J. Green.

ARSINOITHERIUM ZITTELI

A DESCRIPTIVE CATALOGUE

OF THE

TERTIARY VERTEBRATA

OF

THE FAYÛM, EGYPT.

BASED ON THE COLLECTION OF THE EGYPTIAN GOVERNMENT IN
THE GEOLOGICAL MUSEUM, CAIRO,
AND ON THE COLLECTION IN
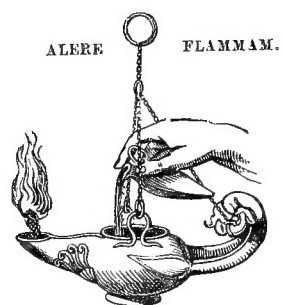THE BRITISH MUSEUM (NATURAL HISTORY), LONDON.

BY

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ALERE FLAMMAM.

PREFACE.

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AMONG recent discoveries in Palæontology, none have excited more interest than the Lower Tertiary Vertebrate Faunas of the Fayûm. They add so much to our knowledge of the primitive Mammalia, especially of the Hyracoidea, Proboscidea, Sirenia, and Cetacea, that an exhaustive account of them, so far as discovered, has become essential. The Trustees of the British Museum have therefore availed themselves of the generous co-operation of the Egyptian Government to produce a Descriptive Catalogue of all the more important fossils by which these ancient Faunas are at present known. The greater part of the collection, now in the Geological Museum, Cairo, was made by Mr. H. J. L. Beadnell under the direction of Captain H. G. Lyons, Director-General of the Egyptian Surveys; while the smaller collection, in the Geological Department of the British Museum, was made partly by Dr. C. W. Andrews, the author of this Descriptive Catalogue, partly by donations of duplicates from the Egyptian Government. During the preparation of the work Dr. Andrews has had the opportunity of studying both these collections in detail, and the result is a satisfactory basis for future research. How much remains to be discovered for the elaboration of the preliminary sketch now given, will be readily realised on perusing the various sections of the Catalogue.

Thanks are due to the Right Hon. the Earl of Cromer, G.C.B., for his sympathetic interest, and to Captain Lyons for his cordial help and successful negotiation with the Egyptian Government. The Trustees of the British Museum are also indebted to Captain Lyons and Mr. Beadnell for their assistance to Dr. Andrews in his collecting expeditions; while special acknowledgment must be made of the funds generously provided for some of these expeditions by Mr. W. E. de Winton, whose presents are severally enumerated in the Catalogue.

A. SMITH WOODWARD.

DEPARTMENT OF GEOLOGY,
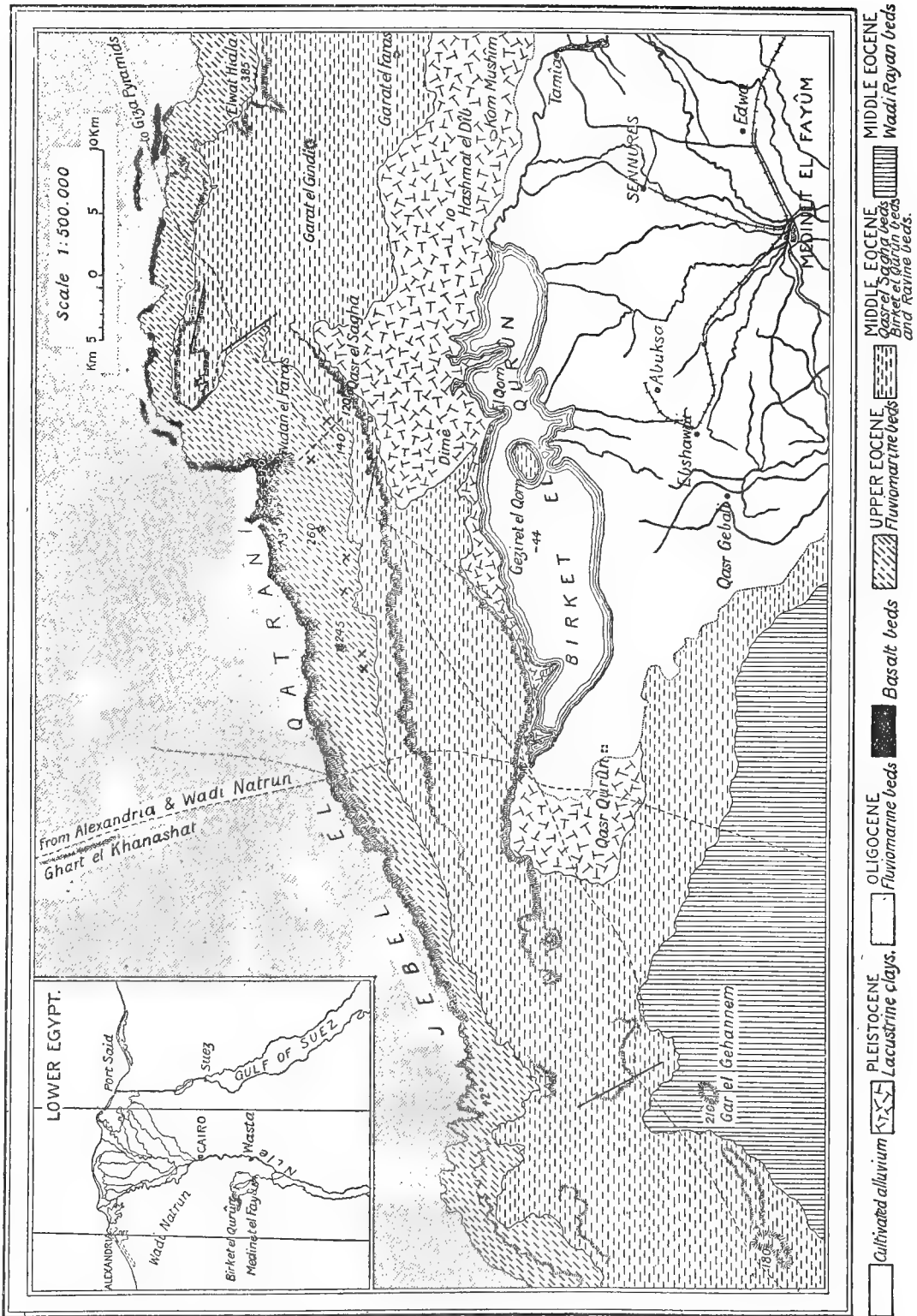BRITISH MUSEUM (NATURAL HISTORY).
5th March, 1906.

INTRODUCTION.

THE FAYÛM *, the lake province of Egypt, is a district occupying a depression in the desert to the west of the Nile Valley opposite Wasta, a small town about fifty-seven miles south of Cairo. This depression, which is roughly circular in outline, is separated from the river-valley by a belt of desert varying in width from about a mile and a half to some six or seven miles, and crossed at one point by a canal, the Bahr-el-Yusef, which runs through a narrow strip of low ground and is practically the only source of water-supply for the whole district. The water thus brought in from the Nile is distributed by irrigation-canals to the cultivated part of the district, and the surplus eventually finds its way through a number of channels, some of which form picturesque gorges, to the lowest part of the depression, occupied by a large expanse of brackish water, the Birket-el-Qurun. This lake is about twenty-five miles long, with a maximum width of only six miles; it is very shallow, the maximum depth at present being about sixteen or seventeen feet, and its shores in most places are very low and gently sloping. In Pleistocene times the floor of the depression was occupied by a body of water of vastly greater area than the present lake, evidences of its former extent being found in the widely spread lacustrine deposits, chiefly clays, containing, in addition to numerous Mollusca, remains of *Elephas africanus, Hippopotamus, Bubalis, Canis,* together with those of Crocodiles, Chelonians, and Fishes (8) †. In one or two places also numerous

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* The following sketch of the Topography and Geology of the Fayûm is mainly founded on Mr. H. J. L. Beadnell's detailed report, The Topography and Geology of the Fayûm Province of Egypt (Cairo, 1905), which should be consulted for further information. The papers by Blanckenhorn, mentioned in the list on p. xxx, are also of great importance.

† The numbers within brackets refer to the list of publications on p. xxix.

GEOLOGICAL MAP OF THE FAYÛM DEPRESSION (taken from pl. xvii. of II. J. L. Beadnell's Report on the Topography and Geology of the Fayûm Province : Survey Dept., Cairo, 1905). The crosses mark some of the chief localities from which Upper Eocene Vertebrates have been collected. Heights are given in metres.

Scale 1 : 500.000

Km 5 0 5 10 Km

LOWER EGYPT.

Port Said

Suez

GULF OF SUEZ

CAIRO

Wasta

Nile

Wadi Natrun

Birket el Qurûn

Medinet el Fayûm

ALEXANDRIA

from Alexandria & Wadi Natrun

Ghart el Khanashat

JEBEL EL QATRANI

Gar el Gehannem

Qasr Qurûn

Geziret el Qorn

BIRKET EL QURÛN

Dime

Qasr el Sagha

Widan el Faras

Garat el Gindi

Elwat Hsala

Gîza Pyramids

Garat el Faras

Hashmat el Dûl

Kom Mushim

Garat el Faras

Tamia

SENNURES

Abuksa

MEDINET EL FAYÛM

Edwa

Kushawir

Qasr Gebel

PLEISTOCENE
Lacustrine clays.

Cultivated alluvium

OLIGOCENE
Fluviomarine beds

Basalt beds

UPPER EOCENE
Fluviomarine beds

MIDDLE EOCENE
Qasr el Sagha beds
Birket el Qurûn beds
and Ravine beds.

MIDDLE EOCENE
Wadi Rayan beds

stumps of trees of considerable size occur, indicating that in some parts, at least, in the neighbourhood of the water the country was wooded. Later, within the historic period (XII. Dynasty, beginning about 2778 B.C.*), the lake was converted into an artificially-controlled reservoir, Lake Mœris, and was employed to regulate the supply of water in years of exceptionally high or low Nile floods. At this date, though smaller than the earlier Pleistocene lake, the water-covered area was far greater than at the present time, indications of its former extent being found in old shore-lines, still fringed with the stumps of tamarisk-bushes, and in the ruins of temples and cities (e. g. Qasr-el-Sagha). These remains are now separated from the water by miles of desert. Later still, probably in Ptolemaic times, the lake ceased to be used as a reservoir, and the quantity of water admitted to the Fayûm was limited, so far as possible, to the amount actually required for the irrigation of the district. The consequence of this was that the lake received only such surplus water as drained from the cultivated lands, and its level began to fall until, within the last year or two, it reached its smallest dimensions. Since then the more abundant supply of water resulting from the vast irrigation-works in the Nile Valley has led to a considerable area being reclaimed, and the consequent increase in the amount of water draining into the lake has brought about a slight rise in its level.

The cultivated land lies to the south and east of the lake, while on the north the desert extends down almost to the water's edge, from which it is separated by a belt of sand-dunes and swamp of varying width, covered with scanty vegetation, consisting mainly of tamarisk and reeds. Along the whole of the north margin also there is a band of lacustrine deposits widening out towards the east. These beds overlap the edge of the Middle Eocene strata which form the lower parts of the depression.

With only one or two exceptions, the whole of the vertebrate remains described in the present volume are derived from the Middle and Upper Eocene deposits lying on the northern side of the lake, and it will only be necessary here to give a brief account of the geological structure of that region. Looking northwards from a suitable point of view on the southern side of the lake, the northern slope of the depression can be seen rising in a series of escarpments of varying height (see Map and Section), and running roughly parallel to one another from about E.N.E. to W.S.W.; the terraces between the successive steps vary in width from mere ledges to plains some kilometres wide. There are three main escarpments, of which the

* Flinders Petrie, ' A History of Egypt,' vol. i. p. 147.

lowest is best developed towards the western end of the lake, running parallel with and at a short distance from the northern shore; this is composed of Ravine beds, Birket-el-Qurun series, and the lower part of the Qasr-el-Sagha beds. The Ravine beds are, for the most part, obscured by the overlying lacustrine deposits. The next main escarpment is seen rising very steeply in the middle distance; it is composed of the higher beds of the Qasr-el-Sagha series. To the north of this, and separated from it by a succession of broad terraces some kilometres wide, is the magnificent range of cliffs, the Jebel-el-Qatrani, composed of the upper beds of the Fluvio-marine (Upper
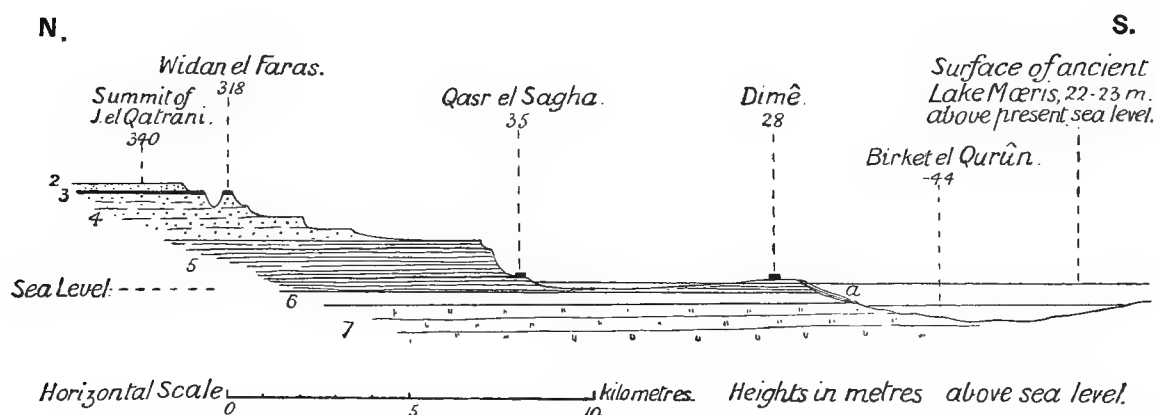
SECTION (from north to south) showing the succession of beds on the north of Birket-el-Qurun. (Reduced from part of the section on pl. xxii. of H. J. L. Beadnell's Report on the Topography and Geology of the Fayûm Province : Survey Dept., Cairo, 1905.)

a. Lacustrine clays; 2. Lower Oligocene; 3. Interbedded basalt sheet; 4. Upper Eocene (Fluvio-marine); 5. Qasr-el-Sagha series; 6. Birket-el-Qurun series; 7. Ravine Beds.

Eocene) series, and capped by a thick bed of basalt, which Mr. Beadnell regards as occurring at the junction of the Eocene and Oligocene beds. This upper range of cliffs practically marks the northern edge of the depression, and beyond it comes the high undulating plateau of brown pebble-strewn desert, composed mainly of fluviatile beds of Oligocene age, in which so far no vertebrate remains have been found. Throughout the whole series the beds dip very gently ($2°$ or $3°$) towards the north, and have been subjected to very little faulting or other disturbance.

    The following Table shows the succession of strata composing the country to the north of the lake, together with a list of the vertebrate remains at present known from the various horizons :—

TABLE SHOWING SUCCESSION AND CLASSIFICATION OF STRATA IN THE FAYÛM.

(Slightly modified from the Table given by Mr. Beadnell in his Report on the Topography and Geology of Fayûm Province, pp. 34–35.)

