	.041	.043	.043		.041	.035
" " " m^3	.081	.088	.098	.106		.098	

	No. 15,492.	*No. 15,000.*	*No. 15,336.*	*No. 15,256.*	*No. 15,001.*
Mandible, length (excl. teeth) . .	.361	.425	.410	.412	.212
" " of symphysis . .	.092	.091		.105	.043
" width at $i_{\overline{3}}$	.065	.076		.065	.042
" depth at $p_{\overline{1}}$	.073	.067	.080	.073	.043
" " " $m_{\overline{3}}$	.077	.100	.080	.084	
" height of condyle . . .	.191	.203	.202	.203	
" " " coronoid . .	.200		.227	.239	
" width, angle to $m_{\overline{3}}$ . .	.149	.192	.152	.168	

The above measurements are taken, in nearly all cases, from the same individuals as those of which the tooth-measurements are given in the preceding tables. No. 15,001 is a very young skull with all the milk-dentition in place and the first molar, above and below, in process of eruption; this skull is not only very much smaller than the adult, but is differently proportioned, the cranium being relatively longer and broader and the face shorter. Of the six adult skulls measured, one, No. 15,135, is very much smaller than any of the others and may possibly belong to a different species, though the evidence is insufficient for such a distinction. The mean basal length of the other five skulls is .435 M. and the skull in question is only 17 per cent. shorter than this average length. Even from the largest of the series, No. 15,141, it differs by only 20 per cent. and such differences are well within the limits of fluctuating variability, as determined by the measurements of many existing species. On the other hand, what suggests the possibility of a specific difference, is the isolated position of the small skull, which is not connected with those of the usual size by numerous intergradations. Nor would this result be materially changed if the measurements of the numerous skulls in the Princeton and New York collections were cited, the series in the table being sufficiently representative.

Bones of the axial and appendicular skeleton are adequately known only in the present species and the account of them in the generic description has been drawn entirely from *N. imbricatus*. In the abundant material there is no complete individual skeleton, though almost all the skeletal elements are represented in the collection. Among these elements there is considerable variation in size and also, in certain cases, some well marked differences in structural features, but, unfortunately, it is not yet practicable to associate these differences with peculiarities of the skull and dentition. It is still an open question, therefore, whether the differences in vertebræ and limb-bones are specific or merely individual.

In two specimens the neck is nearly complete and one of these (No. 15,000) is fortunately associated with a skull, the measurements of which are given in the preceding table.

MEASUREMENTS.

	No. 15,968.	*No. 15,000.*	*No. 15,489.*	*No. 15,967.*	*No. 9192.*
Atlas, length		.069	.078		
" width			?.246		
" height (dorso-ventral) . .		.077	.082		
Axis, length incl. odontoid . . .	.081	.073	.085		
" " excl. "	.055	.051	.059	.060	
" width of anterior face. . .	.101	.093	.113		
" " " posterior face . .	.046	.046	.046	.055	
" height, incl. spine . . .		.097	.105		
Cervical 3, length of centrum . .		.031	.035	.038	
" " width of anterior face .		.042	.042	.044	
" " height excl. spine . .		.063	.072	.074	
" " width over transv. proc. .		.125	.150		
Cervical 4, length of centrum . .		.033	.034	.035	.040
" " width of anterior face .		.040	.042	.047	.048
" " height, excl. spine . .		.062	.068	.071	
" " width over transv. proc. .			.140		
Cervical 5, length of centrum . .		.031	.035	.035	.040
" " width of anterior face .		.039	.043	.046	.048
" " height, excl. spine . .		.058	.067	.071	.079
" " " incl. spine . .		.088		.090	.128
" " ant.-post. width of spine .		.019	.023	.022	.025
" " width over transv. proc. .		.115	.136		.153
Cervical 6, length of centrum . .	.034	.030	.035	.033	.042
" " width of anterior face .	.041		.044	.043	.048
" " height, excl. spine . .	.069	.061	.060	.070	.083
" " " incl. spine . .		.097			
" " ant.-post. width of spine .	.021	.023	.026	.024	.024
" " width over transv. proc. .			.136		.153
" " ant.-post width inf. lamella			.083	.100	?.098
Cervical 7, length of centrum . .	.036	.034	.040	.039	.046
" " width of anterior face .	.043		.044	.047	.049
" " height, excl. spine . .	.076	.068	.065	.076	.084
" " ant.-post. width of spine .	.026	.028	.032	.030	.032

	No. 15,968.	*No. 15,000.*	*No. 15,489.*	*No. 15,967.*	*No. 9192.*
Cervical 7, width over transv. proc. .		.148	.132		.151
Neck, length in straight line . .		.285	.300		
Thoracic 1, length of centrum . .	.044	.037	.045		
" " width of anterior face .	.050	.041	.044		
" " " over transv. proc. .		.115	.138		
" " ant.-post. width of spine .	.034	.032	.032		
Thoracic 2, length of centrum . .				.046	.050
" " width of anterior face .				.048	.045
" " " over transv. proc. .				.120	.132
" " ant.-post. width of spine .				.035	.044
Thoracic 4, length of centrum . .				.048	
" " width of anterior face .				.048	
" " " over transv. proc. .				.101	
" " length of spine . . .				.280	
Thoracic ?11, length of centrum . .	.044				
" " width of anterior face .	.047				
" " " over transv. proc..	.088				
" " length of spine . .	.124				
Thoracic ?16, length of centrum . .				.048	
" " width of anterior face .				.041	
" " " " spine at tip .				.057	
" " length of spine (fr. arch)				.104	
	No. 15,492.				
Lumbar 2, length of centrum . .	.050			.053	
" " width of anterior face .	.035			.046	
" " length of spine (fr. arch) .	.054				
Last lumbar, length of centrum . .			.047		
" " width of anterior face .			.055		
" " " " posterior face .			.057		

No. 15,489 is remarkable for the massiveness of the cervical vertebræ and their thick spines; unfortunately, these spines are all broken, so that their length is not determinable, but they were evidently much longer than in any of the other individuals. No. 15,967 is a large animal, which measures 128 mm. across the occipital condyles, and the third upper molar is 65 mm. in antero-posterior length by 44 mm. in transverse width. No. 15,489 is a very similar animal, of which the skull and teeth are not preserved, while No. 15,968, also a large individual, is represented by a considerable part of the skeleton. No. 15,492, on the contrary, is quite small, the lower series of grinding teeth measuring only 179 mm. in total length.

With the exception of some phalanges of the manus, all of the bones of the fore-limb are represented in the collection, but not by any single individual. The proportions of the various elements cannot therefore, in all cases, be determined by a simple comparison of the measurements.

MEASUREMENTS.

	No. 15,489.	*No. 15,968.*	*No. 15,967.*
Scapula, length	.411	.378	
" greatest width	.205		
" width of neck	.091	.080	
" ant.-post. diam. glen. cav.	.063	.062	
" transv. " " "	.049	.050	
Humerus, length from head		.298	
" " " ext. tuber.		.330	
" proximal thickness		.122	

	No. 15,256.			*No. 15,982.*
Humerus, distal width over epicondyles		.099	.109	
" width of trochlea		.077	.085	
Ulna, length	.331	.349		.349
" " of olecranon	.113	.112		.115
" width at sigmoid notch	.051	.057		.056
" distal width	.015	.020		.020
" " thickness	.021	.029		.0255
Radius, length	.255	.257		.260
" proximal width	.046	.044		.045
" " thickness	.031	.028		.031
" distal width	.055	.051		.056
" " thickness	.044	.042		

The most complete manus in the collection, No. 15,460 (which is shown in Plate XXII, fig. 5), was found isolated, not in association with other bones, but enough is preserved in several other individuals to permit a comparison.

MEASUREMENTS.

	No. 15,460.	*No. 15,968.*	*No. 15,967.*
Carpus, length in median line	.045		
" width of proximal row	.084		
" " " distal row	.084		
Pisiform, length	.050	.045	
" greatest dors.-vent. depth	.032		.030
" width of free end	.023	.022	.023
Metacarpal II, length	.117	.119	.120

	No. 15,460.	No. 15,968.	No. 15,967.
Metacarpal II, proximal width	.0295	.030	.031
" " " thickness	.030	.029	.0315
" " dist. width of shaft	.033		.034
" " width of trochlea	.023		.023
Metacarpal III, length	.123	.125	.128
" " proximal width	.039	.036	
" " thickness	.038	.038	.036
" " dist. width of shaft	.050		
" " width of trochlea	.033	.031	.032
Metacarpal IV, length	.110	.115	.120
" " proximal width	.032	.028	.033
" " " thickness	.029	.0265	.028
" " dist. width of shaft	.0345	.037	
" " width of trochlea	.026	.028	
Phalanx 1, digit II, length	.030		
" " " " prox. width	.024		
Phalanx 2, digit II, length	.024		
" " " " prox. width	.021		
Phalanx 2, digit III, length	.027		
" " " " prox. width	.034		
Phalanx 2, digit IV, length	.024		
" " " " prox. width	.024		

Only in No. 15,967 is the pelvis sufficiently well preserved to yield satisfactory measurements and, even in this case, some of the dimensions can be given only approximately, as, for example, the breadth of the iliac plate.

MEASUREMENTS.

Pelvis, length	.446	Acetabulum, ant.-post. diameter	.066
Ilium, length	.260	" transv. "	.066
" width of neck	.057	Obturator foram., ant.-post. diam.	.098
" " " plate (approx.)	.185	" " transv. "	.065
Ischium, length	.190	Symphysis, length	.142
" posterior width	.151		

Nearly all the femora are more or less damaged, in consequence of which measuring is difficult, but the subjoined table will suffice to show the more important variations in size and proportions.

MEASUREMENTS.

	No. 15,492.	*No. 15,968.*	*No. 15,967.*
Femur, length from head	.311		.336
" " " grt. trochanter	.309		.335
" least width of shaft below 3d troch.	.042	.059	.041
" thickness " " at same point	.033	.037	.038
" proximal width	.120	.138	.123
" distal width	.082	.095	
" " thickness	.096		.110
" width of trochlea	.048	.055	.059
Patella, length		.053	
" width		.058	
" thickness		.042	
Tibia, length (incl. spine)		.297	.315
" proximal width		.085	
" " thickness		.086	
" least width of shaft		.021	.026
" " thickness of shaft		.031	.031
" distal width		.048	
" " thickness		.043	.048
Fibula, length		.260	.266
" proximal width		.029	.033
" " thickness		.048	
" least width of shaft		.015	.018
" " thickness of shaft		.019	.020
" distal width		.032	.033
" " thickness		.039	.041
Pes, length in median line		.216	
Tarsus, length in median line		.073	
Astragalus, length		.050	.063
" width of trochlea		.028	.034
" " of head		.026	.030
Calcaneum, length		.086	.089
" proximal width		.034	.040
" distal width		.031	.033
" width over sustent.		.045	.052
Metatarsal II, length		.073	
" " proximal width		.017	
" " " thickness		.026	
" " distal width of shaft		.023	
" " width of trochlea		.017	
Metatarsal III, length		.075	
" " proximal width		.024	
" " " thickness		.029	
" " dist. width of shaft		.030	

	No. 15,968.
Metatarsal III, width of trochlea . . .	.025
Metatarsal IV, length	.076
" " proximal width . . .	.023
" " " thickness . .	.027
" " dist. width of shaft . .	.028
" " width of trochlea . . .	.023
Phalanx 1, digit II, length	.020
" " " " proximal width . .	.020
Phalanx 2, " " length	.018
" " " " proximal width . .	.017
Ungual, " " length	.024
" " " proximal width . .	.016
Phalanx 1, digit III, length	.028
" " " " proximal width . .	.026
Phalanx 2, " " length	.023
" " " " proximal width . .	.028
Ungual, " " length	.033
" " " proximal width . .	.026
" " " greatest width . .	.033
Phalanx 1, digit IV, length	.027
" " " " proximal width . .	.024
Phalanx 2, " " length	.021
" " " " proximal width . .	.022
Ungual, " " length	.024
" " " proximal width . .	.018
" " " greatest width . .	.020

A comparison of the dimensions of the pes with those of the manus of the same individual, as given in the table on p. 191, will show how very small the hind-foot is, not only in relation to the fore-foot, but still more in proportion to the size of the whole skeleton.

Localities.—This species is one of the most abundant individually and also one of the most widely distributed elements of the Santa Cruz fauna and occurs in almost every fossiliferous locality. Skulls, unfortunately fragmentary, that cannot be distinguished from *N. imbricatus*, are found at Lake Pueyrredon in association with another species, *N. cornutus*, described in a subsequent section. In the region of the plains and the Atlantic coast, the typical Santa Cruz beds have yielded a very large number of individuals and all of those cited in the preceding pages were found on the coast, at Coy Inlet, and 5, 8 and 10 miles south of that Inlet. This, however, is a mere accident of preservation, the better specimens naturally being selected for the purposes of description and measurement. Other points on the coast, such as Cape Fairweather, and in the interior, such as Killik Aike, have produced numerous representatives of this abundant species.

Nesodon conspurcatus Ameghino.

(Text-figure 19, p. 142.)

Protoxodon conspurcatus Amegh.; Enum. sistem., etc., 1887, p. 16. Contrib. al conoc. de Mam. fos. de la Repúb. Argent., 1889, p. 445.
?*Atryptherium bifurcatum* Amegh.; Enum. sistem., etc., 1887, p. 18.
Acrotherium patagonicum Merc.; Rev. del Mus. de La Plata, T. I, 1891.
Nesodon bifurcatus Merc.; Ibid., p. 397.
Nesodon Rutimeyeri Merc.; Ibid., p. 401.
Nesotherium carinatum Merc.; Ibid., p. 412.
Nesotherium elegans Merc.; Ibid., p. 415.
Protoxodon evidens Merc.; Ibid., p. 428.
Nesodon conspurcatus Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 377.
Nesodon andium Amegh.; Ibid.
Nesodon patagonicus (Merc.) Lydekker; Anales del Mus. de La Plata, T. II, 1893, p. 36.

The type-specimen of *N. conspurcatus*, as originally described (Ameghino, '87[b], 16), has only the last two premolars and the molars of the upper jaw, the series of five teeth together measuring 120 mm. in length. From additional material Ameghino subsequently characterized this species by its small size and the rudimentary condition of the first premolar in each jaw ('91[h], 377), the latter feature alone distinguishing it from *N. andium*, as the two supposed species are identical in size. The reduction of the premolar is probably individual rather than specific, for the small teeth that follow the tusks (i^3, $\underline{c}$ and p^1, $\bar{c}$ and $p_{\overline{1}}$) are very variable and of little functional importance. The only character which distinguishes the present species with any degree of constancy is its small size and even this may prove to be fallacious, as there is much difference in this regard among the individuals of *N. imbricatus*, the smallest of which approximate *N. conspurcatus*.

In the Princeton collection there is no specimen which can be confidently referred to the latter species, although one (No. 15,492) has an inferior dentition measuring only 225 mm. from $i_{\overline{3}}$ to $m_{\overline{3}}$, inclusive, while for *N. conspurcatus* and *N. andium* Ameghino gives this measurement as 220 mm. On the other hand, No. 15,492 has a much larger and more robust jaw and probably a considerably larger skull. The skull figured by Lydekker ('93, Pl. XIV) has a sharp descent at the forehead, but this is very much less marked in other individuals of similar size, especially in the type of *N. andium* of the Ameghino collection.

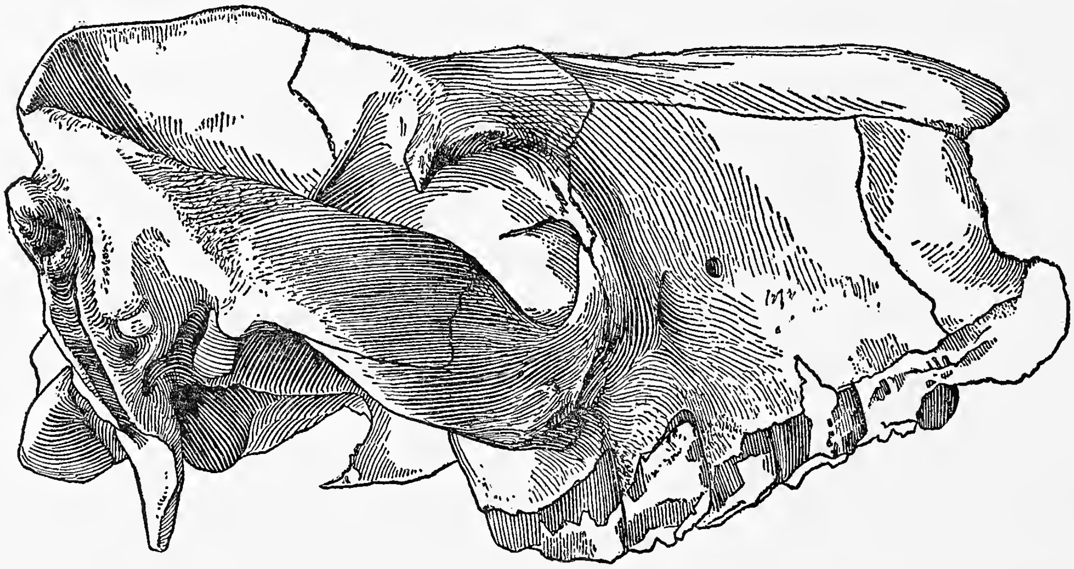
Localities.—No definite localities are given by Ameghino, Mercerat or Lydekker, although the first-named writer states that all of his specimens of *N. andium* were found "near the Cordillera, in the vicinity of Lake Argentino" ('94[b], 239).

Nesodon cornutus, sp. nov.

(Text-figures 35, 36, 38.)

The type, and, as yet the only known representative, of this species is a fairly well preserved skull, without mandible, and with most of the teeth

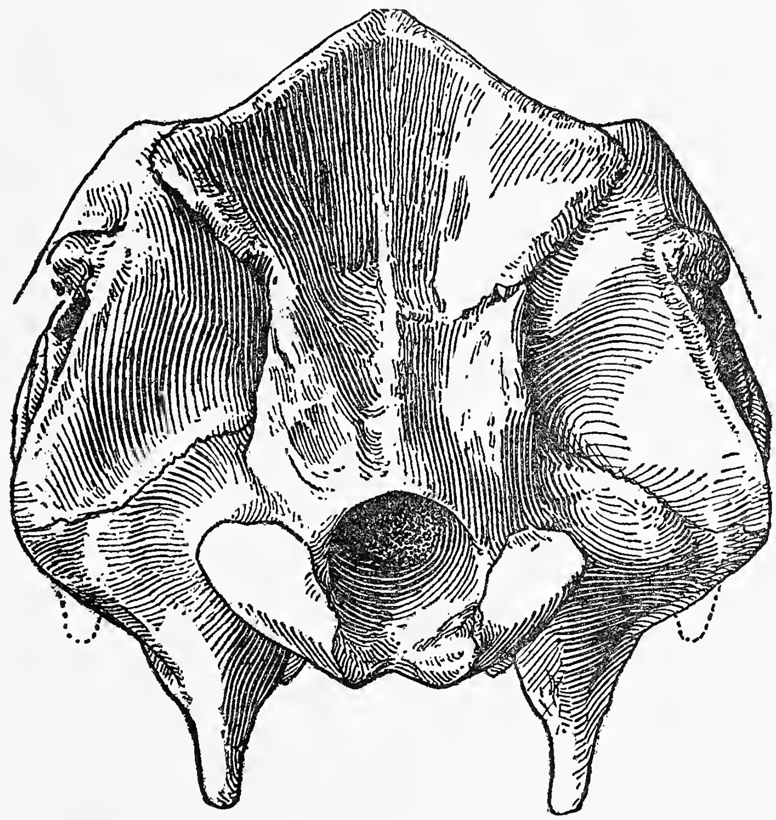
Fig. 35.



Nesodon cornutus, type: Skull, right side, × $\frac{1}{3}$. (No. 16,012.)

either damaged or quite destroyed. In size, it is rather smaller than the average example of *N. imbricatus* and larger than *N. conspurcatus*. One characteristic feature of this skull is the great vertical height of the cranium, which finds expression in the shape of the occiput. This surface, which in *N. imbricatus* is low and wide, the transverse much exceeding the dorso-ventral diameter, in the present species is relatively high and narrow and the two diameters are nearly equal, though the width is slightly greater than the height. The sagittal crest, which is much higher than in any example of *N. imbricatus* that I have seen, rises abruptly at the junction of the supraciliary ridges and thence pursues a nearly horizontal course to

FIG. 36.

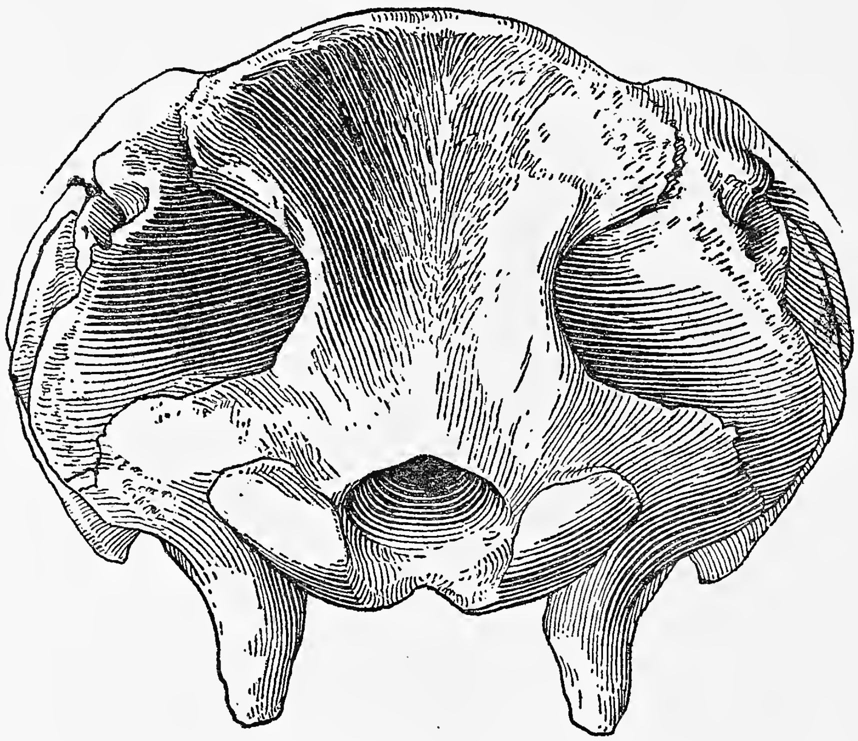


Nesodon cornutus, type: Occiput, × ½. (No. 16,012.)

the occipital crest, where there is a slight descent. The zygomatic arches arise lower down upon the occipital crest than in the preceding species and much more of the cranial wall is visible in side-view than in them. The mastoid process is broken on both sides, but appears to have been somewhat narrower than in *N. imbricatus.*

In all of the many skulls belonging to the latter species which I have examined, the triangular forehead is quite smooth, but in *N. cornutus* there is a low median protuberance, or boss, in the posterior portion of the forehead between the converging supraciliary ridges, very much as in *Adinotherium*. Very probably, this protuberance indicates the

FIG. 37.

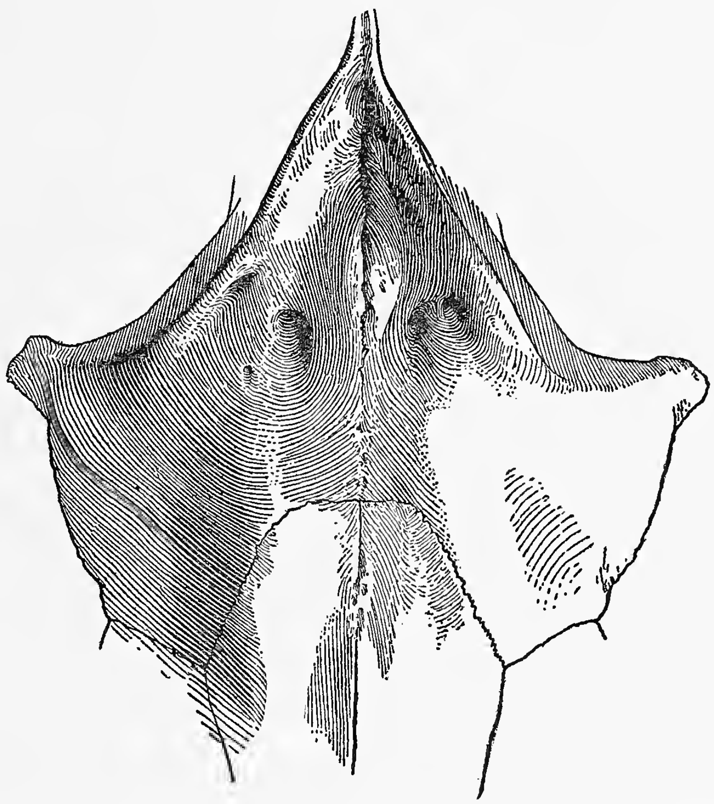


Nesodon imbricatus: Occiput, × ½. (No. 15,437.)

presence, in the living animal, of an incipient dermal horn. Behind and on each side of the protuberance the forehead is finely rugose and quite different from the smooth surface seen in the other species. Above the orbits, the frontals have an unusually swollen appearance, due, no doubt, to a large development of the sinuses, and the postorbital processes are longer and more pointed than in the preceding species. The fronto-nasal suture resembles that of *Adinotherium* in form and in the absence of nasal processes of the frontals, but no dependence can be placed upon this character without a very large suite of specimens. From a single individual it is not possible to say whether this suture is constant or fluctuating.

The nasals, the upper profile of which is a nearly straight, horizontal line, are quite strongly convex in the transverse direction and of spatulate form; they are widest near the anterior end of the premaxillary suture, from which point they narrow very slightly forward and end in very

FIG. 38.



Nesodon cornutus, type: Forehead, showing horn and fronto-nasal suture, $\times \frac{2}{3}$. (No. 16,012.)

bluntly rounded tips, which project but little in front of the free border of the premaxillaries. Posteriorly, the nasals contract very gradually to a point above the second molar and thence broaden slightly to the frontal border; the hinder ends, which are enclosed by the frontals, are wedge-shaped. The lachrymal appears to have no spine, but, as this bone is slightly injured on each side of the head, this is somewhat uncertain.

MEASUREMENTS.

Upper canine, length (i. e. ant.-post. diam.)	.012	Upper premolar series, length	.077
Upper canine, width (i. e. transv. diam.)	.011	P^1, length	.013
Upper cheek-teeth series, length	.187	" width	.014

MEASUREMENTS.

P^{2}, length	.022	M^{3}, length	.055
" width	.022	" width	.045
P^{3}, length	.024	Skull, length occip. crest to tip of nas.	.379
" width	.024	Cranium, length cond. to orbit.	.235
P^{4}, length	.024	Occiput, height	.179
" width	.026	" width at base	.195
Upper molar series, length	.117	Sagittal crest, length	.106
M^{1}, length	.035	Zygomatic arch, length	.156
" width	.033	Cranium, width at constriction	.050
M^{2}, width	.042	Nasals, length	.198

Localities.—The type specimen (No. 16,012) was found by Mr. Hatcher at Lake Pueyrredon. The teeth show that the animal was past maturity.

ADINOTHERIUM Ameghino.

(Plates XII, XVII, XVIII, XX, XXI, XXVI, XXVII.)

Nesodon Owen (in part); Phil. Trans., 1853, p. 291.
Adinotherium Amegh. (in part); Enum. sistemat., etc., 1887, p. 17.
Acrotherium Amegh. (in part); Ibid.
Nesodon Lydekker (in part); Anales del Mus. de La Plata, T. II, 1893, p. 25.
Noaditherium Amegh.; Anales del Mus. Nac. de Buenos Aires, T. XVI, 1907, p. 84.

Most writers on the subject have united this genus with *Nesodon*, but I am inclined to follow Ameghino in regarding it as distinct. The most characteristic features of difference may be enumerated as follows: (1) The species of *Adinotherium* are all much smaller animals than those of *Nesodon*, with no transitions. In itself, this difference is not of generic value, but it is constant and not without significance. (2) The upper premolars are of somewhat simpler pattern, a distinction which can be observed only in nearly or quite unworn teeth. (3) The anterior lobe of the lower molars is relatively broader—the posterior lobe narrower. (4) The rostrum, including the anterior part of the mandible, is much more decidedly broadened, suggesting the form of this region in *Toxodon*. (5) In some species, at least, there is on each frontal a convex rugosity, which apparently indicates the presence of a small dermal horn. In addition, there are several constant and characteristic differences in the vertebræ and limb-bones, to which attention will be called in the succeeding pages. Of these differences, perhaps the most important are to be found in the calcaneum and astragalus, which, though of the same type, are yet quite distinct.

Dentition (Pls. XVII, figs. 4, 5, 10; XVIII, fig. 5; XX, fig. 2; XXVII, fig. 5).—The dental formula is the same as in *Nesodon*, $I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$, and the individual teeth very closely resemble the corresponding ones of the latter, though with certain small and constant differences, which are not altogether without importance.

A. Upper Jaw.—The median incisor is broad, heavy and chisel-shaped, contracting much to the root and therefore diminishing in size with age and the progress of abrasion, while i^2 is a large, trihedral and acutely pointed tusk, growing from a persistent pulp. Both teeth have the same form as in *Nesodon* and pass through the same remarkable series of changes in appearance as in that genus. (See p. 119). Ameghino states ('94[b], 227) that in the fully adult animal the posterior part of this tooth becomes narrowed, ceases to form enamel and gradually develops a long, cylindrical root, but I have seen no example of this. The third incisor and the canine are very small, simple teeth, relatively even smaller and of less functional importance than in *Nesodon*. There is some individual, or possibly specific, difference with regard to the position of the canine; it may either be almost in contact with the first premolar, or separated from it by a very short diastema, or, more rarely, by a considerable diastema.

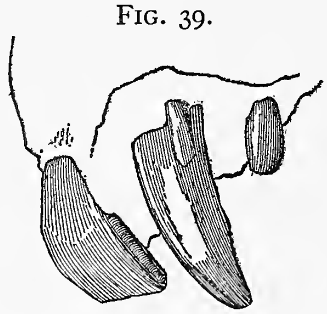
The second and third premolars are somewhat less complex than the corresponding teeth in *Nesodon*, though the difference is not shown in worn teeth, but only in those which are quite freshly erupted; it consists in the much smaller size of the posterior valley in the teeth of *Adinotherium* and in the reduced number, or even absence, of the pits in the floor of that valley. In the worn state, the only noteworthy difference from the premolars of *Nesodon* is in the external wall of the crown, which in p^2 is less distinctly divided into two lobes, but much more so in p^3 and ^{4}. In *Nesodon*, it will be remembered, this division is almost obsolete in p^4. The molars are so precisely like those of *Nesodon*, save only in size, as to require no particular description.

B. Lower Jaw.—The incisors and canine are almost exactly like those of *Nesodon*, but Ameghino states (loc. cit.) that the tusk-like i_3 eventually forms a root and does not continue to grow throughout life. In the material before me I have found nothing confirmatory of this statement, though I am not in a position to question it. The molars differ quite constantly from those of *Nesodon* in a few particulars; the anterior lobe or crescent is relatively somewhat broader and the posterior lobe narrower than in the larger animal, but the difference is not great. All of the lower grinding teeth have, in fact, a curiously narrow, slender appearance.

Milk Dentition (Pls. XVII, figs. 7–9; XVIII, figs. 2, 3).—The temporary teeth differ but slightly from those of *Nesodon* and the functional milk-incisors are almost identical in the two genera, but di^{3} and the upper canine are even smaller in *Adinotherium*, the former especially being a mere slender style; the canine is larger than di^{3}, but still very small. In the accessible material of *Adinotherium*, in which the milk-premolars are considerably abraded, I can detect no tangible difference from those of *Nesodon*, except that in dp^{2} only two spurs, instead of three, project into the principal valley, and that the posterior valley is smaller, as is also the case in its permanent successor. Unworn teeth would probably show greater differences.

Prelacteal Dentition.—As yet, I have seen no well-preserved examples of the prelacteal dentition in this genus, but one individual indicates that

FIG. 39.



Adinotherium ovinum: Left premaxilla with permanent incisors and prelacteal i^{2}, $\times \frac{1}{1}$.

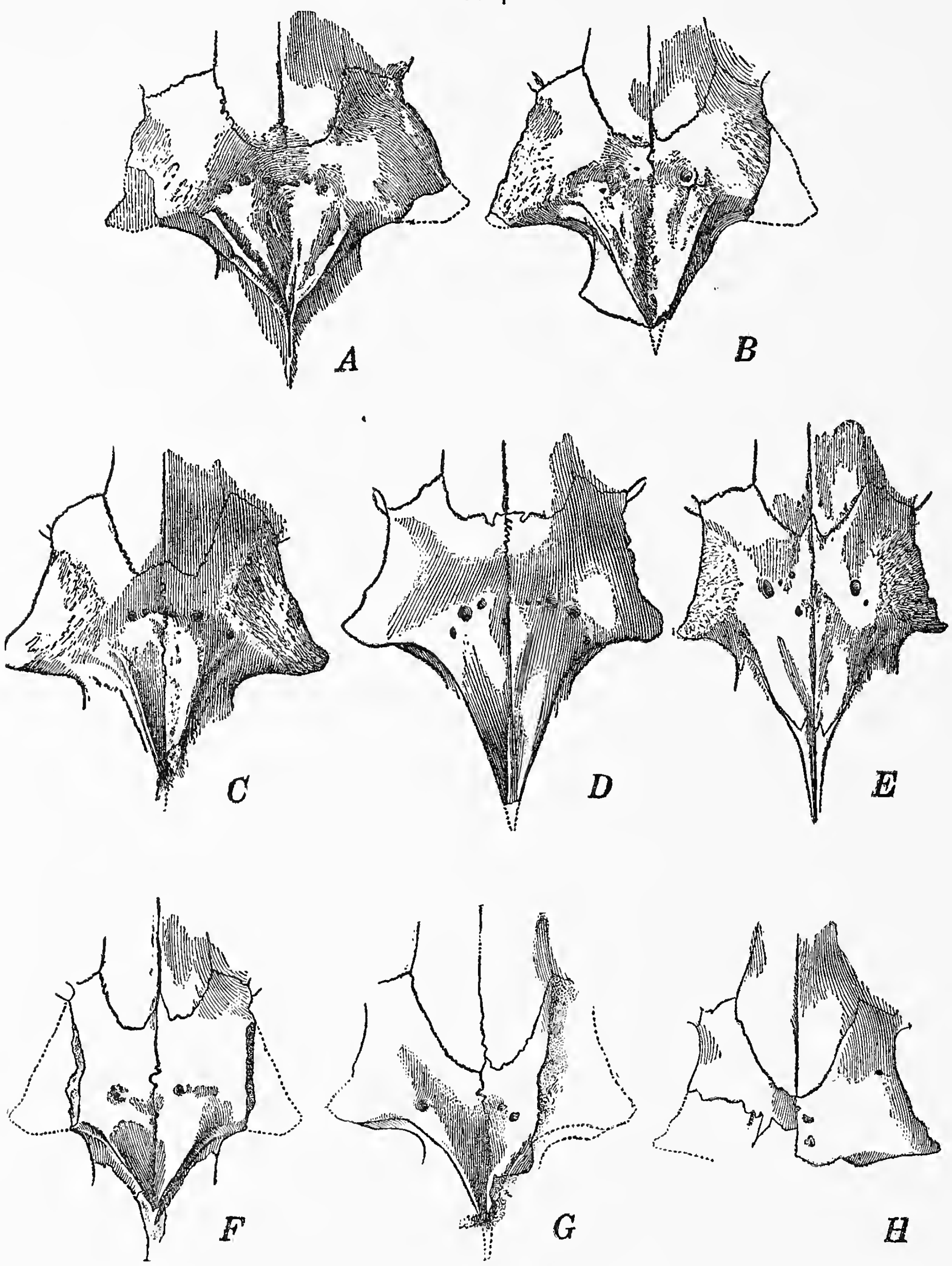
this dentition was present, at least in part. This animal, which is shown in text-fig. 39, retains the small, quill-like, prelacteal upper tusk, which is external to the permanent i^{2} and cannot possibly be di^{2}, as it is far too small, and of an entirely different form.

Skull (Pls. XX, figs. 1–4; XXVI, fig. 2).—Aside from its smaller size and lighter construction, the skull of *Adinotherium* is so very closely like that of *Nesodon*, that it is difficult to find any tangible points of distinction. The most obvious and constant differences are (1) the palatine constriction at p^1 and the forward expansion of the muzzle from that point, which is much more marked than in *Nesodon* and suggests the character of *Toxodon;* (2) the presence of small rugosities on the frontals, which Ameghino regards as the bases of incipient horns; (3) the greater length of the sagittal crest; (4) the different character of the fronto-nasal suture.

The upper profile of the skull is somewhat sinuous, but does not depart widely from a straight line and lies nearly in the same horizontal plane throughout. The sagittal crest is slightly convex in the antero-posterior direction, and the nasals are also somewhat convex in the same direction; between the two, there is a moderate descent at the forehead. The occiput is even lower and wider proportionately than in *Nesodon*, though the difference is not a marked one, and the zygomatic arches rise rather higher upon the lambdoidal crest, giving the skull a somewhat different appearance in side-view. (See Pl. XII, figs. 1 and 2.) The remarkable peculiarities of the auditory region are identical in the two genera except that the mastoid and its process are proportionately less developed in *Adinotherium*. The parietals are relatively somewhat longer than in *Nesodon* and are contracted by a more definite postorbital constriction, and the brain-case is slender and of small capacity.

The frontals differ from those of *Nesodon* in several respects; the supraciliary ridges are rather better defined and extend nearer to the postorbital processes. Between the supraciliary ridges, there is, in a certain proportion of the skulls, a raised and more or less roughened area, which may be single, but is much more commonly divided by a median depression. Ameghino ('07) regards this rugosity as the attachment for an incipient horn and this is very probably the correct explanation, but there is no such definitely rounded form as the dermal horns have in the Perissodactyla, even in the earliest stages, and the median depression would seem to indicate the presence of a pair of very small horns rather than of a single one. Further, there is some indication of a sexual difference in the development of the horns, as in some skulls the rugosities are much less prominent, or may be absent altogether, a difference which is not correlated with the age of the various individuals. Whatever its significance, this roughened area is an almost constant difference from the smooth, plane or even concave surface, which occupies the corresponding position on the forehead of *Nesodon.* Still another difference from the latter is to be found in the character of the fronto-nasal suture. When the frontals possess nasal processes, which separate

FIG. 40.