			Approximate average thickness in metres, north part of Fayûm.	
RECENT and PLEISTOCENE.				Alluvial soil, clays, sands, &c. Blown sand. Lacustrine clays extending to 23 metres above sea-level (*a* in Section).
MIDDLE PLIOCENE.			50	Gravel terraces (? Pleistocene). Shell-boring on rock-surfaces. Fossiliferous deposits of Sidmant.
LOWER OLIGOCENE.	Tongrian.		30	*Fluvio-marine Beds* (*Jebel-el-Qatrani Beds*).—Sandstones and sandstone-grits with silicified trees. (2 in Section.) Basalt sheets, interbedded and contemporaneous. (3 in Section.)
UPPER EOCENE.	Bartonian.		250	*Fluvio-marine Series* (4 in Section).—Variegated sands, sandstones, clays, and marls, with limestone-grits and thin bands of limestone. In the lower beds of this Series are large numbers of silicified trees associated with vertebrate remains, including:—*Arsinoitherium zitteli, A. andrewsi, Saghatherium antiquum, S. minus, S. magnum, S. majus, Megalohyrax eocœnus, M. minor, Palæomastodon beadnelli, P. wintoni, P. parvus, P. minor, Mœritherium* (?) *lyonsi, M. trigonodon, Phiomia serridens, Ancodon gorringei, A. parvus, A.* sp., *Rhagatherium ægyptiacum, Geniohyus mirus, G. fajumensis, G. major, Hyœnodon* sp., *Pterodon africanus, Apterodon macrognathus, Sinopa ethiopica, Eremopezus eocœnus, Crocodilus articeps, C. megarhinus, Tomistoma gavialoides, Testudo ammon, T. beadnelli, T. isis, Stereogenys libyca, Podocnemis fajumensis, P. blanckenhorni* with var. *ovata, Pelomedusa progaleata, Aëtobatis* sp.
MIDDLE EOCENE.	Parisian.	UPPER MOKATTAM.	155	*Qasr-el-Sagha Series* (*Carolia Beds*) (5 in Section).—Alternating limestones, marls, clays, and sandstones. The vertebrate remains include:—*Mœritherium lyonsi, M. gracile, Barytherium grave, Eosiren libyca, Zeuglodon osiris, Crocodilus* sp., *Tomistoma africanum, Psephophorus eocœnus, Thalassochelys libyca, Podocnemis antiqua, P. stromeri* and var. *major, Stereogenys cromeri, S. podocnemioides, Gigantophis garstini, Pterosphenus schweinfurthi, Fajumia schweinfurthi, Socnopœa grandis, Pristis fajumensis, P. ingens, Eopristis reinachi, Propristis schweinfurthi, Myliobatis* sp., *Carcharodon* sp.
		LOWER MOKATTAM.	50	*Birket-el-Qurun Series* (*Operculina-Nummulite Beds*) (6 in Section).—Sandstones and clays, with sandy limestones and one or more well-marked concretionary sandstones weathering into large globular masses. The chief vertebrate fossils are:—*Eocetus schweinfurthi, Prozeuglodon atrox*, and (?) *Zeuglodon isis, Tomistoma kerunense, Saurocephalus fajumensis, Enchodus* sp., *Cœlorhynchus* sp., *Progymnodon hilgendorfi*, a Polypterid fish, *Oxyrhina* spp., ? *Alopecias* sp., *Lamna verticalis, L.* sp., (?) *Odontaspis aschersoni, Odontaspis* spp., *Carcharodon* sp., *Hemipristis curvatus, Galeocerdo ægyptiacus, Alopiopsis* sp., *Aprionodon frequens, Prionodon* sp., *Carcharias* spp., *Propristis schweinfurthi*, (?) *Eopristis reinachi, Amblypristis cheops, Myliobatis latidens, M. fraasi, M. dixoni, M. acutus, M. oweni, M.* spp.
			70	*Ravine Beds* (7 in Section).—White marls and marly limestones with remains of large Zeuglodons and scales and teeth of fishes.
			130	*Wadi Rayan Series* (*Nummulites gizehensis Beds*).—Limestones, marls, clays, &c.

From this Table it will be gathered that, speaking generally, from earlier to later times the strata of the Fayûm were deposited nearer and nearer to some land-mass. In the early Eocene the presence of thick marine beds far to the southwards shows that the shores of the Ethiopian continent were still remote from the area now under discussion ; and this state of things seems to have continued till the Middle Eocene, as shown by the thick nummulitic beds of the Wadi Rayan series, and the exclusively marine character of the fossils both of those beds, the Ravine beds, and the Birket-el-Qurun series above. In the Qasr-el-Sagha series, on the other hand, there is much evidence that the shore was not far off, the presence of thick beds of clay, often current-bedded and containing numerous impressions of leaves, as well as the occurrence of land-mammals pointing to this conclusion. In fact, the deposits at this horizon may be regarded as partly marine and partly littoral, there having been many small oscillations of level. In the Fluvio-marine (Upper Eocene) beds above, the near presence of a large land-mass is still more obvious, these deposits being, in fact, almost entirely fluviatile, and probably representing the remains of the delta of a great river which Mr. Beadnell, for various reasons, considers flowed from the south-west *. At or near the end of the Eocene period this state of things was interrupted by an outburst of volcanic activity, which gave rise to the interbedded basalt-sheets of the Jebel-el-Qatrani (see Map) ; but after this the fluviatile conditions were again resumed and appear to have continued with some interruptions throughout the Oligocene, Miocene, and, in part at least, the Pliocene periods. Throughout this vast epoch there seems to have been a general tendency towards a gradual advance of the coast-line northwards, and such interruptions and oscillations as did occur are marked by the presence of interbedded marine, littoral, and perhaps, in a few cases, lacustrine deposits. This long series of Fluvio-marine beds offers just the conditions necessary for the preservation of a succession of vertebrate faunas, and, in fact, these have already been found at two horizons in addition to the Eocene beds with which this Catalogue is mainly concerned, namely, in the Lower Miocene and the Middle Pliocene. So long ago as about 1898, Dr. Blanckenhorn discovered remains of a Rhinoceros and of an Anthracotheroid Mammal (*Brachyodus africanus*), together with other vertebrate fossils, in the Lower Miocene beds of Mogara, which lies to the north-west of the Fayûm about five days' march. This collection was afterwards described by the present writer (4, 5), who later, with the late Mr. Barron of the Egyptian Survey, revisited the locality, where they obtained, in addition to the forms already known, remains of

* 'Report on the Fayûm Province,' p. 66.

a Proboscidean closely allied to, if not identical with, *Tetrabelodon angustidens*, remains of which occur in beds of the same age in Europe. Mr. Beadnell also has lately made a collection from the same place, but this has not yet been fully examined, and quite recently Dr. Stromer (45) has described some vertebrate remains from the same horizon in the Wadi Faregh, which lies to the north of the Fayûm. To the north of this, again, in the Wadi Natrun, a considerable number of vertebrate remains of Middle Pliocene age have been collected by Captain Lyons, Mr. Beadnell, and, still more recently, by Drs. Stromer and Blanckenhorn. These have been described by Studer (46), Stromer (37, 45), and the present writer (7), and include such forms as *Hipparion* aff. *gracile, Hippopotamus hipponensis, Sus* sp., *Hippotragus cordieri, Libytherium* or *Samotherium* sp., *Mastodon* sp., as well as remains of Carnivora belonging to the Canidæ, Lutrinæ, Phocidæ, and Machærodontinæ. There are also traces of a Sirenian and of a Rodent, probably a species of *Oryctolagus*. It is thus clear that in a north-and-south line from the Fayûm we already know such a succession of faunas as might be expected to occur in such a series of deposits, and it is at least probable that further careful search of this region may lead to the discovery of others of intermediate age which will throw further light on the history of several groups. For instance, it seems very likely that remains of annectant forms between the Zeuglodonts and Odontoceti and between the Anthracotheriidæ and the Hippopotamidæ are entombed in these beds.

The first vertebrate fossils discovered in the Fayûm were collected by Schweinfurth (35) in 1879 on the island Geziret-el-Qorn (see Map), where, in beds of the Birket-el-Qurun series, he obtained remains of Zeuglodons and fishes belonging to the genera *Myliobatis, Propristis, Hemipristis, Corax, Galeocerdo, Carcharias, Carcharodon, Otodus, Lamna (Odontaspis), Saurocephalus,* (?) *Enchodus,* and *Progymnodon*: this collection was afterwards described by Dames (25). In the winter of 1885–6 the same traveller visited the escarpments to the north of the lake, and from the cliffs over Qasr-el-Sagha (Schweinfurth's Temple) collected other remains of *Zeuglodon*, including the mandibular ramus afterwards described by Dames (27) under the name *Zeuglodon osiris*. Nothing further was done until, in 1898, Mr. Beadnell commenced a survey of the depression and collected numerous remains of Fishes and Crocodiles, and noticed that fragments of bone were common on certain horizons, but nothing of particular interest was obtained. In April, 1901, the present writer had an opportunity of visiting the district with Mr. Beadnell, on which occasion a considerable number of vertebrate remains, including portions of the skeletons of *Mœritherium, Eosiren,*

Gigantophis, &c., were collected from the Middle Eocene beds, and it was arranged to revisit the district for the purpose of obtaining further material. This was done, and resulted not only in the collection of much that was new from the Middle Eocene escarpment, but also in the discovery that the Fluvio-marine beds above were bone-bearing and in the finding of the first traces of *Palæomastodon*. Towards the end of the same year Mr. Beadnell returned to the district and paid special attention to the Fluvio-marine beds, from which he obtained the first remains of *Arsinoitherium*, as well as of other new mammals and reptiles; he was also fortunate in finding a spot where bones occur in considerable numbers in a limited area, instead of being widely scattered as is usually the case in these deposits. His expeditions in the winters of 1902–3, 1903–4, resulted in the accumulation of a very large mass of material (only part of which is here catalogued) in the Geological Museum at Cairo. During the springs of 1902 and 1903 the present writer also collected in the same district, and obtained a considerable number of specimens, including several new forms. Lately Baron F. Nopcsa visited the Fayûm and made a collection of vertebrate remains, including some good specimens which he presented to the British Museum: these are referred to in the present Catalogue. In the early part of 1902, Drs. Stromer and Blanckenhorn also made a short stay in the district, and their collections of vertebrate fossils have been in part described: the Zeuglodonts (38, 40, 41) and fish-remains (43, 44) by Dr. Stromer himself; the Chelonians by Dr. Reinach (34); while Dr. O. Abel is preparing a memoir on the Sirenia, including also the earlier forms from the Mokattam Hills (see also 1).

The collections of remains now preserved in the British Museum and in the Geological Museum at Cairo comprise representatives of all the main divisions of the vertebrate phylum except the Amphibia. Both in point of numbers and interest, the Mammals are by far the most important; next to these come the Reptiles, while the Birds are represented by mere fragments of a single species.

The Mammals may be divided into three sections:—(1) the land-mammals which seem to be truly endemic to the Ethiopian region; these occur both in the Upper and Middle Eocene beds, and include such genera as *Mœritherium*, *Palæomastodon*, *Arsinoitherium*, *Barytherium*, *Megalohyrax*, *Saghatherium*, and perhaps *Geniohyus*: (2) forms of which close allies occur in other regions in approximately contemporary deposits; these, so far as at present known, occur only in the Upper Eocene beds, and include such genera as *Ancodon*, *Rhagatherium*, *Hyænodon*, *Pterodon*, *Apterodon*, and *Sinopa*: (3) the aquatic mammals so far not found in the Upper Eocene beds,

and comprising *Eosiren*, *Zeuglodon*, and *Prozeuglodon*. It seems probable that some of these last, like the genera included in section 1, are of endemic origin, having originated from land-mammals inhabiting the region.

In the first section it will be noticed that all the genera belong to the Ungulata, and with one exception to that subdivision of the order to which the name Subungulata has been given—a group in which the feet have not undergone any extreme specialisation. The exception to this is *Geniohyus*, which is an Artiodactyl and should perhaps be placed in the second section.

Among the Subungulates, by far the most striking of the new forms is *Arsinoitherium*, the first remains of which were found by Mr. Beadnell towards the end of 1900. Subsequently a great quantity of remains of one of the species, *A. zitteli*, were collected, including skulls of various ages, and nearly all the other parts of the skeleton (see text-fig. 36, p. 60), so that the structure of this extraordinary mammal is now almost completely known, so far as this is possible from the bones alone.

In its general appearance *Arsinoitherium zitteli* must have been somewhat like a large and heavily built Rhinoceros (see p. xxviii) : on the head there were two pairs of horns, the great anterior nasal horns projecting forwards and upwards, and a much smaller pair situated over the orbits. Both these horns, unlike those of *Rhinoceros*, are bony out-growths of the skull, but most likely the anterior pair at least were covered with horny sheaths, much like those of the Cavicorn Ruminants. The muzzle was very narrow, so that probably the animal did not graze, but browsed on low bushes and herbage, grasping its food by means either of a prehensile tongue or possibly of a mobile upper lip. In correlation with the great weight of the skull, the occipital condyles are large and the ridges for the attachment of muscles prominent; from the form of the occipital condyles and the forward slope of the occipital surface, it appears that the head could be moved freely up and down. The dentition is complete, and the teeth, which form closed series on either side of both the upper and lower jaws, possess extraordinarily high crowns, especially for an animal of such an early period. The molars, which differ very widely from the premolars, consist of two very high transverse crests, and it is very difficult to imagine from what type of low-crowned tooth they were derived; it is, however, possible that they may have originated from a tooth resembling the molars of the Hyracoidea, in which a gradual increase in the height of the crown has been accompanied by the infolding of the outer wall till the crown is divided into an anterior and a posterior column. The possibility that Arsinoitheriidæ may have been descended from the same ancestral stock as the Hyracoidea is supported

by some resemblances of the structure of the skull and by the fact that both groups originated in the Ethiopian region. In the skeleton the chief characteristic is the massiveness of all the bones, a peculiarity that no doubt has had much to do with their preservation in such large numbers, while the much more lightly constructed limb-bones of *Palæomastodon* are extremely rare. The neck was very short and thick, the posterior cervical vertebræ being much like those of *Elephas*. The limbs are extraordinarily massive; the fore limb is a little the shorter and was probably bowed slightly outwards. The feet are pentadactyl; the fore foot is very similar to that of the Proboscidea, the ulna taking an even greater share in the formation of the carpal joint, so that the bones of the proximal row tend to overlap those of the distal row preaxially. In the hind foot the astragalus articulates distally with both the navicular and cuboid as in the Amblypoda, not with the navicular alone as in the Proboscidea.

The relationships of *Arsinoitherium* are very doubtful, and it so far differs from all other Ungulates that a new suborder, the Barypoda*, has been founded for its reception. It is a highly specialised form, of which the ancestors are quite unknown; possibly, as suggested above, it may have originated from the same group which gave rise to the Hyracoidea, and through this primitive stock may be related to some of the early, perhaps pre-Tertiary, South-American types: this possibility will be referred to again below.

The Hyracoidea are an extremely isolated and in some ways very primitive group: previous to the discovery of these Egyptian members of the suborder, no fossil representatives were known, at least in the Old World, except *Pliohyrax* from the Lower Pliocene of Samos and Pikermi. The genera *Saghatherium* and *Megalohyrax* now described from the Upper Eocene of the Fayûm throw little or no light on the history of the group: they are more primitive only in having the incisors and canines all present in the adult, and the premolars all simpler than the molars; otherwise, as in the peculiar modification of the anterior incisors, they are much like the recent forms. The considerable number of species together with the large size of some of them show that in the Upper Eocene period they were an important factor in the fauna of the Ethiopian region, to which the group seems to be endemic. Of their relationships little is known: Ameghino has described as Hyracoids a considerable number of animals from different horizons in Patagonia, and while

* It has been pointed out that this name was used by Haeckel (Generelle Morphologie, vol. iii. p. clvii) to include certain genera of extinct Marsupials, and the alternative name Embrithopoda has been suggested (Nature, vol. lxxiii. (1906) p. 224).

many of these (e. g. *Archæohyrax*) do not seem to differ in any important particulars from some of the smaller Typotheria, others of the more primitive forms belonging to Ameghino's family, the Accœlodidæ, may perhaps approach the ancestral forms from which the Hyracoidea originated.

Although *Arsinoitherium* is certainly the most extraordinary of the Ungulates found in these beds, nevertheless the remains of the primitive members of the Proboscidea are perhaps of greater scientific interest, because they help to fill, at least to a large extent, one of the most obvious gaps in our knowledge of the extinct Mammalia. Previous to their discovery the earliest Proboscideans known were from the Lower Miocene (Burdigalien) of Europe and Northern Africa, and although many earlier deposits rich in mammalian remains were known in various parts of the world, in none of them was any trace of Proboscidea found, so that their appearance in Europe at the beginning of the Miocene period must be the result of their immigration from other regions. The probability that Africa would be found to be the original home of these animals was pointed out by several writers, notably by Osborn, Stehlin, and Tullberg. The first of these [*] suggested that probably not only the Proboscidea but also the " Hyracoidea, certain Edentates, the Antelopes, the Giraffes, the Hippopotami, the most specialised Ruminants, and among the Rodents the Anomalures, Dormice, and Jerboas, among Monkeys the Baboons," and, as his map suggests, the Sirenia also, originated in this region. Osborn also put forward the theory that a succession of migrations from Africa to Europe occurred, notably at the end of the Eocene, at the beginning of the Miocene, and again in the earliest Pliocene. It was in the early Miocene migration that the Proboscidea passed out of Africa for the first time so far as known. Stehlin [†], who also emphasized the importance of Africa as a probable centre of mammalian evolution, expressed much the same views. Tullberg [‡] likewise regarded Africa as a centre of mammalian radiation, and pointed to *Hystrix* (or the whole of the Hystricognathi), the Simiæ (Anthropoidea), and the Proboscidea as having probably migrated thence in the early Miocene. It is therefore very satisfactory

[*] "Correlation between Tertiary Mammal Horizons of Europe and America," Ann. N. Y. Acad. Sci. vol. xiii. (1900) pp. 1–72.

[†] "Ueber die Geschichte des Suiden-Gebisses, Pt. II.," Abhandl. d. Schweiz. Palæont. Gesellsch. vol. xxvii. (1900) p. 477 *et seq.*

[‡] "Ueber das System der Nagetiere," Nov. Act. R. Soc. Sci. Upsala, [3] vol. xviii. (1899) p. 483. Also for the general question of mammalian distribution, see Lydekker, Geographical History of Mammals (1896).

that the earliest traces of land-mammals from the Eocene of Africa include remains of primitive Proboscidea, as well as early forms of Hyracoidea, Sirenia, and perhaps some of the other groups.

The earliest-known Proboscidean is *Mœritherium*, which occurs first in the Qasr-el-Sagha beds (Middle Eocene) and persisted till the Upper Eocene, its remains having been found in the Fluvio-marine series. This animal was about the size of a Tapir, which it must have greatly resembled in general appearance. The skull (see fig. 40, p. 100) presents no very striking peculiarities, the chief points of interest being that (1) the nasals are short and the nasal opening is not quite at the end of the snout; (2) the bones of the back of the skull tend to become swollen by the presence of air-cells; (3) the maxillæ send forward on the palate processes which help to support the enlarged second incisors. The mandible is short and stout, its ascending ramus being inclined a little forwards; the symphysis is spout-like and the upper surface is continuous with that of the sloping lower incisors. The teeth are of greater interest. The dental formula is $i. \frac{3}{2}, c. \frac{1}{0}, pm. \frac{3}{3}, m. \frac{3}{3},$ so that of the complete primitive Eutherian dentition only one lower incisor, the lower canine, and the first upper and lower premolars are wanting. Of the upper incisors, the second pair are greatly enlarged, forming trihedral downwardly directed tusks; the others as well as the canine are quite small. The three premolars are all simpler than the molars, but the fourth approaches them most nearly. The premolars replace milk-teeth in vertical succession in the ordinary way. The molars consist essentially of four low blunt tubercles, arranged so as to form two transverse ridges; the last upper molar has a very small posterior lobe in addition to the main ridges. In the lower jaw only the first and second pairs of incisors remain: of these the median ones are small, the second enlarged and tusk-like; both slope strongly forwards and their upper surface is continuous with that of the spout-like symphysis. The canines and first premolar are entirely lost, and, as in the upper jaw, all the remaining premolars are simpler than the molars, although the last approaches them in complexity. The molars are on the whole like those of the upper jaw, but on the first and second there is a very small posterior ridge which in the third becomes a large talon.

In the vertebral column the most striking point is that the axis retains the peg-like form of its odontoid such as occurs in generalised Ungulates, *e. g.* the Pig, and at the same time the centra of the cervicals are not shortened to any great extent, so that no doubt the animal could reach the ground with its mouth in the ordinary way.

The limbs are unfortunately not well known. The humerus differs considerably from that of the later Proboscidea, but some of the smaller species of *Palæomastodon* (see text-fig. 56) from the Upper Eocene seem to supply intermediate forms: probably the difference arises from the fact that *Mœritherium* was a more or less amphibious type, while the later Elephants became fitted for progression on firm ground. The femur approximates very nearly to the form found in the later Proboscideans.

As already mentioned, *Mœritherium* was probably an amphibious, shore, or swamp living animal, and it was no doubt owing to the continuation of the conditions favourable to its mode of life that it persisted into the Upper Eocene period. In the meantime, however, either from this or some closely allied type, there had arisen another animal more adapted to terrestrial life and showing a great advance in the direction of the typical Proboscidea: to this creature the name *Palæomastodon* has been given. The intermediate links between it and *Mœritherium* or some allied form are not yet definitely known, unless some of the smaller species referred to *Palæomastodon*, under the names *P. minor* and *P. parvus*, or the animal called *M. trigonodon*, are such. Certainly in many respects the limb-bones, particularly the humerus (see text-fig. 56, p. 164), referred to *P. parvus*, are both in size and structure intermediate between those of *Mœritherium lyonsi* and *Palæomastodon beadnelli*.

The largest species of *Palæomastodon* (*P. beadnelli*) must have been about the size of a half-grown Indian Elephant: in its general appearance it was Elephant-like, but differed in having a longer neck and the symphysial portion of the mandible prolonged beyond the skull (see text-fig. 48, p. 131) and covered only with the fleshy snout. Probably it could reach the ground with its lower incisors, and the end of the snout may already have been prehensile. In the skull the chief peculiarities are: (1) the external nares are shifted backwards, so that they are only just in front of the orbit, and, in consequence, the nasal bones are shortened and relatively very small; (2) the back of the skull is greatly enlarged by the development of spongy bone in the occipital region. The occipital surface above the prominent condyles slopes a little forwards and has a deep median fossa for the attachment of muscles. The upper dentition is much more reduced than in *Mœritherium*, and now assumes more definitely Proboscidean characters. The only remaining incisors are the large tusk-like second pair, which are directed downwards and have a band of enamel on their outer side. Sections of these tusks examined microscopically show no traces of the peculiar "engine-turning" so characteristic of the dentine of the tusks of the later forms. Either this structure was only acquired when the tusks became greatly enlarged or the

condition of the specimens examined is not favourable to its preservation. The canine and the first premolars are lost; the other premolars are evidently undergoing reduction, but at the same time the last has become bilophodont. The molars are all trilophodont, each transverse crest consisting of at least two distinct tubercles; there is also a tendency to the addition of another posterior ridge from the cingulum. One notable point about the molar series is the sudden enlargement of the second and third true molars, compared with the teeth in front. This is accompanied by the considerable development of cellular tissue in the posterior part of the maxilla and the neighbouring bones, and appears to be the first indication of the great increase in the size of the posterior molars found in later types. This increase in the size of the maxilla, which is probably correlated with the general tendency of the bones of the posterior part of the skull to develop diploë, seems almost as if it were a preparation for the subsequent changes in the teeth, but, on the other hand, it is possible that the increase in their size may be in part a consequence of possessing more room in which to develop.

As already noted, the mandible is greatly elongated in the symphysial region, and its ascending ramus slopes backwards, both modifications tending to increase the distance the animal could reach with its lower incisors. Of these there is a single pair (the second) projecting forwards from the symphysis: the canines and first and second premolars are lost; the other premolars and molars are generally similar to those of the upper jaw. In the vertebral column the axis still has a peg-like odontoid process and a comparatively long centrum, though the centra of the posterior cervicals are much shortened. The limb-bones, so far as known, are closely similar, except in size, to those of *Elephas*.

In general appearance *Palæomastodon* must have resembled a small rather long-necked Elephant, the most notable difference being that the trunk, instead of being freely flexible, was supported by, and formed the upper covering of, the elongated mandibular symphysis; its extremity, however, may have been free and to some degree prehensile.

The further history of this group can only be briefly summarised here (see Phil. Trans. 196 B, 1903, p. 99). The next form, *Tetrabelodon angustidens* from the European Lower Miocene, has the symphysis still more elongated and the narial opening shifted further back. At the same time the molars, or at least the posterior ones, are greatly increased in size and possess more transverse ridges. There are three milk-molars in both jaws, and the posterior two are succeeded in the normal way by premolars;

but, in consequence of the increased size of the posterior molars, the premolars, and eventually even the anterior molar, are shed as the posterior molars come into position from behind. This animal attained the size of a moderately large Indian Elephant, and except for the inflexibility of the mandible-supported trunk must have been very similar in appearance. In the later Miocene the mandibular symphysis shortened, leaving the trunk mobile and unsupported, as we now know it; at the same time traces of its original elongated condition are retained in the occurrence of deciduous lower incisors in some species of *Mastodon* and in the peculiar sharp process of the symphysis in the Elephants. In the teeth there is a gradual increase in the number and height of the ridges composing the molars, together with the great increase in the size of the individual teeth. The milk-teeth are never replaced by premolars, but are early displaced by the advance of the molars into position from before backwards; the culmination of this line of evolution is met in the latest Elephants, in which in old age the only cheek-teeth in position are the very large third upper and lower molars. The above is, of course, only a general summary of the succession of forms which lead up to the modern Elephants, and no doubt there have been many checks and side-branches leading only to extinction in the course of the vast period that has elapsed since *Mœritherium* existed.

The position of *Barytherium* in relation to the other Ungulates is quite uncertain. It cannot be related to *Arsinoitherium*, since not only are the teeth widely different in type, but the anterior part of the dentition, in the mandible at least, has undergone great modification, the anterior lower premolars, canines, and posterior incisors having been lost and the anterior incisors modified to form large procumbent tusks. In this respect it approaches the primitive Proboscidea, but the fore limb so far as known differs widely from the Proboscidean type: this is especially noticeable in the distal articulation of the radius, which rather resembles that seen in *Uintatherium* than that found in the Elephants, and seems to show that the carpus differed considerably from that of the latter group. Another possibility must be referred to, namely, that some kind of relationship with the Pyrotheriidæ of Patagonia may exist; in both the molars are bilophodont, the anterior lower incisors tusk-like and procumbent and separated by a long diastema from the premolars, the other incisors, the canine, and anterior incisors being lost; in the carpus also the scaphoid seems to have been large in both groups. The probability of such a relationship will be discussed below.

The Artiodactyla, which are represented in the Upper Eocene by members of the Anthracotheriidæ and Suidæ, may possibly be regarded as a foreign element in this

fauna, although there is much to be said for the opposite view. The Anthracotheriidæ are represented in the almost contemporary deposits of Egerkingen by the genera *Ancodon* and *Rhagatherium*, just as in the Fayûm, and, moreover, in both places they are accompanied by Creodonts belonging to the Hyænodontidæ; but while the Creodonts occur in the earlier beds of Europe, this does not seem to be the case with the Anthracotheres, so that here there may be a trace of an interchange of forms possibly towards the end of the Middle Eocene, the Creodonts having passed into Africa at the same time as the Anthracotheres migrated north. Professor Osborn has already suggested that such a migration took place about this time, in order to account for the appearance in the Upper Eocene of Europe of forms like certain highly specialised Ruminants, the Anomalures, and perhaps some Edentates. The Anthracotheres persisted in Africa at least till the Lower Miocene, at which horizon they are represented by *Brachyodus africanus*, and it is pointed out below that these animals in many points, *e. g.* in the pelvis (see p. 185), approach very nearly to the Hippopotamidæ, which are probably derived from them. Remains of one of the earliest and most primitive Hippopotami known, viz. *H. hipponensis*, have already been found in the Middle Pliocene of Egypt, so that there is every prospect that annectant forms between *Hippopotamus* and the Anthracotheres may be discovered in this region in deposits between the Lower Miocene and the Pliocene.

The peculiar genus *Geniohyus* is perhaps the earliest-known member of the Suidæ, but although the lower cheek-teeth seem to be undoubtedly those of a primitive Pig, the great enlargement of the anterior pair of incisors and the reduction of the posterior incisors and canines are quite different from what is usually found in members of this family. *Geniohyus*, in fact, may be regarded as an early specialised form of a group of which the generalised members have still to be found; they probably inhabited Africa and passed north, perhaps in the Middle Eocene migration referred to above. The occurrence of the peculiar ventral process arising from the symphysial region of the mandible suggests some possible relationship with the Elotheriidæ of the Miocene of Europe and America, a group in which somewhat similar processes occur; but, if only on account of the peculiarities of its anterior teeth, it seems impossible that *Geniohyus* can at most be more than an early offshoot of the ancestral stock of that group.

In the Fayûm the Sirenia are represented by one genus, *Eosiren*, only, but in the earlier and more exclusively marine beds of the Mokattam Hills, near Cairo, other more primitive types occur, the skull of one of which, *Eotherium*, is described below

(p. 204) at some length. *Eosiren*, though primitive, is already in all respects a typical Sirenian, almost the only important characters distinguishing it from the later members of the order being: (1) the presence of traces of the second and third pairs of incisors and of the canines; and (2) the rather less degree of reduction in the pelvis (see fig. 68 B, p. 214), which still possesses a well-defined acetabulum. In the case of the incisors and canines reduction is already far advanced and they have also been thrust out on to the side of the snout, possibly by the development of the horny plate, which most likely already replaced them functionally. In *Eotherium*, from the lower beds of the Mokattam Hills, the incisors and canines are larger and occupy their normal position on the edge of the jaw, and the pelvis has a completely closed obturator foramen and a large and well-defined acetabulum, showing that probably the femur was still large and perhaps to some degree functional. In these points *Eotherium* approaches a normal land-mammal, but in other respects, so far as known, is essentially a Sirenian and its actual terrestrial ancestor must be sought in earlier deposits. One of the most striking Sirenian characters of the skull in both this genus and *Eosiren* is the deflection of the snout, a peculiarity evidently of great value to a short-necked, long-bodied, aquatic animal feeding on plants growing at the bottom of the water in which it lived; in the most primitive type of Sirenian, the imperfectly known *Prorastomus* described by Owen (Quart. Journ. Geol. Soc. vol. xi. 1855, p. 541) from the Eocene beds of Jamaica, this character has not yet been acquired.

The question of the origin of the Sirenia is of great interest, and there seems to be a considerable amount of evidence in favour of the view first put forward by de Blainville, that they are intimately related to the Proboscidea. In the first place, the occurrence of the most primitive Sirenians with which we are acquainted in the same region as the most generalised Proboscidean *Mœritherium* is in favour of such a view, and this is further supported by the similarity of the brain-structure and, to some extent, of the pelvis in the earliest-known members of the two groups (see pp. 202 & 214). Moreover, in the anatomy of the soft parts of the recent forms there are a number of remarkable points of resemblance. Among these common characters may be noted the possession of: (1) pectoral mammæ, (2) abdominal testes, (3) a bifid apex of the heart, (4) bilophodont molars with a tendency to the formation of an additional lobe from the posterior part of the cingulum. The peculiar mode of displacement of the teeth from behind forwards in some members of both groups may perhaps indicate a relationship, although in the case of the Sirenia the replacement takes place by means of a succession of similar molars, while in the Proboscidea the molars remain the same

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numerically, but increase greatly in size and number of transverse ridges.   Dr. Chalmers
Mitchell has lately shown (Trans. Zool. Soc. vol. xvii. 1905, pp. 464–7) that the Sirenia
and Proboscidea resemble one another in the arrangement of the intestinal tract and
that in neither group is there any trace of the Ungulate specialisation : it is also
significant that he states that *Hyrax* likewise approaches the Sirenia in this respect.
In a former paper (Phil. Trans. vol. 196 B (1903) p. 116) it was stated that the possession
of a non-deciduate zonary placenta was common to the two groups in question, but it
has been pointed out by Messrs. Assheton and Stevens (Quart. Journ. Micr. Sci. vol. xlix.
1905, p. 1) that this is an error, and that, as a matter of fact, in the Proboscidea the
placenta is deciduate.   At the same time, these writers show that in both groups
the placenta, in addition to the short villi, also possesses a number of larger and longer
villi, which deeply penetrate the maternal tissue and seem to be torn off at parturition.
Although these points of similarity, taken separately, may be of no great value,
together they supply a very strong argument in favour of the close relationship of the
two orders.

All the Carnivora at present known from the Upper Eocene of the Fayûm belong
to one family, the Hyænodontidæ, of the primitive group, the Creodonta.   They are
remarkable from the fact that in the four genera represented, viz. *Sinopa*, *Apterodon*,
Pterodon, and *Hyænodon*, the molar teeth show four stages in the development of the
cutting-blade and in the reduction of the talon and the postero-internal cusp.   It
seems highly probable that these animals entered Africa from the north, where
Creodonts are found in the earlier Eocene deposits ; but at the same time the fact that
the Zeuglodont *Protocetus* from near the bottom of the Lower Mokattam beds, has a
dentition which is practically that of a Creodont, clearly indicates its origin from
members of that group, which may therefore have inhabited this region at a still
earlier period.   Since, however, *Protocetus* is already fully adapted for marine life,
this is by no means certain, for it may have crossed from the northern side of the
Nummulitic sea.   Another argument for the existence of earlier Creodonts in
the Egyptian region is that, since there is considerable probability that Africa was
connected by a land-bridge with South America in late Cretaceous and possibly even
at the beginning of the Tertiary period, their presence in Africa would account for
the existence of the Sparassodonta in the Tertiaries of Patagonia.