Adinotherium ovinum: Series showing the variations of the fronto-nasal suture and the frontal horn, $\times \frac{1}{2}$. *A*, No. 15,983; *B*, No. 15,482; *C*, No. 15,382; *D*, No. 9140, A. M. N. H.; *E*, No. 15,159; *F*, No. 15,118; *G*, No. 9571, A. M. N. H.; *H*, No. 15,493.

the hinder ends of the nasals, these processes are always much shorter and narrower than in *Nesodon*, though of similiar triangular shape. More commonly, however, there are no such processes and the anterior border of the frontals is deeply emarginated to receive the nasals in a concavity. According to Ameghino ('94[b], 245) the skulls which have triangular processes of the frontals between the hinder ends of the nasals are the most abundant, but this is certainly not true of the Princeton collections.

The nasals are long and narrow, slightly convex antero-posteriorly and strongly so in the transverse direction; anteriorly, their projection in front of the premaxillæ is rather shorter proportionately than in *Nesodon*, giving a slightly different shape to the narial opening. Posteriorly, there are considerable differences among the various skulls in the form of the nasals, differences which Ameghino has employed for taxonomic purposes ('94[b], 245; '07, 65, ff.), though the variability is such that the taxonomic importance of these characters is very doubtful. Four different types may be distinguished in the form of the hinder ends of the nasals and in the consequent character of the fronto-nasal suture. (1) The nasals are of almost uniform width from end to end and are simply rounded posteriorly; (2) they are suddenly narrowed at the contact with the frontals and make the fronto-nasal suture almost triangular; (3) they gradually narrow backward from the frontal contact and the frontals are less deeply emarginated than in the preceding types. (4) In the first three types the two nasals are in contact with each other throughout their entire length, while in the fourth their posterior ends are separated by small nasal processes of the frontals, as above described. Other slight differences, probably individual, though perhaps specific, may be noted in the shape of the nasals. Usually, these bones are of nearly constant width, with a very shallow constriction near the middle of their length and broadening slightly in front of and behind the constriction. In some cases, however, the bones are widest near the middle, contracting toward the ends, but the difference is by no means striking.

The premaxillæ differ hardly at all from those of *Nesodon;* the ascending ramus is somewhat broader antero-posteriorly in proportion to its height dorso-ventrally and its anterior free border is more vertical, forming a more definite angle with the horizontal ramus. The spine-like rugosities which arise from the antero-dorsal angles of the horizontal rami are rather less conspicuous than in the larger genus. The maxillaries have almost the same proportions as in the latter, while the lachrymals are distinctly smaller, though of similar shape, and have quite prominent spines. Owing to the posterior height of the zygomatic arches, where they rise almost to the level of the sagittal crest, the descent of the arches forward is steeper than in *Nesodon* and the jugal has a more distinct postorbital process or angulation.

The hard palate differs in some particulars from that of *Nesodon*, though the difference can be fully appreciated only when the comparison is made between skulls which are quite free from lateral crushing. In such skulls, the most obvious difference in the palate is its much more triangular form in *Adinotherium*, being relatively broader behind and narrowing forward more strongly to the line between the foremost premolars, thence widening again to the muzzle, which, as already frequently mentioned, is decidedly broader than in *Nesodon*. Individually, the various elements of the bony palate differ very little from those of the last named genus, save as such difference is conditioned by the general form of the whole. The two rows of grinding teeth converge forward much more strongly than in *Nesodon*. The posterior nares, palatines and pterygoids are so nearly as in the latter that no particular description of these parts is required.

The mandible differs in some respects from that of *Nesodon*. As in the latter, the two halves are, in the adult, indistinguishably fused into a single bone and form a long symphysis which is deeply channelled on the dorsal side. One of the most obvious differences from *Nesodon* is in the shape of the symphysial region, which, when viewed from above, is seen to be more distinctly constricted at the line of $p_{\overline{2}}$ and to widen more from this point to the incisive alveoli, in correlation with the similar broadening of the upper jaw. The ventral profile of the chin also differs in being somewhat less steeply inclined and more procumbent. The horizontal ramus has a relatively greater dorso-ventral depth than in *Nesodon*, though the difference is not a striking one, while the proportions of length and thickness are nearly identical in both genera. In *Adinotherium*, however, the ventral border is more strongly and simply convex, less sinuous, and the ascending ramus has a considerably greater antero-posterior breadth in proportion to the length of the tooth-row. The sigmoid notch is shallower than in *Nesodon* and the coronoid is reduced, not rising above the level of the condyle, which is much as in the latter genus and has a similar dependent hook given off from the inner end. The anterior border of the ascending ramus is narrower than in *Nesodon* and the lineæ obliquæ are very obscurely marked, except distally, where the internal border becomes very prominent, but the fossa behind the last tooth is much shallower than in the other genus.

No part of the hyoid apparatus is preserved in connection with any of the skulls and I am therefore unable to say whether the place of attachment is the same highly exceptional one as in *Nesodon*, or not, though one decided difference from that genus should be noted. In *Nesodon* almost every well preserved adult skull shows the stylohyal ankylosed with the anterior end of the bulla, but I have seen no instance of such ankylosis in *Adinotherium*.

Vertebral Column and Ribs.—So far as can be determined from the available material, the vertebral formula appears to be the same as in *Nesodon*, viz.: C. 7; Th. 16–17; L. 4–5; S. 6; Cd.? The neck is short and rather weak and the individual vertebræ closely resemble those of *Nesodon*, with such differences of detail as would naturally occur in a much smaller and lighter animal.

The atlas (Pl. XXVI, figs. 7–9) is very short antero-posteriorly and very broad transversely; the anterior and posterior cotyles are quite as in *Nesodon*, on a smaller scale, but the neural arch is narrower and more slender and has a more pronounced upward curvature, and the spine is quite obsolete, or very faintly indicated. The inferior branch of the first spinal nerve perforates the base of the transverse process, but the ventral opening of this canal is more widely separated from the anterior opening of the vertebrarterial canal than in *Nesodon*.—Except for its smaller size and lighter construction, the axis (Pl. XXVI, figs. 10, 11) is very like that of the latter genus; it has a short centrum which is very broad anteriorly, contracting abruptly behind the transverse processes. The following small differences from the axis of the larger animal may be observed: (1) The odontoid process is more cylindrical and more abruptly truncated at the free end. (2) The anterior cotyles are proportionately narrower transversely, higher and more convex dorso-ventrally and they are separated more distinctly from the odontoid; in some individuals (or perhaps species) this separation is by means of a well-defined sulcus on each side of the process. (3) The centrum has a more distinct ventral keel and a rather more concave posterior face. (4) The neural canal is relatively larger and the spine lower and less massive, but more produced anteriorly. (5) The postzygapophyses are more oblique, presenting more ventrally, less laterally, and their long diameter is antero-posterior, not dorso-ventral. (6) The transverse processes project less laterally and more posteriorly.

The succeeding cervical vertebræ are smaller and lighter proportionately than those of *Nesodon* and have narrower neural arches, leaving wider intervertebral spaces; the neural spines are very low and but feebly developed, except on the seventh vertebra. The transverse processes are more slender than in *Nesodon* and have no such development of the inferior lamella as in that genus.

The thoracic vertebræ (Pl. XXVI, fig. 12) differ from those of the last named genus chiefly in the form of the neural spines. In the anterior portion of the region the spines are long, laterally compressed and thin and have a strong backward inclination, but they do not have any such exaggerated length as in *Nesodon* and *Toxodon* and there is no hump at the shoulders. Posteriorly, the spines decrease in length very gradually and, owing to the upward curvature of the back-bone in this region, the tips of the spines lie in nearly the same horizontal plane throughout, which is in marked contrast to the arrangement seen in the larger genera (see Pl. XII, figs. 1 and 2). Behind the middle of the thoracic region the spines are quite low and weak, becoming broader and stronger in the posterior region, where they lose their backward inclination and become nearly erect. Cylindrical, interlocking zygapophyses are present only on the last two vertebræ and metapophyses only on the last. In all of the thoracic vertebræ, except the first and last, the neural arch is perforated on each side by a conspicuous foramen for the passage of the spinal nerve.

Of the lumbar vertebræ (Pl. XXVI, fig. 1) probably five were present normally, though no individual has yet been found in which all of the lumbars are preserved. As compared with those of *Nesodon*, these vertebræ have relatively lower and broader neural spines, which are either erect, or have a slight backward inclination, none of them inclining forward, while the transverse processes are longer, narrower and more antroverted. On the penultimate lumbar the transverse processes are broader than on the preceding vertebræ and on the last one they become very much broader and have articular facets for those of the penultimate lumbar and first sacral, as already described for *Nesodon*. In all of the lumbar vertebræ the spinal nerves pass out through deep and narrow notches, which emarginate the pedicles of the neural arch.

The sacrum (Pl. XXVI, fig. 1) resembles that of *Toxodon* on a very small scale, but is relatively longer and has one additional vertebra, six instead of five. The centra are broad and much depressed and that of the last vertebra is so large as to indicate a well developed tail, which was probably proportionately longer and more slender than in the Pampean genus. The surfaces for the attachment of the ilia are remarkably small, though relatively as large as in *Toxodon*, and, as in that genus, are formed almost entirely by the pleurapophyses of the second sacral. The transverse processes of the succeeding vertebræ are fused into a broad, very thin plate on each side, perforated by the foramina for the spinal nerves, which are relatively much smaller and less conspicuous than in *Toxodon*. In the latter the last sacral has on each transverse process a facet for articulation with the first caudal, but in *Adinotherium* the first caudal seems to be fused with the sacrum. The prezygapophyses of the first sacral are prominent and functional and bear well defined metapophyses; those of the succeeding vertebræ are vestigial, but less reduced than in *Toxodon*. At the anterior end of the sacrum the neural canal is broad, but very low and depressed, and at the posterior end it is very small and nearly circular, the relative size of the canal being much the same as in *Toxodon*. The degree to which the neural spines of the sacrum are fused into a ridge differs in various specimens, though the material is insufficient to show whether the difference is specific or individual, or merely a matter of age. The spines of the first and last sacrals are isolated, while those of the intermediate vertebræ are ankylosed for more or less of their height, but the tips are always free. In *Toxodon* only the first spine is separate; all the others are indistinguishably fused into a continuous ridge.

No caudal vertebræ of this genus have as yet been identified, though the character of the tail may be inferred from that of the sacrum.

The ribs are much more slender than those of *Nesodon*, but otherwise so like them as to require no particular description. The sternum is still unknown, but was doubtless essentially similar to that of *Nesodon*.

Appendicular Skeleton.—The scapula (Pl. XXVII, figs. 8, 9) closely resembles that of *Nesodon*, but differs in a number of details, as may be readily seen on comparing Figs. 1 and 2 of Plate XII. The outline of the blade is much the same in the two genera, but in *Adinotherium* the coraco-scapular notch is shallower and less distinct and the coracoid border has a more regularly convex curvature, passing without angulation into the suprascapular border. The spine arises farther below the suprascapular border and rises to its full height more abruptly. The two metacromial processes are of quite different shape and relative size from those of the larger animal; the proximal one is smaller and of more triangular shape, while the distal one is much longer and narrower and has a rounded border at the free end, instead of the straight border seen in *Nesodon*. In all of the available specimens the acromion proper is broken away, but, from the thinness of the fractured bone, it is very probable that this process was decidedly shorter than in *Nesodon* and may have been almost absent. The coracoid also is very small and much more reduced than in the last-named genus.

The humerus (Pl. XXVII, fig. 4) differs little, save in size, from that of *Nesodon*. The external tuberosity is a high and very broad ridge, which extends across nearly the whole proximal end, concealing the head in front-view; the free proximal border is more horizontal than in *Nesodon*. The internal tuberosity is very small and the broad bicipital groove is divided into two parts by a very inconspicuous bicipital tubercle, which is in hardly more than an incipient stage. The deltoid ridge is more prominent and ends more abruptly below than in *Nesodon*. The distal end of the humerus differs in a number of particulars from that of the latter genus; the supinator ridge is longer and more prominent, but the epicondyles, especially the external one, are much less so; the trochlea is relatively narrower and has a more prominent internal flange for the ulna and a more convex facet for the head of the radius; the supratrochlear fossa is shallow, but the anconeal fossa is very deep and a perforation connects the two.

The fore-arm bones are almost exact replicas, on a smaller scale, of those of *Nesodon*, with hardly any differences that can be expressed in a description. The ulna (Pl. XXVII, figs. 10, 11) has a very prominent and stout olecranon, which, however, is relatively somewhat shorter than in the last named genus. The sigmoid notch is almost identical in form in the two genera, but in *Adinotherium* the external border of the proximal portion is not flared upward so strongly, while the distal portion presents more anteriorly and less proximally. The shaft, which is relatively somewhat longer than in *Nesodon*, is rather less distinctly trihedral and has a more concave posterior border and the interosseous crest is much less prominent. The styloid process and carpal facet are similar to those of *Nesodon*, but are proportionately narrower and thicker palmo-dorsally.

The radius (Pl. XXVII, figs. 12–15) differs from that of *Nesodon* in a number of unimportant details. It is somewhat more slender in proportion to its length and the shaft is more irregular in shape, with less marked antero-posterior compression, and very feebly developed interosseous crest; the proximal articular surface is more distinctly divided into two facets for the humeral trochlea and, near the internal side, the anterior border is raised into a more prominent and pointed process, and on the external side of the head is a large facet for the attachment of a sesamoid bone. On the distal end, the two carpal facets are more distinctly demarcated than in *Nesodon* and the external portion of the scaphoid facet does not notch the dorsal border so deeply, while the lunar facet is narrower palmo-dorsally.

The manus (Pl. XXI, figs. 4, 7) is of exactly the same type as in *Nesodon* and, save in size and in a few details of proportion, the differences are quite insignificant. The scaphoid is slightly lower and narrower, in proportion to its dorso-palmar thickness, than in *Nesodon*, and there are several differences in the shape of the facets. The proximal surface, for the radius, narrows more and is less elevated toward the palmar side; the facet for the trapezoid is narrower and less deeply concave and that for the magnum contracts more toward the palmar border. There is no surface for the trapezium. On the ulnar side, in addition to the proximal facet for the lunar, there is a very small distal one for the same bone, which is not present in *Nesodon*. The lunar is of almost identical form in the two genera, but there are some differences in the facets. In *Adinotherium*, the dorsal portion of the proximal surface is more convex and is reflected farther down upon the dorsal face of the lunar, while the palmar portion is decidedly narrower, as is also the palmar prolongation of the unciform facet, between which and the magnum facet there is no such emargination from the palmar border as occurs in *Nesodon*. On the ulnar side, as in the latter, there is no proximal contact with the pyramidal and the distal articulation is confined to a very narrow strip. The pyramidal is broad transversely, but very short proximo-distally, relatively shorter than that of *Nesodon*, but otherwise resembling it, though the proximal surface for the ulna is somewhat less deeply concave.

There is more difference between the two genera in the shape of the pisiform than in any other carpal element. In *Adinotherium*, the proximal end of the pisiform is relatively broader and much more depressed and the facets for the ulna and pyramidal are relatively smaller; the tuber is more slender and has a straighter inferior border, while the free, or distal, end is less thickened and rugose. It should be added, however, that there is considerable difference among various individuals in the shape of the pisiform. Its character in some specimens approaches that of *Nesodon*, but I have no means of determining whether this variation is specific or merely individual.

The trapezium is not preserved in any of the examples of the manus, but was no doubt present. The trapezoid differs in hardly any appreciable way from that of *Nesodon;* it is a little broader in proportion to its proximo-distal length and contracts to a narrow palmar edge, while the distal facet for mc. II is more concave transversely, less so palmo-dorsally. The magnum differs from that of *Nesodon* chiefly in its reduced dorso-palmar diameter and in the very small size of the palmar rugosity. Like the trapezoid, the magnum also narrows more to a palmar edge and the facets are all correspondingly narrowed. The trapezoid facet is relatively larger and the sulcus which invades it from behind is much smaller. The unciform, like most of the other carpals, is proportionately lower and wider than in *Nesodon* and has a narrower palmar projection. Of the two proximal facets, that for the lunar is not reflected down upon the palmar side so far as in the latter genus and that for the pyramidal has no such palmar extension. The same is true of the facet on the radial side for the process from the head of mc. III, this surface being confined to the dorsal moiety of the unciform, instead of extending over the whole dorso-palmar diameter of the bone, as it does in *Nesodon*.

As in *Nesodon*, the metacarpus consists of three functional members, mc. II, III and IV, and a vestigial representative of mc. V. The functional elements, except for their very much smaller size, closely resemble those of *Nesodon*, but are proportionately somewhat more slender. Metacarpal II reproduces that of the last-named genus almost exactly, but the projection from the palmar side of the head is decidedly more prominent, though less rugose. On the radial side, the facet for the trapezium is somewhat smaller and the proximal surface for the trapezoid is rather less concave; the projection from the ulnar side, which abuts against the magnum, overlaps the head of mc. III less extensively and the facet on the distal side of this projection is considerably narrower. The shaft, save for its smaller size and slightly more slender proportions, does not differ from that of *Nesodon*, but the distal trochlea is rather more symmetrical and the carina is even less prominent. Metacarpal III differs in only a few details from that of *Nesodon*. The proximal facet, which is overlapped by mc. II, is narrower and, on the ulnar side, the process which articulates with the unciform is smaller and the facet for the unciform is narrower, especially toward the palmar side; the two large, concave facets which articulate with corresponding surfaces on mc. IV, are more completely separated, not connected by a narrow, articular band. The shaft has a slightly different shape, being of a more uniform width and not broadening distally so much.

Metacarpal IV is slightly longer in relation to mc. II, which it almost exactly equals in length, than is that of *Nesodon*, though, owing to the manner of articulation with the carpus, mc. IV. extends distally below mc. II. This outer metacarpal differs in a few respects, besides relative length, from that of *Nesodon*: The proximal facet which is covered by the head of mc. III is narrower and is confined to the dorsal moiety of the head; the two projections on the radial side, which fit into corresponding depressions on the ulnar side of mc. III, are more completely separated and the palmar one is more prominent and, on the ulnar side, the facet for mc. V is narrower. The shaft is somewhat straighter and less irregular than in the larger animal. A small and very irregular nodule represents the vestigial remnant of mc. V; it has three well-defined facets, for mc. IV, the unciform and pyramidal respectively, for it has the remarkable peculiarity of articulating with the proximal carpal as well as with the distal one. I have not seen this bone in *Nesodon*, though there can be no doubt as to its presence in that genus. Judging from Ameghino's figure of the manus in *Xotoprodon* ('94[b], 246, fig. 1) it is relatively longer and narrower than in *Adinotherium*.

The phalanges are very much like those of *Nesodon*, but smaller and relatively lighter. Those of the lateral digits (II and IV) are of almost exactly the same size, forming digits of nearly equal length. Of the median digit (III) the proximal phalanx is slightly shorter than in the other digits, but broader, more depressed and symmetrical; the second and ungual phalanges are both longer and broader than in the lateral digits, but also more depressed and flattened.

The pelvis (Pls. XXVI, fig. 1; XXVII, fig. 17) displays a number of differences from that of *Nesodon.* The ilium has a somewhat longer neck, which is thin and laterally compressed and has no distinct ilio-pectineal process or pubic border, having lost, as in the other genus also, the original trihedral shape. The iliac expansion or plate is relatively narrow and but little everted and the gluteal surface is nearly flat; the crista shows a slight tendency to a division into dorsal and ventral portions, which, however, are much less distinct than in the Litopterna. The acetabulum is of a slightly depressed, oval shape and the sulcus for the round ligament is relatively much larger than in *Nesodon.* The ischium is slender and compressed and has no definite tuberosity or sciatic notch; the pubis also is slender and enters into a long symphysis with its fellow. The obturator foramen differs in shape from that of *Nesodon* in being broader and less regularly oval.

The femur (Pl. XXVII, figs. 1–3) besides being smaller and lighter than that of *Nesodon*, differs from it in a number of details. The head is set upon a more distinct neck and is lower, not rising above the level of the great trochanter; the pit for the round ligament is even smaller, though a trifle deeper, than in the last named genus and the notch between head and great trochanter is deeper and narrower. The posterior face of the proximal part of the shaft is very flat and smooth and there is no intertrochanteric ridge. The second trochanter is more prominent than in *Nesodon*, but not so elongate proximo-distally, while the third trochanter is distinctly shorter and less prominent than in the latter. The shaft has a shape similar to that of *Nesodon*, but is more compressed antero-posteriorly and has a less convex anterior face, and the pit for the plantaris muscle is very inconspicuous. The rotular groove and femoral condyles do not differ in any significant features from those of *Nesodon.*

The patella (Pl. XXVII, fig. 16) is very similar to that of the latter, but is relatively more elongate proximo-distally, which is chiefly due to the greater extension of the external part of the distal border, and it has the same great antero-posterior thickness; the articular surface for the femoral trochlea is less unequally divided into outer and inner facets and the dividing ridge is even less distinct.

As in *Nesodon*, the leg-bones (Pl. XXVII, figs. 6, 7) are ankylosed at the proximal, but not at the distal end. Except in size, there is hardly any tangible difference between these bones and those of *Nesodon*, at least so far as the damaged specimens at my disposal admit of a comparison. The tibia has a somewhat less prominent and less rugose cnemial crest, which ends rather more abruptly below. A more important, though not at all striking, difference between the two genera is in the character of the surface for the astragalus, which in *Adinotherium* has a better defined intercondylar ridge, covers the distal end of the bone more completely and is more broadly continuous with the facet on the internal malleolus. This latter facet is also larger and extends over the entire fibular side of the process. The fibula lacks the interosseous crest, which is so conspicuous on the distal half of the bone in *Nesodon*, and the distal end is relatively narrower, especially on the posterior side.

There is a close resemblance to *Nesodon* in the character of the hind-foot (Pl. XXI, figs. 3, 5, 6, 8, 9), though accompanied with more difference of detail than is the case in most of the other skeletal structures. A full comparison of the two genera in regard to the pes is not, however, practicable, as I have seen no quite perfect example of the hind-foot of *Adinotherium*. The astragalus is proportionately longer and narrower than in *Nesodon* and, on the tibial side, is considerably depressed planto-dorsally; the trochlea is somewhat, though not very much, more deeply and narrowly grooved; the external condyle is relatively larger and rises higher above the level of the internal one, and the whole trochlea is more convexly arched proximo-distally, while the facet for the fibula is broader planto-dorsally. The rugose tuberosity on the tibial side of the trochlea, near the proximal end, which is so conspicuous in *Nesodon*, is much reduced and hardly perceptible in *Adinotherium*. In the latter genus the neck of the astragalus is considerably longer and more oblique, projecting more strongly toward the tibial side. On the plantar side, the two calcaneal facets are more widely separated and the pit between them is much shallower, and the sustentacular facet, indeed the whole tibial side of the bone, projects much more strongly plantarwards. The external calcaneal facet is of more uniform width and the sustentacular facet is much smaller, more oval in shape, and partly or completely separated from the surface for the navicular, which, owing to the obliquity of the neck, it touches near the fibular border, while in *Nesodon* it becomes confluent with the navicular facet near the tibial border. The navicular facet itself is relatively narrower and of more quadrate outline in *Adinotherium*.

The calcaneum has a somewhat more elongate, slender and laterally compressed tuber than in *Nesodon*, with a more nearly straight plantar border; the fibular facet is shorter proximo-distally, but more prominent and rises more abruptly from the dorsal side, and the external facet for the astragalus is less oblique and is not extended so far upon the tuber. The sustentaculum is less produced proximo-distally and its two diameters are more nearly equal; it is also relatively thinner planto-dorsally and has a deeper and better defined sulcus on the plantar face. The distal facet for the cuboid is rather more concave. Ameghino, who has given a very full comparison of the calcaneum and astragalus of *Adinotherium* and *Nesodon*, says of them: "Ces différences dans la forme du calcanéum et de l'astragale sont aussi importantes que celles qui existent entre les mêmes os des Paleothères et des chevaux, animaux qui l'on place dans deux familles différentes" ('94[b], 243). In my judgment, however, this greatly overstates the importance of the differences above described. These differences are merely such as one would expect to find between a relatively large and heavy animal and a small and light one of the same group.

The remaining elements of the tarsus in *Adinotherium* are less different from those of *Nesodon* than are the calcaneum and astragalus. The navicular and cuboid differ hardly at all in shape and proportions from those of the latter, but the plantar hook of the navicular is even more reduced and on the cuboid also this hook is very inconspicuous, and the proximal surface of the cuboid for the calcaneum is somewhat more convex. The ento- and mesocuneiforms are ankylosed and the compound bone agrees in every respect, save size, with that of *Nesodon*, but the ectocuneiform differs in several details. It is relatively narrower and slightly higher proximo-distally and contracts more rapidly toward the plantar side; the proximal facet for the navicular is more nearly concave and the facet on the fibular side for the cuboid is much more extended planto-dorsally.

The metatarsals are very much smaller than the metacarpals and show the same lack of symmetry as in *Nesodon*. Metatarsal II is the shortest and most slender of the series, though there is no great difference in length between any of the three members, and is considerably more slender in proportion to its length than in *Nesodon*, which it otherwise resembles in shape and connections. Metatarsal III is much heavier and somewhat longer than mt. II, and in shape and proportions is very similar to that of *Nesodon*, except that the distal broadening of the shaft is more gradual. Metatarsal IV is also very stout, much heavier than mt. II; indeed, the proximal end has as great a dorso-plantar diameter as that of mt. III, but is a little narrower transversely.

The phalanges of digit II are much more reduced than those in the corresponding digit of the manus and are considerably smaller proportionately than those of *Nesodon;* they are short, narrow and thick, not depressed, and the small ungual is not cleft. In digit III the phalanges are very much larger than in either of the lateral digits and thus make the median toe greatly exceed both the laterals in length. Nearly all of this excess is due to the phalanges, for the three metatarsals differ but little in regard to length and, relatively, these phalanges are longer and narrower than in *Nesodon*. Compared with those of the median digit of the manus, they are slightly longer, broader and more depressed and flattened. The phalanges of digit IV, as in *Nesodon*, considerably exceed those of digit II in size.

Restoration (Pl. XII, fig. 1).—In its general appearance and proportions, the skeleton of *Adinotherium* differs very considerably from that of *Nesodon*, being not only a much smaller, but also a much lighter animal, and lacking entirely the massiveness of structure which characterizes *Nesodon*. The proportions of the skull, as to length and dorso-ventral height, do not differ materially in the two genera, but in *Adinotherium* the neck is slightly shorter, the length of the skull being taken as a standard, and much lighter, the processes of the cervical vertebræ being relatively shorter and more slender. The trunk, on the other hand, is proportionately longer and the vertebral column has quite a different appearance, owing partly to the lesser degree of curvature in the anterior region of the thorax and still more to the shorter and more slender neural spines. The changing length of the spines quite accurately compensates for the curvature of the column, so that their free ends reach nearly the same horizontal plane and the profile of the back must have been almost straight in the living animal. This is in very marked contrast to the arrangement seen in *Nesodon*, in which the great length of the anterior thoracic spines produces a considerable hump at the shoulders. In *Adinotherium* also the posterior thoracic and lumbar spines are broader and lower. The thorax is shallower and less capacious in the latter and the ribs more slender and less strongly arched outward.

The scapula differs more from that of *Nesodon* in appearance than does any other bone of the skeleton; the blade is narrower and more recurved and the spine also pursues a more curved course, running nearly parallel with the coracoid border. But the chief difference lies in the position and shape of the two very conspicuous metacromial processes, which in *Adinotherium* are closer together and the proximal one is smaller and more triangular, while the distal one is very much longer and narrower than in *Nesodon*. The pelvis also is longer and narrower than in the latter, the ilium having a longer neck and less expanded plate and the ischium being more elongate and slender. The limbs are relatively shorter, so that *Adinotherium* was proportionately a longer and lower animal, but the limb- and foot-bones are almost copies, on a smaller and lighter scale, of those of *Nesodon*, though there are several differences in the details of structure. For the most part, however, these minor differences are such as may properly be referred to the merely mechanical conditions of a rather massive and a small, light animal, and are hardly visible in a general view of the two skeletons, though obvious enough when the bones are separately compared. A not inconspicuous difference is in the character of the femur, which in *Adinotherium* is more slender, less flattened, and has a more prominent third trochanter; the calcaneum also has a longer and less massive tuber, which lends a somewhat different appearance to the pes.

This comparison has reference entirely to the two commonest species of their respective genera, *A. ovinum* and *N. imbricatus*. No doubt, other and greater differences might be enumerated, were the comparison extended to several species of each genus, but for this purpose the material now available is not sufficient.

Species.—The lack of accurate knowledge of the stratigraphy of the Santa Cruz beds is an insuperable obstacle to any satisfactory discrimination of the species of almost any genus of the Santa Cruz fauna and the toxodonts offer nearly as difficult a problem in this regard as do the gravigrade edentates. At present, we have but very inadequate means of distinguishing contemporary and fluctuating variations from successive and relatively constant mutations and, until that distinction can be made, nothing more than a tentative arrangement of species is practicable. Ameghino has, it is true, given some valuable stratigraphical notes upon the vertical range of the species, but these notes are far from exhaustive and they do not entirely agree with the results obtained by Messrs. Hatcher, Peterson and Brown. Before full and trustworthy evidence upon these points can be obtained, it will be necessary to make very much larger collections than have yet been gathered and, above all, to make these collections together with a minutely accurate stratigraphical survey. Until then, the problem of species will be incapable of satisfactory solution.

In his latest publication on this genus ('07, 67–89) Dr. Ameghino recognizes six species of *Adinotherium*, *A. magister*, *A. ovinum*, *A. nitidum*, *A. corriguenense*, *A. ferum* and *A. robustum*, to which should be added two species referred to other genera, the so-called *Acrotherium karaikense* and *Noaditherium splendidum*. *A. haplodontoides* Amegh. ('91[b], 129; 91[h], 376; 94[a], 25) is not mentioned, even in the synonymy. The six species enumerated are arranged in two series, in accordance with the presence or absence of the incipient frontal horn. An obvious suggestion, which almost forces itself upon the observer, is that this minute horn is a sexual rather than a specific character, especially as the horned skulls are almost always larger and more robust and have more prominent and rugose crests and processes, all of which are characteristically male features. Of course, this suggestion does not necessarily imply that some of the species may not have been hornless in both sexes, for that would be quite compatible with the presence of horns in the males of other species, as appears to have been the case in *Nesodon*. In that genus only one of the known species, *N. cornutus*, distinguishable as such upon other grounds, shows any indication of the frontal horn, but, within the limits of the species, the horn may well have been a sexual character. At present, however, there is no way of deciding whether this is true or not.

Ameghino attaches much importance to the form of the fronto-nasal suture for the discrimination of species in both *Nesodon* and *Adinotherium*, but I have found this character, in the latter genus as well as in the former, too fluctuating to be trustworthy. Broadly speaking, there is a distinction between the two genera in regard to the form of this suture; in *Adinothe-*

rium the frontals usually have no nasal processes and, when present, these processes are always very small, while in *Nesodon* they are commonly large and conspicuous, but may be entirely absent, and every gradation between the two extremes may be found in any large series of skulls.

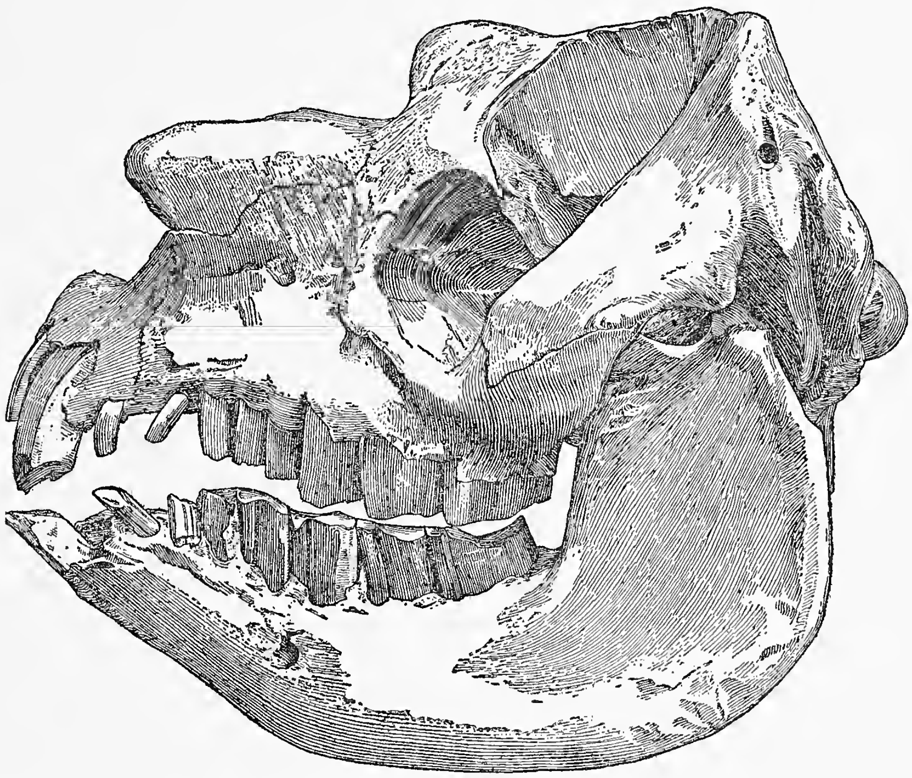
In the original description of most of the species (Amegh., '87[b], 17, 18) they are distinguished almost entirely by differences of size, but in the latest paper ('07) the diagnoses and descriptions are much more full and complete and deal largely with the characters of the skull, distinguishing the species in what appears, at first sight, to be a very satisfactory manner. I have, however, found the greatest difficulty in applying these definitions to the material contained in the Princeton and New York collections. Not only does Ameghino take no account of individual and possible sexual differences, but the characters upon which he lays the chief stress are combined in a very different way in the material before me from the association of features found in his specimens. To adopt his method would involve a great increase in the number of species, for hardly any of the skulls at my disposal agree at all closely with his descriptions and figures and there is such variation among them that any constant characters are very difficult to find. It is just here that the lack of stratigraphic information makes itself so painfully felt and it may very well turn out, when that information shall have been secured, that several of the species, here regarded as synonyms, are entitled to recognition.

The arrangement of species which follows is, it must again be emphasized, purely tentative and is founded upon the assumption that the females were hornless and that the males, of most of the species at least, possessed a small frontal horn, or possibly a pair of such horns.

The Systematic Position of Adinotherium.

In the paper already so often cited ('07, 57–59) Ameghino reports the extraordinarily interesting and unexpected fact that the genus *Trigodon* (or *Eutrigodon*, as it was formerly called) from the Monte Hermoso beds, possesses a very large and conspicuous, median, frontal boss, which must have served in life to support an unpaired dermal horn, like that of certain rhinoceroses, especially, though on a far smaller scale, like that of *Elasmotherium*. "Cette protubérance s'élève graduellement du bout antérieur du plan sagittal vers l'avant, mais dans la partie antérieure elle descend brusquement, de sorte que la bosse entière semble penchée en avant. La surface de cette protubérance est très rugueuse, la partie se trouvant dans cette condition parfaitement délimitée de la partie lisse, de sorte qu'il ne peut rester aucun doute que cette bosse servait à supporter une forte corne qui était inclinée en avant" (t. c., p. 57). Another remarkable peculiarity of *Trigodon* is that in the mandible the number of

Fig. 41.



Trigodon gaudryi. Skull, left side, about $\frac{1}{6}$ nat. size. From a photograph of a specimen in the Ameghino collection. Monte Hermoso beds.

incisors is uneven, 5 instead of 6, the unpaired one standing in the median line of the symphysis. So many individuals have been found, all of which show the same curious arrangement, that the chance of its being an abnormality is very small; both Lydekker ('93, 20) and Ameghino ('07, 55) agree in regarding it as normal and constant in the genus. Unusual as the condition is, the fact of its constant occurrence may be accepted without difficulty, though few, I think, will be inclined to follow Ameghino in believing that the unpaired tooth has been formed by the coalescence of the two median incisors.

Certain mandibles of *Nesodon imbricatus* appear to show a similar arrangement of the incisors as an individual peculiarity, but the imperfection of the specimens precludes any positive statement regarding them.

Ameghino regards *Adinotherium* as the ancestor of the Haplodontheriidæ, the family to which he assigns *Trigodon*. "Aussi bien les Haplodontheriidæ que les Toxodontidæ, ils prennent leur origine dans les Nesodontidæ. Les Haplodontheriidæ descendent du genre *Adinotherium*, tandis que les Toxodontidæ doivent descendre d'une espèce du genre *Nesodon*" ('07, 91). Not at all improbably, this may prove to be the correct interpretation of the relationships of *Adinotherium*, but, on the other hand, the discovery of a species of *Nesodon*, *N. cornutus*, which appears to have the same small dermal horn as *Adinotherium*, leads to the conjecture that *Nesodon* may perhaps have been the ancestor of *Trigodon*. This conjecture is somewhat strengthened by the fact that in the latter genus the shape of the muzzle and symphysial region of the mandible is more as in *Nesodon*, *Adinotherium* agreeing better in this regard with *Toxodon*. In short, it is possible that Ameghino's suggestion should be reversed, but only the identification of the successive steps of change which led up to *Toxodon*, on the one hand, and *Trigodon*, on the other, will enable us to decide this question.

Adinotherium ovinum (Owen).

(Plates XII, Fig. 1; XVII, Figs. 4, 5, 7–10; XVIII, Figs. 2, 3, 5; XX, Figs. 1–4; XXI, Figs. 3–10; XXVI, Figs. 1–3, 7–12; XXVII.)