The Zeuglodonts of the Fayûm, taken together with a species, *Protocetus atavus*,
recently described by Prof. E. Fraas (29) from the limestones of the Mokattam Hills,
form a series showing a complete transition, so far at least as the dentition is concerned,

from the Creodonts to the true Zeuglodonts. In the earliest type, *Protocetus*, the skull is already practically that of a Zeuglodont, the rostral portion being, in fact, even more elongated than in some of the later forms; at the same time, however, the opening of the nares is situated nearer to the end of the snout. The teeth are most remarkable; the incisors are not known, but the rest of the dentition is practically that of a typical Creodont, none of the teeth having assumed the peculiar serrated form characteristic of the later Zeuglodons. The canine is large, with a single though grooved root; the first premolar is much smaller, the second large and two-rooted, the third and fourth have posterior cusps and are supported by three roots; the molars, which are small, are also three-rooted. In *Prozeuglodon* (p. 243) from the later Birket-el-Qurun series the skull is likewise essentially Zeuglodont, though the external nares have shifted a little further back. The canine is much larger than the teeth before and behind it, and although the third and fourth premolars and the molars have serrated crowns, as in the later Zeuglodons, they, or at least the premolars, retain their inner buttress supported by a third root, so that in tooth-structure this genus is exactly intermediate between *Protocetus* and *Zeuglodon*. Fraas (29) has lately described still another annectant form, *Eocetus*, from about the same horizon as *Prozeuglodon*, which attained a very large size; the skull approaches that of *Zeuglodon* in the position of the nares, but the teeth are Creodont-like and possess inner (third) roots. Remains of *Zeuglodon* itself seem to have been found in the same deposits as these intermediate types, but that genus continued to exist in the Qasr-el-Sagha beds above after they had disappeared.

The Birds are represented in these beds by one or two fragments only, but those of considerable interest, because they show that most likely a true Ratite (*Eremopezus*) existed in this district in the Upper Eocene period. This is of importance, because it indicates that possibly some at least of the main subdivisions of the Ratitæ may have had a common ancestry in the Ethiopian region. If so, this would account for the likeness between the Æpyornithes and Struthiones referred to by Burckhardt, and also suggests the possibility of the relationship between these groups and the South-American Rheas. It is, of course, just possible that this genus is merely another instance of the results of retrogressive modification leading to loss of flight and increase in size in some group of Carinate Birds, such as has occurred in the case of the Gastornithes and Stereornithes; in any case, much more material is required before any final conclusion can be reached as to the precise position of this genus.

The Reptiles are represented by members of the orders Crocodilia, Chelonia, and

Ophidia. The Crocodilia, remains of which occur in both the Middle and Upper Eocene beds, are of no special interest, the most important point being the occurrence of the genus *Tomistoma,* a further proof of the former wider range of this genus, which at the present day is represented by a single species found in the rivers of Borneo, Sumatra, and Malacca. One of the species now described is interesting, as being in several features intermediate between *Gharialis* and *Tomistoma,* in this respect approaching the genera *Thoracosaurus* and *Gavialosuchus,* the latter of which, however, is regarded by Mr. Lydekker as identical with *Tomistoma.*

Among the Chelonia the Athecate group are represented only by a species of *Psephophorus,* the humerus of which represents the extreme degree of modification for pelagic life. This form occurs in the marine Middle Eocene beds, where it is accompanied by remains of another Sea-Turtle, a member of the genus *Thalassochelys.* The terrestrial Cryptodira, remains of which are confined to the Fluvio-marine (Upper Eocene) beds, are represented by several very large species of *Testudo,* which approach in size the giant Tortoises of Madagascar, the Mascarene and Galapagos Islands. In the presence of a nuchal shield and double gulars, they approach most nearly the Tortoises of Aldabra and Madagascar, and may, in fact, be the direct ancestors of those species, as well, possibly, as of some of the extinct Indian forms. The occurrence of numbers of the shells of such strictly terrestrial forms as these, mingled with tree-trunks and bones of mammals, makes it clear that we owe these richly fossiliferous deposits to floods sweeping down a great river draining a land-area lying immediately to the south or south-west (see Beadnell, ‘Report on the Fayûm,p. 66).

The Pleurodira are represented in both the Middle and Upper Eocene beds : two genera are at present known, one (*Stereogenys*) especially remarkable on account of the modification of the mandible and palate for crushing the food. In the mandible the greatly enlarged symphysis is broad and flat; and in correlation with this a secondary hard palate is formed by the meeting of the maxillæ and palatines in the middle line beneath the nasal passage, so that the internal nares open far back, behind the level of the crushing-surface of the jaws. The other genus of Pleurodirans is *Podocnemis,* remains of which are found both in the Middle and Upper Eocene beds of this region. The same genus also occurs in the Lower Eocene of England and India, but at the present day is confined to Madagascar and South America. This peculiar distribution suggests that although these Chelonians may in the first instance have reached the Ethiopian continent from the north, probably it was thence that they

spread to their present habitats, the genus becoming extinct elsewhere, though it persisted in Egypt till the Miocene.

The Ophidia are represented by two genera only : one *Gigantophis*, a Python of very large size, the other *Pterosphenus*, of which one species, *P. schweinfurthi*, is found in the Fayûm, while another, *P. schucherti*, occurs in the Eocene of Alabama ; in both localities remains of Zeuglodonts are abundant in the same beds, a circumstance which, coupled with the peculiar structure of the vertebræ, shows that these Snakes were aquatic and probably marine. Nevertheless, it does not seem likely that they would cross oceans of great width, and their presence in Egypt and in Alabama seems to be an argument in favour of the presence of a shore-line across what is now the Atlantic Ocean, probably lying somewhat to the south. The presence of primitive Sirenians in Egypt (*Eotherium*) and the West Indies (*Prorastomus*) is explicable on the same grounds.

No Amphibia have yet been found, and the Fishes are of no great interest, being all either Elasmobranchs or Siluroids : among the former occur several types of Sawfish, while the latter are chiefly remarkable for their great similarity to forms now living in the Birket-el-Qurun and the Nile.

From the above summary of the contents of this Catalogue, it will be seen that a very considerable number of early Tertiary Vertebrates, especially Mammals, are already known from Egypt, and that practically all of them have been discovered since the beginning of 1900, so that, although Professor Osborn writing in that year could say of Africa with truth, " It is the dark continent of Palæontology, for it has practically no fossil mammal history," this reproach is at least in a fair way to be removed. At present, of course, the species known must be a mere fraction of the faunas inhabiting the Ethiopian region during the Middle and Upper Eocene periods, but the proportion of peculiar types included in them is great enough to show how fully justified the writers above referred to were in their assumption that the Ethiopian continent in early Tertiary (and perhaps pre-Tertiary) times was a very important centre of mammalian evolution.

The question of the relations of this Ethiopian region to the rest of the world is one of very great interest. The probability of a series of temporary land-connections between it and the Palæarctic continent has already been referred to above and has been fully discussed by Osborn, Stehlin, Tullberg, &c.; in all cases so far as known these connections occurred during the Tertiary period. Furthermore, the probability of a former land-connection with South America has been argued with much force by

a number of authors, including, among others, Ameghino *, Blanford †, Boulenger ‡, Lydekker §, Neumayr ‖, Ortmann ¶, Scott **, Suess ††, and von Ihering ‡‡. These writers, basing their arguments on many diverse kinds of evidence, all seem to arrive at the general conclusion that a land-connection did exist between Africa and South America throughout at least most of the Secondary period and may have persisted into the Lower Tertiary. Concerning the precise position of this land-connection, and whether it may have existed at more than one point, there is some diversity of opinion, but these differences do not seem to be of any great importance compared with the general agreement that there must have been such a connection. Speaking generally, it appears that (1) probably in Jurassic times Africa and South America formed a continuous land-mass; (2) in the Cretaceous period the sea encroached southwards over this land, forming what is now the South Atlantic. How far this depression had advanced southwards at the end of the Secondary period is not clear, but it appears certain that the final separation of the two continents did not take place till Eocene times, and that there may have been a chain of islands between the northern part of Africa and Brazil which persisted even till the Miocene §§.

On the assumption that this series of events did happen, there is little difficulty in accounting for most of the peculiarities in the distribution of the various groups. Thus, to mention only a few instances, the presence in both continents of the Hystricomorphine Rodents, of Chelonians of the family Pelomedusidæ, and of the Fishes of the family Cichlidæ is at once accounted for. So also is the presence in the Santa Cruz

* La Argentina al través de las Ultimas Epocas Geologicas (Buenos Aires, 1897). Also "Linea Filogenética de los Proboscideos," Anales Mus. Nac. Buenos Aires, vol. viii. (1902) p. 19; and "Les Edentés fossiles de France et d'Allemagne," *loc. cit.* vol. xiii. (1905) p. 175.

† Presidential Address to the Geological Society, 1890.

‡ Presidential Address to the Zoological Section, Brit. Assoc. (South Africa, 1905).

§ A Geographical History of Mammals (1896), p. 127.

‖ Erdgeschichte (1890), p. 376.

¶ "Geographical Distribution of Freshwater Decapods and its Bearing on Ancient Geography," Proc. Amer. Phil. Soc. vol. xli. (1902) p. 267.

** Reports of the Princeton University Expeditions to Patagonia (1896–1899)—Palæontology, vol. v. pt. ii. (1905).

†† Das Antlitz der Erde, vol. ii. (1888).

‡‡ "On the Ancient Relations between New Zealand and South America," Trans. New Zealand Instit. vol. xxv. (1891) p. 431.

§§ For evidence of the probable existence of shallow water across this region, perhaps as late as the Miocene, see Gregory, Quart. Journ. Geol. Soc. vol. li. (1895) p. 306.

beds of *Necrolestes*, apparently a close ally of the Cape Golden Moles, and of the Sparassodonta, which, after all, seem to be Creodonts and not Marsupials. Furthermore, light is also thrown on the numerous points of similarity between Struthiones and the Rheæ, especially when it is remembered that a large Ratite bird, *Eremopezus*, existed in the Eocene of Africa. As to the Ungulates, it seems likely that the separation of the two areas took place when the main divisions were only just beginning to be differentiated, and that groups like the Pyrotheria and the Archæohyracidæ are not ancestral to the Proboscidea and Hyracoidea of the Old World, but more probably represent terms of partly parallel series which had a common ancestry on the common land-surface before the separation of the two regions took place. If this were so, we should expect to meet with a general resemblance between the various groups rather than a close similarity of structure, and this, in fact, is what we find. In the case of the occurrence of the primitive Sirenian *Prorastomus* in the West Indies, and of the Water-Snake *Pterosphenus* in the Eocene beds of Alabama, it seems likely that these animals passed either along the southern coast of the Eocene Atlantic or across the bridge of shallow water between the chain of islands above referred to as probably lying between West Africa and Brazil. The fact that the mammalian fauna of Madagascar is a comparatively poor one and entirely lacking in many of the groups that must have inhabited the Ethiopian mainland, is considered by Tullberg to be accounted for by supposing that the eastern part of Africa with Madagascar was separated from the main South-west African continent by an arm of the sea, and that it was not till after the isolation of Madagascar (probably in the late Oligocene) that the two portions of Africa became united. At this time East Africa was probably united to South-western Asia by continuous land, along which the Proboscidea reached India, and perhaps thence penetrated to North America. In both these regions, as well as in Europe, the group seems to have undergone the further series of modifications which gave rise to the modern type of Proboscideans.

Another consideration which adds to the importance of Africa as a centre of mammalian evolution has been pointed out by Stromer (42), namely, that part of it at least has probably never been submerged since the Palæozoic period, and formed a portion of a vast Permo-Triassic land-area inhabited by a great variety of mammal-like Theriodont reptiles from which the Mammalia may have actually arisen. This being the case, it is not only the Tertiary, but also the Secondary, deposits of this region that may be expected to yield most important data for the history of the Mammalia.

From the foregoing summary it will be seen that Africa appears to offer a most promising field for the Vertebrate Palæontologist, and it is greatly to be desired that travellers, whether geologists or not, should observe and record the position of any beds that contain bones, even if mere fragments only are found.

In conclusion, I wish to express my sincere thanks to Captain H. G. Lyons, Director-General of the Egyptian Survey, for kindly allowing me to describe the Vertebrate remains preserved in the Geological Museum, Cairo, in conjunction with those in the British Museum, and by so doing to increase very greatly the value of the present volume. I am also greatly indebted to him for valuable advice and assistance in arranging my own collecting-expeditions. Best thanks are also due to Mr. W. E. de Winton, whose generosity made my visits to Egypt in 1903 and 1904 possible. I am indebted to Dr. W. F. Hume, of the Geological Survey of Egypt, for much help when working in the Museum at Cairo, and to Mr. H. J. L. Beadnell, late of the same service, for the privilege of accompanying him on his visit to the Fayûm in 1900, and for much help subsequently in working my own collecting-expeditions. Thanks are also due to Mr. C. Davies Sherborn, who kindly volunteered to make the Index to this volume; to the Council of the Zoological Society and the Editors of the Geological Magazine for the loan of illustrations; and, finally, to Mr. F. O. Barlow for his help in collecting in the early part of 1903, for the subsequent successful preparation of the specimens obtained, and also for the preparation of excellent models of the restored skulls and mandibles of *Mœritherium* and *Palæomastodon*.

CHARLES W. ANDREWS.

SKETCH OF *ARSINOITHERIUM ZITTELI*, RESTORED.

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SYSTEMATIC INDEX.

f

LIST OF ILLUSTRATIONS IN THE TEXT.

A DESCRIPTIVE CATALOGUE

OF THE

TERTIARY VERTEBRATA

OF

THE FAYÛM, EGYPT.

Class MAMMALIA.

Order UNGULATA.

Suborder *BARYPODA*.

[C. W. Andrews, Geol. Mag. [5] vol. i. (1904), p. 481.]

FULL eutherian dentition without diastemata. Molars tending to become hypsodont; premolars differing widely from molars. Anterior palatine foramen very large and single. Alisphenoid canal present; no condylar foramen hitherto observed. Brain-cavity relatively much larger than in the Amblypoda. No entepicondylar canal in the humerus; no third trochanter in the femur. Both feet probably pentadactyl. Fore foot much like that of the Proboscidea ; the metacarpals alternating to the same extent as in *Elephas*, and the scaphoid closely similar to that of the latter genus. Ulna entering into the carpal joint much more extensively than the radius ; the cuneiform consequently large and sometimes overlapping the magnum, and the scaphoid relatively small. Hind foot differing widely from that of the Proboscidea, and approaching that of the Amblypoda. Astragalus and calcaneum both bearing large fibular facets ; the low broad astragalus articulating distally with the cuboid and navicular, the former having only a small surface of contact with the calcaneum. A small tibiale probably present.

From the shape of the calcaneum it seems probable that the heel sometimes rested on the ground.

Family ARSINOITHERIIDÆ.

Comprising only the genus *Arsinoitherium*, and not yet precisely definable.

Genus **ARSINOITHERIUM**, Beadnell.

[Prelim. Note on *Arsinoitherium zitteli*, Beadn. : Survey Dept., Cairo, 1902.]

Occipital surface of skull strongly inclined forwards; a pair of small frontal horns over the orbits, and a pair of enormous nasal horns arising from a common base constituted by the nasals and frontals. In the adult, a prenasal bar of bone uniting the anterior border of the nasals with the premaxillæ. Orbit open posteriorly. Palate strongly arched from side to side. Molars bilophodont. Neck very short. Humerus and femur considerably longer than the radius and tibia respectively.

So far as known, this genus is represented by two species only in the Upper Eocene of Egypt. Nearly all parts of the skeleton have been discovered.

Skull (Pls. I., II., III.; text-figs. 1–4).—The skulls in the collections belong to individuals of various ages, ranging from young animals in which the last molar is still uncut and most of the sutures remain open (Pl. III. fig. 2) to fully adult individuals with the last molar much worn and almost all the sutures obliterated (Pls. I., II.). An intermediate condition is shown in Pl. III. fig. 1, where the last molar is just coming into wear, and some of the sutures (*e. g.* that between the exoccipital and squamosal) are still open, while the horns are rounded and the character of the bone shows that growth was actively proceeding at their summit. An adult skull in the British Museum (Pls. I., II.) suffices for the greater part of the general description, and this specimen is important because it was found in actual association with its mandible.

The general appearance of the skull is most remarkable. Seen from behind (text-fig. 1) the most notable characters are:—(1) The large size and great prominence of the occipital condyles; (2) the extreme inclination forwards of the occipital surface; (3) the great development of the lambdoidal crest, the lower ends of which form strong prominences in the adult animal. In a front view (Pl. II. fig. 1 A) the appearance is very curious, the two great horns and the sharp wedge-shaped extremity of the snout giving the whole a triradiate form. Beneath the base of the horns are the two very large narial apertures, divided in the adult by a vertical prenasal bar of bone. An upper view of the skull (Pl. III. fig. 2) shows the large widely-separated and prominent condyles, the forwardly-inclined occipital surface, and in

front of this the nearly flat parietal region, passing anteriorly into the rounded common base of the great horns. The zygomatic arch does not project very strongly, and

Text-fig. 1.
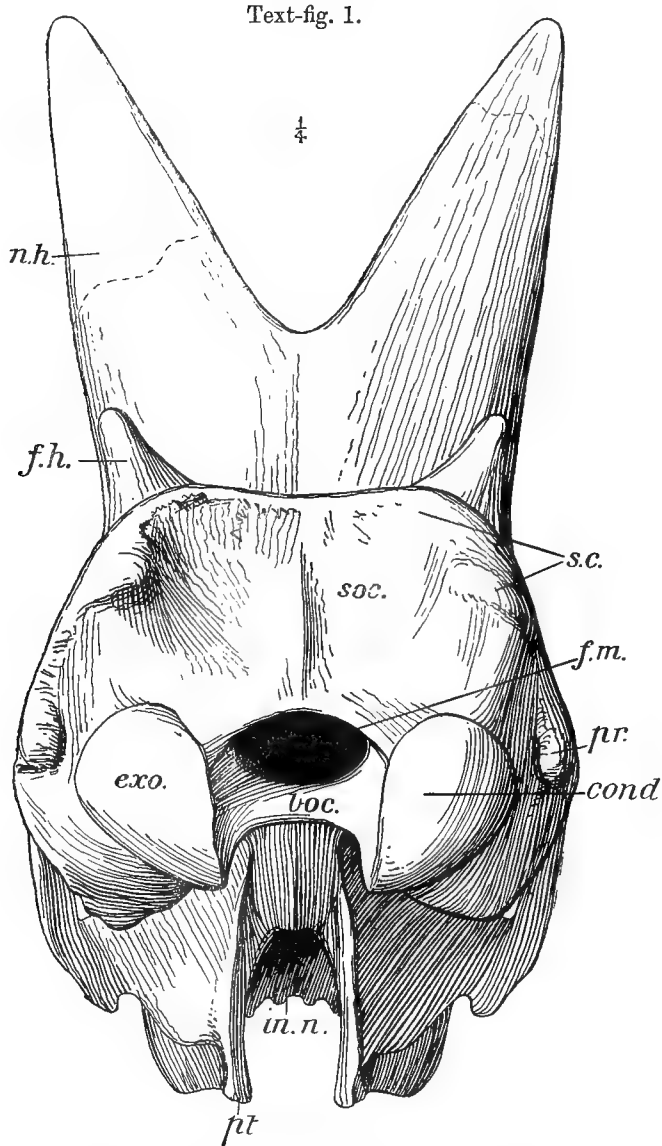
Skull of *Arsinoitherium zitteli*, seen from behind.

boc., basioccipital ; *cond.*, condyles ; *exo.*, exoccipital ; *f.h.*, frontal horn ; *f.m.*, foramen magnum ; *in.n.*, internal nares ; *n.h.*, nasal horn ; *pr.*, prominence of squamosal ; *pt.*, pterygoids ; *s.c.*, lambdoidal crest ; *soc.*, supraoccipital. ¼ nat. size.

the widest part of the posterior portion of the skull is situated just above and behind the auditory opening. In a palatal view (Pl. II. fig. 1) the peculiar wedge-shaped

form of the skull is well shown, other notable points being the highly arched palate and the large median anterior palatine foramen.

The *exoccipitals* (*exo.*) seem to form the whole of the great occipital condyles, though the sutures between them and the basioccipital are obscure. The condyles (text-fig. 1, *cond.*) themselves are somewhat pedunculate and project entirely beyond any other portion of the skull. Their inner faces are flattened, with a deep depression near their base. The articular surface is much less convex from side to side than from above downwards, in which direction the curvature of the surface is nearly a semicircle. In fact, the articulation may almost be described as a slightly oblique section of a cylinder, and must have allowed great freedom of movement to the head in an up-and-down direction. There is no condylar foramen, or at least none has yet been observed. The *foramen magnum* (text-fig. 1, *f.m.*) is large and oval in outline. Its concave upper border is formed entirely by the exoccipitals, which meet in a median suture, thus excluding the supraoccipital entirely from the opening (Pl. III. fig. 2); while its ventral border, which is nearly straight and somewhat posterior to the upper border, is probably formed mainly by the basioccipital. The suture between the exoccipitals and the supraoccipital runs outwards and somewhat upwards from the middle line (Pl. III. fig. 2), and crosses the lower end of the massive lambdoidal crest, of which the thickened and prominent ventral end is therefore formed by the exoccipital. Laterally the exoccipitals are applied by a broad surface to the posterior face of the post-tympanic process (Pl. I., Pl. II. fig. 1, Pl. III. figs. 1, 2 A, *pty.*) of the squamosal, the suture between the two being nearly vertical. Between this squamosal process of the exoccipital and the condyle, below the level of which it projects considerably, there is a blunt prominence, which seems to represent the paroccipital process (Pl. I., Pl. III. fig. 1, *p.p.*).

The *basioccipital* (*boc.*), which, as already mentioned, forms the nearly straight ventral border of the *foramen magnum* (text-fig. 1, *f.m.*), is broad and flat posteriorly, but its outer boundaries are not clear. Antero-laterally it seems to be notched on either side by the posterior angles of a pair of large fossæ, which open into the cranial cavity, are separated by the narrow anterior portion of the bone, and must in life have lodged the tympanic bones. The anterior portion just mentioned deepens considerably from before backwards, so that near its junction with the basisphenoid the vertical diameter is much greater than the transverse extent. In this anterior region the ventral surface bears a median keel, while a transverse ridge marks its junction with the *basisphenoid* (Pl. II. fig. 1, *bsp.*), the ventral surface of which is likewise keeled in the middle line. The axis of this bone is not quite in the same straight line as that of the basioccipital, but turns slightly upwards in front, its anterior portion being embraced by the upper edges of the pterygoids posteriorly and of the palatines anteriorly. The *vomer* has not been observed in any specimen.

The *supraoccipital* (*soc.*), as already mentioned, is excluded from the *foramen magnum*. It forms the whole of the upper part of the sloping occipital surface, which is bounded above by the thickened, rugose, and very prominent lambdoidal crest (*s.c.*). This seems to be situated along the junction of the supraoccipital and the parietals, though it is impossible to determine precisely which is the line of union, since even in the youngest specimens the suture is closed. In the middle line there is a prominent ridge for the attachment of the *ligamentum nuchæ*, and on either side of this the surface is greatly roughened, like the surface of the lambdoidal crest.

The *parietals* (*pa.*) are not only fused with the supraoccipital, but also with one another in the youngest specimens available for examination. In the immature skull figured on Pl. III. fig. 2 there is, in the middle line of the skull-roof, a small foramen, which opens into the sinus occupying this part of the cranial wall and is probably a remnant of the sagittal suture. This opening is absent in other specimens, and therefore cannot be regarded as of importance. The parietals form the anterior portion of the lambdoidal crest, in front of which they constitute the skull-roof, which is nearly flat from side to side, and slightly concave from before backwards. Laterally they turn downwards almost at right angles, and help to form the side-walls of the skull, their lower edges meeting the squamosals in a nearly straight suture, which runs downwards and forwards (Pl. III. figs. 1, 2 A). The upper edge of this lateral region of the parietals is sharply defined by the strongly-marked ridge, which forms the upper limit of the temporal fossa and is continued forwards on the frontals as far as the orbits. In the adult the fronto-parietal suture is closed, but in the young (Pl. III. fig. 2) it can be seen that the parietals extend forwards in the middle line between the small frontal horns. Immediately behind these the fronto-parietal suture turns forwards to the supratemporal ridge, after crossing which it turns downwards and somewhat backwards, running down to join the parieto-squamosal suture.

The *squamosal* (*sq.*) is a large and complicated bone which takes a considerable share in the formation of the side-wall of the cranium. Its sutures with the parietal and exoccipital have already been referred to. It cannot be determined whether or not it had any contact with the supraoccipital, but probably its upper posterior angle, which helps to form the large lateral occipital prominence, united with that bone at least for a short distance. Beneath this prominence the surface of the bone is roughened and raised into a ridge, which in the adult skull forms a strong, backwardly-directed, hook-like process (text-fig. 1, *pr.*) for the attachment of muscle, situated above and rather behind the opening of the external auditory meatus (Pls. I., II. fig. 1, *e.a.m.*). Ventrally the bone is produced downwards into a broad post-tympanic flange (*pty.*), which terminates below in a blunt point and is supported posteriorly by the downward process of the exoccipital

mentioned in the account of that bone. The post-tympanic process (*pty.*) curves forwards and forms the posterior wall of the large external auditory meatus (*e.a.m.*). The anterior wall of this opening is formed by an extremely long and broad postglenoid process (*pgl.*), which curves backwards so as nearly to meet the lower end of the post-tympanic. The outline of the external auditory meatus is oval, the long axis being nearly vertical; the meatus narrows somewhat towards its inner end, where it opens into the large fossa occurring on either side of the *basis cranii*, and no doubt lodging in life the petrosal and tympanic, the latter of which may have extended into the passage between the post-tympanic and postglenoid processes just described. In one skull (M. 8463) a portion of the inner surface of the petrosal is preserved, but in all other cases both that bone and the tympanic are wanting, leaving the large vacuity just referred to. The glenoid surface (Pl. II. fig. 1, *gl.*) is much wider from side to side than from before backwards; it is slightly concave in the former direction, and rather more so in the latter. Internally it is bounded by a deep groove, which separates it from the upper end of the pterygoid plate, and outwardly it extends upon the base of the zygomatic process. This latter is stout and is laterally compressed anteriorly, where it terminates in a sharp point. Ventrally it unites in suture with the jugal, which extends back beneath it to the level of the anterior border of the glenoid surface. The sharp upper edge of the zygomatic process is continued backwards and upwards as a ridge forming the posterior and outer boundary of the temporal fossa. The upper surface of the squamosal between this ridge and the parieto-squamosal suture forms a sort of concave floor to the posterior portion of the temporal fossa; the anterior boundary of this surface is the sharp front edge of the glenoid articulation (Pl. II. fig. 1 and Pl. III. fig. 2).

The *frontals* (*fr.*) not only form the lower part of the upper surface and the hinder portion of the sides of the base of the great anterior horns, but each of them also bears a small horn, which is situated near their junction with the parietals and on the outer edge of the skull-roof. These small horns are hollow and their cavity is continuous with the extensive sinus occupying the great anterior horns and the roof of the skull generally. This sinus will be described below. The parieto-frontal suture has already been referred to; that between the frontals themselves persists for some time, and both it and the fronto-nasal suture are shown on Pl. III. figs. 2, 2 A. It will be seen that the fronto-nasal suture first runs nearly vertically downwards, then downwards and forwards, and finally directly downwards, meeting the fronto-maxillary suture nearly at right angles. This latter suture runs directly backwards until just outside the border of the orbit, where the two bones are separated by the small square lachrymal; within the orbit they again unite, the suture between them running downwards to a large orbito-nasal foramen (*on.f.*, see text-fig. 4, p. 13). The supratemporal ridge is continued on the frontals

from the parietals and sharply defines the upper border of the temporal fossa. It ends some distance in front of the small horns, and its termination may be taken as marking the posterior limit of the upper border of the orbit, there being no definite postorbital process. The antero-superior portion of the orbital border is formed by the frontal; it is broadly rounded, and at one point near the middle it is crossed by a broad shallow depression, which runs upwards and forwards on to the side of the base of the horn, where it divides into three or four divergent branches, forming deep channels in the bone (Pl. I., *b.v.*). These channels evidently lodged blood-vessels which served for the conveyance of blood to or from the covering of the horn, and judging from the marked way in which both these vessels and those on the anterior face of the horns impress the bone, it seems probable that the covering was hard and of much the same nature as that clothing the horn-cores of the cavicorn ruminants.

The *lachrymal* (*l.*) is a small bone occupying the anterior angle of the orbit, wedged in between the frontal above, and the maxilla and jugal below. It bears a vertically-elongated prominence (see Pl. I., *l.*) which forms the actual edge of the orbit and is connected below with a strong crest borne on the front of the maxillary process of the jugal. There seems to be no trace of any lachrymal foramen.

The *nasals* (*na.*) are the most remarkable bones of the skull, and they are enormously enlarged, forming almost the whole of the great anterior horns. The sutures between these bones and the frontals have already been referred to: they are open only in the young (Pl. III. figs. 2, 2 A); in the adult or even three-parts-grown animal they are completely obliterated (Pl. I. and Pl. III. figs. 1, 1 A), and the same is the case with the suture between the nasals themselves. On the side of the face the ventral border of these bones unites first with the upper edge of the maxilla, and in front of this with the premaxilla, the suture with which is continued forwards just into the nasal cavity. Here a downgrowth of the lower surface of the portion of the nasals forming the roof of the nasal cavity unites with a corresponding upgrowth of the maxilla which overlaps it (text-fig. 2). The two form a sort of column on either side of the posterior face of the nasal cavity, and these columns help to support and form a base for the horns. Furthermore, owing to their presence the nasal passage is greatly contracted and forms a vertical cleft between them. The roof of the nasal cavity is nearly flat and in the adult its edges are thin, sharp, and somewhat everted (Pl. I., Pl. II. fig. 1 A): in the young, on the other hand, this edge is wanting (Pl. III. figs. 2 A, 2 B), so that the nasal roof passes by a gentle curve into the outer face of the horn. In the young also the anterior ends of the nasals are free and not connected by a bar of bone with the premaxillæ. This bar, which is formed only at a comparatively advanced age, appears to result from the ossification of the anterior edge of a cartilaginous nasal septum, the presence of which is indicated by the peculiar groove (Pl. III. figs. 1 A, 2 B, *ms.g.*; see also text-fig. 2, *mes.g*)

situated between the upper edges of the facial processes of the premaxillæ: this
will be described more fully in the account of the latter bones. The anterior
face of the prenasal bar is flattened and towards its lower end deeply pitted by
what seem to be muscle-impressions: possibly the animal possessed a pointed mobile
upper lip, something like that of *Rhinoceros bicornis*, and the muscles inserted in
these impressions were concerned in its movements. The general form and relations
of the prenasal bar are well shown in Pl. I. and Pl. II. fig. 1 A; also in text-fig. 2.

Text-fig. 2.
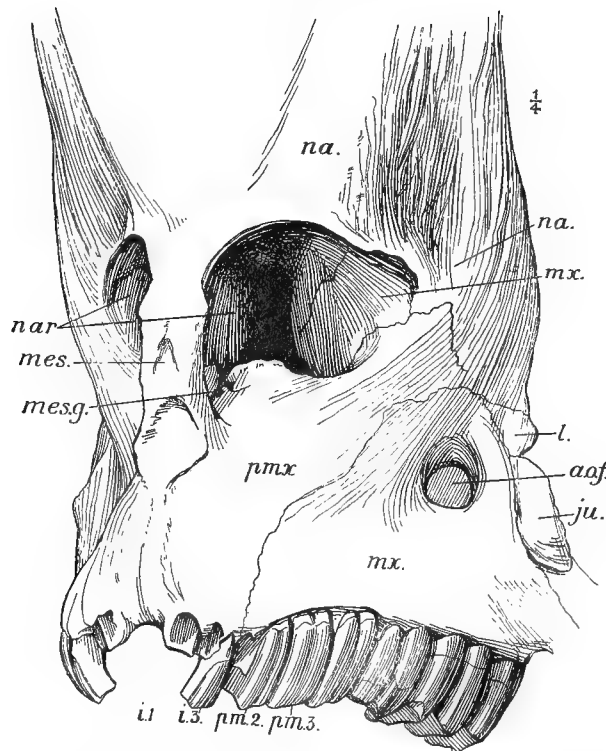
Skull of *Arsinoitherium zitteli*: oblique view of anterior portion showing the relation
of the nasal and maxilla in the narial opening.

a.o.f., antorbital foramen; *i.* 1, *i.* 3, incisors; *ju.*, jugal; *l.*, lachrymal; *mes.*, prenasal bar; *mes.g.*, mesethmoid
groove; *mx.*, maxilla; *na.*, nasals; *nar.*, nares; *pm.* 2, *pm.* 3, premolars; *pmx.*, premaxillæ. $\frac{1}{4}$ nat. size.