Nesodon ovinus Owen; Phil. Trans., 1853, p. 291.
? *Adinotherium magister* Amegh.; Enum. sistem., etc., 1887, p. 17.
Adinotherium proximum Amegh.; Ibid.
Adinotherium ferum Amegh.; Ibid., p. 18.
? *Acrotherium mutabile* Mercerat; Rev. del Mus. de La Plata, T. I, 1891, p. 393.
? *Nesodon typicus* Mercerat; Ibid., p. 402.
? *Adinotherium haplodontoides* Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 129.
Adinotherium ovinum (Owen) Amegh.; Ibid., p. 376.
Adinotherium Kobyi Mercerat; Rev. del Mus. de La Plata, T. I, 1891, p. 410.

As here regarded, this species is of medium size, horned in the male (*A. ferum* Amegh.) and hornless in the female and in the former the cranium is lower and wider and the zygomatic arches are much more expanded. *A. magister*, as figured by Ameghino ('07, 70, fig. 9) differs so much from his specimen of *A. ovinum* (ibid., p. 73, fig. 10) in the form of the cranium and especially of the nasals, that it should perhaps be admitted as distinct, but, as already pointed out, dependence upon such characters would increase the number of species beyond all reasonable probability. As the description of the genus is drawn principally from individuals referred to *A. ovinum*, it remains merely to give the dimensions.

MEASUREMENTS.

	No. 15,131.	*No. 15,118.*	*No. 15,382.*	*No. 15,003.*
Upper dentition, length	.143	.147		
I^1, length (i. e. ant.-post. diam.)	.0055	.007		
" width (i. e. transv. diam.)	.008	.018		
I^2, length	.013	.014	.0125	
" width	.0135	.013	.014	
I^3, length	.005	.0045		
" width	.004	.0035		
Upper canine, length	.006			
" " width	.004			
Upper cheek-teeth series, length	.096	.094	.096	
" premolar series, length	.041	.0435	.0405	
P^1, length		.008	.006	
" width		.006	.006	
P^2, length	.0105	.0105		
" width	.0105	.0115		
P^3, length	.011	.012	.011	
" width	.0125	.012	.014	
P^4, length	.012	.013	.013	
" width	.014	.0155	.016	
Upper molar series, length	.057	.0555	.059	.051
M^1, length	.015	.017	.0135	.016
" width	.019	.021	.0215	.017
M^2, length	.020	.022	.020	.019
" width	.0205	.0235	.024	.0195
M^3, length	.028	.026	.030	.0225
" width	.019	.021	.0235	.017
		No. 15,136.		
Lower dentition, length	.135	.143		.124
I_1, length	.006	.006		.004

	No. 15,131.	*No. 15,136.*	*No. 15,003.*
$I_{\bar{1}}$, width	.008	.010	.008
$I_{\bar{2}}$, length	.008	.0055	.005
" width	.0105	.013	.010
$I_{\bar{3}}$, length	.014	.014	.012
" width	.010	.010	.007
Lower canine, length	.010	.009	.0085
" " width	.0045	.004	.0045
" cheek-teeth series, length	.105	.102	.091
" premolar series, length	.043	.044	.038
$P_{\bar{1}}$, length	.008	.007	.0075
" width	.005	.0045	.0043
$P_{\bar{2}}$, length	.009	.010	.010
" width	.006	.006	.0055
$P_{\bar{3}}$, length	.011	.012	.010
" width	.007	.0075	.007
$P_{\bar{4}}$, length	.0125	.0135	.0115
" width	.008	.007	.0073
Lower molar series, length	.062	.059	.053
$M_{\bar{1}}$, length	.014	.016	.0145
" width	.008	.008	.007
$M_{\bar{2}}$, length	.0185	.019	.017
$M_{\bar{3}}$, length	.030	.025	.0235
" width	.008	.008	.007

Aside from the effects of age and wear, these measurements, it will be observed, agree quite closely. The effects of abrasion are clearly shown, for example, in the very small size of I^{1} in No, 15,131, which is quite an old female and in which the median upper incisors are worn to mere stumps. In the old animals also the third molar is relatively larger, as appears from a comparison of the measurements of Nos. 15,131 and 15,003, the latter a young and quite small female. The other individuals are males and No. 15,136 is especially large and robust; the skull has the frontal protuberance, but the upper cheek-teeth are unfortunately all missing.

Several young individuals enable me to give the dimensions of the milk-teeth, but the skulls in all cases but one have lost the lower jaw.

MEASUREMENTS.

	No. 15,159.	*No. 15,945.*	*No. 16,011.*	*No. 15,114.*
Upper milk-dentition, length	.085	.082		.0835
Di^{1}, length (i. e. ant.-post. diameter)	.004	.004		.0043
" width (i. e. transv. diameter)	.011	.011		.013

	No. 15,159.	*No. 15,945.*	*No. 16,011.*	*No. 15,114.*
Di^2, length	.0055	.0055		.006
" width	.008	.008		.010
Di^3, length	.005	.005		.0045
" width	.004	.003		.003
Upper milk-canine, length.	.0065	.006		.0066
" " " width	.005	.0035		.0036
Upper milk-premolar series, length . .	.0455	.051		.045
Dp^1, length	.008	.009		.009
" width	.005	.005		.0055
Dp^2, length	.011	.012	.011	.0103
" width	.0095	.009	.009	.0095
Dp^3, length	.0135	.017	.0155	.014
" width	.012	.012	.011	.012
Dp^4, length	.017	.019	.018	.017
" width	.015	.0135	.0135	.014
M^1, length	.021	.021	.0215	.0205
" width	.0145	.012	.0125	.013

Of these four specimens, No. 16,011 is the youngest and in it m^1, though almost fully erupted, shows no signs of wear; next in point of age comes No. 15,945, in which the foremost part of m^1 is somewhat abraded, while in No. 15,114 this tooth was in full use and is considerably worn. No. 15,159 is the oldest of the series. The dimensions of the lower milk teeth are all taken from a single individual, No. 15,159, in which m$_1$ is in quite an advanced stage of wear.

Lower milk-dentition, length . .	.073	Dp$_1$, length	.006
Di$_1$, length.	.004	" width.	.004
" width	.007	Dp$_2$, length	.0105
Di$_2$, length.	.0035	" width.	.006
" width	.0095	Dp$_3$, length	.013
Di$_3$, length.	.004	" width.	.0065
" width	.008	Dp$_4$, length	.015
Lower milk-canine, length	.0075	" width.	.007
" " " width	.003	M$_1$, length	.017
Lower milk-premolar series, length .	.0445	" width	.0075

From the considerable number of skulls which are probably referable to this species it is necessary to make a selection for measuring and the choice is made so as to display the different proportions which are believed to characterize the two sexes and also to bring out the range of individual variation in size. Nos. 15,003 and 15,131 are presumably females, while the others are supposedly males with frontal horn.

MEASUREMENTS.

	No. 15,003.	*No. 15,131.*	*No. 15,118.*	*No. 15,382.*	*No. 15,983.*
Skull, length in med. basal line . .		.236	.245	.238	
" " fr. occ. condyles . .		.253	.256	.258	
" " fr. occ. crest to end of nasals			.224		
Cranium, length fr. cond. to orbit .	.148	.145	.146	.151	
Face, length fr. orbit to prmx. . .		.115	.116	.117	.117
Occiput, height	.101		.085		
" width at base . . .	.104		?.121	.133	
" " over condyles . .	.051	.054	.059	.061	
Sagittal crest, length	.087		.082		
Zygomatic arch, length fr. glen. cav. .	.088	.100	.093	.096	.081
" " width (dorso-vent.) .	.039	.048		.048	
Cranium, width at constriction . .	.030		.034	.042	.039
" zygomatic width . . .	.139		.154	.161	.180
" depth at tympanic bulla .	.107	.110	.102		
Face, width over lachrymals . .			.070	.080	.084
" " " prmx.			.049	.047	
" depth at m^1		.099	.098	.083	.095
" " " p^1		.080	.079	.061	.079
Nasals, length		.101	.092	.105	.101
Palate, length in median line . .		.153	.152	.143	.145
" width at p^1		.018	.023	.022	.024
" " " m^3	.054	.040	.052	.048	
Mandible, length (excl. teeth) . .	.202	.212			
" " of symphysis . .	.054				
" width at i_3.	.031	.042			
" depth at p_3	.041	.039			
" " " m_3	.045	.050			
" height of coronoid . .	.125				
" " " condyle . .	.124				
" width, angle to m_3 . .	.084	.084			

In some respects these measurements are misleading, owing to the distortion of the skulls through pressure. Nos. 15,003 and 15,982 are almost free from distortion, though in the latter the great zygomatic breadth may have been somewhat exaggerated. No. 15,118 is slightly asymmetrical, but in Nos. 15,181 and 15,382 material changes in the proportions of the skull have been caused by pressure; the former has suffered from a lateral compression, which has notably diminished the transverse dimensions, while in the latter the compression was vertical, increasing the transverse and decreasing the vertical dimensions, except in the case of the palate, which appears to be normal.

The measurements of the skeleton are nearly all taken from a single individual, No. 15,131, missing parts supplied from other specimens.

MEASUREMENTS.

Atlas, length	.037
" height (dors.-vent.)	.043
Axis, length incl. odontoid	.044
" " excl. "	.030
" width of anterior face	.056
" " of posterior face	.022
" height, incl. spine	.049
Cervical 3, length of centrum	.018
" " width of ant. face	.019
" " height, excl. spine	.034
" " " incl. "	.040
Cervical 4, length of centrum	.018
" " width of anterior face	.022
" " height, incl. spine	.041
Cervical 5, length of centrum	.019
" " width of anterior face	.022
" " height, excl. spine	.033
" " " incl. "	.043
Cervical 6, length of centrum	.018
" " width of anterior face	.022
" " height, incl. spine	.043
Cervical 7, length of centrum	.020
" " width of anterior face	.022
" " height, excl. spine	.031
Thoracic 1, length of centrum	.019
" " width of anterior face	.023
" " " over trans. proc.	.067
Thoracic 4, length of centrum	.025
" " width of anterior face	.020
" " " over trans. proc.	.044
" " height, incl. spine	.103
Thoracic 7, length of centrum	.028
" " width of anterior face	.025
" " " over trans. proc.	?.042
" " height, incl. spine	.088
Thoracic 9, length of centrum	.025
" " width of anterior face	.021
" " height, incl. spine	.068
Penult. thoracic, length of centrum	.029
" " width of ant. face	.027
" " height, incl. spine	.046
Lumbar 1, length of centrum	.028
" " width of ant. face	.022
" " height, incl. spine	.050
Lumbar 2, length of centrum	.031
" " width of ant. face	.023
" " height, incl. spine	.050
Lumbar 3, length of centrum	.032
" " width of ant. face	.025
Sacrum, length in med. line	.184*
Sacral 1, width of ant. face.	.035*
" " " over pleurap.	.103*
Sacral 6, width of post. face	.030*
" " depth " " " (dors.-vent.)	.015*
Scapula, length	.199†, .190
" greatest width	.108†
" width of neck	.046†, .040
" " glen. cav. (trans.)	.025†, .024
Humerus, length from head.	.165*, .163
" " " ext. tuber.	.180*, .175
" proximal width	.050*
" " thickness	.059*, .061
" distal width over epicondyles	.051*, .051
Humerus, distal width of trochlea	.039*, .040
Ulna, length	.198
" " of olecranon	.065
" width at sigmoid notch	.024
" distal width	.010
" " thickness	.0135
Radius, length	.146
" proximal width	.024
" " thickness.	.016
" distal width	.033
" " thickness	.019

* No. 15,966.
† No. 15,004.

The dimensions of the manus are taken from two individuals, one of which, No. 15,158, is a very young animal with metacarpal epiphyses still separate.

	No. 15,131.	*No. 15,158.*
Carpus, length in median line	.024	.025
" width of proximal row	.041	.038
Pisiform, length	.023	.020
" greatest dors.-vent. depth	.013	.013
Metacarpal II, length		.052
" " proximal width		.013
" " distal width of shaft	?.0155	.015
" " width of trochlea	?.011	.011
Metacarpal III, length	.060	.055
" " proximal width.	.016	.017
" " distal width of shaft.	.019	.017
" " width of trochlea	.0135	.013
Metacarpal IV, length	.050	.050
" " proximal width	.014	.015
" " distal width of shaft	.015	.014
" " width of trochlea	.0105	.0115
Phalanx 1, digit II, length.	.013	
" " " " proximal width	.012	
Phalanx 2, digit II, length.	.009	
" " " " proximal width	.0105	
Ungual, digit II, length	.010	
" " " proximal width	.010	
Phalanx 1, digit III, length	.013	
" " " " proximal width	.015	
Phalanx 2, digit III, length	.0105	
" " " " proximal width	.013	
Ungual, digit III, length	.011	
" " " proximal width	.0125	
Phalanx 1, digit IV, length	.014	.011
" " " " proximal width	.012	.0125
Phalanx 2, digit IV, length	.010	
" " " " proximal width	.0105	
Ungual, digit IV, proximal width	.0095	

The pelvis is not sufficiently well preserved in any of the specimens to render satisfactory measurements practicable, and in the most complete skeleton (15,131) the bones of the hind leg and foot are all more or less injured and distorted, so that measurements of other individuals are added for comparison.

	No. 15,131.	No. 15,127.
Femur, length from head	.187	.185
" " " grt. trochanter	.187	.187
" least width of shaft below 3rd troch.		.026
" " thickness at same point.		.016
" proximal width	.058	.061
" " thickness.		.027
" distal width	.044	.047
" " thickness	.048	.048
" width of trochlea	.024	.026
Patella, length	.029	
" width	.026	
" thickness	.028	
		No. 15,480.
Tibia, length incl. spine	*.165	?.186
" proximal width	.042	.051
" " thickness	.041	.049
" least width of shaft		.013
" " thickness of shaft	.018	.017
" distal width	.023	.025
" " thickness	.0225	.0265
Fibula, length	.140	.156
" proximal width	.015	.018
" " thickness.	.022	.027
" least width of shaft	.006	.009
" " thickness of shaft	.010	.011
" distal width	.017	.017
" " thickness	.021	.023

* Considerably reduced by distortion.

Unfortunately, the pes of No. 15,131 is quite incomplete, lacking the calcaneum and astragalus, which are supplied from No. 15,978, and most of the fourth digit. In the American Museum collection, however, is a nearly perfect hind-foot, No. 9275, with only the astragalus missing. All these individuals agree well in size.

	No. 15,131.	No. 9275.
Tarsus, length in median line	.038	
Astragalus, length	.030	
" width of trochlea	.014	
" " " head	.013	
Calcaneum, length	.053	.053
" proximal width		.018
" distal width	.017	.016
" width over sustentaculum	.025	.024

	No. 15,131.	*No. 9275.*
Metatarsal II, length	.040	.041
" " proximal width	.0085	.008
" " " thickness	.015	.015
" " distal width of shaft	.010	.011
" " width of trochlea	.009	.010
Digit II, length	.068	.071
Metatarsal III, length	.044	.044
" " proximal width	.0135	.015
" " distal width of shaft	.015	.016
" " width of trochlea	.013	.014
Digit III, length		.095
Metatarsal IV, length		.041
" " proximal width	.014	.014
" " " thickness	.016	
" " distal width of shaft		.015
" " width of trochlea		.0125
Digit IV, length		.079
Phalanx 1, digit II, length	.0105	.011
" " " " proximal width	.0095	.0105
Phalanx 2, " " length	.008	.009
" " " " proximal width	.009	.0095
Ungual, digit II, length	.013	.012
Ungual, digit II, proximal width	.008	.008
Phalanx 1, digit III, length	.0155	.0175
" " " " proximal width	.014	.015
Phalanx 2, " " length	.012	.013
" " " " proximal width	.0115	.012
Ungual, digit III, length		.021
" " " proximal width		.014
Phalanx 1, digit IV, length		.015
" " " " proximal width		.013
Phalanx 2, " " length		.011
" " " " proximal width		.012
Ungual, digit IV, proximal width		.0105

Localities.—Nearly all the representatives of this species in the collections of Princeton University and the American Museum, collected by Messrs. Hatcher, Peterson and Brown, were obtained on the Atlantic coast near Coy Inlet and from five to twenty miles south of that point; a few only were found at Killik Aike.

ADINOTHERIUM NITIDUM Ameghino.

Adinotherium nitidum Amegh.; Enum. sistem., etc., 1887, p. 18.
?*Adinotherium corriguenense* Amegh.; Anales del Mus. Nac. de Buenos Aires, T. XVI, 1907, p. 77.

The only definite character which distinguishes this species is its small size. In the original description (loc. cit.) the length of the last five lower teeth ($p_{\overline{4}}$–$m_{\overline{3}}$) is given as 52 mm. and the depth of the jaw below $m_{\overline{3}}$ as 37 mm., dimensions which in a small individual of *A. ovinum* are 74 and 46 mm. respectively. The skull-characters which Ameghino cites in his last paper ('07, 74, 76, fig. 12) are not trustworthy, because the specimen figured is a very young animal and agrees closely with young skulls of *A. ovinum*. None of these small skulls has yet been found having any indications of horns and it may well be that this was a hornless species in both sexes.

Localities.—The type of *A. nitidum* was found in the cliffs of the Rio Santa Cruz and that of *A. corriguenense* at Corriguen Aike on the Atlantic coast.

ADINOTHERIUM ROBUSTUM Ameghino.

Adinotherium robustum Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 376.

Among the material now accessible to me, this probably valid species is represented by a photograph of the type in the Ameghino collection, a skull (No. 9532) and an incomplete fore-foot (No. 9184), both belonging to the American Museum. The skull, which is in a good state of preservation, though much cracked and somewhat distorted by vertical down-crushing, agrees well with the type in size and proportions (cf. Amegh., '07, 83, fig. 16), but has quite a different fronto-nasal suture, which is more regularly curved than in the type and the nasals narrow less toward the posterior end. The skull in question is without frontal boss and is therefore probably a female.

A. robustum is distinguished by its larger size and heavier and more robust proportions than in any of the other known species of the genus; the cranium is unusually broad and capacious and the zygomatic arches are greatly expanded, even in the female skull. The auditory chamber in the post-tympanic portion of the squamosal is inflated so as to form a protuberance on the occipital surface, which is more conspicuous than in any of the other species, indeed, than in any other known member of the sub-order. The sagittal crest is very high and descends quite steeply to the forehead.

The dimensions in the following table are taken from No. 9532, A. M. N. H., an adult, still rather young, as is shown by the relatively small size of m^3.

MEASUREMENTS.

Upper dentition, length	.160
I^1, length (i. e. ant.-post. diam.)	.007
" width (i. e. transv. diam.)	.018
I^2, length	.0125
" width	.014
I^3, length	.005
" width	.003
Upper canine, length	.007
" " width	.005
Upper cheek-teeth series, length	.107
Upper premolar series, length	.043
P^1, length	.008
" width	.006
P^2, length	.011
" width	.011
P^3, length	.0115
" width	.0125
P^4, length	.013
" width	.016
Upper molar series, length	.064
M^1, length	.018
" width	.0225
M^2, length	.023
" width	.024
M^3, length	.030
" width	.022
M_2, length	.021
M_3, length	.031
" width	.009
Skull, length in med. basal line	.246
" " fr. occ. cond. to prmx.	.270
Cranium, length fr. cond. to orb.	.157
" width at constriction	.059
Occiput, width at base	.145
" " over cond.	.065
Zygomatic arch, length fr. glen. cav.	.097
" " width (dors.-vent.)	.052
Skull, zygomatic width	.190
Face, length fr. orb. to prmx.	.132
" width over lachrymals	.095
" " " prmx.	.059
" depth at m^1	.094
" " " p^1,	.069
Palate, length in median line	.155
" width at p^1	.026
" " " m^3	.066
Mandible, depth below m_3.	.056

The fore-limb and foot differ from those of *A. ovinum* even more than the comparative measurements would indicate. The distal end of the radius is much more massive and has a far larger and more rugose expansion toward the ulnar side, and on the inner side of the dorsal face is a conspicuous tendinal sulcus not present in *A. ovinum.* The carpals are broader and heavier than in the latter and have more roughened dorsal faces. The metacarpals are longer and relatively much heavier and the tubercles for muscular attachment are decidedly more prominent.

The dimensions are taken from No. 9184, A. M. N. H.

MEASUREMENTS.

Radius, distal width	.041	Metacarpal III, length	.065
" " thickness	.028	" " proximal width	.019
Carpus, length in median line	.030	" " distal width of shaft	.0225
" width of proximal row	.043	" " width of trochlea	.016
" " " distal row	.0445	Metacarpal IV, proximal width	.016
Metacarpal II, length	.060	Phalanx 1, digit II, length	.013
" " proximal width	.017	" " " " prox. width	.0145
" " distal width of shaft	.0185	Phalanx 2, " " length	.011
" " width of trochlea	.0115	" " " " prox. width	.012

Localities.—The type-specimen in the Ameghino collection is from Kar Aike. Nos. 9184 and 9532 were collected by Mr. Barnum Brown, the former 15 miles south of Monte Leon and the latter 5 miles north of Coy Inlet.

ADINOTHERIUM KARAIKENSE (Ameghino).

Acrotherium karaikense Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 131.

Nesodon imbricatus Lydekker; Anales del Mus. de La Plata, T. II, 1893, p. 26.

This species, which is known only from the type-specimen, appears to be merely an *Adinotherium* with a supernumerary premolar, just as the so-called *Acrotherium rusticum* would seem to be an example of *Nesodon imbricatus* with an additional premolar, such as Bateson has noted in many recent mammals. That *A. karaikense* is specifically distinct is made extremely probable by the following facts: (1) In size, this species exceeds any other known example of the genus, the length of the skull, which in *A. robustum* is 27 cm., being 29 cm. (2) In proportion to its length, the skull is narrow, the zygomatic arches curving outwardly but little, which is in strong contrast to the broad head and greatly expanded arches of *A. robustum.* (3) The facial region narrows anteriorly much more gradually than in the latter.

My photograph shows a pair of rough frontal ridges, which may or may not represent the horn-bosses; it is difficult to determine this from the photograph.

Locality.—Kar Aike.

ADINOTHERIUM SPLENDIDUM (Ameghino).

Adinotherium splendidum Amegh.; Enum. sistem., etc., 1887, p. 17.
Adinotherium pulchrum Mercerat; Rev. del Mus. de La Plata, T. I, 1891, p. 407 (*fide* Ameghino).
Adinotherium silvaticum Merc., in part; Ibid., p. 408 (*fide* Ameghino).
Adinotherium antiquum Merc.; Ibid., p. 410 (*fide* Ameghino).
Nesodon ovinus Lydekker, in part; An. del Mus. de La Plata, T. III, 1893, p. 25.
Noaditherium splendidum Amegh.; An. del Mus. Nat. de Buenos Aires, T. XVI, 1907, p. 84.

No example of this well-defined species is contained in either the Princeton or the New York collection. Ameghino's account of it is, briefly, as follows: The cranium is notably higher dorso-ventrally than in the preceding species. The forehead is short and triangular and the temporal ridges are very thick and prominent and describe a sigmoid course in converging into the sagittal crest; the postorbital processes have an unusually anterior position and are long and extremely broad and massive, projecting almost directly outward, they conceal the orbits when the skull is viewed from above. These processes are very rugose and Ameghino believes that they supported small horns. "Tout paraît indiquer que ces apophyses portaient une paire de petites cornes super-orbitaires" ('07, 88–9). This is a most improbable suggestion, and such rugose postorbital processes occur in old males of the other species, not to mention the various rugosities of the rhinoceros skull which have no relation to horns. The frontal horn-bosses of *A. splendidum* are better defined and form a more distinct pair than in any of the preceding species.

Though specifically well distinguished, there is nothing in the known structure of *A. splendidum* which would justify its generic separation from *Adinotherium*.

Localities.—The type-specimen was obtained from the cliffs of the Rio Santa Cruz (Amegh., '89[b], 453) and, in general, it is stated that the species occurs in the *Notohippus* Beds and the base of the Santa Cruz.

PHOBEREOTHERIUM Ameghino.

Phobereotherium Amegh.; Enum. sistem., etc., 1887, p. 18.
Adinotherium Mercerat, in part; Rev. del Mus. de La Plata, T. I, 1891, p. 408.

Nesodon Lydekker, in part; An. del Mus. de La Plata, T. II, 1893, p. 25.

This is a small animal which differs from *Adinotherium* by the absence of the median upper incisors, giving the dental formula: $I\frac{2}{?}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$.

Phobereotherium silvaticum Ameghino.

Phobereotherium silvaticum Amegh.; Enum. sistem., etc., 1887, p. 18.
Adinotherium silvaticum Mercerat, in part; Rev. del Mus. de La Plata, T. I, 1891, p. 408.

The only specific description yet given is that the length of "the five upper molars" (presumably $p\frac{3}{}$–$m\frac{3}{}$) is 105 mm. ('87[b], 18).

Locality.—Cliffs of the Rio Santa Cruz.

STENOTEPHANOS Ameghino.

Stenotephanos Amegh.; Bol. de la Acad. Nac. de Cienc. de Cordoba, T. IX, p. 107,
Stenostephanus Lydekker; An. del Mus. de La Plata, T. II, 1893, p. 24.

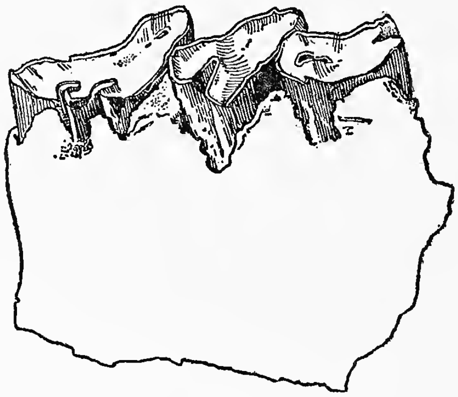
No example of this interesting, but imperfectly known, genus is contained in the collections at hand and I shall therefore quote Lydekker's account of it, which is the most complete that has yet appeared. "The upper molars are characterized by their narrowness, and by the strong curvature of the outer wall of the third; that tooth having the middle column very largely developed and consequently two well marked inner clefts. . . . The first and second molars . . . seem to have had but one cleft; and as this did not extend to the base of the crown, when much worn these teeth show a central island of enamel. In the lower jaw, the molars are almost if not quite indistinguishable from those of *Xotodon;* but the premolars have complex internal and external folds, and are thus quite different from the simple premolars of the latter" ('93, 24).

Stenotephanos speciosus Ameghino.

Stenotephanos speciosus Amegh.; Enum. sistem., etc., 1887, p. 14.
Stenostephanus speciosus Lydekker; An. del Mus. de La Plata, T. II, 1893, p. 24.

Lydekker's account of the species is as follows: "The smaller size of the third upper molar serves to distinguish the specimen from the corresponding tooth of *S. plicidens* from the Parana." The upper molars "present the characters already noticed, while the lower molars are almost indistinguishable from those of *Xotodon;* the premolars being of

Fig. 42.



Stenotephanos speciosus. Fragment of right upper maxillary with the molars in place. About natural size. Type specimen, La Plata Museum.

a very complex type. The length of the space occupied by the five lower teeth [$p_{\overline{3}}$–$m_{\overline{3}}$] is three inches" ('93, 24–5).

Locality.—Cliffs of the Rio Santa Cruz.

GENERA INCERTÆ SEDIS.

Ameghino has named a number of genera, concerning which very little is known and which will therefore be merely listed, as none of them is represented in the collections at my disposal and I have no information to add to the little already published. I am not in a position to express an opinion as to the validity of these species.

RHADINOTHERIUM Ameghino.

Rhadinotherium Amegh.; Enum. sistem., etc., 1887, p. 18.
Nesodon Mercerat, in part; Rev. del Mus. de La Plata, T. I, 1891, p. 394.

Rhadinotherium limitatum Ameghino.

Rhadinotherium limitatum Amegh.; Enum. sistem., etc., 1887, p. 18.
Nesodon limitatum Mercerat; Rev. del Mus. de La Plata, T. I, 1891, p. 403.

PALÆOLITHOPS Ameghino.

Lithops Amegh.; Enum. sistem., etc., 1887, p. 15. (Preoccupied.)
Palæolithops Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 240.

PALÆOLITHOPS PRÆVIUS Ameghino.

Lithops prævius Amegh.; Enum. sistem., etc., 1887, p. 15.
Palæolithops prævius Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 241.

ACROTHERIUM Ameghino.

(See pp. 181, 233.)

ACROTHERIUM STYGIUM Ameghino.

Acrotherium stygium Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 133.

XOTOPRODON Ameghino.

Xotoprodon Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 241.

XOTOPRODON SOLIDUS Ameghino.

Xotoprodon solidus Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 241.

XOTOPRODON MAXIMUS Ameghino.

Xotoprodon maximus Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 375.

NOTOHIPPIDÆ.

NOTOHIPPUS Ameghino.

Notohippus Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 63 (*nomen nudum*), Ibid., p. 135.
Nesodon Burmeister, in part; Anal. del Mus. Nac. de Buenos Aires, T. III, fasc. XVIII, 1892.

NOTOHIPPUS TOXODONTOIDES Ameghino.

Notohippus toxodontoides Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 63 (*nomen nudum*), Ibid., p. 135.
Nesodon ovinus Burmeister, in part; Anal. del Mus. Nac. de Buenos Aires, T. III, fasc. XVIII, 1892.

This very interesting, but imperfectly known, species is remarkable for having the lower molars surrounded by an uninterrupted wall of enamel and having the crowns covered by a thick layer of cement ("por un grueso depósito de cemento"). Originally, Ameghino referred the genus to the

Litopterna, making it the type of a family, at first called Protequidæ ('91[b], 135), subsequently Notohippidæ ('94[a], 27). Later, he assigned the family to his new order Hippoidea and regards it as closely related to the true horses ('04, 33). With this view I am not able to agree, being of Roth's opinion that the Notohippidæ are of toxodont affinities ('03, 33). The molar pattern is typically toxodont and, as Roth points out, the structure of the auditory region, at least in the pre-Santa Cruzian genera, is also that of the toxodonts. Whether the family is referable to the suborder Toxodonta, or not, is not yet entirely clear, though I am inclined to believe that it should be so referred, as has been done by Schlosser ('11, 519).

PART III. ENTELONYCHIA.

The members of this suborder are relatively rare in the Santa Cruz beds and the Princeton and New York collections contain but few and unsatisfactory specimens. For this reason, the following account is largely drawn from the collections of Dr. Ameghino and the La Plata Museum. I am under great obligations to Dr. Ameghino and to Sr. Moreno for the very liberal manner in which the material in their charge was placed at my disposal. It is much to be regretted that I was not permitted to see the skeletal material in the Paris Museum on the occasion of my last visit, August, 1911, the absence of M. Boule rendering the Patagonian collections of M. Tournouër inaccessible to me.

In Santa Cruz times the Entelonychia were evidently verging toward extinction, for the group is not known to be represented in any later formation and their rarity is in striking contrast to the abundance and variety of them in the more ancient Deseado stage (*Pyrotherium* Beds). From this latter formation, Ameghino has described no less than twelve genera, which are distributed in three families, while but one family and, at most, two genera are known from the Santa Cruz. Individual abundance corresponds to this variety of form and members of the Entelonychia are among the commoner fossils of the *Pyrotherium* fauna, which thus records the culmination of the group, followed by swift decline and extinction. The interval of time between the Deseado and the Santa Cruz Beds, which is occupied by the marine Patagonian formation and its presumable equivalents, the *Colpodon*, *Astrapothericulus* and *Notohippus* faunas of Ameghino, cannot have been very great, as measured by the degree of structural change in the mammalian groups common to both, but the difference in regard to the Entelonychia in the two formations is a very marked one. Obviously, the Entelonychia of the Santa Cruz are the reduced and vanishing remnants of a previously dominant group. Any description of them which leaves their predecessors out of account must necessarily be partial and even misleading. It will therefore be advisable to depart from the method followed in the other sections of these reports on Santa Cruz mammals, so far as to consider more fully the pre-Santa Cruzian representatives of the suborder, with particular reference to those of the *Pyrotherium* Beds, for which Gaudry's geographical term, the *Deseado stage*, will be employed as more convenient (Gaudry, '06, 107).

Throughout the suborder the teeth are brachyodont and rooted, never prismatic, and most of the genera have them in unreduced number, though in the early and prematurely specialized family of the Notostylopidæ there is considerable reduction in the anterior teeth, the second and third lower incisors and the canine being usually absent and the first upper premolar is frequently wanting; *Diorotherium* of the Santa Cruz lacks p^1. Typically, there is a gradual transition in form from the incisors to the molars, as is implied in the name of the genus first described, but there are some exceptions to this rule. In *Notostylops* the first incisor is enlarged and, though not growing from a permanent pulp, is yet scalpriform in appearance. In *Leontinia*, of the Deseado stage (the reference of which to the Entelonychia I strongly question) we find the toxodont feature of prominent tusks formed by the enlargement of the second upper and third lower incisor. Should this genus, when its structure is fully known, prove to be a rightful member of the Entelonychia, it would show that this curious transference of function had occurred separately and independently in three groups of South American ungulates, the Toxodonta, the Entelonychia and in the Proterotheriidæ of the Litopterna.

In the Isotemnidæ, though the canines are enlarged in some instances, the transition in pattern from one tooth to the next succeeding one is very gradual throughout the dental series, while in the Homalodontotheriidæ there is considerable variation in regard to the development of the canines. In the most ancient known genera of this family, as *Thomashuxleya*, for example, the general appearance of the dentition recalls that of the Eocene Perissodactyla of the northern hemisphere, the canines forming stout and conspicuous, though not very long, tusks and the lower canine passing in front of the upper one and received into a diastema between the latter and the external incisor. Much the same description applies to *Asmodeus* of the Deseado. Subsequently, these tusks diminish in relative size and in the Santa Cruz forms the lower canine is hardly larger or more prominent than an incisor; but the upper one is still fairly large in what are presumed to be the male animals, much smaller in the supposed females.

The premolars are always less complex than the molars, though the transition from one to the other is gradual, except in some of the earlier genera, in which the molars are extremely simple. Probably even in those cases, however, perfectly unworn teeth would show a difference between the two classes. Ameghino states ('02, 34–5) that in *Prochalicotherium*, of the *Colpodon* Beds, the upper premolars have isolated and conical inner cusps, which are not connected with the external wall till a very advanced age. I have not seen these specimens. The molar-pattern is essentially that of the Toxodonta. In the upper molars the external wall is completely formed, even in the most ancient genera, and is nearly smooth, the lobes being very obscurely, or not at all, indicated; there are two oblique transverse crests, of which the posterior one is much the shorter, and a varying number of spurs or "combing plates" from the outer wall, which are much less prominently developed than in the Toxodonta. When well worn, these teeth have as a conspicuous feature an elongate and narrow enamel-lake, the remnant of the main valley, which has a very oblique direction, more antero-posterior than transverse. The lower molars are made up of two crescents, the hinder one of which is much more elongate antero-posteriorly and has in its internal valley a spur or pillar, such as is found in all of the groups of indigenous South American ungulates. That the grinding teeth of the Entelonychia have a certaiu resemblance to those of the rhinoceroses is not to be denied, but perfectly fresh and unworn examples show this likeness to be but superficial, the approximation to the Toxodonta being much closer and more fundamental.

As Roth has pointed out ('03), all of the Toxodontia, or Notoungulata, agree in the unusual structure of the auditory region, but each of the three suborders has its particular modification of the general plan. In the Entelonychia the inflated post-tympanic region of the squamosal makes up less of the occipital surface than in the Toxodonta; the mastoid portion of the periotic is excluded from the surface of the skull, by the junction of the post-tympanic and postglenoid processes, and the external auditory meatus is tubular in the Notostylopidæ, and a mere hole in the Homalodontotheriidæ. Only in these two families is the skull known, if, as I think should be done, the Leontiniidæ are excluded from this suborder. In the Notostylopidæ the skull is depressed and flattened and has a very short, pointed muzzle, which, with the enlarged and scalpriform incisors, gives it quite a rodent-like appearance. Little is known of the skull in the earlier and more primitive genera, though it may be seen that in *Thomashuxleya* and *Asmodeus* the premaxillæ are relatively very large; there is a considerable diastema between the canine and external incisors and all of the incisors are arranged in nearly the same fore-and-aft line as the grinding teeth, making the muzzle long and pointed. In the Santa Cruz genera the premaxillæ are greatly reduced, the incisors are in a transverse row and the muzzle and chin are abruptly rounded. The nasals are much shortened and the anterior nares greatly enlarged and are no longer terminal in position. The zygomatic arch does not rise so high upon the side of the cranium and the tympanic bulla is much larger than in the Toxodonta.

Hardly anything is known of the vertebral column, and limb-bones have been found in association with only a very few of the genera. There is no coössification of the fore-arm or leg bones, nor any loss or fusion among the bones of the feet, so far as these elements are known. In *Asmodeus* of the Deseado stage, and in *Homalodontotherium* the humerus is extremely massive and is remarkable for the great development of the deltoid crest, the external epicondyle and the supinator ridge, and in *Asmodeus* and *Diorotherium* an entepicondylar foramen is present. The fore-arm bones are very long and stout, quite as in the Chalicotheres, but without any tendency to coössification; the radius has a relatively small head, with more or less power of rotation upon the humerus, and very heavy distal end. The ulna is also very stout, especially in *Asmodeus*, in which it does not taper so much distally as it does in the Santa Cruz genus. The femur, which is known only in *Homalodontotherium*, is somewhat proboscidean in appearance, owing to the antero-posterior compression and flattering of the shaft, but the third trochanter is large and conspicuous, though not very prominent. The leg-bones, likewise known only in the same genus, are proportionately short. The tibia is very heavy and broadens distally, where it extends over and rests upon the fibula. The latter has a stout, subcylindrical shaft and very massive distal end, with large, oblique facets for the calcaneum and astragalus.

Aside from *Leontinia*, which will be considered below, the very curious feet are not at all fully known except in the Santa Cruz genus. The manus is pentadactyl, with interlocking carpus and relatively very long metacarpals, of which the fifth is considerably the stoutest; the distal trochlea is curiously recessed and thrown back of the axis of the shaft.

The phalanges show an unusual degree of mobility and the unguals are converted into large, pointed and deeply cleft claws. The pes, also pentadactyl, has an astragalus with almost ungrooved trochlea, elongate neck and small, strongly convex head. The tuber calcis is very much longer and more compressed than in the Toxodonta, in which the tuber is short and massive; the fibular facet of the calcaneum is very large, forming a prominent external projection, and very oblique, presenting distally almost as much as dorsally. The metatarsals are extremely short, hardly more than one-third as long as the corresponding metacarpals; the fifth (mt. V) has a great, hook-like projection from the fibular side of the proximal end, much as in the Santa Cruz genera of Gravigrade Edentates. Phalanges of the pes have not yet been obtained. A few isolated bones, including an ungual phalanx, show that in *Asmodeus*, of the Deseado stage, the feet were of the same character as in *Homalodontotherium*, but in the very small *Trimerostephanus* (of the same stage) which Ameghino refers to the family Isotemnidæ, the calcaneum and astragalus are much more primitive, the former having a slender, elongate tuber and a narrow, non-projecting fibular facet.

Under the name of *Colpodon* Gaudry has given a brief description of the pes of *Leontinia* and a figure of the astragalus and calcaneum ('06[a], 28, fig. 46, 30). According to this writer, *Leontinia* has a tridactyl pes, of which the calcaneum and astragalus are closely similar to those of *Nesodon* and altogether different from those of *Homalodontotherium*. The calcaneum has a short and very heavy tuber and large, but not projecting, fibular facet; the astragalus has a narrow and elongate trochlea, a very short neck and but moderately convex head. Schlosser states ('11, 523, apparently on the authority of Gaudry) that in this family the ungual phalanges are broad hoofs. If there is no error in attributing these foot-bones to *Leontinia*, it is perfectly evident that this genus is not referable to the Entelonychia at all, but to the Toxodonta, of which it forms a somewhat aberrant, but perfectly characteristic member. So far as the structure of these animals is known, they resemble the Entelonychia only in having rooted molars, while, on the other hand, the peculiar development of tusks from the second upper and third lower incisors, the character of the skull and the hind-foot are typically Toxodont.

THE SYSTEMATIC POSITION OF THE ENTELONYCHIA.

The early view of Flower ('84, 181) and of Lydekker ('86, 160) that *Homalodontotherium* was allied to the rhinoceroses, which was suggested when nothing was known of these animals save the teeth, may be disregarded, especially as Lydekker subsequently adopted a very different opinion ('96, 77). Of late years, but two conflicting opinions, each in somewhat varying forms, concerning the systematic position and relationships of the Entelonychia have been expressed, (1) that of Ameghino, that the Entelonychia are to be referred to the Ancylopoda, and (2) Roth's view ('03) which makes them a part of his "Notoungulata," a term equivalent to the "Toxodontia" as here employed. Lydekker's opinion, which may be regarded as essentially like that of Roth, assigns the Homalodontotheriidæ to the suborder "Astrapotheria," but holds that the Toxodonta, Typotheria, Astrapotheria and Litopterna "have originated from a common ancestral stock" ('96, 77), which is merely adding the Astrapotheria and Litopterna to the Notoungulata, a procedure for which much may be said.

Ameghino's views on this subject may best be made clear by a series of quotations: "Cette apparence lophodonte des molaires et prémolaires de l'*Homalodontotherium* est due à l'âge tres avancé des individus figurés. Cette denture est en realité buno-lophodont, les deux lobules internes des molaires supérieures (protocone et hypocone) restant longtemps separés en forme de tubercules pointus" ('94[a], 56). "Les relations de parenté entre les *Homalodontotheridæ* et les *Chalicotheridæ* se manifestent d'une manière très évidente par la forme crochue des doigts, par la disposition des surfaces articulaires distales des métacarpiens et des métatarsiens, par la forme des articulations proximales des premières phalanges, par les phalanges onguéales qui ont une forme semblable et sont fendues perpendiculairement à leurs extrêmités, par le caractère tout particulier d'avoir le doigt externe de chaque pied plus développé, et enfin par le caractère encore plus singulier d'être les doigts externes des pieds ceux qui supportaient le poids principal du corps.

"Tous les caractères par lesquels les *Homalodontotheridæ* s'éloignent des *Chalicotheridæ* . . . indiquent un dêgré d'évolution peu avancée" (pp. 60, 61). "Les caractères qui distinguent les *Chalicotheridæ* indiquent au contraire un degré d'évolution très avancée. Parmi ces caractères, celui du diplarthrisme du pied est peut-être le plus notable; il consiste dans l'articulation de l'astragale avec le scaphoïde et le cuboïde à la fois comme chez les perissodactyles stéréopternes. Mais, il s'agit certainement d'un diplarthrisme acquis indépendamment de celui des perissodactyles, par un modification graduelle de l'astragale taxeopode des *Homalodontotheridæ*" (p. 61). In a later publication he suppresses the term Entelonychia, merging it with the Ancylopoda, and distinctly recognizes a relationship with the Toxodonta. "Par la disposition de la denture dans son ensemble, par la forme générale du crâne ainsi que par les parties commes du squelette, ces animaux [*Leontiniidæ*] paraissent constituer une transition entre les *Homalodontotheriidæ* et les *Nesodontidæ*" ('97, 65).

Roth's position is very briefly, but sufficiently, stated in his summary. "Das Vorhandensein der Pars mastoidea bei den Homalodontotheriden zeigt uns aber, dass diese Familie zu den Notoungulaten gehört, während bei den Astrapotheriden keine Spur eines solchen vorhanden ist und sie folglich nicht zu dieser Gruppe gehören können. In der That zeigt auch eine eingehende Untersuchung der Entwicklung des Gebisses der beiden Familien, dass dasjenige von Homalodontotherium auf dem Grundplan des Zahnsystems der Toxodonten und das von Astrapotherium auf dem der Rhinoceriden basirt ist" ('03, 33).

My own opinion is entirely in agreement with that of Roth, so far at least as the relationship of the Entelonychia to the Toxodonta is concerned. Every known part of the skeleton confirms this view and testifies against any connection with the Ancylopoda of the northern hemisphere. The points of resemblance to the Ancylopoda upon which Ameghino lays stress are essentially but three in number, (1) the bunolophodont teeth, (2) the form of the phalanges, (3) the enlargement of the external digit of both manus and pes to carry the chief part of the body-weight.

(1) The difference in pattern between the upper molars of the chalicotheres and the homalodontotheres is not accurately expressed by calling one bunolophodont and the other lophodont. As a matter of fact, they are both lophodont, having well-defined transverse crests, though in the former family the antero-internal cusp (protocone) is sometimes, not always, isolated. The important difference is in the character of the external wall, which in the chalicotheres has two deeply concave cusps separated by a prominent mesostyle, as in the titanotheres, palæotheres, horses and Litopterna, while the South American family has the almost

smooth, continuous outer wall, in which the distinction of cusps is nearly obliterated. So far as the development of tooth-patterns is understood, it would be quite impossible to derive either type from the other.

(2) That the phalanges have a resemblance in the two families, though not an especially close one, is undoubtedly true, but this of itself forms a very insecure foundation for any theory of relationship. The distal trochleæ of the metapodials are very peculiar in the Santa Cruz genus, and quite different from the convex, hemispherical knobs of the chalicotheres, which are more like those of the clawed oreodont *Agriochœrus*.

(3) The discovery of nearly complete skeletons of the chalicotherian genus *Moropus* in the lower Miocene of North America, and the descriptions given by Mr. Peterson ('07) and Professor Barbour ('08) clearly indicate that in the Chalicotheriidæ the greater development of the external digit was acquired within the limits of the family, not inherited from any Santa Cruz or earlier South American ancestry. *Moropus* is much less extremely specialized than the genera found in the middle and upper Miocene of Europe and its feet are nearly mesaxonic, the third metapodial being the longest. In the manus the second digit is much the heaviest of the series and has by far the largest claw, while in the pes the third and fourth digits are of nearly equal size. (See Peterson, '07, 746, fig. 26.)

That the so-called Ancylopoda are aberrant perissodactyls, is the conclusion reached by all who have examined *Moropus* and in my judgment, it is equally clear that the Entelonychia represent an analogous variant of the toxodonts. The likeness between these two aberrant groups is really a remote one and is confined to the phalanges of the fore-foot, while the resemblance between the chalicotheres and the perissodactyls, on the one hand, and between the homalodontotheres and the toxodonts, on the other, is fundamental, involving all parts of the dentition and skeleton. Whichever conclusion be adopted, it will be impossible to avoid the admission of a convergent development, either of the Ancylopoda toward the Perissodactyla, or of the Entelonychia toward the Ancylopoda.

HOMALODONTOTHERIUM Flower.

(Plates XXVIII–XXX.)

Homalodotherium Huxley; Quart. Journ. Geolog. Soc. London, Vol. XXVI, 1870, p. lvii (*nomen nudum*).

Homalodontotherium Flower; Phil. Trans. Roy. Soc. London, Vol. CLXIV, 1884, p. 173.

Homalodon Burmeister; Anales del Mus. Nac. de Buenos Aires, T. III, 1891, p. 389.

Homalotherium Ameghino; Ibid., T. XV, 1906, p. 317 (*errore*).

It is customary to attribute this genus to Huxley, but it is much more properly referable to Flower. The name proposed by Huxley is the baldest *nomen nudum*, as becomes perfectly clear when the original account (it cannot be called a description) is read. "Still more perplexing are the strange and interesting forms *Toxodon*, *Macrauchenia*, and *Typotherium*, and a new *Anoplotherioid* mammal (*Homalodotherium*) which Dr. Cunningham sent over to me some time ago from Patagonia." (Huxley, *loc. cit.*) The first description of the genus was given by Flower (*loc. cit.*) who adopted Huxley's name in emended form. I am unable to comprehend the course followed by Dr. Palmer in his admirable "Index Generum Mammalium"; he attributes the genus to Flower and yet retains Huxley's name, which is marked "nomen nudum." This is a self-contradictory procedure, since a nomen nudum can have no rights of priority (Palmer, '04, 330).

Homalodontotherium is a comparatively rare member of the Santa Cruz fauna and the Princeton and New York collections contain but little material illustrating it. In the La Plata Museum are the valuable specimens which have been figured and briefly described by Lydekker ('93, 44–47) and the genus is very well represented in the collection of Dr. Ameghino. It is from this material, as well as from the publications of Flower, Ameghino, Lydekker and Gaudry, that the following account has been chiefly drawn, through some of the specimens collected by Messrs. Hatcher and Peterson have proved very useful. Thanks principally to the work of Ameghino, the structure of these very curious animals is now fairly well known and their systematic position may be made reasonably clear.

Dentition. — The dental formula is unreduced; $I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$; as Flower has pointed out, the teeth, which in both jaws are arranged in unbroken series, "in their configuration present a remarkable and gradual transition from the first incisor to the last molar, easily traced in both jaws, and more even and regular than in any other known heterodont mammal" ('84, 175). At the time when this description was written, the dentition of *Theosodon*, a genus of Santa Cruz Litopterna, was not yet known; in this animal the transition in the form of the teeth, from the first incisor to the last molar, is even more regular and gradual than it is in *Homalodontotherium*.

The teeth are of nearly even height, except that in some individuals, probably males, the canines project above and below the level of the lower and upper series respectively. Roots are formed at an early stage of tooth-development, but the crowns are relatively high, though I cannot follow Flower in calling them "hypsodont," a term which should be reserved for the prismatic tooth, which develops roots only in advanced age.

A. *Upper Jaw* (Pls. XXVIII, figs. 1, 2; XXIX, figs. 2, 3).—The two straight and slightly divergent dental series are connected in front by the short and moderately curved, transverse row of incisors. These teeth are quite simple and conical, increasing somewhat in size from $i^{\underline{1}}$ to $i^{\underline{3}}$ and have very strongly developed cingula, both internal and external. The first incisor, $i^{\underline{1}}$, has a long, bluntly pointed crown, with a median vertical thickening, thinning to an edge on each border. The crowns of $i^{\underline{2}}$ and $^{\underline{3}}$, when viewed from below, have an acutely pointed, hastate shape, broadening abruptly from the root. The median thickening produces quite a distinct convexity upon the external face of the tooth and the edges are trenchant. $I^{\underline{3}}$ is considerably broader than $i^{\underline{2}}$, but otherwise of similar shape; it has, sometimes at least, a small internal cusp arising from the cingulum.

The canine differs considerably in the various individuals in relative size and prominence. Presumably, this is a sexual rather than a specific character, but the materials are insufficient for a definite determination of this question. In Flower's specimen, the type of *H. cunninghami*, the canine "only differs from the posterior incisor in being somewhat larger and in trifling details of configuration. The apex is rather more pointed and conical, being supported by a median vertical ridge, not only on the outer, but also on the concave inner surface of the crown; the inner tubercle is relatively smaller to the principal cusp" (Flower, *loc. cit.*, p. 176).

In his original description of *H. segoviæ*, Ameghino distinguishes this species from *H. cunninghami*, among other characteristics, by "the largely developed upper canine" ('91, 295). Much more probably, however, this difference is sexual rather than specific, for a palate in the La Plata Museum, obviously referable to *H. cunninghami*, has relatively quite large and tusk-like upper canines, which are much more prominent than in the type; presumably, therefore, the latter individual was a female. The palate in question has been figured by Lydekker ('93, Pl. XIX).

The premolars, which increase gradually in size posteriorly, have a decided resemblance in pattern to the molars, yet are easily distinguishable from them and none is altogether molariform. Except in $p^{\underline{1}}$, in which the transverse and antero-posterior diameters are nearly equal, the transverse width of the premolar crowns considerably exceeds the antero-posterior length. A strong cingulum is developed all around the crown, being especially prominent and conspicuous on the internal and external sides; on the latter it is most prominent, rugose and tuberculated. The first premolar ($p^{\underline{1}}$) varies considerably in size, both individually and specifically, though always the smallest of the series; it is much smaller in *H. segoviæ* and relatively quite large in *H. cunninghami*. In the type of the latter species this tooth is somewhat displaced toward the inner side and overlapped externally by the canine, but this is no doubt an individual peculiarity, as I have not observed it in any other specimen. The crown is supported, according to Flower, by two roots, one internal and the other external, and is not very different from that of the canine. It is, however, less pointed and conical and lower dorso-ventrally, longer antero-posteriorly and broader transversely; the external face is more quadrate and the vertical ridge is displaced to a position which is somewhat behind the middle. The internal cusp, or deuterocone, is much better developed than that of the canine and forms a prominent ridge; the broad valley opens anteriorly and, at least in the moderately worn condition, is closed posteriorly by a raised border, which connects the internal cusp with the external wall of the crown. From this border a large spur projects forward, incompletely dividing the valley into external and internal portions, the anterior part of the valley being undivided.

The remaining premolars ($p^{\underline{2}}$, $^{\underline{3}}$, $^{\underline{4}}$) have more nearly acquired the molar pattern and differ merely in size. Each is implanted by three roots, two external and one internal, the latter being very large in $p^{\underline{3}}$ and $^{\underline{4}}$, quite slender in $p^{\underline{2}}$. I am quite at a loss to understand Ameghino's statement that the upper premolars have "the roots all coalesced into a single one" ('98, 172), for I have seen no specimen that would even suggest such a description. The external face of the crown, in the unworn or moderately abraded condition, is short antero-posteriorly, and quite high dorso-ventrally, but their appearance changes much with advancing abrasion, which steadily reduces the height of the teeth. This outer face seems to be convex, but there is a well-defined vertical ridge near the anterior border and another, much less distinct, near the posterior border, with a very shallow concavity between the two ridges. Two short, transverse crests are given off from the anterior and posterior borders of the external wall and curve towards each other so as to meet internally. The two internal cusps (deutero- and tetartocones) with which the transverse crests are indistinguishably fused, are very incompletely separated by a shallow vertical groove and only in perfectly unworn teeth is there an internal opening of the valley between the apices of the inner cusps, the valley being almost immediately converted into a closed enamel-lake. I have actually observed this internal opening of the valley only in $p^{\underline{4}}$, no perfectly unworn examples of $p^{\underline{2}}$ and $^{\underline{3}}$ being available. If present in them at all, the opening must be exceedingly shallow. Flower states that $p^{\underline{4}}$, "in addition to the principal oval fossa [*i. e.*, valley], has a second smaller one behind and to the outer side of it" (p. 177). This is very early removed by attrition; it appears in one of the skulls of the La Plata Museum collection, but not in any other individual which I have examined.

The molars have considerable resemblance to those of the rhinoceroses, but the likeness is seen to be a superficial one, when the freshly erupted, unabraded teeth are examined. While all of the upper molars are of the same essential pattern, they differ appreciably from one another in construction. Here again, it is necessary to compare unworn teeth, for the differences are much less clear after abrasion has made much progress. The molars are notably larger than the premolars, the change from $p^{\underline{4}}$ to $m^{\underline{1}}$ in this respect being quite striking, and not only is there a difference of size, but also one of proportions. In the premolars the transverse diameter of the crown distinctly exceeds the antero-posterior, while in the molars the two diameters are nearly equal, or the antero-posterior is the greater one. The fore and aft dimension increases posteriorly and is greatest in $m^{\underline{3}}$, though the width of $m^{\underline{2}}$ makes that tooth the largest of the series. All the molars are so closely appressed that the antero-external angle of each tooth overlaps the one in front of it, another difference from the premolars, which is also found in the Toxodonta.

The disposition of enamel upon the molar-crowns is very peculiar. In unworn teeth the enamel is not reflected over upon the inner side of the external wall, or upon the hinder side of the anterior crest, or the front face of the posterior crest. The valley is thus enclosed in walls of enamel-free dentine, except near the base of the crown, where it reappears. In the abraded tooth, however, the enamel is again displayed as completely lining the valley and the resulting pattern is the same as though the unabraded crown had been entirely covered with enamel.

The development of the cingulum varies greatly, but the differences are fluctuating and are not correlated with other characters; apparently they are individual, not sexual, and have not the taxonomic significance which has sometimes been attributed to them. In Flower's type: "All the teeth have crowns . . . with a well-marked cingulum around their base" (p. 175), but his figures seem to show that only $m\frac{1}{}$ has it on the outer face and even in this tooth the external cingulum is much less prominent than in the premolars, while all of the molars have it strongly developed on the internal, anterior and posterior sides of the crown. Ameghino states that the molars "have a cingulum on the inner, but not on the outer side" ('89[b], 551), a conclusion which agrees with my own observations, for in none of the individuals which I have had an opportunity of examining is there an external cingulum on any of the upper molars and it is variable on the other faces. In both of the La Plata specimens it is prominent on all sides except the outer one, while in one individual of the Princeton collection (No. 16,016), which agrees quite closely in size with the type of *H. cunninghami*, the cingulum is present only on the anterior and posterior faces and there is no trace of it on the inner side. In another of the Princeton specimens (No. 16,014), a smaller species, probably referable to *H. segoviæ*, the internal cingulum is partially and faintly developed on $m\frac{1}{}$, and entirely lacking on $m\frac{2}{}$ and $\frac{3}{}$. On the other hand, Ameghino's type of *H. segoviæ* has a prominent internal cingulum. While invariably present, so far as I have observed, on the anterior face of all of the molars and on the posterior face of $m\frac{1}{}$ and $\frac{2}{}$, it varies even here in degree of prominence and tuberculation.

The facts just cited make it clear that the development of the cingulum of the upper molars is subject to great fluctuation in specimens which, on every other ground, are referable to the same species. That the variation is individual and not sexual is made extremely probable by the type of *H. cunninghami*, which has an exceptional development of the cingulum and yet would appear to be a female, as indicated by the small size of the canines.

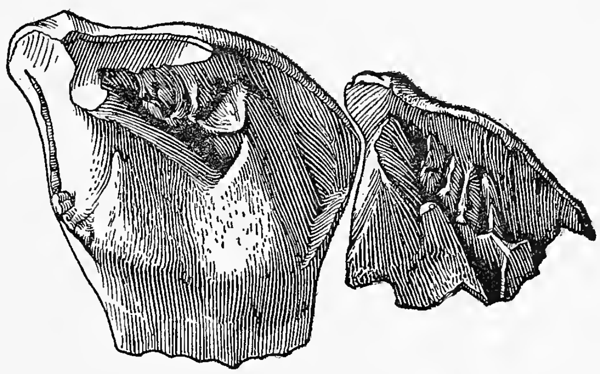
Like the premolars, the molars are each carried upon three very long roots, of which the two external ones are comparatively slender and the internal one is very large, extending for the whole antero-posterior length of the crown. This inner root, however, is obviously formed by the coalescence of two roots and on the buccal side the fusion is incomplete, a ridge of bone in the alveolus partially separating them.

The first molar ($m^{\underline{1}}$) is considerably larger than $p^{\underline{4}}$ and has a subquadrate crown, the antero-posterior and transverse diameters of which are nearly equal. The external face is nearly smooth and convex, but there is a low vertical ridge near the anterior border, which is much less conspicuous than in the premolars. This ridge is followed by an extremely shallow concavity and, opposite the posterior transverse crest (metaloph), by a second very faintly marked ridge. The outer face is thus feebly sinuous. From the external wall two transverse crests are directed inward, ending in the two internal cusps, the proto- and hypocones, with which the crests are indistinguishably fused. Even in quite well worn teeth these transverse crests are widely separated internally by a broad and deep valley, which is the most obvious difference from the premolar pattern. The crests are nearly transverse in direction and are less oblique than in the rhinoceros molar, but, owing to the shape of the valley, the posterior crest is much shorter than the anterior. The external wall of the crown extends well behind the metaloph, with which it partially encloses a shallow fossa. As the valley is much deeper toward the external side, its internal opening is obliterated with the progress of abrasion and the valley is converted into a narrow, elongate lake, which has an oblique course, running backward and inward. At this stage of wear the difference in pattern between molars and premolars is far less obvious than in the unworn condition.

The second molar differs from $m^{\underline{1}}$ chiefly in its greater size, especially in the antero-posterior diameter, and in a slightly greater complexity of pattern. In the fresh and unworn state the two internal cusps are very widely separated by a broad, V-shaped notch, the inner opening of the valley. The anterior crest is simple and nearly straight and a shallow notch demarcates it from the external wall of the crown, but this notch speedily disappears with wear. The posterior crest is much shorter and the notch between it and the outer wall is much deeper, but it also is soon destroyed by abrasion.

Presumably, it is to the presence of these notches that Ameghino refers when he says: "Cette denture est en realité buno-lophodonte, les deux lobules internes des molaires supérieures (protocone et hypocone) restant longtemps separés en forme de tubercules pointues" ('94[b], 56). This statement is quite erroneous, as immediately appears when the upper molars of *Homalodontotherium* are compared with those of the titanotheres, which family has truly buno-lophodont teeth. Disregarding the peculiar character of the external wall in this family, which it shares with the horses and the palæotheres, we find that there in no indication of a transverse crest in the titanotheres, the internal cusps being altogether distinct and of conical shape. In some of the Eocene genera more or less definite remnants of the conules may be found, but there is no tendency for these conules to coalesce with the inner cusps. In the Santa Cruz genus, on the contrary, there are well defined transverse crests, which are partially separated from the outer wall, in the unworn state of the teeth, by shallow notches, which are soon obliterated by wear.

Fig. 43.



Homalodontotherium segoviæ: Second and third upper molars of left side, $\times \frac{1}{1}$. Oblique view of grinding surface. M^2 slightly worn, m^3 not yet erupted. (No. 16,014.)

In m^2 a thin, almost plate-like ridge runs obliquely forward from the isolated apex of the posterior crest, dividing the valley into two portions, a deep internal and shallow external part. Besides, two short spurs are given off inward from the external wall and, with the ridge just mentioned, enclose two shallow fossæ. After a short period of use, however, these complications disappear; the outer portion of the valley, the oblique ridge, spurs and fossæ are no longer visible, the external wall is much thicker and the valley is a mere oblique slit, which eventually is converted into a closed lake. The external wall has the same ridges and sinuosities as in $m^{\underline{1}}$, but extends farther behind the posterior crest, enclosing a larger fossa. In the unworn condition this wall has a trenchant edge and behind the metaloph curves upward abruptly to the base of the crown. When abrasion is well advanced, hardly any difference from $m^{\underline{1}}$ remains, except the greater antero-posterior elongation of the crown.

When fully protruded, $m^{\underline{3}}$ is still more elongate antero-posteriorly than $m^{\underline{2}}$ and is of quite a different shape, being less quadrate and more triangular, somewhat as in the rhinoceroses, but the external wall is not fused with the metaloph, as it is in the latter. In the freshly erupted tooth the crown-pattern differs in several details from that of $m^{\underline{2}}$. The anterior crest is well developed and at its inner end, behind the protocone, a conspicuous conical cusp is added, no trace of which is visible in $m^{\underline{1}}$ or $^{\underline{2}}$; the anterior crest is thus L-shaped, and its transverse and antero-posterior limbs are of nearly equal length. The notch between the anterior crest and the outer wall is much shallower than in $m^{\underline{2}}$, nothing more than a slight depression of the free margin. The external wall has a trenchant edge, where the thick enamel ends abruptly, and, seen from the side, the tooth has somewhat the appearance of a carnivorous sectorial; the upward curve of the trenchant edge begins a little behind the anterior transverse crest. The sinuosity of the outer wall is very much as in $m^{\underline{2}}$, but the anterior vertical ridge is even less distinct.

The posterior transverse crest is greatly reduced and is very short and very low; to this reduction is chiefly due the triangular shape of the crown; the crest is widely separated from the external wall, a striking difference from $m^{\underline{1}}$ and $^{\underline{2}}$, but it is, nevertheless, a crest and not a conical cusp. The oblique ridge which in $m^{\underline{2}}$ passes forward from the isolated apex of the posterior crest, in $m^{\underline{3}}$ originates in the middle of the crest and is shorter, lower and less distinct than in $m^{\underline{2}}$, not dividing the valley into internal and external portions and extending only to the third of the four spurs which project from the outer wall. These spurs are shorter, thinner and more closely crowded together than the two which are found in $m^{\underline{2}}$; a small fossa is enclosed between the third and fourth spurs and the oblique ridge and a much larger one by the fourth spur, the ridge, the metaloph and the outer wall, but the latter fossa opens posteriorly between the metaloph and the wall. The inner face of the wall is very rough and given a wrinkled appearance by numerous irregular vertical ridges of dentine.

The third upper molar, in the unworn condition, thus differs from m^1 and m^2 in several particulars, which may be thus summarized: (1) the triangular shape of the crown; (2) the presence of a large, conical, accessory tubercle on the posterior side of the protocone; (3) the great reduction of the posterior transverse crest and its wide separation from the external wall; (4) the presence of four separate spurs projecting inward from the outer wall.

The appearance of the tooth is much changed by abrasion, though the characteristic triangular shape of the crown is always retained. The accessory tubercle, the oblique ridge and the spurs are all worn away and the metaloph becomes connected with the external wall, but remains conspicuously short; the valley is converted into a narrow, oblique slit and, in old animals, into a closed lake, while the enamel lining of the valley is displayed. In this abraded condition the resemblance to the other molars is much closer.

B. *Lower Jaw* (Pl. XXIX, figs. 1, 1*a*).—Mandibles are even more rare in the collections than skulls and such as are known belong in nearly all cases to old animals. I am therefore unable to give as complete an account of the inferior dentition as of the superior, having seen no examples of quite fresh and unworn teeth. The youngest specimen known to me is Flower's type of *H. cunninghami*.

The incisors are smaller than those of the upper series, but quite similar to them in form; they are comparatively simple, compressed-conical teeth, with acute points, trenchant edges and prominent cingulum, and grow larger from $i_{\overline{1}}$ to $i_{\overline{3}}$. The third incisor is figured by Flower (*t. c.*, Pl. XVI, figs. 2, 3) in an almost perfect state and shows on the internal face "a vertical ridge running from base to apex of the crown, rather nearer the anterior than the posterior edge of the tooth" (pp. 177–8). The canine in the type of *H. cunninghami*, and in a mandible of the Ameghino collection referred to the same species, is larger than $i_{\overline{3}}$, but considerably smaller than the upper canine. Whether in the supposed males with enlarged upper canine, the lower tooth is also tusk-like, cannot be determined from the available material. In Flower's specimen the lower canine is very similar to $i_{\overline{3}}$ in form, but is less regularly conical, the crown is more elongate antero-posteriorly and thicker transversely, and the vertical ridge on the inner side is more prominent and massive.

The premolars are all different from one another and from the molars, though $p_{\overline{4}}$ approximates the latter in structure and $p_{\overline{3}}$ does so also, but in a less marked degree, the transition from $p_{\overline{1}}$ to $p_{\overline{4}}$ being very gradual. The first premolar is subject to considerable variation in size, which may be specific, or only individual, and to some fluctuation in form. In the type of *H. cunninghami* $p_{\overline{1}}$ on the left side has a smooth, convex and undivided external surface, while on the right side there is an incipient division into two lobes visible on the outer face. (Flower, *t. c.*, p. 178, Pl. XVI, fig. 2.) This division into two crescents becomes more conspicuous and the posterior one grows larger on each successive tooth of the premolar series. In a specimen of the Princeton collection (No. 16,015) which agrees almost exactly with the type in size, $p_{\overline{1}}$ on both sides of the jaw has a simple and rounded outer surface without trace of a division. Internally, the valley is divided into anterior and posterior portions by a vertical, wedge-shaped ridge, the deuteroconid, which is broad at the base and narrows regularly to the apex. In the unworn tooth, of which I have seen no examples, this apex no doubt forms a distinct and separate cusp, but after a very brief period of wear it becomes confluent with the external wall. The broad and shallow posterior valley has a tubercle and one or two short, vertical ridges of enamel, which differ in number and prominence on the two sides of the jaw. The cingulum is very prominent all around the crown.

The first premolar is implanted by a single root, the others have each two roots, which Ameghino states ('89[b], 552) are again divided, each into two, near the tip. I am unable to confirm or dispute this statement.

The second premolar is plainly divided by a deep external groove into two imperfect crescents, of which the anterior one is the larger; its internal valley is shallow, but distinctly marked, while that of the posterior crescent is small but deep, and has an extremely narrow internal opening, owing to the backward extension of the internal pillar (deuteroconid) which arises at the junction of the two crescents, and also to the forward curvature of the hinder horn of the posterior crescent. The valley is thus soon converted into a lake by abrasion. The cingulum is prominent all around the tooth, except on the anterior and posterior faces, where it rises high upon the crown and dies away in the median line.

The third premolar is closely appressed to $p_{\overline{2}}$, so that it has a concave anterior face, where the enamel becomes very thin, or fails altogether; and the cingulum is wanting, as it also is on the posterior face, at least in some individuals. The posterior crescent is both actually and relatively larger than in $p_{\overline{2}}$, equalling or slightly exceeding the anterior one in fore-and-aft diameter. The anterior valley is extremely shallow, so shallow that it can hardly be said to be present at all in moderately worn teeth, while the posterior valley is well-defined, considerably larger than in $p_{\overline{2}}$ and more widely open internally. The internal pillar (deuteroconid) forms a backward curving ridge, with convex inner face and, in conjunction with the posterior crescent, makes up a C-shaped masticating surface, which is more regular in outline than that of $p_{\overline{2}}$.

In $p_{\overline{4}}$ the hinder crescent is still larger and more distinct than in $p_{\overline{3}}$ and its posterior horn curves forward more sharply, while the valley of the anterior crescent is still extremely shallow. The internal pillar is a more elongate ridge and more nearly closes the posterior valley, so that the masticating surface formed by the ridge and the posterior crescent is of an almost complete, but very irregular oval shape. The cingulum is heavy and prominent on the internal and external faces of the crown, but incomplete on the forward and hinder ends.

All of the lower molars are very nearly alike, there being no such differences among them as are found in the upper series. In size, there is a moderate increase from $m_{\overline{1}}$ to $m_{\overline{3}}$, though $m_{\overline{2}}$ has the greatest transverse breadth. There is no talon or heel on $m_{\overline{3}}$, as is generally the case throughout the order. Each of the molars is carried upon two broad roots, which, according to Ameghino ('89[b], 552), are bifurcated near the free ends, but I have seen no specimens which make this point clear and therefore can make no comment upon Ameghino's statement.

All of the molars have the bicrescentic pattern common to all known Santa Cruz ungulates, but the anterior crescent is very short and the posterior one very elongate, the latter having more than twice the fore-and-aft length of the former. The external groove which demarcates the crescents is less deep and distinct than in the hinder premolars; especially is this true of $m_{\overline{3}}$. While the forward crescent is far shorter antero-posteriorly than the hinder one, it is more complete, its posterior horn curving inward and backward and taking the place of the internal pillar of the premolars, with which it is perhaps homologous, though probably it is not. The valley of the anterior crescent is narrow, but deeply impressed and thus differs strongly from the same structure in the premolars; that of the hinder crescent is much broader, but relatively shallower. In the valley of the posterior crescent is a vertical pillar, or spur, such as is found in almost all Santa Cruz ungulates and is highly characteristic of the South American types generally. In the rare cases, such as the horse-like *Thoatherium*, in which this pillar is lacking, its absence is obviously due to a secondary reduction. In *Homalodontotherium* the pillar is very conspicuous, and, after a short period of abrasion, becomes connected with the hinder horn of the anterior crescent, enclosing an enamel lake, which is worn away in old teeth. The cingulum is quite strongly developed on the internal and external sides of the crown, but not on the anterior and posterior ends. The three teeth of the series are very closely appressed, the anterior face of each being flattened or concave and the posterior face convex. On these approximate surfaces the enamel is incomplete, being reflected over from the inner and outer faces, but becomes very thin and dies away in the middle. Needless to say, the hinder end of $m_{\overline{3}}$, which is freely exposed, is completely covered with enamel.

Nothing has yet been learned of the *milk-teeth* in this genus.

The dentition of *Homalodontotherium* is obviously of the same plan as that of the Toxodonta, but is in a somewhat simpler and more primitive stage of development. That there is a certain resemblance, especially in the grinding teeth, to the dentition of the rhinoceroses, is not to be denied and Flower goes so far as to say: "On comparing a lower molar of *Homalodontotherium* with an equally worn tooth of *Rhinoceros*, it will be seen that they are formed on precisely the same type." "The molar and premolar teeth of both upper and lower jaws thus without question show strongly marked Rhinocerotic characters" (*t. c.*, p. 180). A study of perfectly fresh and unworn teeth, however, leads to the conclusion that the rhinocerotic resemblances are superficial and without special significance, the toxodont affinities being far stronger, and, as has been shown in a preceding section (p. 112), the toxodont dentition has certain distinct likenesses to that of the rhinoceroses.

In making the comparison, the peculiar and simplified pattern of the grinding teeth in the Pampean toxodonts should be omitted from consideration and the Santa Cruz forms, such as *Nesodon* and *Adinotherium*, employed, since in them the essential characteristics of the toxodont dentition are much more clearly displayed. From the dentition of the Santa Cruz toxodonts that of *Homalodontotherium* differs: (1) in the relatively unmodified form of the incisors and canines; (2) in the brachyodont character of the dentition; (3) in the presence of the cingulum on all of the teeth, though very incomplete in some cases; (4) in the much greater transverse width and consequently less compressed form of the grinding teeth; (5) in the somewhat less complex pattern of these teeth, due especially, in the upper molars, to the shortening of the posterior crest and to the less prominence and early disappearance of the spurs ("combing plates") from the external wall of the crown. In *Nesodon* the principal spur is very prominent and even in well-worn teeth divides the valley into two parts and give it its characteristic Y-like shape (see Pls. XV, XVII).

The skull (Pls. XXVIII, figs. 1, 1*a*; XXIX, fig. 2) is quite small in proportion to the size of the trunk and the length of the limbs. The two specimens which I have had an opportunity to study have both suffered from distortion by pressure, though in different directions. That belonging to the type of *H. segoviæ* in the Ameghino collection which is shown in Plates XXVIII and XXIX, is very complete, but has been depressed and flattened by vertical pressure, making it appear to be unduly flat and low in the dorso-ventral dimension, as is clearly indicated by the shape of the orbit. A very young and imperfect skull in the Princeton collection (No. 16,014) lacking the preorbital portion, has undergone a lateral compression, which has diminished the transverse width and increased the dorso-ventral diameter. On this account the two skulls, at first sight, seem to have very different appearance and proportions. The skull of *Homalodontotherium* is essentially toxodont in character, differing only in a number of relatively unimportant details; the very unusual and peculiar structure of the auditory region, which is common to all of the Toxodontia, is repeated in this genus, though in somewhat less pronounced fashion.

The upper profile of the skull is nearly straight and horizontal throughout its length, but there may be present a slight descent at the forehead. The orbits have a forward position, with the anterior rim over m^2, and the preorbital portion of the face is somewhat shorter than in *Nesodon*, making the cranium relatively longer, though the brain-case proper, measured from the postorbital constriction, is quite short. The whole skull is lower dorso-ventrally than in the Toxodonta, and the greatly shortened nasals, the much larger and obliquely placed anterior nares and the reduced premaxillaries, as well as the absence of large tusks, give a very different appearance to the entire facial region. The zygomatic arch, which is very broad dorso-ventrally, making it seem to be very heavy and massive in side view, does not rise so high or so steeply backward and conceals less of the cranial wall, while the dorsal border of the posterior portion descends quite strongly and unites with the occipital crest at a much lower level than in *Nesodon* or *Adinotherium* or the Santa Cruz typotheres, in all of which types the dorsal border of the zygomatic process at its origin is nearly on a level with the sagittal crest. The sagittal crest is quite long and very prominent, its development varying with age and perhaps with sex also.

A very characteristic difference from the skull of the Toxodonta and Typotheria is the backward prolongation of the dorsal portion of the occiput, which extends well behind the plane of the condyles and, in side view, makes the occipital surface appear to be deeply concave, while in *Nesodon* and *Adinotherium* this surface is either almost vertical, or slopes forward and upward from the condyles. Though the structure of the auditory region is essentially the same as in *Nesodon*, the appearance of this region, when seen from the side, is very different. The very large tympanic bulla, with its great antero-posterior extension; the long and freely projecting postglenoid process; the small size, inferior position and non-projecting form of the external auditory meatus; the very long, slender and antroverted paroccipital process, and, apparently, at least, the absence of any surface exposure of the mastoid portion of the periotic and of the mastoid process, are all highly characteristic features of this skull and clearly differentiate it from that of the Toxodonta and Typotheria.