The horns themselves are borne on a common base, formed by the frontals
posteriorly, but for the rest by the nasals alone. The mid-dorsal line of the
basal portion is marked by a shallow groove, but in the adult the median suture
is completely obliterated. A section of the basal region taken at right angles to
its dorsal surface would give an arc of about three quarters of a circle, though
somewhat inflated at the sides. From this base the paired horns arise and project
forwards, upwards, and somewhat outwards. In adult, probably male, animals they

are somewhat triangular in section: the sharp anterior angle is continued downwards to the border of the nasal opening (Pl. I. and Pl. II. fig. 1 A). The inner face is nearly flat, the posterior is also flattened, while the outer side is rounded. In what may be regarded as an adult female skull the horns are much smaller, more erect, and very irregularly ossified at their tips, which are rounded anteriorly, but terminate posteriorly in an irregular mass of bone. This skull was figured by Mr. Beadnell in his original paper (pls. iii.–v.). The specimen in question is fully adult, for the last molar is well worn, all the sutures are closed, and the prenasal bar fully ossified. In the young the horns are rounded at the summit, where the bone is of a peculiarly fibrous or spongy texture, showing that growth was actively proceeding at this point. The central portion of the horns is occupied by an enormous sinus, the walls being relatively thin, about ·5 cm. to 1 cm. in thickness in the adult, and much less in the young. The sinus occupies the bodies of the nasals and frontals and in the latter extends into the small supraorbital horns. Furthermore, it extends back into the parietal and in the old animal even into the base of the lateral prominences of the lambdoidal crest. In the cranial region the sinus is more or less completely divided into a right and left half by a median septum occupying the position of the suture between the parietals. Here the lower table of bone forming the actual wall of the braincase is very thin, while the upper table is greatly thickened. In the frontal and nasal regions the separation into two halves is not complete, but there is both in the mid-dorsal and mid-ventral line a greatly thickened ridge projecting into the cavity of the sinus; the ventral ridge is the stronger and forms a laterally compressed bar of bone. These main longitudinal thickenings are connected transversely by less prominent, more or less regularly arranged thickenings of the walls, and these again are occasionally united by irregular ridges. In the paired portion of the horns there are only transverse ridges running round the cavity, with some irregular secondary ridges joining them at a few points. The great anterior horns thus consist of comparatively thin bony walls, which are strengthened by a complex system of buttresses, and are further braced against thrusts in the direction of their long axis by the columns resulting from the union of the nasals and maxillæ above noticed, and, in the adult, by the prenasal bar. The surface of the horns is marked by a series of shallow grooves running more or less in the direction of their long axis and frequently anastomosing. On the antero-lateral faces of the horns, a little above the nasal opening, there are impressions of blood-vessels (see Pl. I., *b.v.'*) similar to those described on the frontals.

The *premaxillæ (pmx.)* are relatively small bones. The alveolar border of each, as usual, bears three incisor alveoli. Of these the first pair is considerably the largest; they are rounded with a raised border and are separated in the middle line by an interval of about 2·5 cm., in which the edge of the bone is rounded and

roughened. The other alveoli are smaller, compressed from before backwards, and crowded together; they are separated by a very small space from the socket of *i*. 1 in front and by none at all from that of the canine behind. The palatine portion of the premaxillæ is small: the premaxillo-maxillary suture runs backwards from immediately behind the alveolus of the last incisor, and the bones form little more of the palate than the high arched roof of the unpaired anterior palatine foramen, the posterior or ventral edge of which is formed by the anterior border of the palatine plates of the maxillæ. The facial portions of the premaxillæ form the very narrow wedge-shaped extremity of the snout, the actual angle of which is somewhat truncated and roughened. The suture with the maxilla (Pls. I., II., III.) runs upwards and backwards to a point midway between the nasal opening and the orbit; and in front of this the bone unites with the nasal, the suture with which runs just into the narial opening. Within the latter the premaxilla again meets the maxilla, forming a suture with the upward prolongation of that bone, which together with a downgrowth of the nasal forms a support for the large horns in the manner above described (see the description of the nasals and text-fig. 2). The posterior part of the border of the nasal opening formed by the premaxilla is rounded, but in front of this the bone is bent inwards and downwards and terminates internally in an irregular roughened edge, the posterior angle of which forms a blunt tuberosity. This inturned edge is separated from the corresponding portion of the bone of the opposite side by a deep groove (text-fig. 2, *mes.g.*), which in life probably lodged the lower edge of a vertical cartilaginous nasal septum. In the young this remains unossified, but in the fully adult animal its anterior region ossifies and forms the prenasal bar of bone joining the nasals with the premaxillæ, as above described (see Pls. I., II. fig. 1 A; also text-fig. 2).

In consequence of the great size and the hypsodonty of the teeth, the *maxilla* (*mx.*) is very large. Its facial suture with the premaxilla has already been described, and it will be noticed that it is completely excluded from the margin of the nasal opening by the meeting of the premaxilla and the nasal. Within the nasal opening, however, it is produced upwards into a process which unites with a downgrowth of the nasal in the manner already mentioned. Behind its union with the premaxilla the upper border of the bone meets the frontal, and its suture with that bone terminates just behind the *antorbital foramen* (*a.o.f.*), at which point the small lachrymal is interposed, and helps to form the outer side of the bar of bone which closes the antorbital foramen externally. This foramen is very large and opens by a wide passage into the orbit. The maxilla is excluded from the actual margin of the orbit by the junction of the lachrymal with the upper end of the jugal, which sends up a long process forming the whole ventral border of the orbit, and uniting anteriorly with the maxilla. The zygomatic process of the maxilla is very short, extending very little

behind the posterior border of the alveolus of the last molar. The facial surface of the bone slopes inwards, especially in its anterior portion (see Pl. II. fig. 1 A). The suture between the maxilla and premaxilla crosses the alveolar border immediately behind the last incisor. On the palate it runs backwards for a short distance, behind which the anterior edge of the maxilla becomes free and forms the lateral and hinder borders of the large median anterior palatine vacuity (Pl. II. fig. 1). The anterior portion of the palatal surface formed by the maxilla is very highly arched, so much so, in fact, that the sides of the palate are nearly parallel with the facial surface of the bone (see text-fig. 3), the

Text-fig. 3.
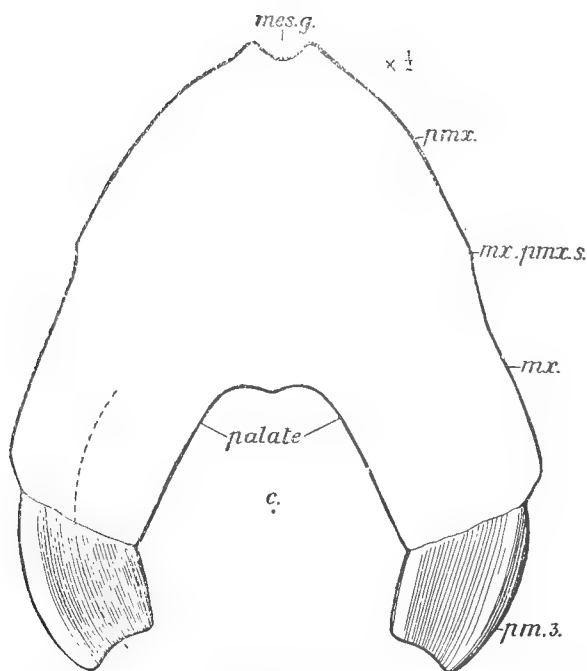
Skull of *Arsinoitherium zitteli*: diagrammatic section through snout at the level of the third premolar.

c., centre about which the teeth move in growth; *mes.g.*, mesethmoid groove; *mx.*, maxilla; *mx.pmx.s.*, maxillo-premaxillary suture; *pm.* 3, third premolar; *pmx.*, premaxilla. $\frac{1}{2}$ nat. size.

distance between them being practically the width of the alveolar surface. This peculiarity seems to be mainly due to the deepening of the alveolar region of the bone in order to carry the high-crowned and long-growing cheek-teeth. The diagram given in text-fig. 3 is a vertical section of the snout taken at the level of the third premolar, showing that the teeth and the deepened portion of the maxilla form a continuous curve which is almost a part of a circle with the centre at the point *c*. The growth of the teeth along this curve accounts, in a great

c 2

measure at least, for the much greater height of the outer side of the crown than of the inner side. The same diagram also shows in section the junction of the maxillæ with the premaxillæ (*mx.pmx.s.*), and the probably mesethmoid groove (*mes.g.*) which lies between the upper ends of the premaxillæ and was no doubt occupied in life by the lower edge of a vertical cartilaginous nasal septum. Another possible explanation of the deeply concave palate is, that *Arsinoitherium* may have possessed a tongue of peculiar form, probably extensible and prehensile; for it is difficult to understand how an animal of such great size could grasp sufficient food with so extremely narrow an incisor region if it had not some additional means of prehension in the form of a mobile upper lip or tongue.

Further back the palatal surface of the maxillæ becomes more flattened, and opposite the second molar these bones unite with the palatines in a broad transverse suture; behind this point they only appear on the palate as a narrow strip on either side. Behind the last alveolus the maxilla is produced backwards into a short pointed process which forms the outer wall of a foramen (Pl. II. fig. 1, *m.p.f.*), the rest of which is a deep notch in the edge of the palatine. Above this foramen the hinder border of the maxilla forms the outer edge of a groove (*p.p.g.*), running up towards the anterior opening of the alisphenoid canal (text-fig. 4, *al.c.*). This groove and foramen, which seem to be homologous with the posterior palatine foramen of the human skull, also occur in *Hyrax* (*Procavia*) and possibly other Ungulates, and no doubt transmitted branches of the palatine nerve and blood-vessels. The foramina to which the name posterior palatine is applied in most mammals lie on the palate at or near the junction of the anterior end of the palatines with the maxillæ; and these openings are also present in *Arsinoitherium*, though very small. Probably both pairs of openings simply mark the points at which the palatine vessels and nerves passed between the maxillæ and the palatines, when these bones were still separate in the young; and the presence or absence of the anterior or posterior of the foramina mentioned depends on whether the palatine nerves and vessels passed out in one or more groups on either side. In *Arsinoitherium* the posterior openings are large, and those near the anterior end of the palatines small, owing probably to some structural peculiarity which rendered necessary a larger nerve- and blood-supply for the posterior region of the palate. In some animals there is a series of small foramina on either side, the anterior one usually being much the largest.

In front of the posterior edge above mentioned the maxilla widens into a large mass, which in the adult lodges the roots of the posterior molars, and in the young, in which it is relatively still larger, contains the developing germs of the same teeth. This alveolar mass to a considerable extent forms a floor to the orbit. Although the maxilla is excluded from the actual border of the orbit by the union of the lachrymal and jugal, it nevertheless forms a large part of its anterior wall in the neighbourhood of the posterior opening of the antorbital canal, where it unites in suture with the

frontal, and behind this appears to form the ventral edge of an elongated orbito-nasal foramen (text-fig. 4., *on.f.*), opening from the orbit into the nasal passage. Behind this again the maxilla joins the orbital portion of the palatine in a suture running backwards some distance till it disappears in the depression marking the inner side of the swollen alveolar mass of the bone.

Text-fig. 4.
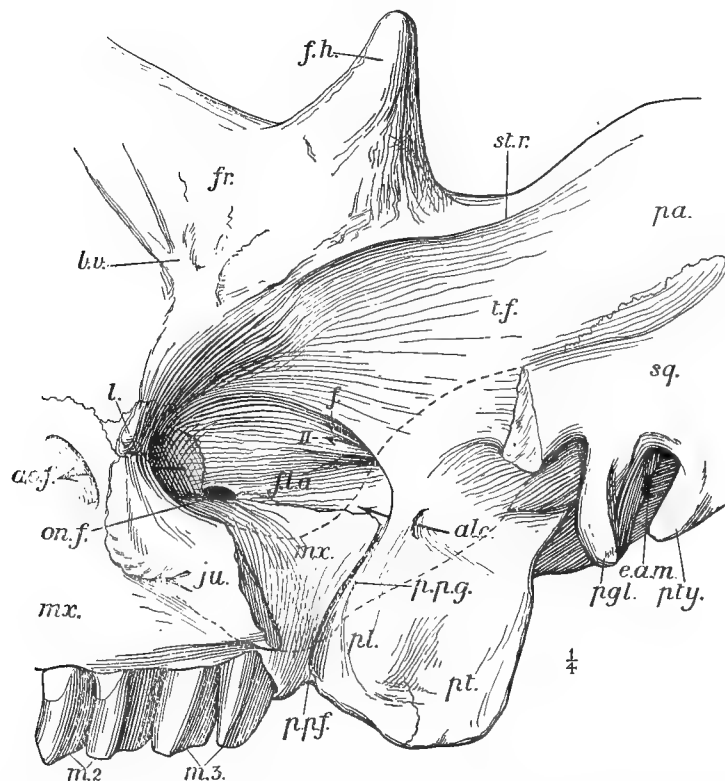
Skull of *Arsinoitherium zitteli*: side view of orbital region with the zygomatic arch removed.

al.c., alisphenoid canal; *a.o.f.*, antorbital foramen; *b.v.*, impressions of blood-vessels; *e.a.m.*, external auditory meatus; *f.*, ? vascular foramen; *f.h.*, frontal horn; *f.l.a.*, foramen lacerum anterius; *fr.*, frontal; *ju.*, jugal; *l.*, lachrymal; *m.*2, *m.*3, molars; *mx.*, maxilla; *on.f.*, orbito-nasal foramen; *pa.*, parietal; *pgl.*, postglenoid process; *pl.*, palatine; *p.p.f.*, posterior palatine foramen; *p.p.g.*, posterior palatine groove; *pt.*, pterygoid; *pty.*, post-tympanic process; *sq.*, squamosal; *st.r.*, supratemporal ridge; *t.f.*, temporal fossa; II., optic foramen. ¼ nat. size.

The *jugal* (Pl. I., Pl. III. figs. 1, 2 A, *ju.*) articulates in front with the malar region of the maxilla by a long process which runs up as far as the anterior angle of the orbit, where it meets the lachrymal and completely excludes the maxilla from the margin of the orbit, as already mentioned in the description of that bone. Immediately below and in front of the orbit there is a very prominent, rough, curved ridge (marked *ju.* in text-fig. 4) which projects considerably from the side of the face and must have served

for the attachment of powerful muscles. Beneath the orbit the jugal bar is narrower from above downwards, but it is considerably thickened ventrally and bears several strong ridges. Posteriorly it turns upwards and widens out to some extent, meeting the zygomatic process of the squamosal in a long and nearly straight horizontal suture. The posterior angle of the jugal extends well back behind the anterior border of the glenoid surface, of which it may even help to form a part at the outer border.