The upper view of the skull (Pl. XXVIII, fig. 1*a*) has not the truncated triangular outline seen in the corresponding view of *Nesodon* and *Adinotherium* (cf. Pl. XIV and Pl. XX, fig. 3), but rather that of an elongate, somewhat narrow oval, with the maximum transverse width across the zygomatic arches a little behind the orbits, not at the glenoid cavity, as it is in the Santa Cruz Toxodonta. The backward projection of the dorsal portion of the occiput conceals the condyles from sight in this view, as is also the case in *Adinotherium*, but not in *Nesodon*. A conspicuous feature, at least in *H. segoviæ*, is the notch which emarginates the occipital crest on each side and interrupts the connection between the crest and the dorsal border of the zygomatic arch, the continuity of which with the crest and the elevated position give such a peculiar appearance to the skulls of all the Santa Cruz Typotheria and Toxodonta. Another striking difference from these suborders is the inferior position and lack of prominence of the external auditory meatus and the post-tympanic process of the squamosal, so that no trace of them is visible when the skull is seen from above, while in the other two suborders the projecting tubular meatus and the swollen post-tympanic form the postero-external angles of the skull.

The brain-case, though quite narrow, is more capacious than in *Nesodon*, but contracts rapidly forward to the postorbital constriction, making the temporal openings very wide, but quite short, while in *Nesodon* and *Adinotherium* the antero-posterior diameter much exceeds the transverse. The sagittal crest differs much in the two skulls, a difference which is obviously in part a matter of age, though possibly both do not belong to the same species. In the type of *H. segoviæ*, which is quite an old animal with well worn teeth, the crest is long and very high and prominent, while the young skull (No. 16,014) in which m^2 is just beginning to come into use, it is lower and much shorter, broadening anteriorly into a narrower, elongate sagittal area. In neither specimen are there any definite temporal ridges, extending upon the forehead. The latter is very wide, expanding more than in *Nesodon*, but remarkably short antero-posteriorly, which is due to the backward displacement of the nasals. The nasals are far shorter and flatter than in the Santa Cruz Toxodonta, making the anterior narial opening much larger and of entirely different shape; instead of being terminal, it presents more dorsally than anteriorly. The dorsal narrowing of the face is very much less marked than in *Adinotherium* or *Nesodon* and the border of the maxillaries receives a curiously fluted appearance from the prominence of the alveoli. The very small premaxillaries differ greatly in appearance from the large and massive ones of *Nesodon*.

Seen from below (Pl. XXVIII, fig. 1) the skull presents corresponding differences from that of the Santa Cruz Toxodonta, though the resemblances are more fundamental and significant. The different character of the incisors and canines is one of the most striking features of the base-view and, in correlation with this, is the reduction of the premaxillaries, which form a much smaller portion of the palate than in the last named suborder. The muzzle narrows regularly to the anterior end, without the broadening forward so characteristic of nearly all the known Toxodonta, and the whole palate is relatively shorter, wider and less deeply concave. The peculiar form of the posterior nares, which obtains in all of the Santa Cruz Toxodonta and Typotheria, with its prominent and divergent side-walls, formed by the palatines, pterygoids and alisphenoids, is repeated in the present genus, but the divergence of the walls and consequent breadth of the opening are even more striking than in *Nesodon*. This base-view also displays the shortening and strong outward curvature of the zygomatic arch, reducing the distance between m^{3} and the glenoid cavity, as compared with the last named genus. The tympanic bulla is much larger than in the contemporary Toxodonta, especially in the antero-posterior dimension. The lack of prominence in the region of the external auditory meatus and the swollen post-tympanic process is even better displayed than in the superior view of the skull, the broadening of the cranium external to the paroccipital processes being much less than in *Adinotherium* and *Nesodon*. The much narrower occiput and the different shape of the condyles are also noteworthy features.

The condition of the material at my disposal is such that no very detailed account of the various elements of the skull can be given, yet a certain number of important facts may be made out. The basioccipital is quite long and heavy, though narrowing between the large tympanic bullæ, broadening considerably behind them; it has a short, but quite well-defined ventral keel. The condylar foramina occupy a conspicuous position on each side of the posterior expansion and are not hidden by the condyles. The latter are rather small, but quite prominent, so as to be fully visible in the side-view of the skull. On the ventral side, the articular surface of each condyle, near the outer end, is emarginated by a deep notch, which is not shown in any of the Santa Cruz Toxodonta, and the articular surface is continued over upon the basioccipital in a median, shield-shaped area, which is peculiar to the present genus.

I am unable to determine with certainly the limits of the exoccipitals, but they would appear to be much higher dorso-ventrally and to form a larger proportion of the occipital surface than in *Adinotherium* or *Nesodon;* they also are of quite a different shape, not being so broad at the base nor so much constricted above. The paroccipital process is longer than in the last named genera and differently formed: the proximal portion is almost as massive as in *Nesodon*, but distally it becomes much more slender, laterally compressed and of trihedral cross-section. The process has a strong inclination downward and forward, and ends distally in a bluntly rounded point. The supraoccipital is quite narrow at the suture with the exoccipitals, but widens dorsally and is alone concerned in the formation of the occipital crest: this dorsal portion is also extended and recurved, so as to overhang the occipital plane and project behind the condyles, but is not so thickened and heavy as it is in *Nesodon*. The broad median convexity of the exoccipitals above the foramen magnum becomes, on the supraoccipital, divided into two ridges by a median groove. The occipital crest is thin and prominent and, as has been mentioned before, is demarcated on each side from the dorsal border of the zygomatic arch by a well-defined notch, which, however, does not prevent the junction of the two crests.

As a whole, the occipital surface, though constructed on the same peculiar plan as in the Toxodonta and Typotheria, has yet a very different appearance, being higher and narrower without any such broadening of the base, while the inferior position of the zygomatic arches and the very long and relatively slender paroccipital processes are important factors in the difference, as are also the more pronounced median convexity and lateral concavities, the surface in the Toxodonta and Typotheria being more nearly plane. As in those suborders, the occiput proper is sharply constricted above the foramen magnum, which is low and wide, of transversely oval shape. The constriction leaves on each side a broad space, which is filled by the convex, inflated, hinder surface of the post-tympanic process of the squamosal, which is not so large and, in particular, not so broad as in *Nesodon*, the supraoccipital expanding dorsally and extending somewhat over the post-tympanics. The whole structure of the occipital surface is rather less extremely aberrant than in the Toxodonta.

Nothing can be determined as to the extent and relations of any of the sphenoidal elements, because in the Ameghino specimen they are concealed by the matrix and in the Princeton skull they are so badly crushed that no identification is possible.

The parietals are long and narrow, forming but little of the side-walls of the cranium. So far as I can make out, these bones are thin throughout their length and do not have the posterior thickness and massiveness which they have in *Nesodon*. In the fully adult animal the sagittal crest, which is very prominent, continues for the entire length of the parietals, but in the young skull it passes anteriorly into a narrow, triangular area, which broadens to the frontal suture. The anterior ends of the bones diverge less than in *Nesodon* and the frontals do not project nearly so far backward between these divergent ends. Along the squamosal suture on each side is a row of four or five large and conspicuous vascular foramina.

As in *Nesodon*, the squamosals are very large and form the greater part of the cranial side-walls, but there are many differences of detail, especially in the shape and size of the various processes. The glenoid cavity is a saddle-shaped surface, the direction of which is rather oblique; it is narrow and very slightly convex antero-posteriorly, broad and somewhat concave transversely. Externally, this articular surface forms a low and barely perceptible protuberance, which is very much lower and less conspicuous than in the Santa Cruz Toxodonta. The space between the glenoid cavity and the postglenoid process is much narrower than in the latter and the postglenoid process is of an entirely different shape; it is a long, freely projecting and rather massive process, broad and thick proximally, where it is extensively applied to the post-tympanic process, completely excluding the mastoid from the surface of the skull, but tapering and becoming styliform distally. In *Nesodon* and *Adinotherium* this process is a broad, heavy and swollen-looking plate, no part of which is free, but is closely united with the mastoid, which separates it from the post-tympanic. The glenoid foramen is a larger and more conspicuous opening than in the genera last named, and channels the postglenoid process.

The post-tympanic process is of the same curious and anomalous character as in all of the other Toxodontia, though each of the three suborders of this group has its own particular modification of the general plan. In *Homalodontotherium* the lateral exposure of the post-tympanic is much greater than in *Adinotherium* or *Nesodon*, forming the posterior portion of the zygomatic arch and its dorsal border being raised into a ridge, which is continuous with that of the zygomatic process on one side and with the occipital crest on the other. This lateral portion is inflated and, partially at least, filled with cancellous bone. The posterior portion, which makes up part of the occipital surface, is also much inflated and contains a sinus, which no doubt communicates with the cavity of the tympanic bulla, as in *Nesodon*, though I have not been able to make sure of this communication. This occipital exposure is relatively narrower and the occiput proper wider than in the Toxodonta, while in the Typotheria the true occiput is much broader and the post-tympanic narrower than in either of the other suborders.

The zygomatic process also differs in certain details from that of *Nesodon*, though, as in that genus, it has considerable resemblance to the same structure in the rhinoceroses, being rather thin and compressed, but very deep dorso-ventrally, giving it quite a massive appearance when seen from the side. It does not have the steep anterior descent seen in the Santa Cruz Toxodonta, but the dorsal border rises moderately forward to a point about the middle of its course and thence, in one of the skulls, descends anteriorly, while in the other it rises gently almost to the boundary of the orbit. In *Adinotherium* and *Nesodon* the process ends abruptly in front and is received into a shallow notch of the jugal, forming little or none of the orbital boundary, while in *Homalodontotherium* it is relatively longer, does not notch the jugal, but rests upon it and narrows anteriorly to a blunt point, forming the posterior and much of the inferior boundary of the orbit. The dorsal border descends very abruptly in a concave curve to make the posterior orbital boundary.

The jugal is a large and heavy bone, with great dorso-ventral depth and with its ventral border projecting downward freely, so as to conceal, in side view, the alveolus of $m^{\underline{3}}$ and, in the young skull, of $m^{\underline{2}}$ as well. In the Toxodonta there is no such prominent projection of the ventral border. As already mentioned, the jugal is not excavated to receive the anterior end of the zygomatic process, but extends beneath that process almost to the glenoid cavity, where it terminates in a rounded end. The jugal forms some of the inferior and nearly the whole anterior margin of the orbit.

Though agreeing in essentials with that of *Nesodon*, the tympanic has a very different appearance, whether viewed from the side or from below. The inflated bulla is much larger than in that genus, especially in antero-posterior diameter and, in ventral view, forms an elongate, narrow oval.

The walls of the bulla are thin and the interior is hollow and free from cancellous tissue. The external auditory meatus is far removed from the bulla and yet there is no visible connection between them and it is uncertain whether there is any tube other than that formed by the junction of the postglenoid and post-tympanic processes of the squamosal. The meatus itself is a small, irregularly circular opening, without any projecting edge or lip, which has a far lower position, level with the upper part of the occipital condyle, than in the Santa Cruz Toxodonta or Typotheria.

The lachrymal, the limits of which are not easy to make out in either of the skulls, is, to all appearance, a very small triangular bone, without spine, which is exposed at the supero-anterior margin of the orbit; the foramen is not visible from the side.

The frontals have a decidedly curious and exceptional form and their appearance changes considerably with age. They are very short and broad and anteriorly are very deeply emarginated to receive the nasals, the emargination extending backward nearly or quite to the line joining the two postorbital processes. Behind the latter the frontals are very much contracted and pass into the notch formed by the divergent anterior ends of the parietals, but these posterior extensions are decidedly shorter than in *Nesodon*. In the young animal the postorbital processes are quite short and the orbits have hardly any bony roof, but in the fully adult skull the processes are very prominent, though not so long or so much decurved as in *Nesodon*, and the frontals are extended well outward over the orbits, thus greatly changing their appearance. The forehead is very broad across the postorbital processes, narrowing anteriorly, and moderately convex transversely, showing the low protuberances caused by the frontal sinuses. There are no distinct temporal, or supraorbital ridges, but in the type of *H. segoviæ* a shallow depression (which seems to be too symmetrical to be the result of the down crushing that the skull has undergone) makes the posterior part of each frontal stand out as a broad, flattened ridge. The anterior emargination, which lodges the nasals, is very deep and greatly shortens the frontals in the median line. The sutures with the posterior ends of the nasals form two nearly straight lines, which meet at an angle considerably greater than a right angle, though interrupted, it may be, by a very short, asymmetrical nasal process from one frontal only.

The nasals are altogether different from those of the Santa Cruz Typotheria and Toxodonta, and are one of the most characteristic features in the skull of the present genus. They are very short, of moderate width and almost plane both antero-posteriorly and transversely. In shape, each nasal is trapezoidal, the external border being much shorter than the mesial, for at both ends the bone narrows rapidly to a blunt point and thus anterior and posterior ends are much alike in shape. Owing to the depth of the median excavation of the frontals, the nasals have a long lateral suture with these bones, for more than half their length, in fact, while the maxillary suture is short, the anterior ends of the nasals projecting freely. There is no suture with the premaxillaries, from which the nasals are far removed, one of the most obvious differences from the skulls of the contemporary Typotheria and Toxodonta.

In correlation with the reduction of the incisors, the premaxillaries are very small and hardly visible when the skull is seen from the side, which is in striking contrast to the arrangement found in the other two suborders, in which these bones have great lateral extension upon the face. They are short, narrow transversely and low, with little or no distinction of horizontal and ascending ramus. The palatine processes are extremely small and contribute almost nothing to the long palate, but the spines are stout and quite elongate, separating the large and conspicuous incisive foramina.

The maxillaries differ considerably in their proportions from those of *Nesodon* and *Adinotherium*, being relatively longer, on account of the reduction of the premaxillæ, and lower, in correlation with the more brachyodont character of the teeth, and there is no such dorsal narrowing of the face. The maxillaries are also produced somewhat farther posteriorly over the orbits than in the latter and have quite extensive oblique sutures with the frontals. The infraorbital foramen occupies nearly the same relative position as in *Adinotherium*, over $m\frac{1}{}$ and well in advance of the orbit. The zygomatic process of the maxilla is rather better developed than in *Nesodon* and extends farther back beneath the jugal. The palatine processes are very large and form much the greater part of the hard palate, but are deeply incised in front by the premaxillæ and behind by the palatines. As a whole, the bony palate is much less concave transversely than in the Toxodonta, in which the strongly curved teeth, hypsodont or semi-hypsodont in character, produce very prominent alveolar borders and a profoundly concave palate.

The palatines extend forward to about the middle of m^2 as narrow, wedge-shaped plates; their median contact ceases a little behind m^3 and is not carried back so far as in *Adinotherium* and *Nesodon*, so that the front border of the much larger posterior nares is farther forward than in those genera. The ventral border of that portion of the palatines which forms the side-walls of the posterior nares is thick and rounded, but not nearly so broad as in the Toxodonta, and these walls diverge more rapidly than in the latter and form a much wider opening. The limits of the pterygoids and the descending processes of the alisphenoids cannot be determined in either skull.

No complete specimen of the mandible is known to me, the few which are to be found in the collections all lacking the ascending ramus and angle. It is obvious, however, from the position of the glenoid cavity with reference to the level of the upper teeth that the ascending ramus cannot have been so high as in *Nesodon* and that the condyle was much less elevated above the teeth than in that genus. Enough remains in one mandible to show that the linea obliqua externa is not at all prominent and the interna much more so, though far less developed than in *Nesodon* and enclosing a much shallower fossa behind m^3. The horizontal ramus is of only moderate dorso-ventral depth, but very thick and heavy; the ventral border is nearly straight, with but slight sinuosity, at least as far back as m_3. The two rami are firmly coössified in a long, oblique symphysis, which extends to p_4 and is very deeply concave on the dorsal side, but the chin is abruptly rounded, rising steeply from the ventral border and with decidedly convex profile, which is very different from the gently inclined and more or less procumbent chin of most of the Toxodonta and Typotheria.

As yet, nothing has been found of the hyoid apparatus, nor of its place or mode of attachment to the skull.

Little is known concerning the vertebræ of *Homalodontotherium*. I did not have an opportunity to examine those in the Ameghino and La Plata Museum collections and neither Lydekker nor Ameghino give any description of them, except of the axis, which is figured and very briefly described by Lydekker ('93, 45, Pl. XX, fig. 5). This axis is of the same type as that of *Nesodon* and other Toxodonta, but is somewhat longer in proportion to its breadth. The centrum is much depressed and very wide anteriorly and the surfaces for the atlas have much the same shape as in

Nesodon; the odontoid process is a short and heavy peg and the neural spine is a hatchet-like plate, similar in shape to that of the genus last named, but longer antero-posteriorly and lower dorso-ventrally. Of the other vertebræ, Ameghino says merely that the centra have flat faces with a small fossette in the middle ('94[a], 59).

The scapula is not known, but a well-preserved pelvis in the La Plata Museum, referred to this genus, differs much from that of *Nesodon*, owing to the great expansion and eversion of the ilia, which, with the shortness of the ischia, produce quite a Proboscidean appearance and are points of resemblance to *Toxodon.*

The limb-bones are mostly, so far as they are known, quite elongate and very heavy. They are much larger in proportion to the size of the skull than are those of the contemporary Toxodonta and indicate animals which were massive and slow-moving, but with small heads.

The humerus, which has been described and figured by Lydekker (*op. cit.*, Pl. XX, fig. 1) is very peculiar. It is a large bone, measuring in *H. cunninghami* 16½ inches in length, and very heavy; the head is low and the internal tuberosity is much reduced, while the external one is very large. The shaft is stout, rounded for most of its length, becoming very broad and antero-posteriorly compressed distally. "Its chief characteristic is to be found in the enormous development of the deltoid crest, which extends three fourths down the shaft, where it terminates in a bold prominence, standing some three inches above the general level of the surface. . . . In the great development of this crest the humerus of *Homalodontotherium* is approached by that of *Phascolomys* and the conformation in question suggests fossorial powers" (Lydekker, *op. cit.*, pp. 45, 46). The posterior surface of the distal broadening of the shaft is very flat and smooth and the anconeal fossa must be variable, for Lydekker describes it as small and shallow and Ameghino as "profonde" ('94[a], 59). The trochlea is broad, very low and simple, saddle-shaped and undivided by any indication of an intercondylar ridge, but the external portion for the head of the radius is quite strongly convex. The internal epicondyle is large and prominent and not perforated by a foramen, while the external one is enormously developed and, with the extremely large supinator ridge, adds greatly to the unusual breadth of the distal end.

While this humerus differs strongly in appearance from that of *Neso-*

don, there is no material difference of structure; in *Homalodontotherium* the great development of the deltoid crest, the epicondyles and the supinator ridge is what gives the characteristic form.

The fore-arm bones are separate and show no tendency to coössify. Of the radius, only the distal end is known, but, from the form of the capitellum of the humeral trochlea and the proximal end of the ulna, it may be inferred that the head of the radius was discoidal in shape and allowed considerable freedom of rotation. Further, the length of the ulna makes it very obvious that the radius must likewise have been very elongate. The distal end is extremely heavy and of broad, transversely oval shape; on the outer side is a large, nearly plane facet for articulation with the ulna. The scaphoid facet is very broad transversely, narrow antero-posteriorly, and behind its internal moiety is a very large and deep pit completely encircled by bone. The lunar facet, which is very obscurely demarcated from that for the scaphoid, is as broad transversely as the latter and very much more so antero-posteriorly, covering the entire thickness of the distal end; it is decidedly concave in both directions. The missing shaft may be reconstructed from these indications; the proximal portion was evidently slender and crossed over the front of the ulna; the shaft became heavier downward and was actually massive at the lower end.

Of the ulna, I have examined a distal epiphysis in the Ameghino collection and an entire isolated bone in the Princeton Museum (No. 15,747), the lower end of which agrees closely, save in one unimportant particular, with the Ameghino specimen. I am inclined to believe that there is some mistake in the identification of the very fragmentary ulna which is figured by Lydekker ('93, Pl. XX, fig. 4). The complete ulna shows that the fore-arm was extremely elongate and far longer than the leg, the disproportion being much as in *Macrotherium*, as figured by Filhol (sub *Chalicotherium*, '91, Pl. XLIII) but this is true only in very much less marked degree of the North American genus *Moropus*. In its whole character the ulna of *Homalodontotherium* is closely similar to that of *Nesodon*, but on a much larger scale and relatively far more elongate. The olecranon is long and is continued upward nearly in the line of the shaft, projecting backward even less than in *Nesodon;* the posterior border of the process is broadened and flattened in a way not seen in the latter genus, but the proximal end is only moderately thickened and rugose. The sigmoid notch displays the same remarkable peculiarity as that of *Nesodon*, though with some modifications. The coronoid process is less prominent and the facet for the posterior part of the humeral trochlea is much broader and less convex transversely, not being reflected upward so strongly on the outer and inner sides. The anterior humeral surface is entirely internal, as in *Nesodon*, but is much broader than in that genus and is so extended as to project inward beyond the plane of the shaft in a shelf-like overhang. Thus there is the same strange obliquity of the articular surface, when seen from the front, as in the Toxodonta, inclining downward and inward. The head of the radius is not embraced by the ulna, but the two are merely in contact, as is shown by a narrow articular surface on the outer side of the internal projection for the humerus, above described. The shaft has quite a different shape from that of *Nesodon*, being less trihedral and more compressed laterally; it contracts distally but little, so that it is stout and heavy throughout. The interosseous crest is short, only the proximal portion being present and that not very prominent. The styloid process is formed by a sudden contraction of the distal end to hardly more than half its width, so that the facet for the pyramidal and that on the radius for the lunar are widely separated. The pyramidal facet is simply convex and forms an obscure angulation with the large surface for the pisiform. In Ameghino's specimen there is a deep, irregular pit on the distal end, internal to the styloid process, but this may be merely an abnormality, as may indeed be the pit on the distal end of the radius of the same individual, as mentioned in the preceding description.

The very remarkable and curious manus (Pl. XXX, fig. 1) has been quite fully described and figured by Ameghino ('94[a], 57, '94[b], figs. 3, 4) who emphasizes its many likenesses to that of the Ancylopoda. These likenesses are, however, less fundamental than the similarities to the toxodont manus, though the fore-foot of *Homalodontotherium* is at once the more primitive and the more highly specialized. The carpus is interlocking or "diplarthrous," not serial; the bones of the proximal row are relatively lower and those of the distal row higher proximo-distally than in *Nesodon*. The scaphoid is not known, but evidently it was broad and rested chiefly upon the trapezoid and, in much less degree, upon the magnum; it appears to have had no contact with the trapezium.

The lunar resembles that of *Nesodon*, but is much wider transversely and shorter proximo-distally; the proximal end has a strongly convex facet for the radius, which projects dorsally and overhangs the anterior face of the carpal. The contact with the pyramidal is entirely distal, the two bones being quite widely apart at the proximal end, as might be expected from the corresponding surfaces on the ulna and radius. Distally, the lunar rests upon the magnum and unciform, more extensively upon the former, and the magnum facet differs from that in *Nesodon* in being more distal and less lateral, in consequence of which the two surfaces meet at a more obtuse angle. The pyramidal is very much like that of *Nesodon* in form, except that the interno-distal angle is more produced and tends to extend underneath the lunar; it has quite an oblique position in the carpus, diverging proximally from the lunar, in accordance with the space between the distal facets of the ulna and radius. The surfaces for the ulna, pisiform and unciform are not particularly characteristic.

The trapezium is a small, laterally compressed and scale-like bone, and, though it supports a functional pollex, it would seem to have had no connection with the scaphoid, as is also the case in *Nesodon*, in which mc. I has completely disappeared. The trapezoid is quite different in appearance from that of the contemporary Toxodonta, being much higher proximo-distally in proportion to its width, and is closely interlocked with the magnum. The proximal end has an oblique facet for the scaphoid and the distal portion of the radial side articulates with the trapezium. The long axis of the magnum is oblique to that of mc. III, inclining downward and toward the ulnar side. The bone is much longer and narrower than in *Nesodon* and contracts proximally, so that the dorsal face has almost the shape of an inverted wedge, the truncation of which forms the narrow facet for the scaphoid. The lunar facet is far larger than in *Nesodon* and less lateral, more obliquely proximal in position and is quite convex. The magnum is not overlapped by the unciform, the facet for which on the fibular side is vertical and quite narrow. The distal end is also oblique, but sloping in the opposite direction, toward the radial side. The unciform, which is much the largest of the carpal elements, is higher and narrower than in *Nesodon*, with its principal diameter proximo-distal. The proximal end is unequally divided between the narrow surface for the lunar and the much broader one for the pyramidal; the latter slopes steeply downward, making the external, or ulnar, border of the bone very much shorter than the internal, reversing the proportions seen in *Nesodon*, in which the internal border is a mere angle. The distal end is occupied chiefly by the facet for mc. IV, that for the larger and heavier mc. V is more lateral than distal. The internal border is nearly straight, the facets for the magnum and mc. III lying in almost the same vertical plane.

The metacarpus is incompletely known, inasmuch as only mc. III is represented by an entire specimen, but parts of all the others are also preserved. This metacarpus is totally different in character from that of any other known Santa Cruz ungulate: (1) It is pentadactyl, all the digits complete and functional; (2) the symmetry is not mesaxonic, for, though mc. III is symmetrical in itself, the two parts of the manus resulting from the vertical bisection of digit III are by no means equal, the outer part preponderating, which is chiefly owing to the large size of mc. V, the heaviest and, very possibly, the longest of the series; (3) there is very little interlocking of the metacarpals; (4) the distal trochlea is altogether exceptional.

The first metacarpal, represented only by the proximal half, is the most slender of the series. As figured by Ameghino ('94[b], 254, fig. 3) the head is placed considerably below that of mc. II, with which the trapezium articulates laterally. There is a possibility of error in this arrangement, but unfortunately, my attention was drawn to this question too late for a re-examination of the originals. The second metacarpal, likewise known only from the proximal portion, differs notably from the shape seen in *Nesodon* and in the three- and four-toed perissodactyls, in having no process which overlaps the head of mc. III to articulate with the magnum. This articulation is present, but it is vertical and lateral, the head of mc. II rising above that of mc. III, but not extending over it. The third metacarpal is remarkably long and straight and relatively slender; the proximal end is narrow, but little wider than the shaft, and bears an oblique, saddle-shaped facet for the magnum, which is slightly concave transversely and strongly convex palmo-dorsally. On the radial side of the head is a narrow, curved facet for mc. II, which extends over the entire dorso-palmar thickness, and on the ulnar side a very large, vertical and nearly plane surface for the unciform, but this connection is lateral only and there is no process extending over mc. IV, such as occurs in most polydactyl ungulates. On the dorsal face near the ulnar border is a large tubercle for tendinal attachment. The shaft is long and slender, broadening but slightly to the distal end, and subcylindrical in shape, with nearly equal transverse and dorso-palmar diameters. The distal trochlea is most peculiar; instead of projecting forward from the dorsal face of the shaft, or being coincident with the latter, it is displaced far toward the palmar side, its proximo-distal axis making an angle of nearly 45° with that of the shaft. Dorsally, the articular surface is at first concave, where it is reflected upon the overhanging distal end of the shaft, while the trochlea proper is a low, transverse semicylinder. The carina is quite prominent, but so completely palmar in position as to be invisible in front view.

The proximal end of mc. IV is somewhat broader than that of mc. III, which is due to a short, heavy process on the radial side, which carries the facet for articulation with mc. III. The shaft, so far as it is preserved, is rather more slender than that of the latter and of more angular, subquadrate cross-section. The distal end has the articular surface carried up much higher proximally than that of mc. III, which gives it quite a different appearance. The fifth metacarpal is the heaviest of them all. The head is made somewhat wider than the shaft by the presence on the radial side of a heavy, but very short projection, which articulates by a large facet with mc. IV. The surface for the unciform is very oblique and concavely curved, the head of the metacarpal extending around the outer side of the unciform so as almost to reach the pyramidal. The stout shaft, the length of which cannot be determined, is trihedral in shape, with broad radial side, thinning to a rounded border on the ulnar side. As much of the shaft as has been preserved is quite straight. The distal articular surface is extended upward much more than in mc. IV and receives an asymmetrical appearance from the distal production of the internal portion of the trochlea.

The phalanges (Pl. XXX, fig. 2) are as peculiar as the metacarpals would lead one to expect. Only in digit III are they all preserved, but apparently those of the other digits differ merely in size and relative width. The first phalanx is broad proximally, narrowing much to the distal end. The proximal facet is concave and very oblique, in consequence of which the palmar face considerably exceeds the dorsal in length. The distal facet is divided by a median groove into two condyles, but the articular surface is not carried far over upon the dorsal face and indeed is hardly visible from that side. The second phalanx is much more slender and but little shorter than the first, in marked contrast to *Nesodon*, in which this bone is very short and wide. The proximal trochlea is divided by a median ridge into two shallow pits, and the distal one, which is feebly grooved in the median line, is remarkably extended, being reflected far over upon the dorsal side and, when seen in profile, describes nearly two-thirds of a circle. This gives to the phalanx quite the appearance of the corresponding bone in certain Carnivora. The ungual is much modified and has assumed the shape of a claw, somewhat as in *Macrotherium* and *Chalicotherium* of the European Miocene and in the North American *Moropus*, but the modification is less extreme and the departure from the ordinary ungulate type not so great. The phalanx is long, almost equalling the combined first and second in length, very rugose and cleft at the distal end, the cleft continuing as a deep groove of the dorsal surface for nearly half the length of the bone. The proximal portion of the ungual is very thick palmo-dorsally, this dimension exceeding the transverse, but the dorsal face is strongly curved and the thickness diminishes rapidly to the distal end. Proximally, there is a beak-like extension of the median dorsal line, but no conspicuous subungual process.

In the other digits the ungual phalanx differs somewhat in size and form. The arrangement made by Ameghino (which is followed in Pl. XXX, fig. 1) gives the smallest of the unguals to digit II, but this is more probably referable to the pollex, while the one assigned to the latter, the broadest and heaviest of the entire series, should probably be transferred to the fifth digit. In none of the digits is there visible any tendency to coössification of the phalanges, such as constantly occurs between the proximal and second phalanges of digit II in *Moropus*.

The phalanges have an unusual degree of mobility upon the metacarpals and apparently could move through an arc of 180°. This but adds to the difficulty of understanding how the manus was used. The fact that in three continents three different orders of ungulates, the Artiodactyla, Perissodactyla and Entelonychia, should have acquired clawed feet, certainly would seem to indicate a response to some general need, but no one has yet made any plausible suggestion as to what that need was, nor does any existing herbivorous mammal throw any light upon the problem. From the character of all the articulations involved, it is probable that this manus was digitigrade, with the phalanges of each digit extending forward nearly at a right angle with the metacarpal, as shown in Ameghino's Fig. 4, A ('94[b], 255) and as Peterson ('07, 746, fig. 26) and Barbour ('08, Pl. X) have figured the fore-foot of *Moropus*. Yet the manus was capable of some rotation upon the arm and the phalanges could be strongly flexed, whatever the use that was made of these movements.

Filhol, on the other hand, restores *Macrotherium* (*Chalicotherium*) as strictly plantigrade both before and behind ('91, Pl. XLIII) and Ameghino expresses still another view regarding the gait of *Homalodontotherium:* "Ces animaux étaient plantigrades parfaits, dans ce sens, que le tarse et la carpe reposaient sur le sol, mais le poids du corps était porté par la partie externe des pieds d'une manière aussi accentuée que chez les édentés gravigrades, ou chez les fourmilliers actuels" ('94[a], 60). This suggestion does not appear to be a very happy one, for its only support is the somewhat larger size of the external digit in both manus and pes, and all the articulations involved are radically different in the anteaters and the Gravigrada from those in *Homalodontotherium*. So far at least as the pes is concerned, the foot could not be brought to rest upon its external border without complete dislocation of the ankle.

The femur preserved in the La Plata Museum (Pl. XXX, figs. 3, 3*a*) is of somewhat uncertain reference, for, though the evidence for the identification as presented by Lydekker ('93, 46) seems very convincing, some doubt is thrown upon it by Gaudry's figures of the leg of *Astrapotherium* ('06, 19, fig. 29). Yet the La Plata specimen is by no means identical with that figured by Gaudry, despite the strong general resemblance, differing in the following particulars. In *Astrapotherium* (1) the head of the femur is on an even shorter neck and is directed more internally; (2) the great trochanter is higher and the second trochanter is wanting; (3) the shaft, especially the distal half, is much broader and more flattened; (4) the third trochanter has a more elevated position, is shorter proximo-distally and decidedly less prominent; (5) the trochlea is extended farther up the shaft. Ameghino's brief description: "Le fémur est un os, court, tres large, plat et presque rectangulaire, resemblant à celui des édentés gravigrades" ('94[a], 60) does not seem to fit the La Plata specimen at all and yet Dr. Ameghino pronounced the photographs of the latter which I showed him as properly referable to the present genus, and, owing to the circumstances of the moment, I was unable to see his own specimens and compare them with the photographs.

Assuming, then, that the La Plata femur has been correctly identified, it may be described as follows. The head is large, hemispherical and set upon a very short neck, which is directed obliquely upward and inward. The great trochanter, though massive and rugose, is low, not rising to the level of the head and there is scarcely any notch between them. The proximal third of the shaft is very broad, narrowing to a point below the third trochanter and thence broadening very gradually to the distal end. The shaft is much compressed antero-posteriorly and flattened, as in the very large ungulates generally, and the internal border describes a strongly concave curve, interrupted only by the second trochanter. This is a low, elongate ridge, with convex free border, placed very far down on the inner side of the shaft, so far indeed as to make it somewhat doubtful whether this ridge be actually homologous with the second trochanter or not. The third trochanter also has a very distal position and is elongate, but rather low, and, while very conspicuous, is yet not very prominent. The distal end of the femur is very heavy, especially in breadth, which exceeds the antero-posterior dimension inclusive of the trochlea. The latter is wide, deeply grooved, with prominent borders and nearly symmetrical, the internal border projecting but little in advance of the external; proximally, the trochlea ends abruptly in a nearly straight line, and distally, the articular surface is separate from that of the inner condyle, connected with that of the outer. The condyles, which are separated by a very wide intercondylar space, project but slightly behind the shaft, and differ considerably from each other in form and size. The external condyle is of nearly uniform width, with straight mesial border; while the internal one is more prominent, both posteriorly and laterally, and more strongly convex and widens backward, having a very concave mesial border.

The leg-bones, like those of the fore-arm, are entirely separate and free. The tibia (Pl. XXX, figs. 6, 6*a*) is relatively short and heavy, much shorter than the femur and distantly resembles that of the Gravigrada, with which Ameghino has compared it. The proximal end is broad and massive, projecting far externally over the head of the fibula, and bears a prominent spine. The shaft is also very heavy near the proximal end, where it is trihedral, and has anteriorly a massive, rugose and T-shaped cnemial crest, which, after a short course, suddenly narrows and is continued as a mere linea aspera for nearly two-thirds of the length of the bone. The shaft rapidly narrows and becomes very much compressed laterally; the middle portion is stout, trihedral in section, with concave posterior face, owing to the elevation of the lateral borders. Distally, it widens very much, attaining nearly the width of the proximal end, but is also greatly compressed antero-posteriorly. The internal border of the shaft, except just below the head, is nearly straight, while the external border is deeply concave, making a very wide interosseous space. At the distal end the inner border is thick and rounded and terminates in a short, but very heavy internal malleolus, on the inner side of which is a massive and rugose prominence; the outer border, on the other hand, is a thin edge. The astragalar surface is broad transversely, narrow antero-posteriorly, especially the external portion; it is very obscurely divided into a larger and moderately concave surface for the inner condyle of the astragalus, which is produced and slightly reflected upward upon the posterior side of the tibia, and a much narrower and nearly flat surface for the external condyle. On the anterior side there is no intercondylar tongue, but a low and inconspicuous one appears on the posterior side. Connected with this external astragalar surface and demarcated by slight difference of level, is the small, D-shaped fibular facet, which presents distally, the tibia here resting directly upon the fibula.

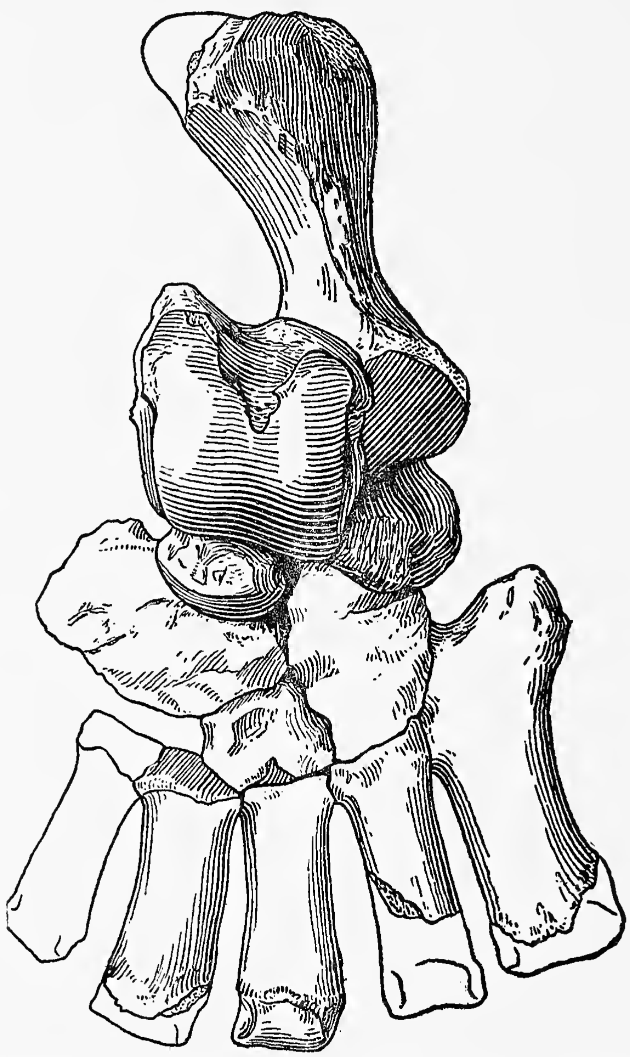
Of the fibula only the distal portion is known. The shaft is very heavy, bowed outward and of subcylindrical shape, while the distal end is very massive both in breadth and antero-posterior thickness. A short, but prominent interosseous crest arises near the bottom of the shaft. Internally, the fibula extends beneath the tibia, which rests upon it and the surface for which faces almost directly upward. On the external side, near the anterior border, is a large and prominent rugosity, which corresponds to that on the postero-internal angle of the tibia. The astragalar facet is large, slightly concave in both directions and has a moderate inclination outward and downward. The facet for the calcaneum is very large, slightly concave and very oblique, presenting backward almost as much as distally.

In this most peculiar animal no structure is more remarkable than the pes, the manner of using which is highly problematical. The astragalus (Pl. XXX, fig. 4), though fundamentally similar to that of the other

Toxodontia and the Litopterna as well, is very characteristic. Aside from the neck, the bone has an almost square outline, with proximo-distal and transverse diameters nearly equal. The trochlea is but feebly grooved, almost flat, and is divided into a much broader internal and a narrower, but elevated and prominent external condyle, somewhat as in *Nesodon*, but a very exceptional feature is the proximal prolongation of the condyles as narrow tongues, which are separated from each other by a broad V-shaped surface. On the plantar side are two narrow, elongate and parallel surfaces for the calcaneum, separated by a straight, deep sulcus, which is much narrower than in *Nesodon*. Of these, the external facet is oblique and concave, more directly plantar and of more uniform width than in the last named genus; the sustentacular facet is slightly convex proximo-distally and is longer, broader and of more uniform width than in *Nesodon* and, as in that genus, extends to a junction with the navicular facet, but is not produced so far proximally. The neck of the astragalus is decidedly longer and more constricted than in the Toxodonta and ends in a narrower, more convex head, which, as in that sub-order, articulates with the navicular only.

The calcaneum (Pl. XXX, figs. 5–5*b*, 7) is likewise highly characteristic and differs in many respects from that of the Santa Cruz Toxodonta. The tuber is much longer proportionately than in that group and is more compressed, with thinner and more prominent dorsal border and the ventral border concave proximo-distally, instead of convexly arched. The tuber broadens to the free or proximal end, which is immensely expanded, thickened, rugose and club-shaped; the internal portion of the free end is still further elongated as an additional process, the length of which varies in the different individuals and species and is most developed in the very large *H. crassum*. The fibular facet is peculiar in several respects: (1) it is very large and projects prominently on the external side as an overhanging shelf, which is not to be found in the Toxodonta; (2) it is but moderately convex proximo-distally and very slightly concave transversely; (3) it presents distally rather than dorsally, a very exceptional arrangement, which is in correlation with the unusual obliquity of the corresponding surface on the fibula. The external astragalar facet is large and has a more dorsal, less lateral presentation than in *Nesodon*; another difference from the latter is that the proximal border of this facet is sharply defined and raised above the level of the tuber, not continued over upon it, as is the case in the Santa Cruz Toxodonta. The sustentaculum is prominent and bears a slightly concave facet for the astragalus; it has a distinctly more distal position than in *Nesodon*, is much thicker in the dorso-plantar dimension and its articular surface is continuous with the facet for the navicular on the inner side of the distal end of the

Fig. 44.



Homalodontotherium segoviæ. Left pes, dorsum, × ½. After Ameghino, except the calcaneum, astragalus and cuboid.

calcaneum, while in the latter genus the two are separated. In correspondence with the longer neck of the astragalus, the portion of the calcaneum distal to the fibular facet is longer than in *Nesodon*. The cuboid facet is much smaller than in the latter and does not cover the whole of the distal end, massive rugosities projecting beyond it on the external and plantar sides.

The navicular is very large, especially in transverse breadth, projecting internally much beyond the astragalar surface, which is rather small and quite deeply concave. On the fibular side, the navicular articulates with both calcaneum and cuboid by distinct facets. Of the cuneiforms only the ectocuneiform is known. This I have not seen, but, if Ameghino's figure ('94[b], 256, fig. 5) is correct, it is a relatively large bone, with nearly square dorsal face; it not only covers the head of mt. III, but overlaps it on each side and articulates by narrow facets with mt. II and IV, a feature not found in any other known mammal. The cuboid differs much from the short, nearly square bone of *Adinotherium* and *Nesodon;* it is much higher proximo-distally and the calcaneal facet is oblique, sloping steeply downward and outward. On the tibial side are two quite large facets, the proximal one for the navicular and the distal one for the ectocuneiform. Most of the distal end is taken up by the facet for the head of mt. IV and, making an obtuse angle with this, is another very large surface for mt. V, which, however, is more lateral than distal.

Like the metacarpus, the metatarsus consists of five members. These show no interlocking or overlapping, but are so arranged that their proximal ends describe a regular, concave curve, which rises much higher on the fibular side, while distally the bones diverge like the sticks of a fan. Mt. II, III and IV have a narrow, projecting facet on each side of the head, which is largest between mt. IV and V, and the prominence of these facets makes wide interspaces between the metatarsals. The shafts are grotesquely short, mt. III being but little more than one-third as long as the corresponding metacarpal. So far as can be determined from the imperfect material, this pes is isodactyl, mt. II, III and IV being of nearly the same length and thickness, though III is a little more slender than the others. The fifth metatarsal is strikingly different in being much broader and heavier and in having a massive and rugose prominence, which is given off from the fibular side of the proximal end, much as in the Santa Cruz Gravigrada. Its facet for the cuboid is very concave and this metatarsal encircles the cuboid much as mc. V does the unciform.

The phalanges of the pes are entirely unknown.

All the articulations, from the femur to the metatarsals, make it probable that the pes was plantigrade, and the peculiar position of the fibulo-calcaneal articulation suggests that only the massive and club-like free end of the calcaneum rested on the ground and that the pes was arched upward somewhat in the manner of the human foot. The improbability of Ameghino's view, that the pes rested its weight chiefly on the external border, has been pointed out in a previous page (p. 276).

Species.—As the material is so scanty and incomplete, it would be premature to attempt any revision of the species, of which Ameghino recognizes four. These are distinguished almost entirely by differences of size, a notoriously untrustworthy criterion, yet so great is the range in this respect that more than one species must certainly be admitted. Much importance has been attached to the development of the cingulum of the upper molars, but this is subject to such fluctuation that it cannot be regarded as even a sexual character, though it is quite possible that it may be constant in some of the species.

HOMALODONTOTHERIUM CUNNINGHAMI Flower.

(Plates XXIX, Figs. 1, 1*a*, 3; XXX, Figs. 3, 3*a*, 6, 6*a*.)

Homalodontotherium cunninghami Flower; Phil. Trans., Vol. CLXIV, 1884, p. 173.

This, the type-species, is the commonest, or more accurately, the least uncommon of the Santa Cruz forms. It can at present be characterized merely by its large size, less than that of *H. crassum*, greater than in *H. segoviæ* and *H. excursum*.

MEASUREMENTS.

	Type.	*No. X.*	*No. 15,496.*
Upper dentition, length C to m^3, incl.		.238	
Canine, length (i. e. ant.-post. diam.)	.017	.026	
Upper cheek-teeth series, length		.223	
Upper premolar series, length	.087	.090	
P^1, length	.020	.020	
" width	.023	.0225	
P^2, length	.022	.0225	
" width	.0295	.0375	
P^3, length	.025	.025	.026
" width	.029	.0375	.029
P^4, length	.027	.030	.027
" width	.035	.043	.035
Upper molar series, length		.133	.121

	Type.	*No. X.*	*No. 15,406.*
$M^{\underline{1}}$, length	.039	.0445	.039
" width	.042	.049	.041
$M^{\underline{2}}$, length		.0525	.049
" width		.054	.047
$M^{\underline{3}}$, length		.056	.047
" width		.051	.045
		No. Y.	*No. 16,015.*
Lower dentition, length C to $m_{\overline{3}}$, incl.	.207	.221	
Lower canine, length	.022	.018	
" " width	.017	.021	
Lower cheek-teeth series, length	.195	.1845	
Lower premolar series, length	.089	.085	
$P_{\overline{1}}$, length	.020	.016	.018
" width	.017	.019	.016
$P_{\overline{2}}$, length	.021	.0195	.0205
" width	.019	.020	.015
$P_{\overline{3}}$, length	.024	.0245	
" width	.019	.023	.017
$P_{\overline{4}}$, length	.027	.026	
" width	.022	.026	
Lower molar series, length	.108	.0995	
$M_{\overline{1}}$, length	.034	.028	
" width	.024	.022	
$M_{\overline{2}}$, length	.040	.0325	
" width	.026	.023	
$M_{\overline{3}}$, length	.044	.041	
" width	.024	.025	

In this table the measurements of the type are taken from Flower's plate, but there is some inaccuracy involved, for the side and crown views do not exactly agree in size. No. X is a palate in the La Plata Museum and No. Y a mandible in the Ameghino collection; in both instances the dimensions are from photographs which I made and are therefore not exact, but the error is probably small. No. X is a somewhat older animal than the type-specimen and No. Y is a very old individual with teeth much worn down. The table illustrates the tendency of the grinding teeth to shorten in antero-posterior length with advancing age.

The isolated ulna (No. 15,747), described in a preceding page, has the following dimensions:

Ulna, length	.585	Ulna, prox. width at radial facet	.081
" " of olecranon	.128	" distal width	.0655
" width of coron. process	.054	" " " of styloid process	.035

The femur of somewhat doubtful reference, belonging to the La Plata Museum and described above, yields the following measurements:

Femur, length fr. head	.536	Femur, width over 3rd trochanter	.128
" " " gr't trochanter	.518	" distal width	.121
" proximal width	.173	" " thickness	.101

In the Ameghino collection are the distal ends of a tibia and fibula, of which the approximate dimensions, measured from photographs, are herewith given and, for comparison, those of an isolated distal moiety of a tibia (No. 15,435) in the Princeton Museum.

	No. 15,435.	*Amegh.*
Tibia, distal width, incl. tubercle	.099	.088
" " " excl. "	.089	.079
" " thickness, int. border	.046	.042
" " " ext. "	.015	
Fibula, width of shaft		.024
" distal width, incl. tubercle		.058
" " " excl. "		.052
" " thickness		.055

Localities.—The type of the species was obtained by Dr. R. O. Cunningham from the cliffs of the Rio Gallegos. The specimens collected by Messrs. Hatcher and Peterson were found on the Atlantic coast in the neighborhood of Coy Inlet. Ameghino and Lydekker assign no localities for the individuals described by them.

HOMALODONTOTHERIUM SEGOVIÆ Ameghino.

(Plates XXVIII, XXIX, Fig. 2; XXX, Figs. 1, 2, 4, 7.)

Homalodontotherium segoviæ Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 295.

This probably valid species differs from *H. cunninghami* chiefly in the narrowing of the muzzle, the smaller incisors and much reduced first upper premolar ($p^{\underline{1}}$). The development of the cingulum and the larger canines, upon which stress was laid in the original description, are too fluctuating to have taxonomic significance. In a later publication Ameghino mentions merely the difference of size, saying that *H. segoviæ* is "one-third smaller than" *H. cunninghami* ('98, 172). It is difficult to know precisely what is meant by this vague expression. In linear dimensions the difference between the types of the two species is only about one-eighth, which is well within the ordinary limits of individual variation. It is probable, therefore, that there is no substantial difference in size between the two species.

In the original description the following dimensions are given: length of skull from incisors to occipital condyles, incl., .400; maximum width, .250; length of upper dental series, .210; breadth of palate at m^3, .061. In the imperfect young skull (No. 16,014) which I have, with some doubt, referred to this species, the almost unworn m^2 measures 45 mm. in antero-posterior, by 40 mm. in transverse diameter.

Localities. — For the type, none is given, and the field-label of No. 16,014 is unfortunately lost, but the specimen almost certainly came from the Atlantic coast near Coy Inlet.

Homalodontotherium excursum Ameghino.

Homalodontotherium excursum Amegh.; Énum. synopt. des espèces de Mamm. Foss. des Formations Éocènes de Patagonie, 1894, p. 64.

This is the smallest of the known Santa Cruz species, as appears from the comparative measurements which Ameghino gives in the original description and may be thus tabulated:

	H. segoviæ.	*H. excursum.*
Astragalus, length	.084	.074
" width	.062	.054
Tibia, proximal width.	.135	.100

Localities. — Not given.

Homalodontotherium crassum Ameghino.

(Plate XXX, Figs. 5, 5*a*, 5*b*.)

Homalodontotherium crassum Amegh.; Énum. synopt., etc., p. 64.

Ameghino has distingushed this species on the ground of its very large size, "taille gigantesque," though only a few foot-bones have been found. His measurement are as follows:

	H. segoviæ.	*H. crassum.*
Metacarpal III, distal width	.036	.042
Unciform, length	.049	.066
" width.	.057	.072
" thickness	.034	.050

A calcaneum in the Princeton collection (No. 15,213), which I refer to this species, has the following dimensions:

Calcaneum, length	.187	Calcaneum, distal thickness	.062
" proximal width	.076	" cuboid facet, transv. diam.	.034
" " thickness	.067	" " " dors.-plant. diam.	.049
" distal width	.046		

Localities. — Not given for the type specimen. No. 15,213 was found by Mr. Hatcher on the coast, ten miles south of Coy Inlet.

DIOROTHERIUM Ameghino.

Diorotherium Amegh.; Rev. Arg. de Hist. Nat., T. I, 1891, p. 296.

The original description, in which there is no discrimination of generic and specific characters, may be reproduced in somewhat abbreviated form. "Distinguished from *Homalodontotherium* by the absence of $p^{\underline{1}}$; a diastema between the canine and $p^{\underline{2}}$; canine very large and with strong vertical striations; true molars with strong external and internal cingulum. Occipital and parietal crests more elevated; skull of more slender form, considerably narrower and higher than in *Homalodontotherium;* forehead and nasal opening much narrower." To this was subsequently added the statement that the humerus possessed an entepicondylar foramen. (Amegh., '94[a], 67.)

Obviously this genus is of very doubtful validity, but it may be allowed to stand pending the discovery of more adequate material.

Diorotherium egregium Ameghino.

Diorotherium egregium Amegh.; Rev. Argent. de Hist. Nat., T. I, 1891, p. 296.

Length of skull from canine to occipital condyles, inclusive, .420; height of skull from the masticating surface of $m^{\underline{3}}$ to dorsal side of nasal, .170. The height and narrowness are partially, at least, due to lateral compression.

Localities. — Not given.

Order TOXODONTIA.

The exigencies of serial publication have made it necessary to defer the account of the order until the descriptions of the three suborders had been completed. As here employed, the term Toxodontia is equivalent to Roth's Notoungulata, which has found a wide acceptance, but I prefer to use the older term and to regard as suborders its three very distinctly marked subdivisions. It may well be that the number of subordinal groups should be increased for the reception of certain of the more ancient genera and families, such as the Notohippidæ, but it would be premature to do so until much more complete material shall have been obtained.

While the essential plan of structure is the same throughout the order, each of the three suborders, Toxodonta, Typotheria and Entelonychia, has its well defined and characteristic modifications, which affect all parts of the organism. The Toxodonta are large and moderate-sized animals, becoming extremely massive in the Pampean and immediately preceding formations, but there are quite small animals of this group in the Santa Cruz. In the Deseado stage, when they reached their culmination, the Entelonychia had some gigantic members and in the Santa Cruz most of the species are large animals. The Santa Cruz Typotheria, on the contrary, are all small creatures, some, like *Pachyrukhos*, very small, and even in the Pampean they attain to no great size.

Dentition.—In the Santa Cruz and subsequent formations the Toxodonta and Typotheria have a strong tendency to hypsodontism, which in the latter is already fully established in Santa Cruz times, and the upper molars are very strongly curved, almost meeting in the median line of the palate. The Santa Cruz Toxodonta have high-crowned but rooted premolars and even the molars develop roots in old age; in the subsequent geological stages the teeth are completely hypsodont, but the Leontiniidæ, of the older Deseado stage, which in my judgment should be referred to the Toxodonta, have brachyodont teeth. The Entelonychia are all brachyodont, though an increase in the height of the crowns may be noted between the more ancient genera, like *Thomashuxleya*, and the Santa Cruz forms, the latter stage marking the end of the series.

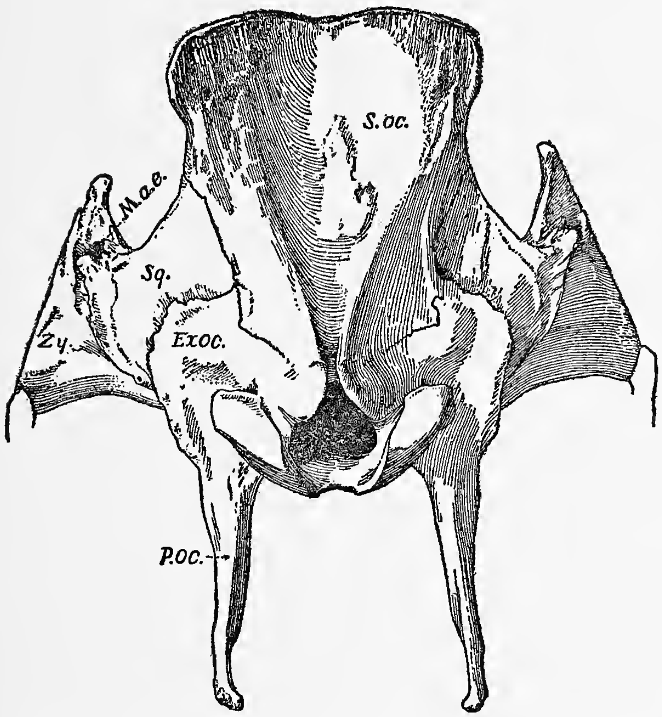
In the Toxodonta the canines are greatly reduced and have lost their functional importance, but the second upper and third lower incisors develop into tusks, which grow from permanent pulps. The Typotheria show great variety in the character of the incisors; in some, e. g. *Protypotherium*, all of the anterior teeth are of moderately large size and very much alike in form; in others, such as *Interatherium* and the Hegetotheriidæ, there is a marked tendency for the first upper incisor to enlarge greatly and become scalpriform and, in the latter family, the tooth is rootless and grows from a permanent pulp. Coincident with this enlargement of the median incisor there is great reduction and ultimate loss of the other incisors, the canine and one or more of the anterior premolars. In the mandible the median and, in less degree, the second incisor become scalpriform, while the succeeding teeth in a varying number atrophy and disappear. In the larger and later genera, such as *Typotherium* itself, which has the formula, $i\frac{1}{2}$, $c\frac{0}{0}$, $p\frac{2}{1}$, $m\frac{3}{3}$, the scalpriform incisors are very large and the rodent-like appearance of the dentition is so strongly marked that these animals have actually been referred to the Rodentia. *Protypotherium* displays the exceptional peculiarity of having the lower incisors deeply cleft and fork-like, somewhat resembling those of the Recent *Procavia* (*Hyrax*). In the Entelonychia the incisors and canines have undergone less modification from the primitive type than in the other suborders. Aside from the early family of the Notostylopidæ, in which the median incisors are scalpriform, the incisors are all retained and have simple, conical or hastate crowns, and the canines are quite large, though not very prominent tusks. The canines are relatively reduced in size in the Santa Cruz genera, *Homalodontotherium* and *Diorotherium*, especially in certain individuals which are presumably females.

The premolars are almost always smaller and simpler than the molars, though the hinder ones approximate the molar pattern so closely, especially in the Santa Cruz Typotheria, that only in unworn teeth is the difference appreciable. The first premolar, particularly the upper one, is generally very small and not infrequently wanting and in *Typotherium* the premolars are reduced to $\frac{2}{1}$. The pattern of the upper molars is somewhat rhinocerotic in character, a feature which is least marked in the Typotheria and is lost in the Pampean Toxodonta. The outer cusps have coalesced to form a smooth continuous outer wall or ectoloph, in which the indication of the constituent elements is but feebly shown or entirely absent. The two oblique, transverse crests, proto- and metalophs, are fused with the external wall and the internal cusps, except in some of the more ancient genera of the Entelonychia, in which the inner cusps are described as being more or less separate from the crest, and doubtless this was the primitive condition in all of the suborders. The external wall is continued well behind the posterior crest, enclosing with it a fossa, which varies in size and distinctness. In addition to these principal crests, a variable number of cristæ or spurs project inward from the ectoloph, which are most prominent and important in the commoner Santa Cruz Toxodonta, in which one of these cristæ is especially large, persisting even in well worn teeth and giving to the valley its characteristic Y-shape, while in *Stenotephanos*, which is a rare and imperfectly known genus, $m^{\underline{1}}$ and $^{\underline{2}}$ have a simple undivided valley, a character which recurs in all the molars of the post-Santa-Cruzian genera *Xotodon* and *Toxodontherium*. In *Toxodon*, on the contrary, this principal crista is very prominent and larger every way than in *Nesodon* and *Adinotherium*. The enamel is not continuous around the whole periphery of the crown, but covers the external side and forms vertical bands on the other sides. The Leontiniidæ of the Deseado stage have a slit-like, undivided valley, agreeing in this respect with the Entelonychia, in which the spurs are short and are speedily removed by wear. In the Typotheria the valley is very shallow and the crests low, so that even in young adults the grinding surface is a smooth expanse of dentine with an enclosing border of enamel and, in some genera (e. g. *Hegetotherium*), a thin coating of cement. On the inner face of the crown, however, the vertical groove which marks the separation of the two internal cusps is persistent.

Skull.—The unity of the order is nowhere better displayed than in the skull, especially in the remarkable structure of the auditory region, to which Roth ('03) was the first to call attention. The peculiarity consists in the relatively great size of an element which Roth regards as homologous with the mastoid in man, but not with the element which is so called in other ungulates and which he designates as the *protuberancia petrosa*. The occiput proper is very broad at the base, is sharply constricted above the foramen magnum and then widens again moderately to the lambdoidal crest. The large area on each side which would be left vacant by the constriction is filled by the element which Roth identifies with the *pars mastoidea* of the human skull. In the Toxodonta and Entelonychia and in some of Typotheria (e. g. *Pachyrukhos*) this element contains a large cavity, which communicates with the cavity of the tympanic bulla by a small canal, but in most of the Santa Cruz members of this suborder is filled with cancellous bone, obviously a secondary condition. Roth gives no convincing reason for regarding this element as homologous with the human mastoid, which is a part of the periotic cartilage, while that so named in the Toxodontia is according to Roth the ossification of a membranous pouch, a difference which is not easy to harmonize. Rambaud and Rénault (*see* Roth, p. 17) have shown that the human squamosal ossifies from three centres, for the squamous portion, the zygomatic process and the auditory portion (*pars Serrialis*) respectively, and Roth figures skulls of *Toxodon*, in which these elements remain separate in the adult stage. He does not make clear his conception of the relation between the *pars Serrialis* of the squamosal and the *pars mastoidea* of the periotic. As a matter of fact, it is the *pars Serrialis*, or post-tympanic portion of the squamosal which is inflated, as clearly appears in those Typotheres in which the two are separate. Sinclair has figured (this volume, p. 71, fig. 14) a skull of *Hegetotherium* (A. M. N. H., No. 9223) in which the element in question is divided by a transverse suture (fig. 14, *mp.*) into dorsal and ventral portions; the former is the inflated *pars Serrialis* of the squamosal and the latter a thin, compressed plate ankylosed with the tympanic, which is the homologue of the similar plate in the skull of *Nesodon* which is called the mastoid or *protuberancia petrosa.* Attention should be called to the fact that my interpretation of these parts differs entirely from that of Sinclair, who has followed Roth. The occiput of the pig (Text-fig. 45) presents at least a very similar appearance to that of the Toxodonta. Here the occiput proper, as in *Nesodon*, is wide at the base and gives off very long paroccipital processes. Above the foramen magnum is a very sudden and sharp constriction, the two exoccipitals being very much broader than the ventral portion of the supraoccipital. The posterior surface of the skull is completed on each side by a large area of the squamosal (*pars Serrialis*) quite as in the Toxodonta, but with the notable difference that there is no cavity in this region. In the very young pig-skull the supra- and exoccipitals are relatively larger and the part taken by the squamosals in the formation of the posterior surface is much smaller, though very distinct, and increases with advancing age to the fully adult condition. The position of the external auditory meatus is much the same as in *Nesodon*, but the mastoid is excluded from the surface of the skull and the postglenoid and post-tympanic processes of the squamosal are fused together.

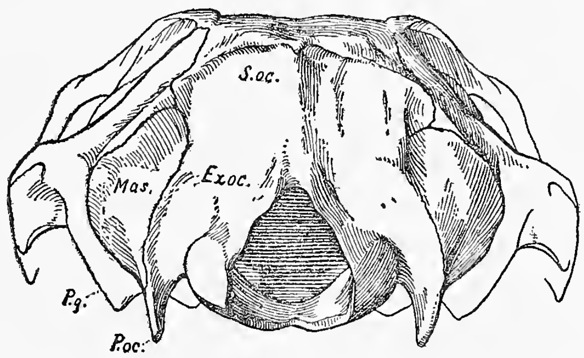
Even if Roth's identification of the mastoid in the Toxodonta should prove to be correct, it would not indicate any radical difference from the

Fig. 45.



Sus scrofa. Occiput, × ½. *S.oc.*, supraoccipital; *Exoc.*, exoccipital; *P.oc.*, paroccipital; *M.a.e.*, external auditory meatus; *Sq.*, post-tympanic portion of squamosal; *Zy.*, zygomatic process.

Fig. 46.



Procavia capensis. Occiput, × $\frac{2}{1}$. *S.oc.*, supraoccipital; *Exoc.*, exoccipital; *P.oc.*, paroccipital process; *P.g.*, post-glenoid process; *Mas.*, mastoid portion of periotic.

Hyracoidea (*see* Text-fig. 46) in which the posterior surface of the skull is completed by the large, inflated mastoids, the cavities of which are filled with cancelli. The mastoids are ankylosed with the tympanics, but usually not with the squamosals, though in some species the latter fusion also occurs.

Roth's view of a near relationship between the "Notoungulata" and the Primates, and radical distinction from all other hoofed animals, involves such a degree of convergence as staggers belief. It further involves, as he has pointed out, the polyphyletic origin of the mammals from reptiles and is thus made extremely improbable from the standpoint of present knowledge. So far as I am aware, his theoretical conceptions have not found any support even among those who accept his homologies of the toxodont skull.

Each of the three suborders has its peculiarities in the structure of the auditory region. In the Santa Cruz Typotheria the tympanic bulla has a long, tubular, auditory meatus, the opening of which has a relatively low position and is directed backward rather than outward. The *pars Serrialis* of the squamosal and even the root of the zygomatic process have a very inflated appearance externally and are either hollow, as in *Pachyrukhos*, or, much more commonly, filled with cancelli. The mastoid (*post-tympanicus* of Roth) has no process, the distal end being closely applied to the paroccipital; it is ankylosed with the tympanic and usually with the squamosal, in which case it appears to form the post-tympanic process. The hyoid arch is loosely attached to the skull and is inserted in a deep pit on the outer side of the bulla, external to the paroccipital process.

The comparison of the Typotheria and Toxodonta, as regards the auditory region, is by no means clear. What would seem to represent the mastoid (the *protuberancia petrosa*) of other ungulates is conspicuous in the Toxodonta as a thin plate which ends in a well defined process; it is ankylosed with the bulla and may, in fact, be an outgrowth of the tympanic. If it is really the mastoid, it occupies a highly exceptional position, being separated from the exoccipital by another element, which appears to be the post-tympanic process (or *pars Serrialis*) of the squamosal, and is almost invariably continuous with the squamous portion, though I have detected traces of a sutural connection with the latter. There is no visible tube leading to the external ear-opening, the passage being entirely concealed by the structures just described. The opening has a very elevated position at the postero-external angle of the zygomatic arch, much as in the pig and, indeed, the whole appearance of the occipital surface is suggestively like that seen in the latter animal. The tympanic bulla is, as in both of the other suborders, large, completely ossified and hollow, free from cancellous bone; in shape it is mammillate, with the principal diameter dorso-ventral. A most exceptional character, at least in the Santa Cruz genera of the suborder, is the position of the hyoid arch, which is ankylosed with the *anterior* end of the bulla in the adult skull.

While very few of the indigenous South American ungulates were horned, all the known genera which display any indications of horns are referable to the Toxodonta. In the *Pyrotherium* Beds the Leontiniidæ, which are usually assigned to the Entelonychia, seem to have had a nasal horn, and in the Santa Cruz one species of *Nesodon* (*N. cornutus*) and nearly or quite all the species of *Adinotherium* apparently had a very small frontal horn, which attains large proportions in *Trigodon* of the Monte Hermoso horizon.

In the Entelonychia the skull is of the same type as in the Toxodonta and Typotheria, with several peculiar modifications. Except in the very ancient family of the Notostylopidæ, the skull has less likeness to that of the rodents than in either of the other suborders and in the homalodontotheres, which are the most specialized family of the Entelonychia, the skull has become very characteristic. The questionable element (*pars Serrialis*), which I have regarded as belonging to the squamosal, is less extensively exposed on the occipital surface, and the mastoid portion of the periotic is not visible externally, so that there is no mastoid process. The external auditory meatus, which is an irregular hole, has a more inferior position than in either of the other groups, while the tympanic bulla is very large, with its principal diameter in the antero-posterior direction. The nasals are very short and the anterior nares present obliquely upward and forward; the premaxillæ are very small, far smaller than in the Toxodonta, though they are quite large in the more ancient and primitive genera, such as *Thomashuxleya* and *Asmodeus*. The muzzle and chin are short and abruptly rounded.

Vertebral column.—This varies considerably, as would of course be expected from the very different stature and bulk of the three suborders. but there is, nevertheless, a general uniformity of structure. In all the neck is short, or of only moderate length, and the axis always has the conical, peg-like odontoid and large, hatchet-shaped neural spine. The trunk is long, with 20–22 vertebræ in the Toxodonta and Typotheria and in the larger genera of the former, such as *Nesodon* and *Toxodon*, the neural spines are very elongate in the anterior thoracic region and form a decided hump at the shoulders. The tail is stout and of moderate length in the Toxodonta, very long in the Santa Cruz Typotheria, except in

Pachyrukhos. Very little is known concerning the vertebral column of the Entelonychia.

The Limb-girdles display characteristic modifications in each of the three suborders. In some, if not all, of the Typotheria there is a clavicle and the scapula has a prominent acromion and a single large metacromion, given off from the spine near the distal end. The pelvis is unguiculate rather than ungulate in form, retaining the narrow, more or less trihedral ilium. There is very considerable change in the limb-girdles between the Santa Cruz and the later genera of the Toxodonta; in the former the scapula has a well-defined acromion and two very prominent metacromia, one arising near the middle of the spine and the other near the distal end, while in the Pampean *Toxodon* there is no acromion or distal metacromion and the proximal one is so reduced as to be hardly more than a thickening of the spine. No trace of the clavicle has yet been found in any member of the suborder and it is highly improbable that the bone was present in the post-Miocene genera, but the distinct acromion in *Nesodon* and *Adinotherium* indicates the possible presence of the clavicle in more or less reduced and vestigial form. In the Santa Cruz genera the pelvis is not greatly modified, the iliac plate being but moderately expanded and very little everted, but in *Toxodon* the ilium is so broadened and flared outward as to give the pelvis quite a proboscidean appearance, and the same is true, in less pronounced degree, of *Homalodontotherium;* otherwise, nothing is known of the limb-girdles of the Entelonychia.

The Limb-bones vary much, though chiefly in their proportions, according to the size and weight of the animal. The fibula articulates largely with the calcaneum in all members of the order, except a few of the Typotheria, in which this articulation has been secondarily lost. In this group, which is made up almost entirely of small animals, the limb-bones are slender and weak and the processes for muscular attachment are mostly low and inconspicuous. The ulna and radius are always separate and the tibia and fibula are sometimes so, but in most of the genera they are coössified at both proximal and distal ends. The femur has the third trochanter, the humerus has an epicondylar foramen. The Santa Cruz Toxodonta have limb-bones very like those of the Typotheria except for their larger size and greater relative stoutness; the epicondylar foramen is lost; the tibia and fibula are ankylosed at the proximal end only, not at the distal, and the fore and hind limbs are of approximately equal length. In *Toxodon*, probably also in its contemporary genera, whose limb-bones have not yet been found, the hind-limbs are very much longer than the fore, a disproportion due chiefly to the great elongation of the femur, which has lost the third trochanter and in other ways has acquired a resemblance to the femur of the Proboscidea. The other limb-bones are extremely heavy and relatively short.

In the Entelonychia the limb-bones, though of the same general type as in the other suborders, are much modified in accordance with the very curiously specialized feet. The humerus has remarkably prominent deltoid and supinator crests and epicondyles and in one genus (*Diorotherium*) there is an epicondylar foramen. The fore-arm is much elongated and the ulna is, for most of its length, heavier than the radius, which probably had considerable freedom of rotation. The femur is also long, and antero-posteriorly flattened and has a reduced third trochanter. The bones of the lower leg are relatively short, so that the fore-limb is longer than the hind, somewhat as in the European *Macrotherium*. The tibia and fibula are separate and the former has a distal end of peculiar shape, being broad transversely and much compressed antero-posteriorly. The fibula is very stout, especially the distal end, which forms a massive external malleolus.

The Feet differ more among the three suborders than does any other part of the skeleton, though the unity of plan is made evident by the uniformity of the carpus and tarsus. Throughout the order, at least in all the genera of which the feet are known, the carpus is arranged in alternating series and there is no free central, that element being probably ankylosed with the scaphoid. Otherwise, there is no coössification among the carpals and the trapezium is always present, except probably in the Pampean toxodonts. In the tarsus the astragalus is grooved in varying degree, but never deeply, and always has a rounded, convex head, which rests only on the navicular and is widely removed from the short cuboid. In the known toxodonts the meso- and entocuneiforms are coössified, but in the other suborders all of the tarsals are free and none is lost. Except in a few of the Typotheria, the calcaneum has a large and prominent facet for articulation with the fibula.

While the fundamental character of carpus and tarsus is thus uniform, there are many varieties in details; thus, in the Toxodonta the astragalus has a very short neck and a short trochlea, which is but little or hardly at all grooved, and the calcaneum has a short, heavy tuber. In the Entelonychia the astragalus has a very elongate trochlea, with parallel sides, a long neck and very convex head, and the tuber calcis is long, laterally compressed and with much thickened free end. The Typotheria have a more deeply grooved astragalus, which is quite different in shape from that of either of the other suborders and the same is true of the calcaneum, as is made clear by a comparison of the plates in this volume.

It is in the metapodials and phalanges that the most striking differences between the three groups of the order are to be noted. All of the known Toxodonta are tridactyl and the feet have a mesaxonic symmetry, which, however, is not perfect, and a vestigial fifth metacarpal is retained in all of the genera, even the latest, but no trace remains of the fifth digit in the pes. The phalanges are short and heavy and the unguals are broad and hoof-like, changing their proportions with the bulk of the animal. In general appearance, the feet of the Santa Cruz genera bear a decided resemblance to those of Eocene perissodactyls, but they are remarkably small and weak in proportion to the size of the skeleton. In the Typotheria the number of digits is more variable; the formula is usually IV–IV, but in one series, including the Pampean *Typotherium*, the pollex is retained. The symmetry of the digits is not very strongly marked and may be either mesaxonic or paraxonic. The phalanges are slender and elongate, the unguals narrow and pointed, nail-like, rather than hoof-like, except in the comparatively large *Typotherium*, in which they are short and wide.

The Entelonychia have the most curious and aberrant type of feet, which in some measure resemble those of the Ancylopoda of the northern hemisphere, though it should be noted that these parts are not fully known in any of the genera and only approximately so in a single genus, *Homalodontotherium*. There are five fully developed and functional metacarpals, which are very long and slender; mc. V is much the stoutest and perhaps the longest of the series; the distal trochleæ are very unusual in form and indicate a remarkable degree of mobility on the part of the phalanges. The unguals are large heavy claws, cleft at the free ends. The pes is likewise pentadactyl and isodactyl in symmetry, and the metatarsals are extremely short, hardly more than one-third as long as the metacarpals; mt. V is the heaviest and from the fibular border, near the proximal end, is given off a large process, much like that seen in the Santa Cruz Gravigrada. The phalanges of the pes are unknown.

The Systematic Position of the Toxodontia.

This difficult problem can be dealt with here only in a brief and tentative manner, reserving the full discussion to a subsequent volume, after the description of the Astrapotheria shall have appeared, for the problem of the Toxodontia is that of all the indigenous groups of South American ungulates.

It is not surprising that different observers should have reached very divergent conclusions, for the difficulty of giving the true valuation to the long lists of likenesses and unlikenesses among the various groups is exceedingly great. Indeed, a definitive solution of the problem is hardly to be hoped for until much more is learned regarding the skeletal structure of the pre-Santa Cruzian genera, especially those of the *Notostylops* Beds.