The *palatines* (*pl.*) form the greater part of the hinder region of the palate, as well as of the side-walls of the nasal canal and of the mesopterygoid fossa. The union of their palatine plates with the maxilla is nearly transverse in front, and in or near the suture there is a pair of small posterior palatine foramina (Pl. II. fig. 1, *pp.f.*), to which reference has been made above. The anterior end of the palatines is opposite the posterior column of *m.* 2 in the adult skull: behind this the maxillo-palatine suture runs backwards and slightly outwards. The posterior border of the palate is opposite the hinder end of *m.* 3: it is greatly thickened and on either side of the median suture there are two roughened ridges directed forwards and outwards. Behind the palate the ventral edges of the vertical plates of the bones are greatly thickened and deeply notched externally, the notch forming the greater part of the posterior foramen (Pl. II. fig. 1, *m.p.f.*) which has already been described in speaking of the maxilla. A little behind this the palatines join the pterygoids (Pl. II. fig. 1, *pt.*), which form only a comparatively small portion of the descending plates which bound the mesopterygoid fossa. From the ventral edge of the plate the palato-pterygoid suture runs first forwards and upwards, then directly upwards to the *basis cranii*, which is overlapped and embraced by the upper edges of both palatines and pterygoids. The palatines also form the side-walls of the posterior portion of the nasal canal, and appear on the inner wall of the orbits above the alveolar mass of the maxilla, with which they unite in suture behind, and from which they are separated by the orbito-nasal foramen in front. The relations of these bones to one another and to the surrounding structures can be best understood by examining a skull of *Dendrohyrax* (*Procavia*) *dorsalis*, in which the sutures all remain open. The upper edge of the orbital plate of the palatine must have united with the orbito-sphenoid, but the suture cannot be made out; indeed all the boundaries of the orbitosphenoid and alisphenoid are obscure, partly because these bones are very thin and greatly cracked.

The *pterygoids* (*pt.*) form only the posterior part of the deep vertical plates which enclose the mesopterygoid fossa. The suture between them and the palatines in front has already been referred to. Their ventral border is thickened and convex: posteriorly they end in a slightly prominent angle (see Pl. I.), above which the posterior border of the bone is very thin. The upper edge of the bone unites with the basisphenoid and runs high up on the side of that bone into the opening lying between it and the glenoid surface of the squamosal, an opening doubtless

partly filled in life by the tympanic, which is wanting in all the skulls hitherto examined. The upper posterior edge of the pterygoid within this opening forms the inner border of a deep groove lying between it and the squamosal and probably representing the *foramen lacerum medium* (the *foramen lacerum anterius* of some German authors).

As already remarked, the boundaries of the *alisphenoid* and *orbitosphenoid* are by no means clear. The alisphenoid appears to send down a long narrow plate to the outer face of the vertical palatine plates, with which its lower end is intimately fused, forming a prominence which is seen in Pl. I. at the end of the reference-line running from the letters *pl.* Further up, this alisphenoid plate is perforated by the short wide alisphenoid canal (text-fig. 4, *al.c.*), the anterior opening of which lies within the anterior edge of the plate, which is continued upwards and forwards as a prominent downwardly directed crest of bone, forming the outer side of a deep groove, at the bottom of which there are several foramina in addition to the alisphenoid canal. The most important of these is a large somewhat vertically elongated opening, the *foramen lacerum anterius* (*foramen sphenoidale* of some authors). Above and slightly internal to the *foramen lacerum anterius*, and separated from it by a narrow bar of bone, is the smaller and more rounded optic foramen (Pls. I., II.; also text-fig. 4, II.) opening into a groove, of which the upper edge is constituted by a continuation of the crest formed by the border of the alisphenoid plate, the lower edge being much less prominent and probably approximately marking the lower border of the orbitosphenoid, in which the foramen itself is no doubt situated. Above and in front of the optic foramen there is a very small aperture, probably for a blood-vessel.

Several more or less nearly complete casts of the cranial cavity have been made, that upon which the accompanying figures (text-fig. 5) are based being taken from the skull figured on Pls. I. and II. (M. 8463). It is the only one in which the prominence marked *aud.* is shown, in consequence of the partial preservation of the inner portion of the periotic. In all the others the loss of the auditory bones leaves a large vacuity on either side of the basicranial axis, as above mentioned.

A detailed account of the brain-cavity will not be attempted, and some of the more important characters only are here referred to. The olfactory lobes (*ol.*) are large, but not so large in proportion to the rest of the brain as in the Amblypoda. The cerebral hemispheres (*h.*) are far more developed than in that sub-order, the frontal region being especially prominent and rounded. The surface of the cast is almost smooth, and in the absence of a distinct rhinal fissure it is difficult to say what portion of the cerebrum belonged to the *neopallium.* The only trace of a sulcus seems to be that marked *s.*, running upwards and backwards on the side of the brain from behind and beneath the olfactory lobes.

The optic nerves leave the skull far forwards, perforating the orbitosphenoids by two diverging passages, the inner openings of which lie close together at the bottom of a fossa (text-fig. 5, ɪɪ.) bounded anteriorly by a transverse ridge. Immediately external to and slightly below the level of the openings of the optic nerves there is a

Text-fig. 5.
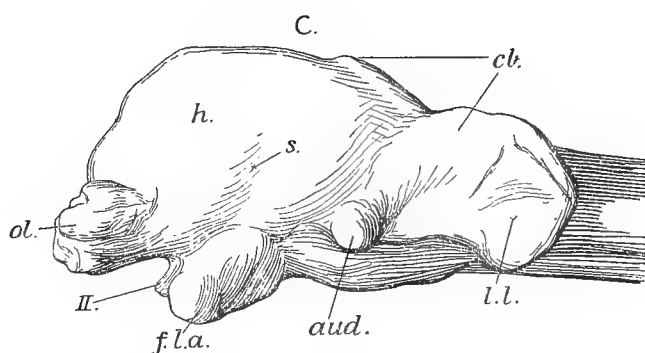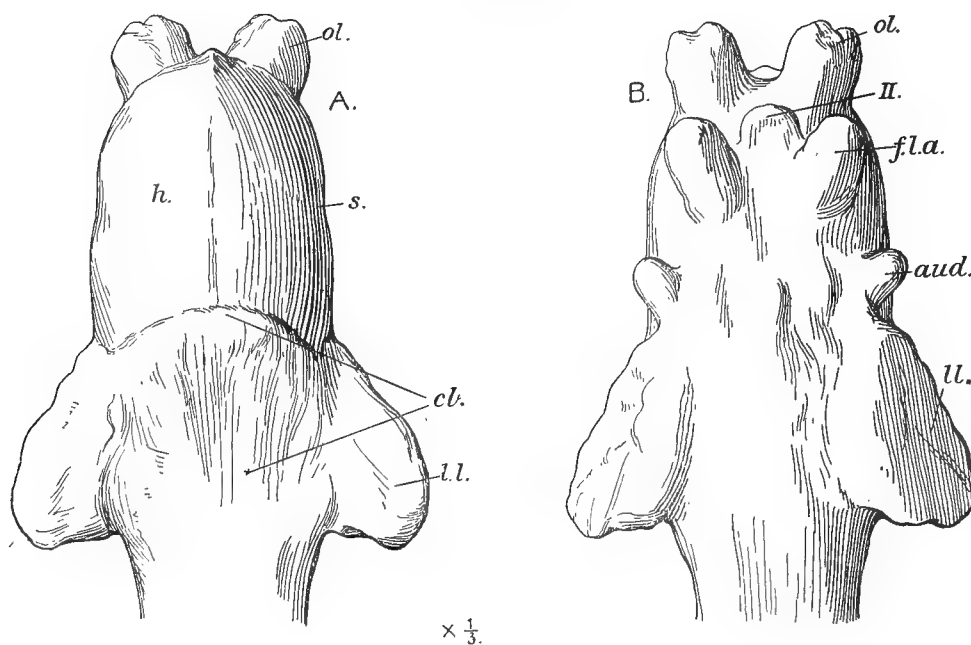
Cast of cranial cavity of *Arsinoitherium zitteli*: A, from above; B, from below; C, from left side.

aud., auditory nerve-root; *cb.*, cerebellum; *f.l.a.*, nerves passing through foramen lacerum anterius; *h.*, cerebral hemisphere; *l.l.*, lateral lobe of cerebellum; *ol.*, olfactory lobe; *s.*, sulcus; ɪɪ., optic chiasma. ⅓ nat. size.

large vertically elongated opening (represented by the projection marked *f.l.a.* in the cast), the anterior aperture of which (*foramen lacerum anterius* or *foramen sphenoidale*) is just over the alisphenoid canal, as described above (see text-fig. 4, ɪɪ. and *f.l.a.*).

Behind and at a slightly higher level there is in the cast another prominence (*aud.*), which probably marks the position of the exit of the auditory and perhaps also of the facial nerve. There is no condylar foramen, and consequently the cast shows no trace of the hypoglossal nerve. No clearly defined *sella turcica* is present, as the whole of the surface of the basicranial axis is flat or slightly convex from side to side.

The central portion of the cerebellum (*cb.*) seems to have been small and flattened: the limit between it and the cerebral hemispheres is marked by a slightly developed tentorial ridge. Laterally the cranial cavity is prolonged into a pair of large fossæ, which may have been wholly or in part occupied by the lateral lobes of the cerebellum (*l.l.*).

This brain is larger in proportion to the bulk of the animal than in the Amblypoda, and seems to be fairly well developed for an Eocene Ungulate. At the same time it should be noted that in the earlier and contemporary genus *Mœritherium* the brain is relatively very much larger (see below).

Upper Permanent Dentition.—The teeth of *Arsinoitherium* (Pls. I.–V.; text-fig. 6) form perhaps the most extraordinary dentition found among the Ungulates, and the interpretation of the peculiar structure of the molars which is here given must be regarded as provisional until it is either confirmed or destroyed by the discovery of earlier members of the group, in which the modification of the teeth from more ordinary types is less extreme.

The modification of the individual teeth has not been accompanied by any reduction in their number, the dental formula being $i. \frac{3}{3}, c. \frac{1}{1}, pm. \frac{4}{4}, m. \frac{3}{3}$, and, except for a short interval between the median incisors in the upper jaw, the teeth form a closed series and wear to a common level throughout. The most striking characteristics of the dentition as a whole are the extreme hypsodonty of the teeth (at least for an Eocene mammal) and the great difference between the molar and premolar teeth (text-fig. 6).

The upper molars (Pl. V. figs. 6–8; text-fig. 6, A) are remarkable for the great height of their crowns and for the considerable changes of pattern their grinding-surfaces undergo in the course of wear. Each tooth consists essentially of two high transverse crests or columns (*p.c.* and *a.c.*), which posteriorly are slightly convex from above downwards and concave from side to side, while anteriorly they are convex in the latter direction. The posterior column is not situated immediately behind the anterior column, but a little towards the inner side, so that its outer edge is nearly opposite the middle of the anterior column (Pl. V. fig. 6). Externally the two columns are completely separated by a deep vertical cleft, but internally they are only divided for a short distance in the upper part of the unworn crown, being united beneath this by a strong crest which seems to belong to the cingulum (*c.'*). This cingulum is

D

also strongly developed as a prominent crest (*c.*) in front of the inner half of the anterior column, from which it is separated by a deep fossa, and there is a trace of it on the inner face of the posterior column. On the inner side of the tooth the enamel ceases just beneath the cingulum, but on the outer and posterior sides the enamel-covered surface is greatly deepened, so that in a tooth in which the almost unworn posterior column is 11 cm. in height (Pl. V. figs. 6 A, 6 B) the enamel-covered portion of the crown is only about 3 cm. deep on the inner side, while on the outer it is some 8 cm. in depth, and the posterior face of the posterior column is covered from base to crown (11 cm.). Wear commences at the summit of the anterior column, giving rise to a transversely elongated surface. Next the summit of the posterior column wears to the same pattern : at this stage the tooth appears as

Text-fig. 6.
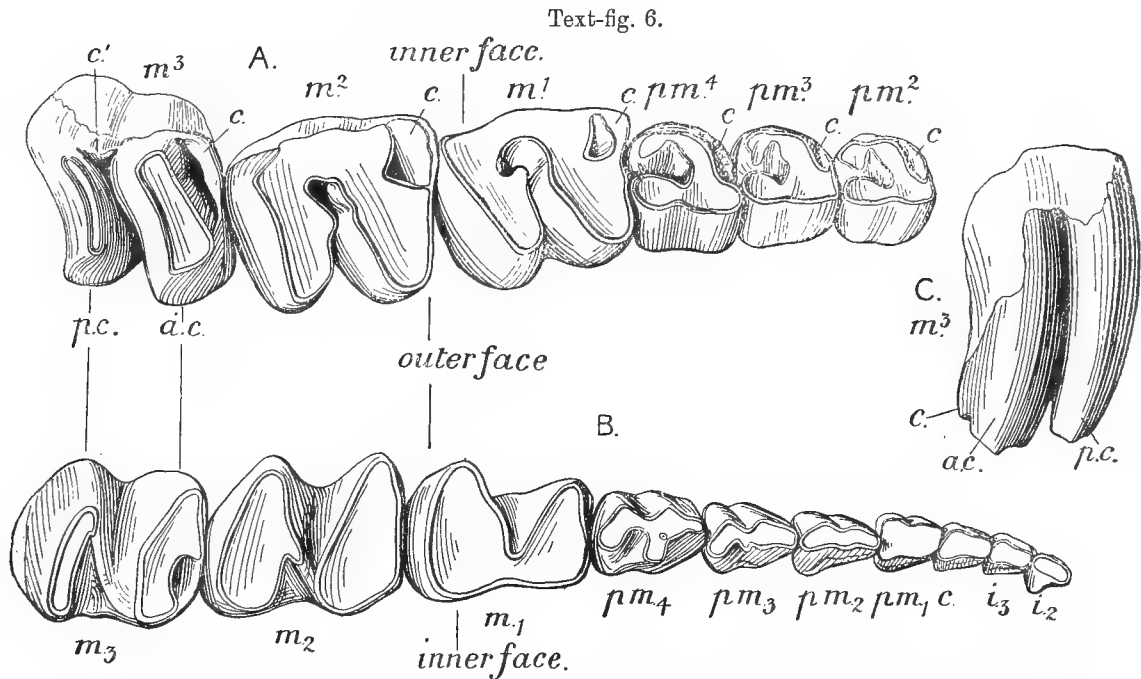
Semi-diagrammatic figure of the upper and lower teeth of the left side of *Arsinoitherium andrewsi* :
A, upper teeth ; B, lower teeth ; C, outer view of last upper molar.

a.c., anterior column of molars ; *c.*, anterior portion of cingulum ; *c.'*, posterior portion of cingulum; *p.c.*, posterior column of molars. About ⅓ nat. size.

an extremely hypsodont bilophodont type. Later the wear on the inner side reaches the level of the cingulum and the surface resulting from the abrasion of the anterior crest of the cingulum joins that of the anterior main column, at first internally only, but afterwards externally also, enclosing with it a deep enamel-lined fossa (Pl. V. fig. 7). At the same time the posterior portion of the cingulum comes into wear : its surface is at first continuous with that of the posterior column, but later with the anterior also, so that at this stage a continuous inner wall is established and the tooth

presents somewhat the pattern of a reversed molar of some such type as that of *Lophiodon* or *Tapirus* (Pl. V. fig. 7). At this stage of wear the inner face of the tooth is covered with cement only, the enamel, as already mentioned, ceasing just below the cingulum on that side, while externally it continues to a much lower level. In the latest stages all that remains of the enamel is found on the posterior and external surfaces of the main columns, round the pit marking the last remnants of the main transverse valley and round that lying between the anterior crest of the cingulum and the anterior main column (see Pl. V. fig. 8). It is by examining the molar in its latest stages of wear, which give a section of the basal part of the tooth, that some explanation of its peculiar character may be arrived at. In this condition (Pl. V. fig. 8) the crown is seen to consist of an outer wall uniting the transverse crests, which are likewise joined at their inner ends, while in the middle they are separated by the remains of the main transverse valley: there is also a remnant of the fossa lying between the anterior main column and the anterior crest of the cingulum. From the appearance of the outer wall it seems probable that the brachyodont tooth from which these hypsodont molars have been derived had an ectoloph composed of well-developed parastyle and mesostyle, together with the antero-external and postero-internal main cusps, the inner portion of the tooth being constituted by the antero-internal and postero-internal cusps, which tended to unite with the antero-external and postero-external cusps respectively to form a pair of transverse ridges. The ectoloph was deeply infolded in front of the mesostyle, and, as the height of the tooth increased, this fold deepened rapidly till the tooth became nearly divided into anterior and posterior columns. If this interpretation be correct, the anterior column includes parastyle, antero-internal and antero-external cusps, while the posterior consists of the mesostyle, postero-internal and postero-external cusps.