In his later writings, Ameghino attempted to bring nearly all the peculiarly South American groups of hoofed animals into relation with the orders of the northern hemisphere; the Litopterna were united with the Perissodactyla, the Astrapotheria with the Amblypoda, the Pyrotheria with the Proboscidea and the Entelonychia with the Ancylopoda, except the Notostylopidæ, which are referred to the Tillodonta. The Notohippidæ are removed from the toxodonts and united with the horses to form a new order, the "Hippoidea." The Toxodontia are retained as a distinct order and no very definite relationship is suggested. An almost diametrically opposite view is that of Lydekker ('96) who considers that all the South American ungulates, except perhaps the Pyrotheria, are more or less closely related and derived from a common stock. In particular, the astrapotheres and homalodontotheres are regarded as nearly related and are included in the same order. Roth, in the remarkable paper so often quoted ('03), refers the Litopterna to the perissodactyls and apparently, though not explicitly, is inclined to make the same reference of the Astrapotheria. The toxodonts, in the narrow sense, the typotheres and the homalodontotheres are included in a new order, the Notoungulata, which Roth believes to be widely separated from all other hoofed animals and related to the Primates. Gregory ('10) extends Roth's term to include all the indigenous South American forms, even the Pyrotheria, and raises the Notoungulata to a super-order. Schlosser's ('11) classification of the hoofed mammals is an unusual one, admitting only three orders and relegating the other groups to subordinal rank. The three orders are I *Ungu-*

lata, with the suborders, 1 Condylarthra, 2 Litopterna, 3 Perissodactyla, 4 Artiodactyla, 5 Amblypoda: II *Notoungulata*, with the suborders, 1 Typotheria, 2 Toxodontia, 3 Entelonychia, 4 Astrapotherioidea, 5 Pyrotheria: III *Subungulata*, with the suborders, 1 Embrithopoda, 2 Hyracoidea, 3 Proboscidea, 4 Sirenia. Except for the position assigned to the Litopterna, this scheme, so far as it deals with South American forms, is substantially the same as that of Gregory and Lydekker, with whose general views I am disposed to agree.

Leaving aside for the present the imperfectly known Pyrotheria and Astrapotheria, the indigenous South American groups of hoofed animals are, in my judgment, all more closely interrelated than they are to any of the northern orders, which is substantially the conclusion reached by Lydekker. That the toxodonts, typotheres and homalodontotheres together form a natural assemblage of allied forms is a matter of practically universal agreement; it is the position of the Litopterna that gives rise to the greatest difference of opinion. My own views on this question and the reasons for them are fully explained in Vol. VII of these Reports.

The four groups, whatever rank be assigned to them, agree in the following significant particulars: (1) Though some of the incisors may be enlarged and tusk-like, there is a gradual transition in form from the incisors to the grinding teeth, except in the Proterotheriidæ. (2) The premolars are different from the molars. (3) The grinding teeth are lophodont. (4) In the upper molars the posterior crest is short and more or less imperfectly developed. (5) The lower molars are bicrescentic and, except in the Litopterna, the anterior crescent is much smaller than the posterior. (6) A pillar, or spur, is present in the inner valley of the posterior crescent this has been secondarily lost in a few of the proterotheres. (7) $M_{\overline{3}}$ rarely has a talon and it is never large. (8) The odontoid process of the axis is always conical, even in the long-necked forms. (9) The scapula frequently has two prominent metacromia. (10) The ulna and radius are always separate, except in the later Macrauchenidæ. (11) Save in the latest toxodonts, the femur retains the third trochanter. (12) The carpal bones are arranged in alternating series and there is no free central. (13) The number of digits in manus and pes ranges from five to one and the symmetry is usually mesaxonic; digital reduction is "inadaptive" in character. (14) The astragalus has a narrow trochlea and convex head, which articulates only with the navicular and is far removed from the short cuboid. (15) There is an extensive articulation between the calcaneum and the fibula, except in a few typotheres which have suppressed this connection.

While some of these resemblances are trivial and without taxonomic importance, it is difficult to believe that so many correspondences are due to a purely convergent mode of development and imply no community of origin. Indeed, there is but one very important structural difference between the Toxodontia (Notoungulata) and the Litopterna and that is the auditory region of the skull. Equally striking differences in the skull of the Rodentia are not held to justify the breaking up of that order.

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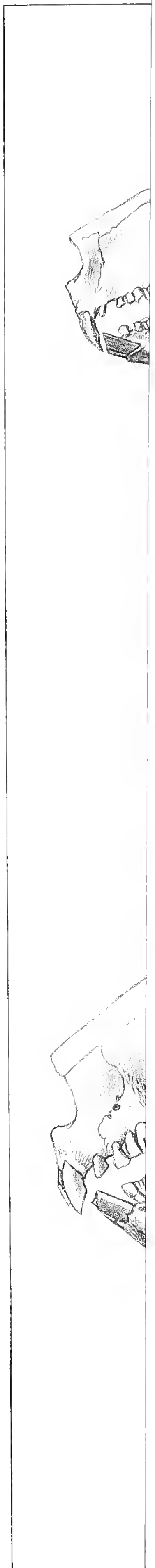
EXPLANATION OF PLATE XII.

PATAGONIA



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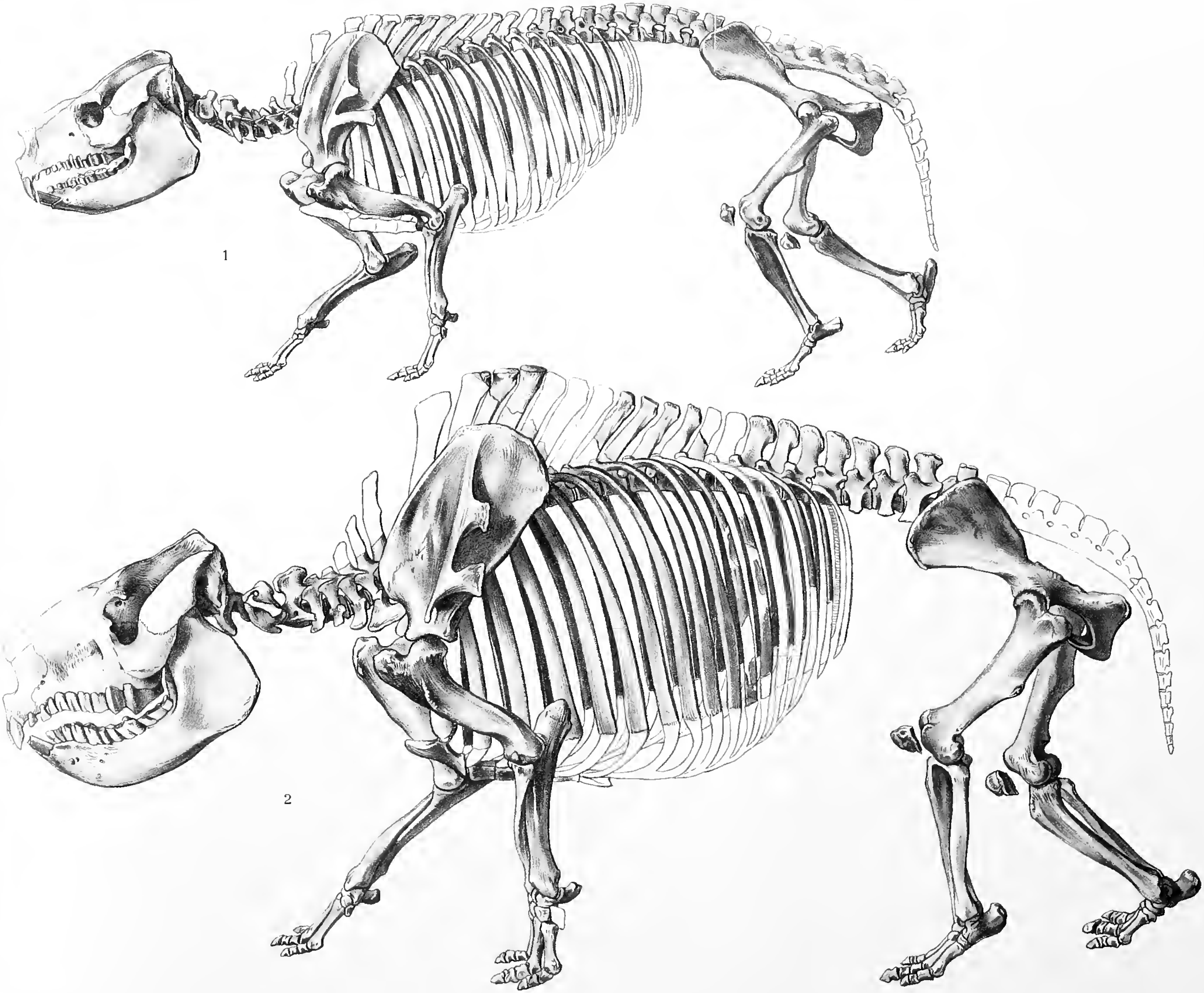

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NESODON

EXPLANATION OF PLATE XIII.

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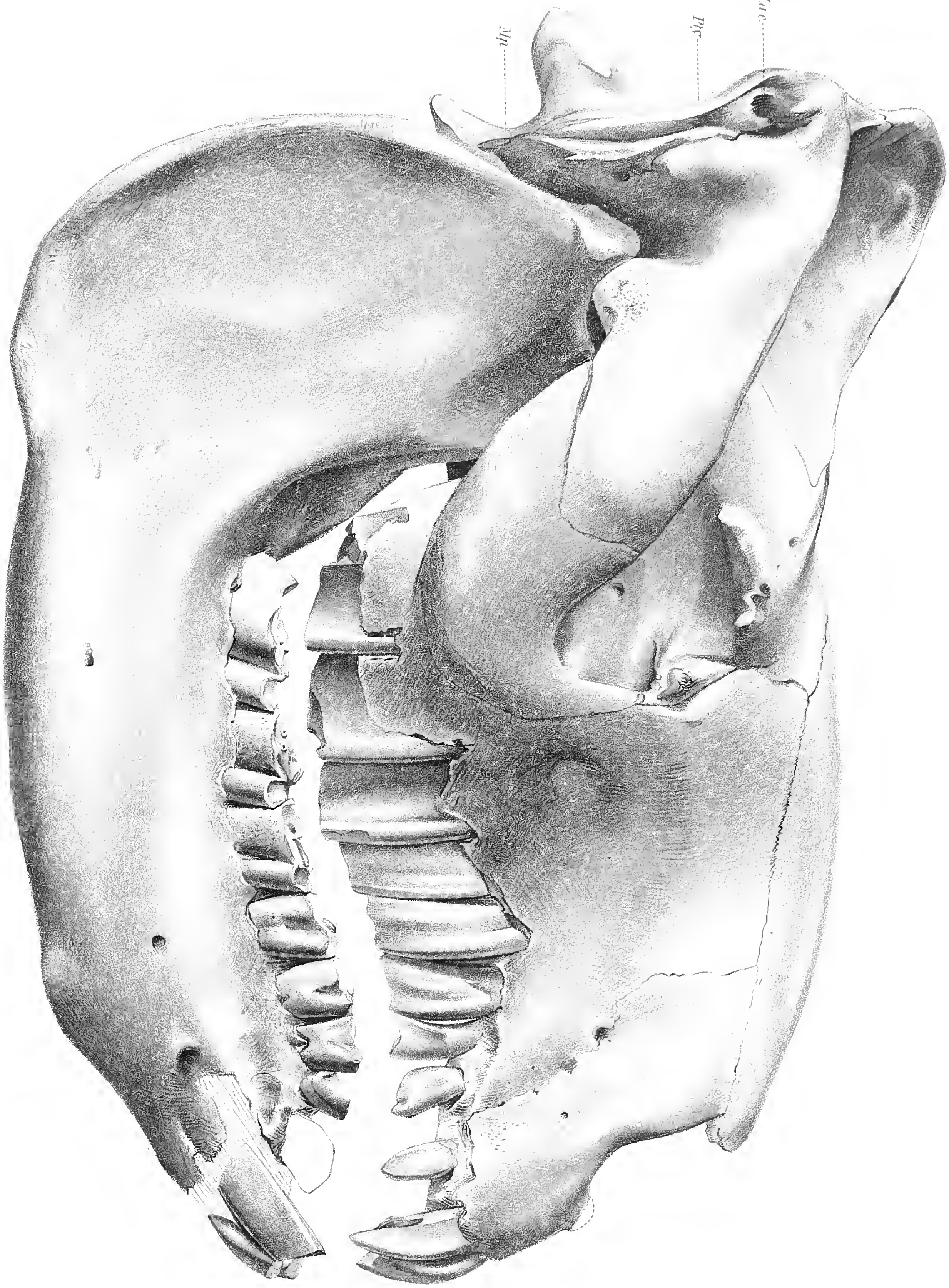

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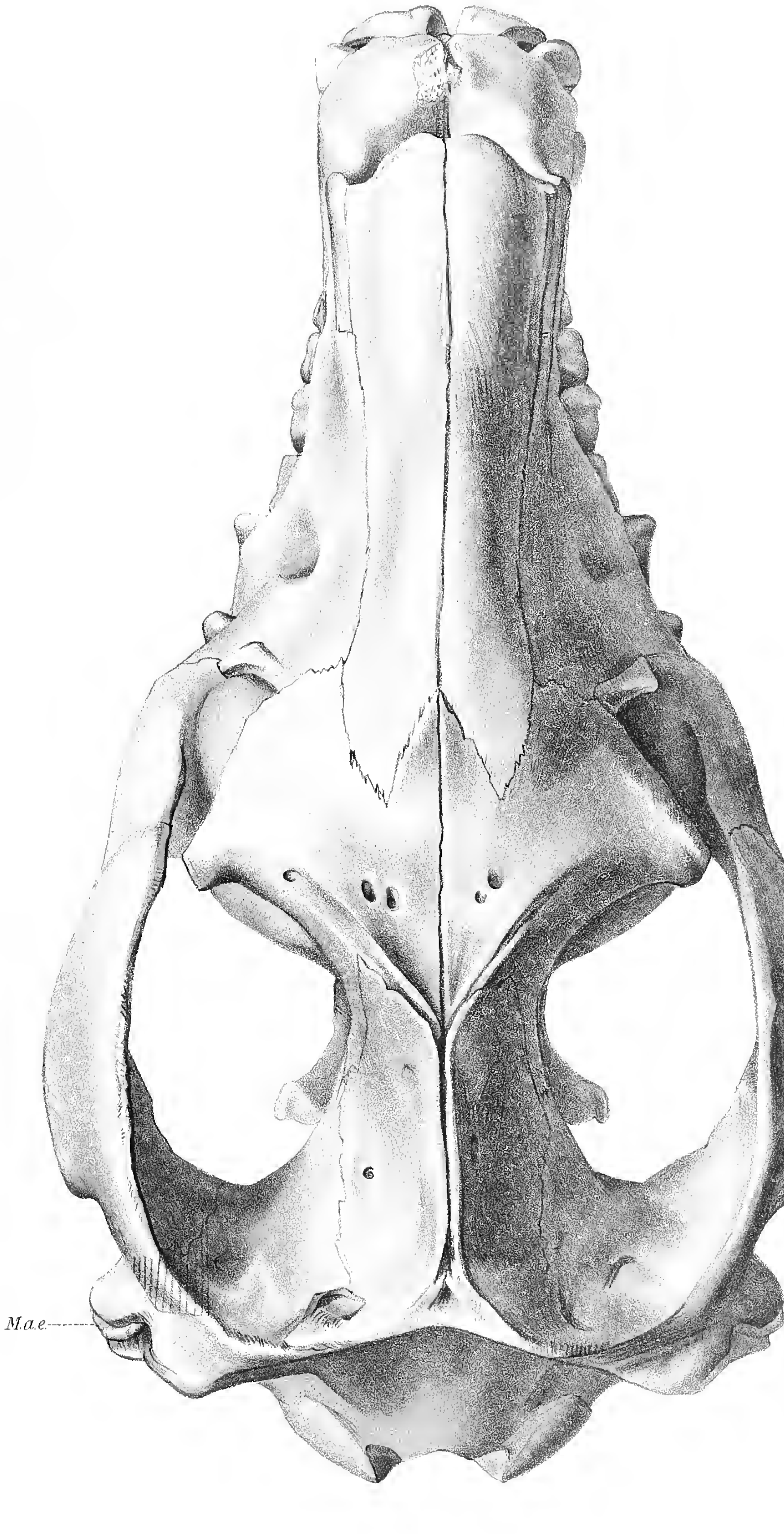
NESODON

EXPLANATION OF PLATE XIV.



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NESODON

EXPLANATION OF PLATE XV.

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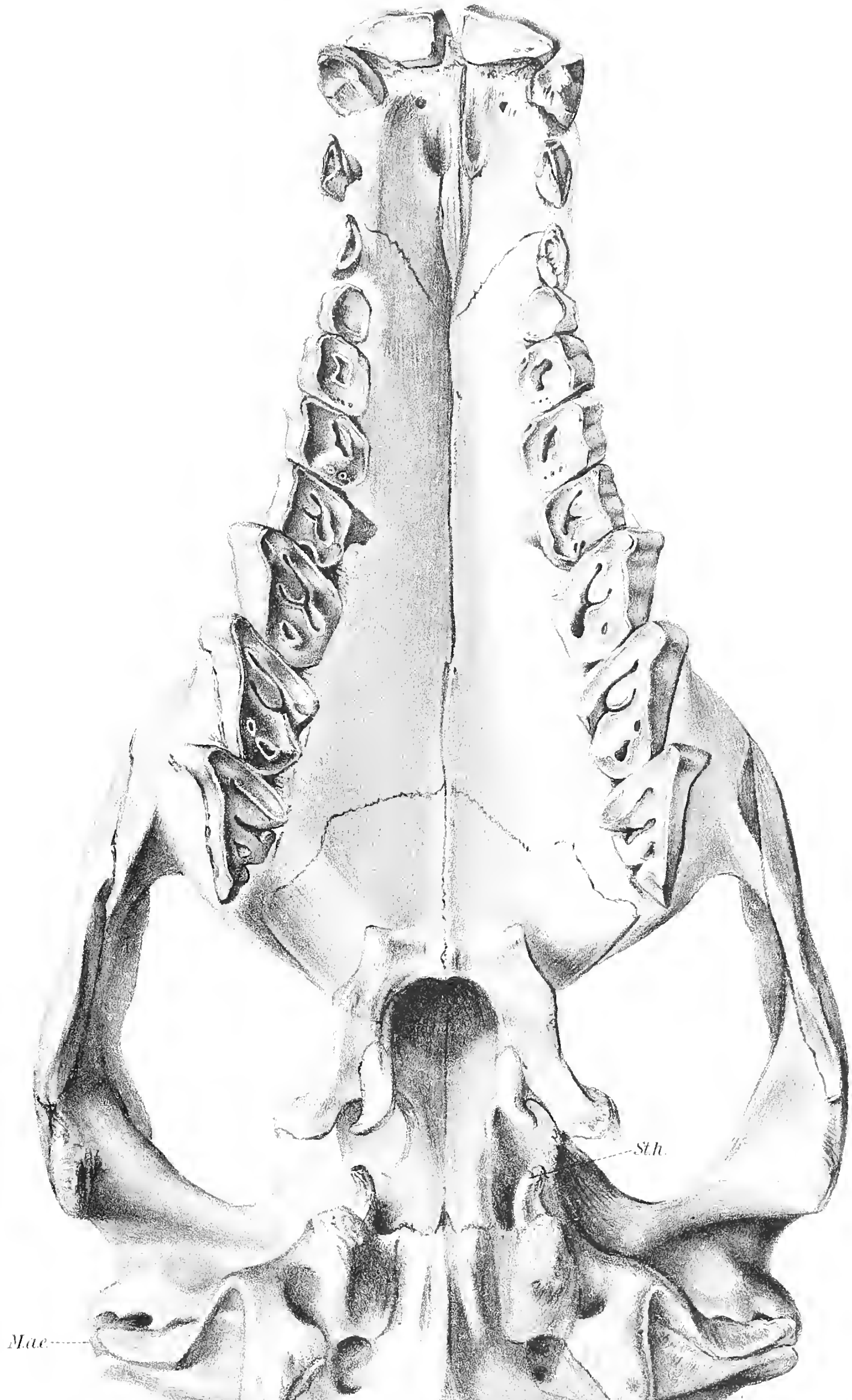

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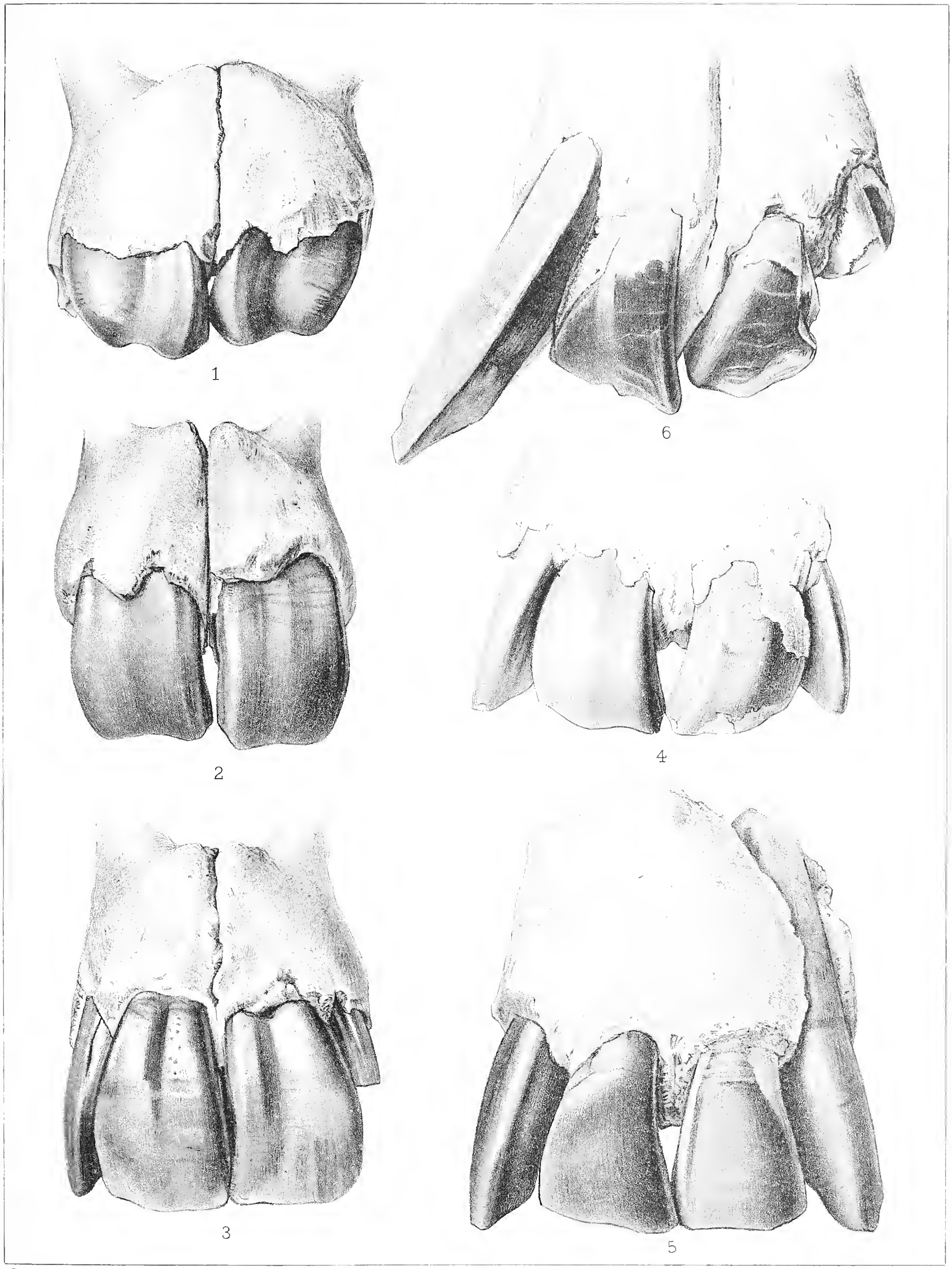

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NESODON.

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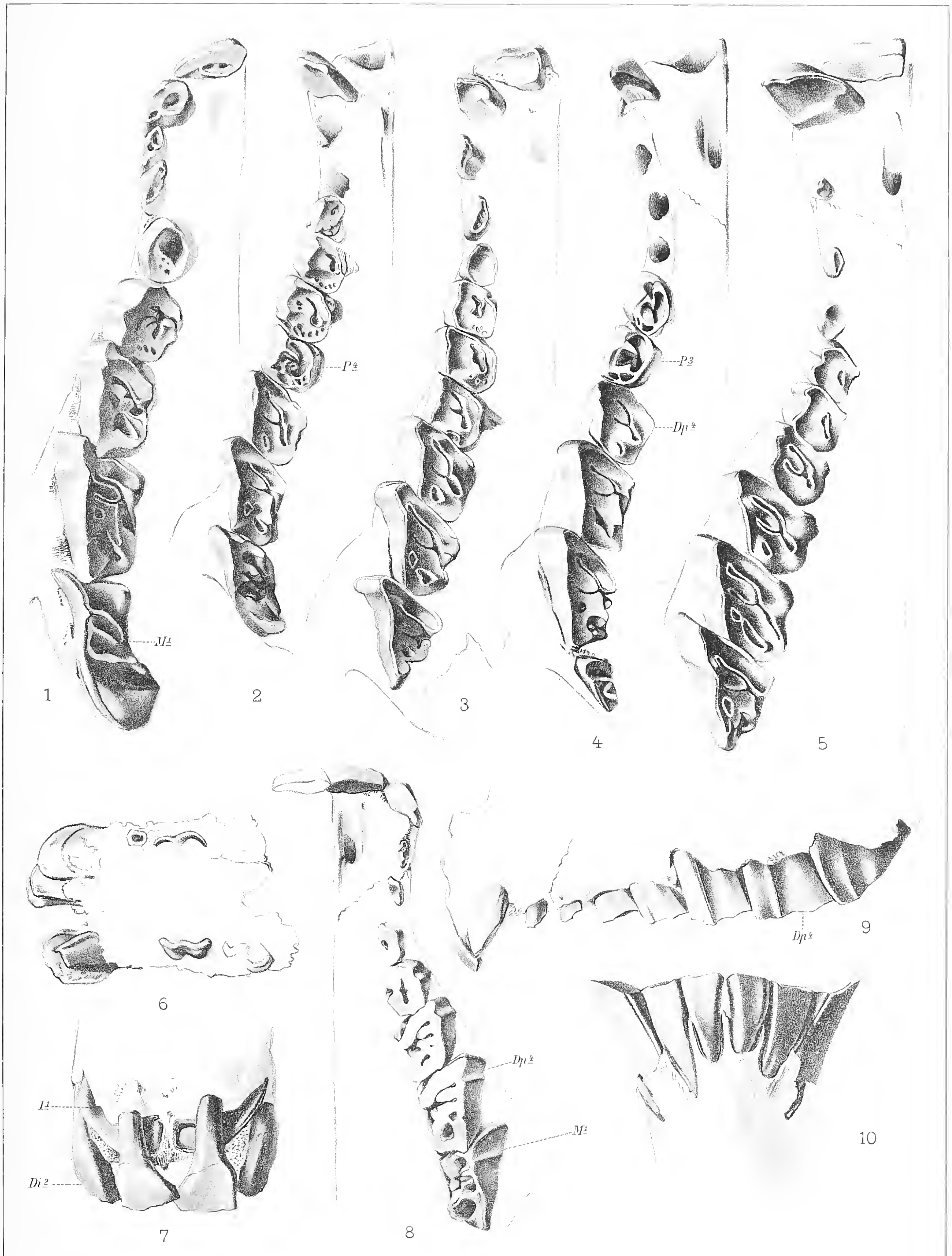

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ADINOTHERIUM, NESODON.

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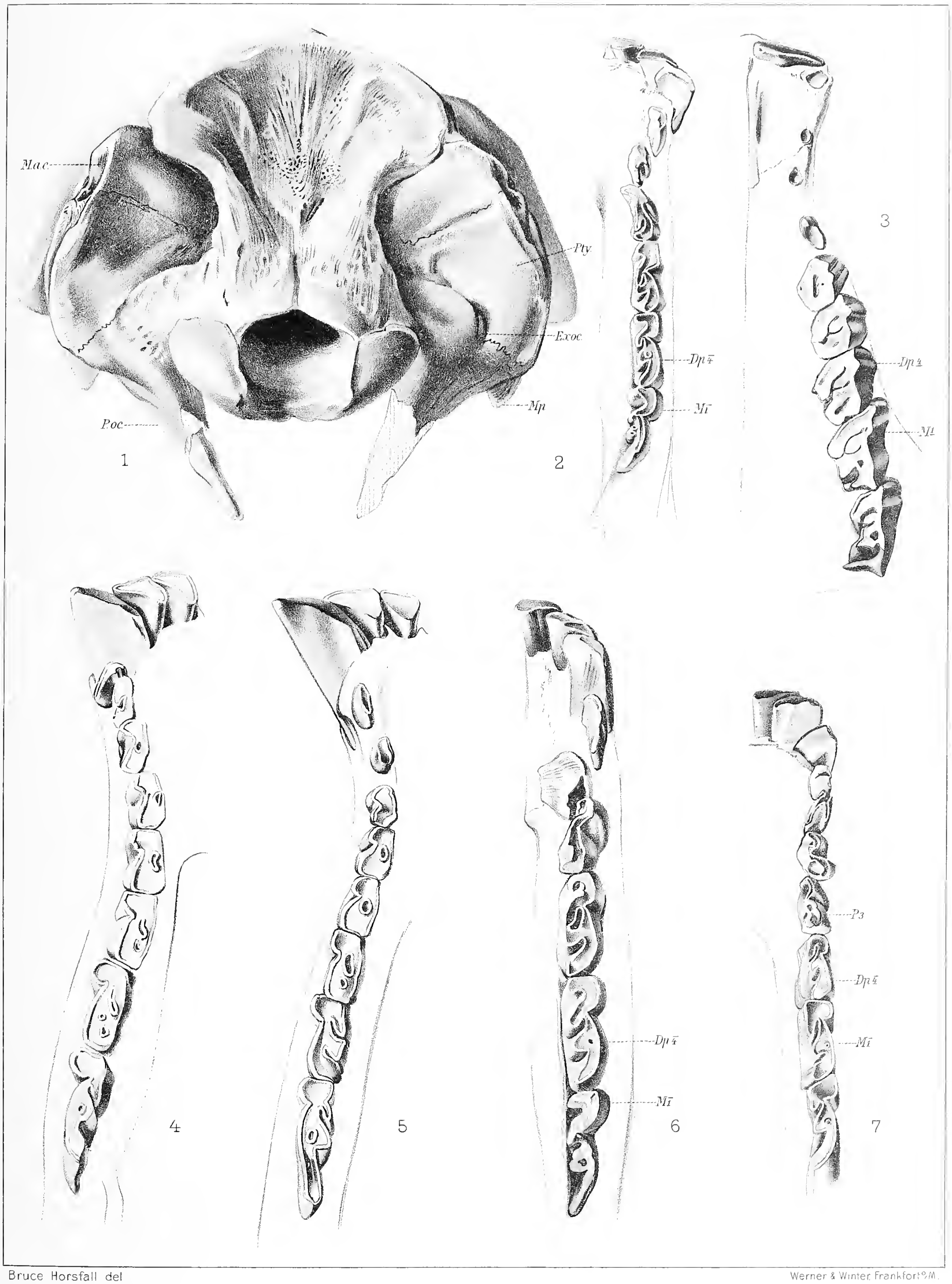

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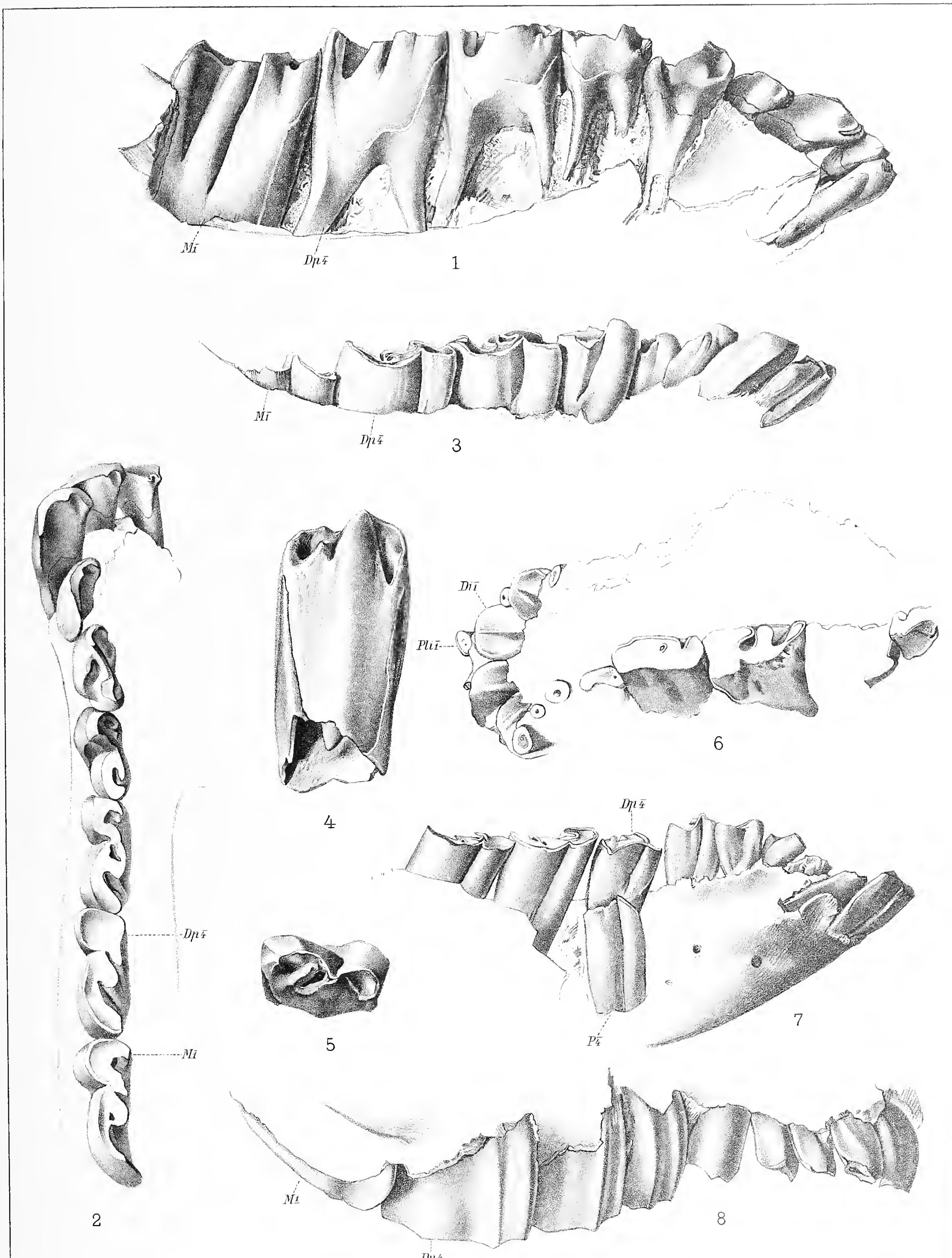

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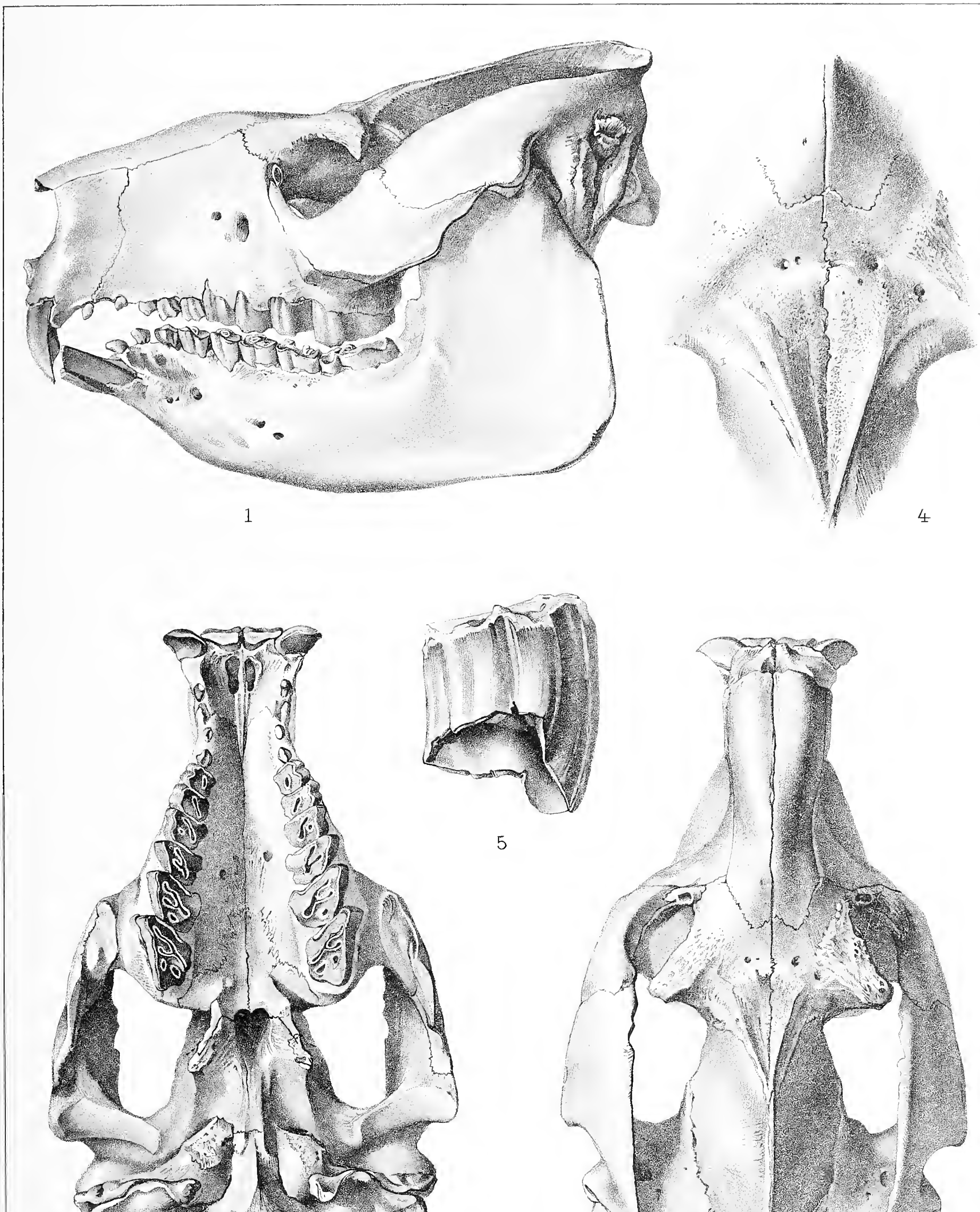

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ADINOTHERIUM, NESODON.

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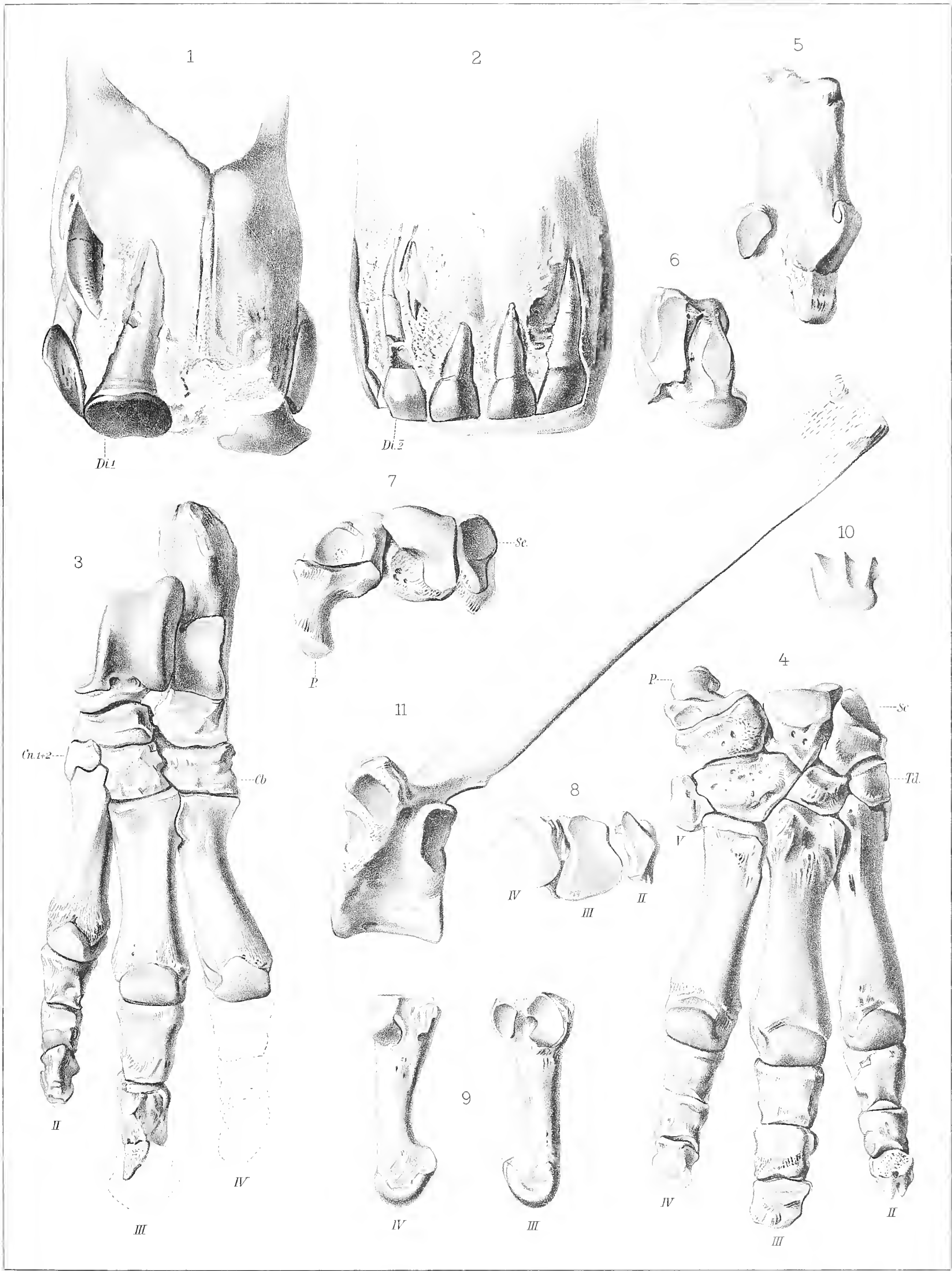

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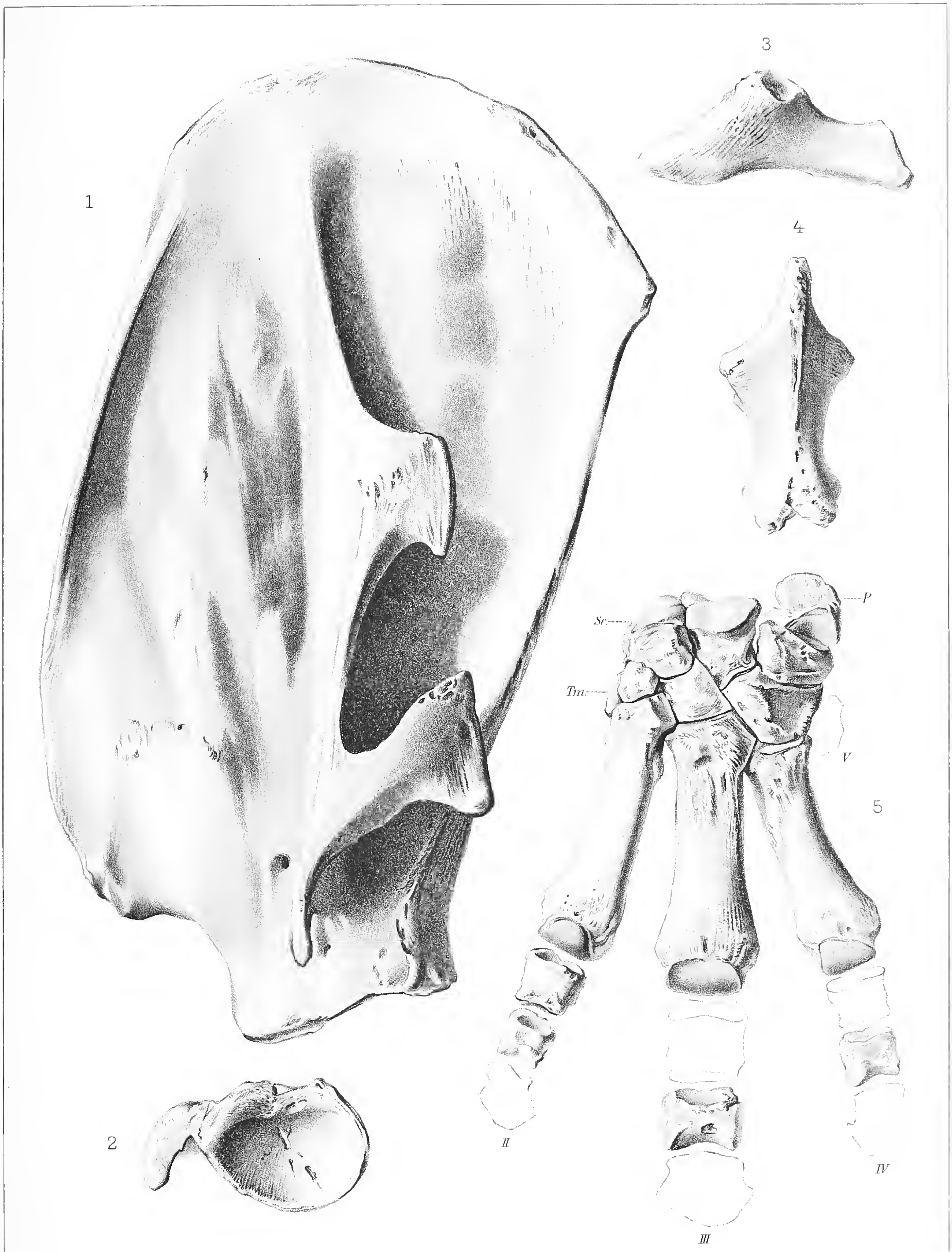

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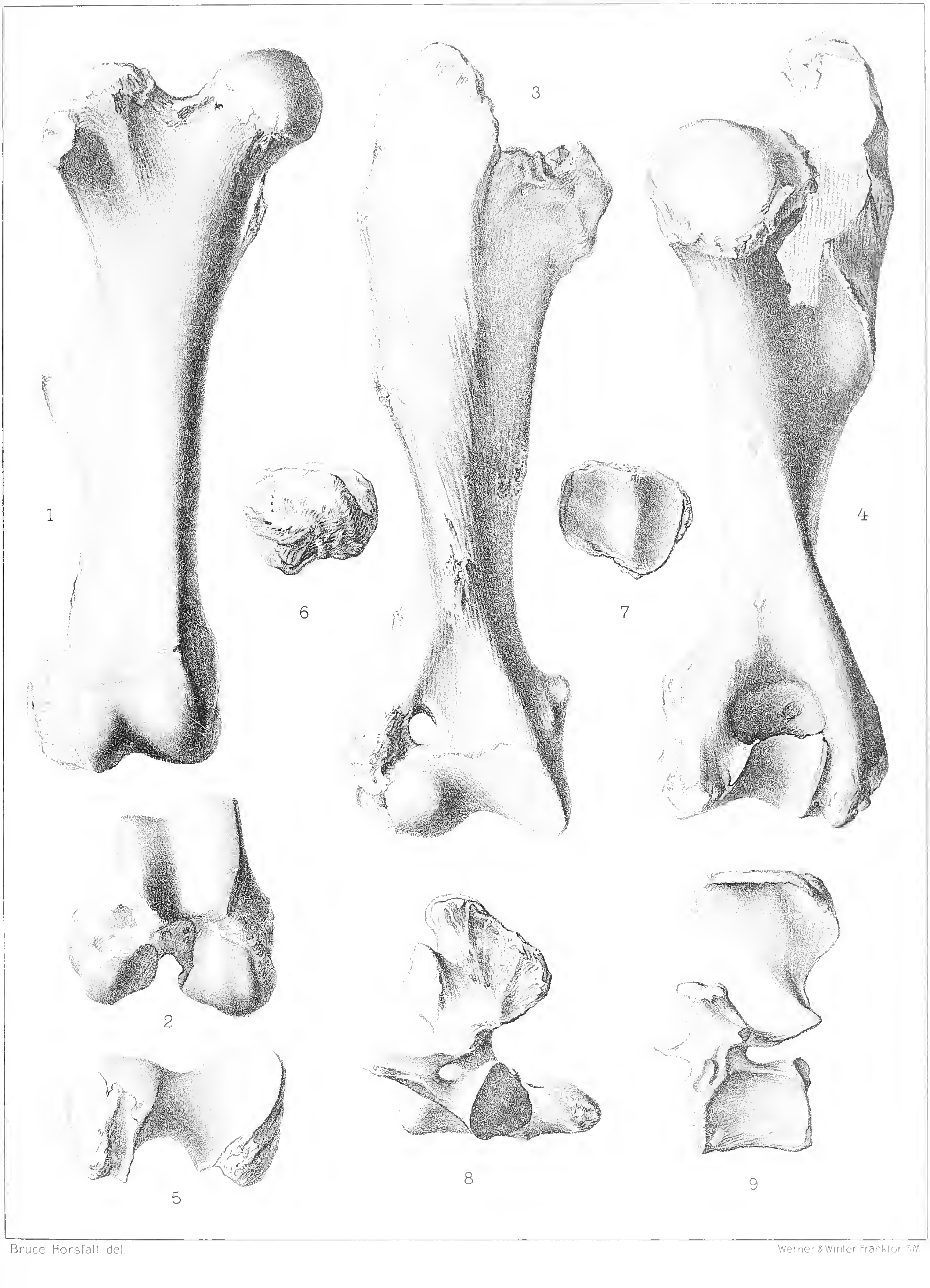

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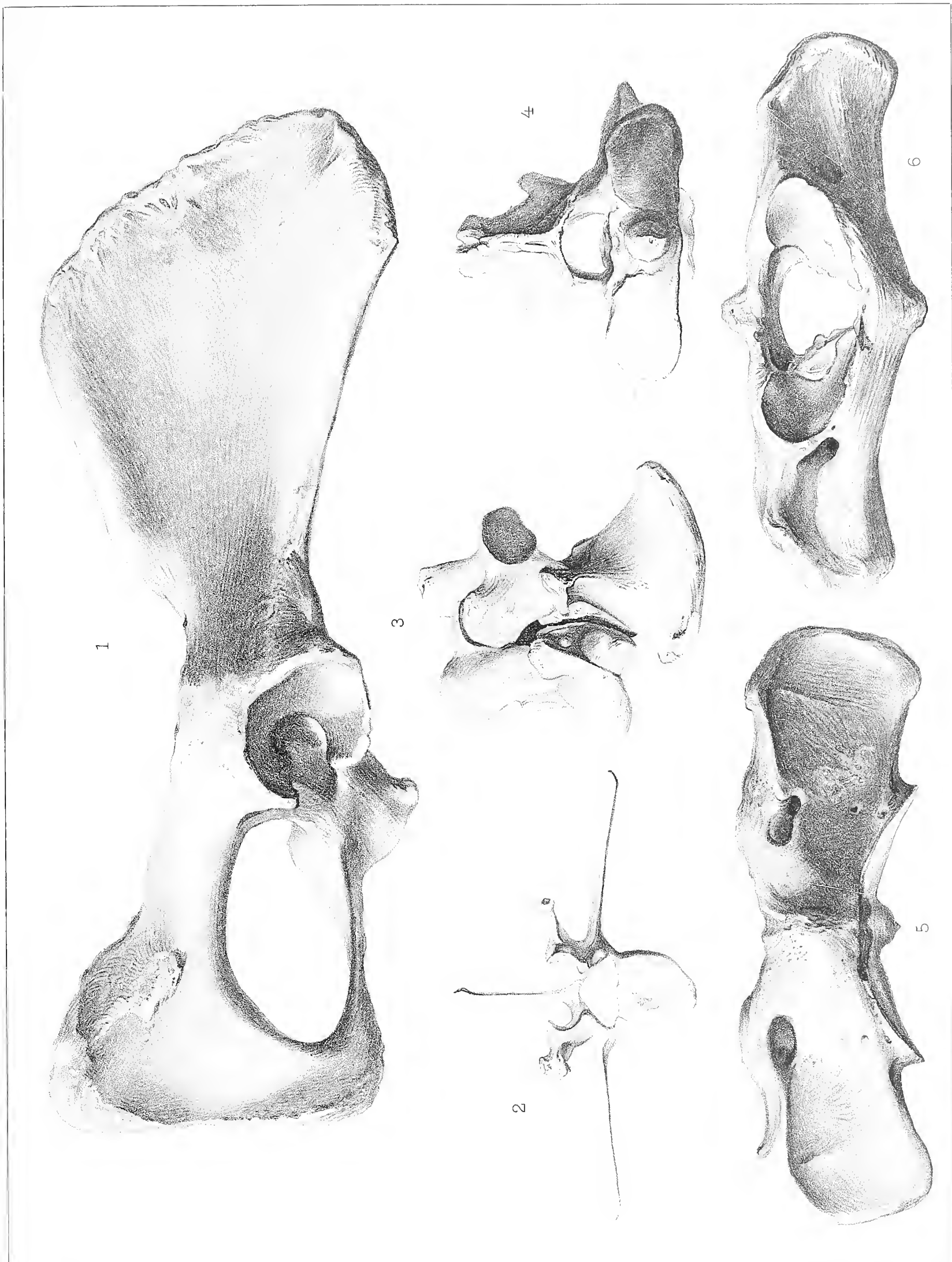

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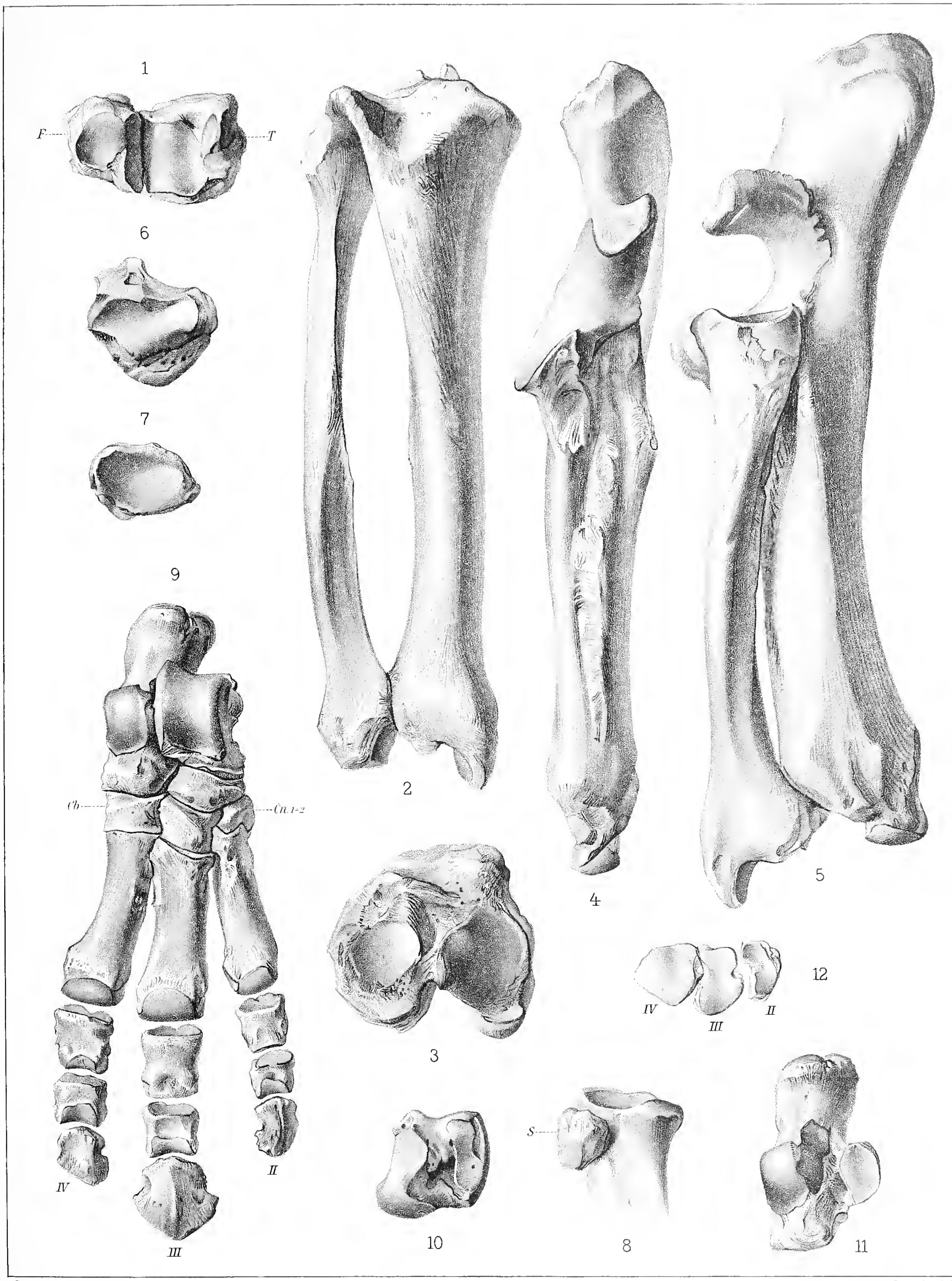

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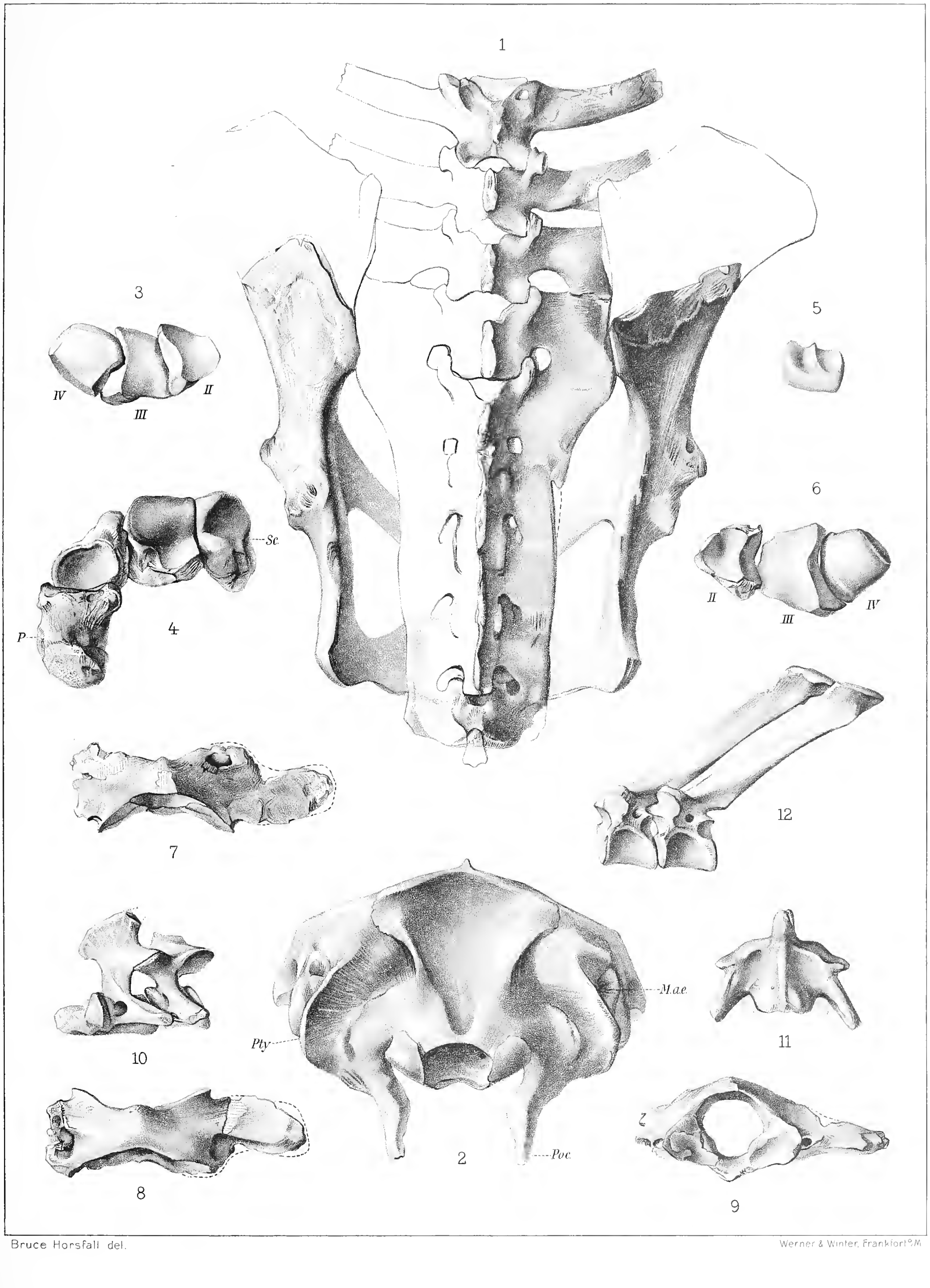

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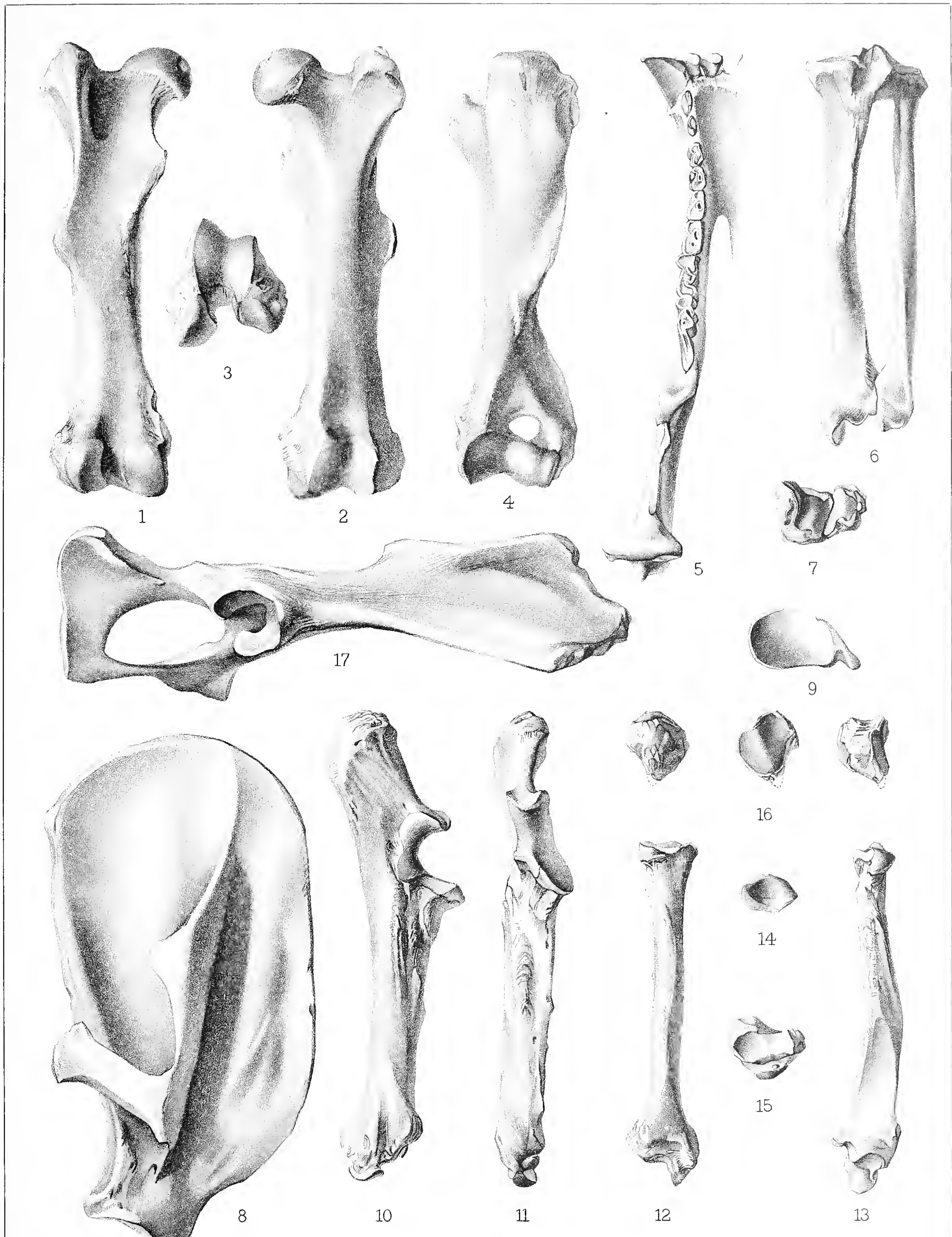

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ADINOTHERIUM.

EXPLANATION OF PLATE XXVIII.

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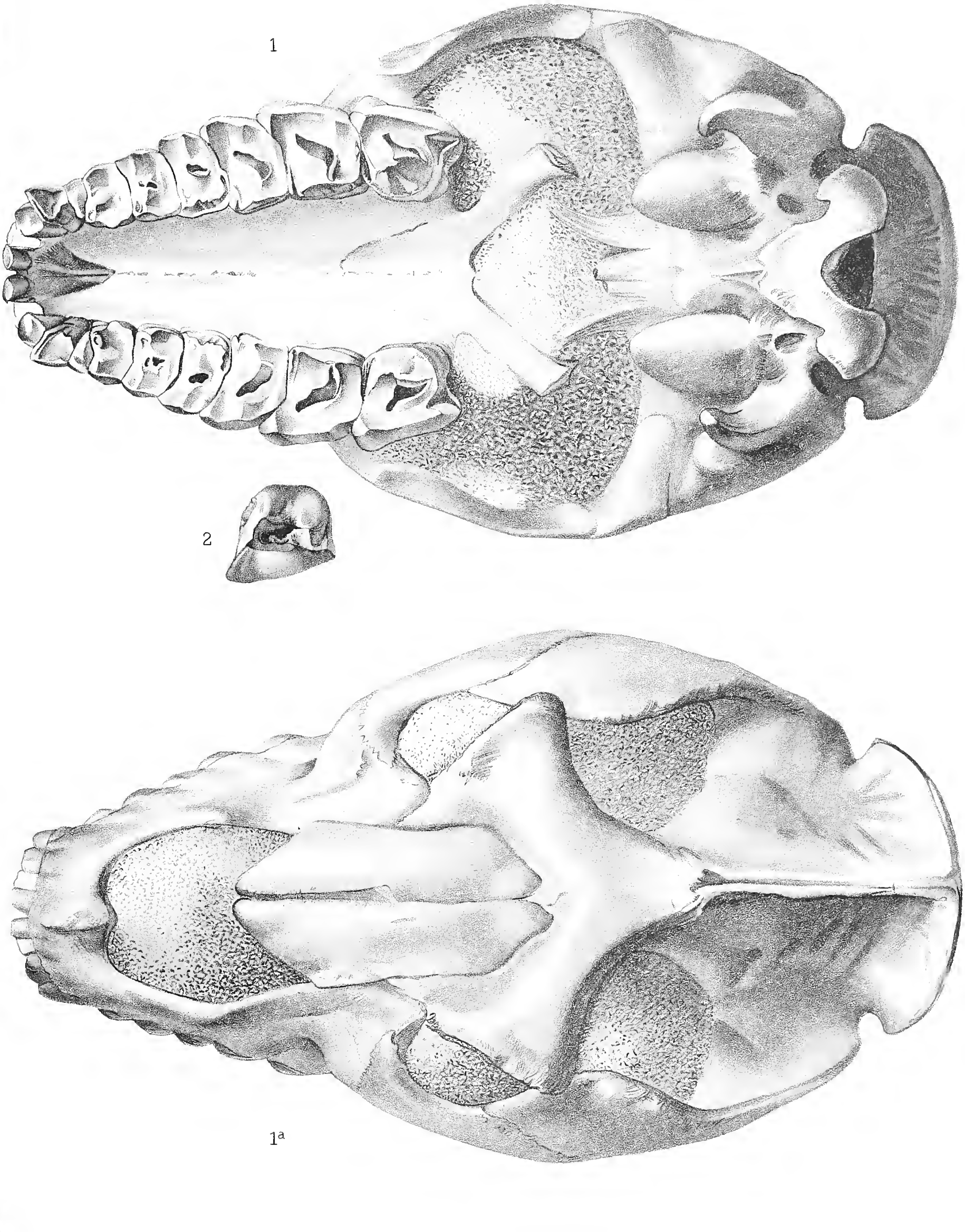

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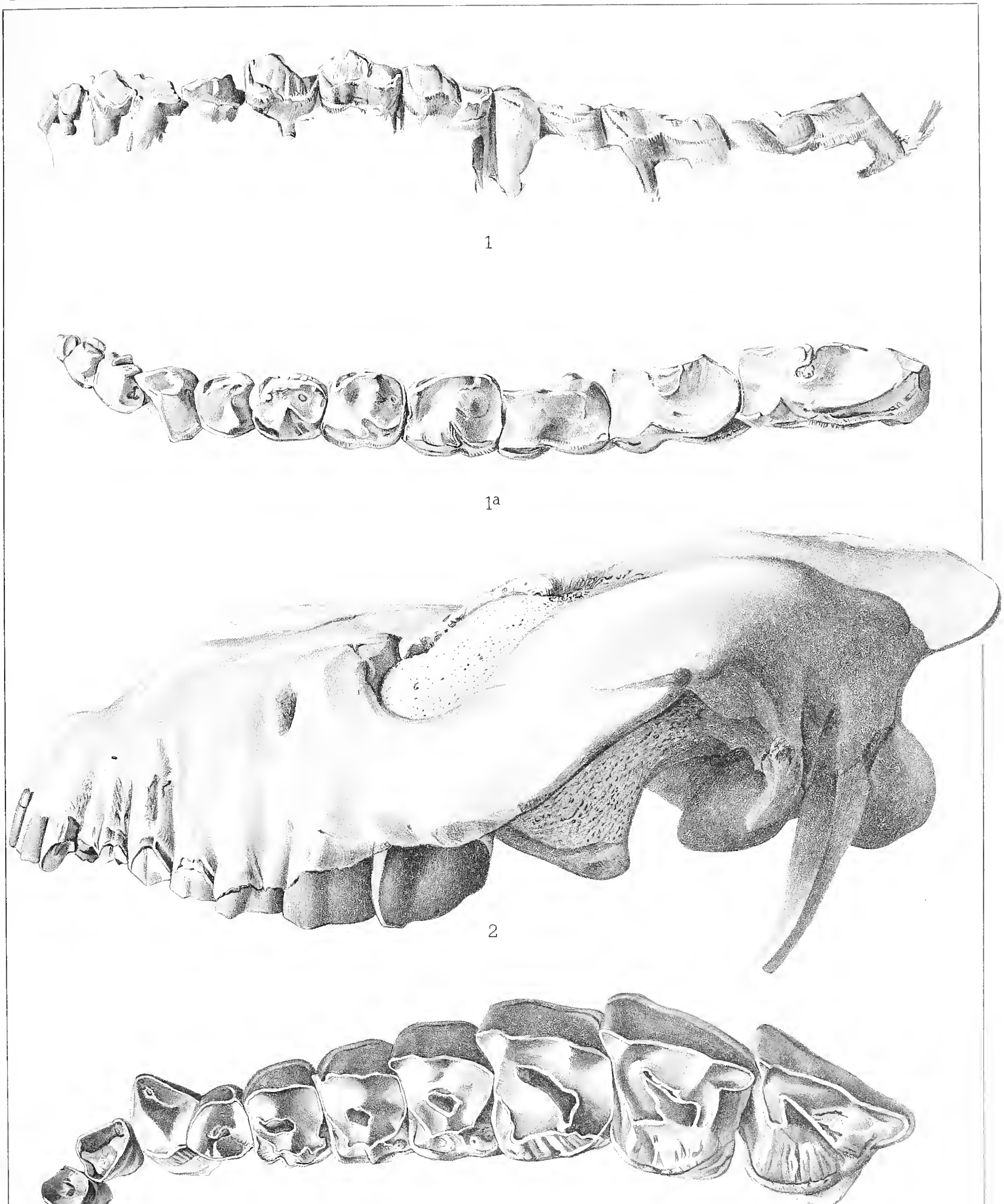

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HOMALODONTOTHERIUM

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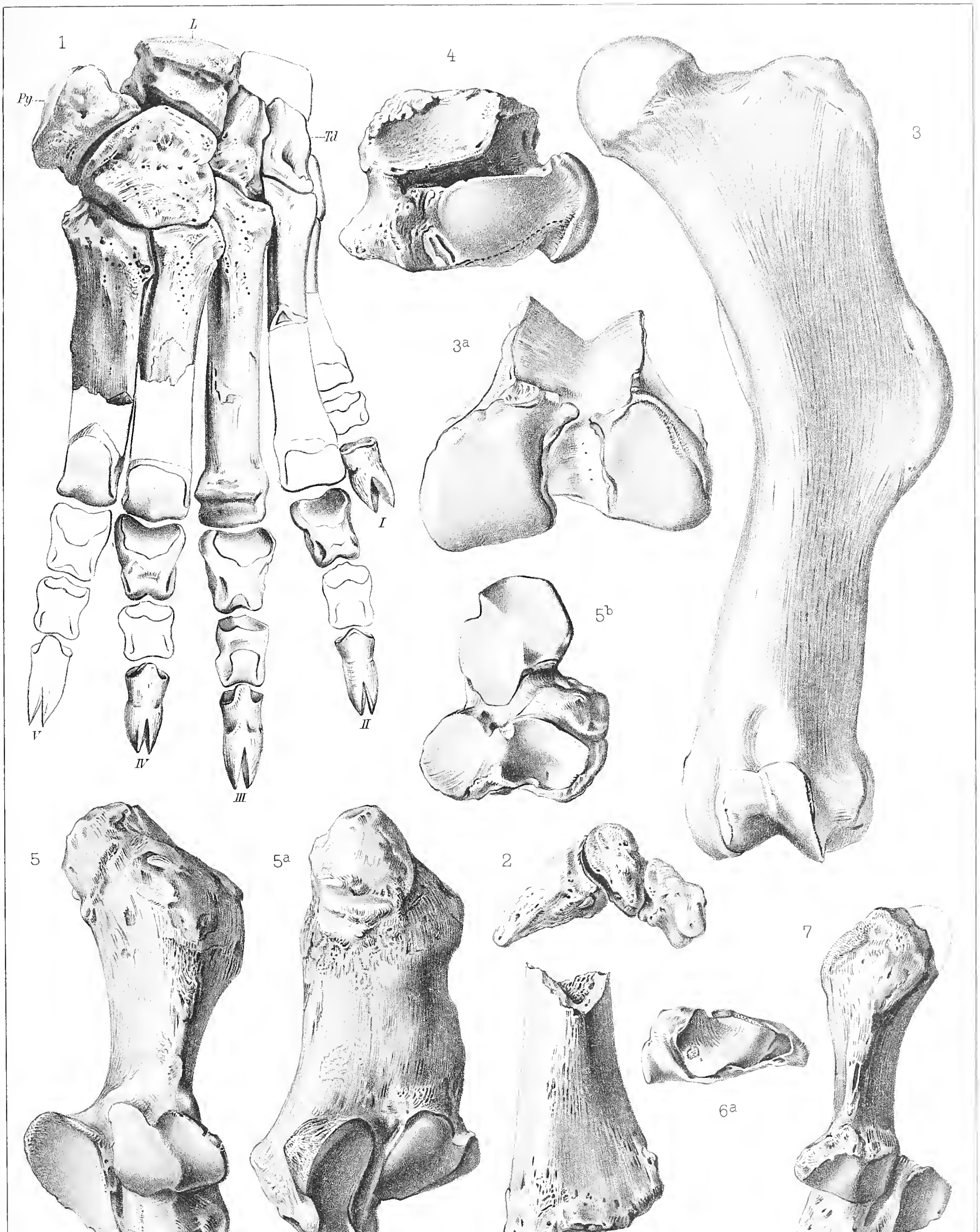

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HOMALODONTOTHERIUM