The form of tooth from which these molars were derived was probably much like that of the Hyracoids, in which the styles are strongly developed and the ectoloph is deeply folded. Moreover, as will be shown, there is a strong tendency in the early forms of that group for the teeth to form a continuous series. These peculiarities may be in themselves of little importance, but they suggest that possibly *Arsinoitherium* and the Hyracoidea may have originated from a common stock at some remote period. At any rate, both seem to have arisen in the same region.

The roots of the molars (Pl. V. fig. 8 A) consist of a pair of transverse plates (*p.r.* and *a.r.*) extending the whole width of the anterior and posterior borders of the tooth, and a much smaller and shorter root (*m.r.*), imperfectly divided into two and situated on the inner border of the tooth between the inner ends of the main roots. These latter seem to remain open for some time after the crown has come into wear, so that the tooth is on the way to become rootless and permanently growing. The anterior main root appears to support the parastyle, the antero-external main cusp, and the antero-internal crest of the cingulum. The posterior root supports the

whole of the posterior column, that is, according to the interpretation here adopted, the mesostyle, the postero-external and postero-internal cusps. The small inner root is imperfectly divided by a vertical groove into a larger anterior portion supporting that part of the anterior main column homologous with the antero-internal main cusp, and a smaller posterior portion supporting the portion of the cingulum (c.') which in wear unites the inner ends of the main columns.

The premolars (Pl. V. figs. 2, 3) present a sharp contrast to the molars, their strikingly different appearance being due to the presence of an almost flat outer wall which shows scarcely any trace of folding. Like the molars they attain a high degree of hypsodonty, particularly on their outer side, where the enamel-covered portion of the crown is almost four times as high as on the inner side (Pl. V. fig. 3 A): in consequence of this, as in the case of the molars, these teeth are strongly curved, the concave face being turned towards the palate (text-fig. 3, p. 11). The ectoloph is flat or at most gently concave from before backwards, and it appears to be composed of three elements. Of these, one forms the antero-external angle of the tooth and is connected with the cingulum on the anterior face of the tooth, so that it may be regarded as a parastyle (ps.). The element behind this is a large cusp (ae.) widened out transversely as it wears down, so that eventually it forms a junction with the cusp (ai.) internal to it. Behind this main outer cusp is a smaller one (pe.) forming the postero-external angle of the tooth. The anterior face of the tooth is occupied by a prominent crest of the cingulum (c.), which dies away internally, while externally, as already mentioned, it is connected with the parastyle. On the inner face of the tooth there are two elements (ai. and pi.), the anterior of which is the larger. This becomes connected with the antero-external cusp, forming a transverse crest, and at the same time it is united by a ridge with the postero-internal cusp. In still later stages of wear this postero-internal cusp becomes united with the postero-external, so that finally the centre of the tooth is occupied by an enamel-lined pit enclosed by the continuous wear-surfaces of the outer and inner pairs of cusps and the connecting transverse ridges (Pl. V. fig. 3).

The three posterior premolars have two roots, one anterior the other posterior, each extending the whole width of the tooth: the division between the roots is much deeper on the inner than on the outer side (Pl. V. fig. 3 A).

The anterior premolar is simpler than the others, having only one root. It is closely crowded between the second premolar and the canine, which it much resembles, being a simple curved columnar tooth. The canine (Pl. V. fig. 1) and the two posterior incisors are similar and are also closely crowded together. On their inner face there is a prominent cingulum enclosing with the crown a deep fosette.

The anterior incisor, judging from its alveolus, is much larger than the others. In no specimen has this tooth been found in situ, but an isolated example almost certainly referable to this position has a curved and pointed crown with a shelf-like

projection of the cingulum on its inner side. This tooth must have projected somewhat below the others, and was separated from its fellow of the opposite side by a considerable interval (about 2·5 cm. in the figured skull).

Upper Milk-dentition.—The upper milk-dentition is imperfectly known. The most nearly complete specimen of what may be regarded as the upper milk-molars is figured on Pl. V. fig. 5 (also text-fig. 7). *Mm.* 4 is precisely similar in structure to the permanent molars, though much smaller. Its anterior column is immediately beneath the hinder border of the antorbital foramen. It is only slightly worn, so that the anterior crescent (*c.*) of the cingulum is not yet reached. *Mm.* 3 is also much like a permanent molar, but the compound character of the anterior column is much more clearly shown than in the molars: it consists of an outer portion, probably equivalent to the parastyle and the antero-external main cusp, and an inner portion, the antero-internal main cusp. The form of the posterior enamel-covered surface of

Text-fig. 7.
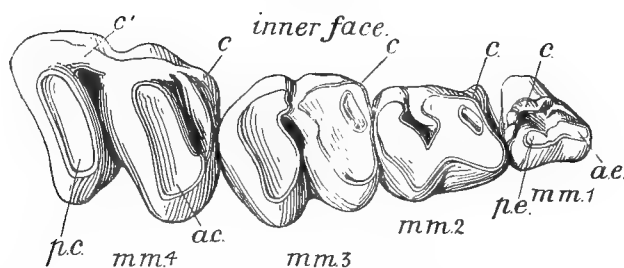
Semi-diagrammatic figure of the upper milk-molars of *Arsinoitherium zitteli.*

a.c., anterior column ; *a.e.,* antero-external cusp ; *c.,* anterior part of cingulum ; *c.',* posterior part of cingulum ; *p.c.,* posterior column ; *p.e.,* postero-external cusp. About ½ nat. size.

the column apparently shows a stage in the infolding of the ectoloph to which the origin of the peculiar bilophodonty is ascribed above. In *mm.* 2 the ectoloph is complete, and is only slightly concave, but it can be seen how a slightly deeper infolding would give rise to a tooth like *mm.* 3. The inner part of the tooth consists of two transverse crests, and in front of these a ridge of the cingulum, which with the anterior crest encloses an enamel-lined pit as in the other teeth. The antero-internal tubercle is large and tends to unite in wear with the postero-internal, so as to form an inner wall similar to that found in the permanent molars.

The first milk-molar is not shown in the figure on Pl. V., but is included in text-fig. 7. Its outer wall consists of parastyle, antero-external and postero-external elements. On the inner face there is a trace of an antero-internal element only, but the cingulum (*c.*) is very strongly developed, particularly posteriorly, where together with the ectoloph it encloses a deep enamel-lined fosette.

The milk-incisors are simple conical teeth.

Mandible.—The symphysis of the *mandible* (Pl. IV. figs. 1, 3, *s.*) is long, and its ventral surface is divided into two regions—an anterior rounded portion sloping back from the incisor alveoli, and a posterior portion which is flattened and is in the same line as the ventral surface of the lower border of the horizontal rami, making an obtuse angle with the anterior region. In the middle of this flattened portion there is a small rugose tuberosity for the attachment of muscles, and the dorsal surface forms a narrow spout-like channel. The length of the symphysis seems to have increased with age, at any rate the relative position of its posterior angle with regard to the teeth alters. Thus in a young mandible in which the last molar is being cut, the hinder angle of the symphysis is beneath the posterior lobe of *pm.* 4, while in another fully adult it is beneath *m.* 2 : there seems, however, to be considerable individual variation in this matter irrespective of age. The horizontal ramus is comparatively narrow from above downwards : it widens out a little beneath the last premolar, and gradually narrows beneath the molars. The alveolar border is slightly convex from before backwards, and its inner edge, at least in the molar region, is higher than the outer. The ventral border is slightly convex from before backwards, and strongly so from side to side. The inner faces of the rami are nearly flat, the outer convex. The two rami are separated from one another by a narrow interval, and are nearly parallel as far back as the last molars, but behind this they diverge considerably. The single mental foramen is beneath the fourth premolar.

The angular region (*a.*) is separated from the ventral border of the horizontal ramus by a slight concavity : it is rounded and its posterior edge is thickened so as to form a broad surface, looking backwards and somewhat outwards. Superiorly it is bounded by a sharp angle which projects considerably behind the condyle, from which it is separated by a concave border about 8 cm. long.

The condyle (*cd.*), which is elongated from side to side, is set somewhat obliquely, and is slightly convex from side to side, rather more so from before backwards. It is supported on either side by a rounded thickened ridge, and in some cases it is divided by a slight median notch into an outer and an inner lobe, which are subequal. The posterior border of the coronoid process (*c.p.*) rises immediately in front of the condyle, and in the specimen described its pointed upper end is about 6 cm. above the articular surface. The anterior border of the coronoid is convex and passes by a gentle curve into the horizontal ramus, its edge dividing into two ridges, which become continuous below with the outer and inner edges of the alveolar border respectively, so that in this region the mandible is quite unlike that of a Proboscidean, in which the coronoid arises on the outer face of the horizontal ramus in advance of the hinder end of the last molar. The jaw further differs widely from that of a Proboscidean in the form of the symphysial region and in the presence of a closed series of incisor, canine, and cheek-teeth : in both the Proboscidea and in *Barytherium* the incisors are modified to form procumbent tusks, and there is a long diastema.

The mandible differs from that of the Dinocerata in being more massively built, in the absence of downwardly directed flanges of bone, in the absence of a diastema, and in the much greater depth and different form of the posterior part of the jaw.

Lower Permanent Dentition.—Although in no specimen are the teeth perfectly preserved in the front of the mandible (Pl. IV. figs. 1, 3; and text-fig. 6, B), it can be determined with certainty that the dentition was complete (*i.* 3, *c.* 1, *pm.* 4, *m.* 3). The teeth all have high crowns, wear to a common level, and form a closed series, the median incisors being in close contact with one another in the middle line.

The molars, like those of the upper jaw, are extremely hypsodont, especially on their outer side, where the enamel-covered portion of the crown is much higher than on the inner side. The unworn molars are bilophodont (Pl. V. fig. 4), consisting of two high narrow transverse crests, which are connected by a much lower oblique crest running from the summit of the outer end of the posterior column to the base of the inner end of the anterior column. A similar ridge also runs from the outer end of the anterior column forwards and inwards, forming the anterior border of the tooth, and enclosing with the anterior face of the front column a shallow depression. The tooth may, in fact, be regarded as composed of two **V**-shaped columns, the posterior limbs of the **V**'s being placed transversely and being much thicker and higher than the comparatively slightly developed anterior limbs. In wear this structure becomes more obvious. The anterior face of the transverse crests (that is, the sides of the **V**'s facing inwards) is covered by very thin enamel, differing entirely from that coating the outer side of the tooth. In the last molar the talon is represented by one or two irregular, small, but prominent cusps. The cingulum is well developed on the posterior face of the molars, where it forms a distinct shelf-like projection.

The phases of wear in the molars are, seen in Pl. IV. figs. 1, 3. In *m.* 3 the two main columns are shown with the anterior arm of the front **V** just in wear and enclosing a shallow fossa in front of the tooth. In the next the anterior arm of the posterior **V** is strongly worn, and the anterior fossa just referred to has been completely lost on the right side, but is still represented on the left by a small island of enamel. In both these teeth the inner face is still covered with enamel, though the covering is much thinner than on the outer side. In *m.* 1 the inner side of the tooth has already been worn down below the level of the crown, so that the enamel is there wanting. The divisions between the two arms of the **V**'s have now quite disappeared, but the outer ends of the two main columns are still separated by a fold of some depth, which also disappears when the tooth is a little more worn. The inner edge of the teeth is considerably higher than the outer, in correlation with the opposite condition in the opposing upper molars.

The premolars differ greatly from the molars, their crowns being much narrower

(see text-fig. 6, p. 18); at the same time the difference is less than that between the upper premolars and molars. They are four in number, the three posterior ones being double-rooted. *Pm.* 1 is not known in *A. zitteli*, but in *A. andrewsi* its crown is very like the others; in both species it has a single root.

Each premolar consists of two columns separated externally by a deep vertical groove. In early stages of wear the pattern is a double **V**, but later the concavity of the **V**'s becomes obliterated, and the inner face of the teeth is nearly straight. In some unworn specimens the postero-internal end of the anterior **V** is seen to project somewhat across the opening of the posterior **V** so as partially to close it: this projection seems to correspond with the metastylid of some other ungulate teeth (e. g. *Hyrax* [*Procavia*], *Equus*). The cingulum is well developed on the inner face of the teeth, and is also present in some specimens, though not all, on the outer side between the main columns.

The closely crowded canines and incisors are, so far as known, closely similar to one another. They are high columnar teeth, convex outwards from above downwards, and nearly rectangular in section. The outer face of the crown is strongly convex from side to side; on the inner side the cingulum is well developed, and between it and the inner face of the tooth there is a deep, more or less developed pit or "fosette."

The lower milk-dentition is imperfectly known, and in such specimens as are preserved it appears that the milk-molars are practically identical in form with the molars of the permanent series.

Vertebral Column.—In correlation with the great size and weight of the skull the *atlas* (text-fig. 8) is very large and massively constructed, its width being especially great. The condylar cups (*cond.*) are large and widely separated both above and below; they are strongly concave from above downwards, and are much wider above than below, where they narrow rapidly as they pass on to the ventral bar. The lateral surfaces for the axis (*ax.*) consist of a subcircular, slightly concave upper portion, from the outer and lower side of which a less well-defined triangular area runs down to the ventral bar, nearly reaching the outer border of the odontoid face (*od.*). This is very broad, sharply defined, slightly concave from side to side, and prolonged somewhat backwards on a median prominence of the ventral bar, the posterior angle of which forms a blunt hypapophysis.

The neural arch is wide both from side to side and from before backwards; its upper surface is strongly convex from before backwards and forms a slight prominence on either side of the middle line (*ns.*). Laterally, close to its anterior border, the arch is perforated by the narrow slit-like passage which transmits the first spinal nerve (*sp.f.*). This foramen opens into a groove, the posterior border of which forms the anterior edge of the large transverse process (*t.p.*). This is very

large and massively constructed; anteriorly it is bounded by the sharp border just mentioned; posteriorly, on the other hand, it has a broad flat surface, and it is perforated near its base by the vertebrarterial canal (*f.tr.*). Its outer ends form broad, roughened, rather convex surfaces.

Text-fig. 8.
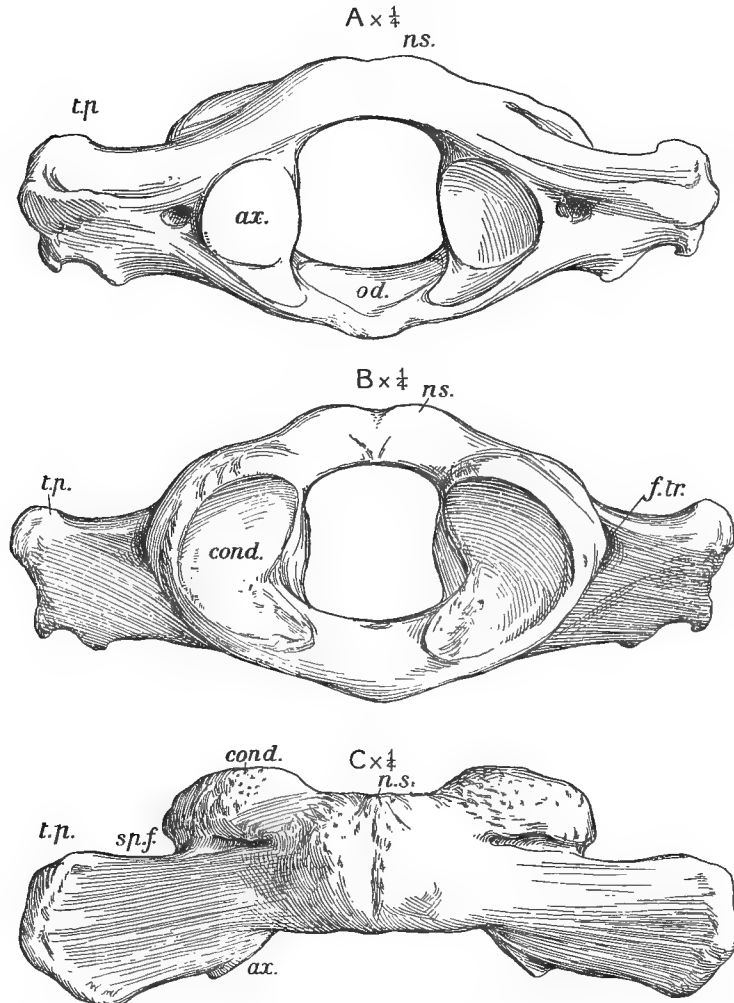
Atlas vertebra of *Arsinoitherium zitteli* : A, from back ; B, from front; C, from above.

ax., lateral surface for axis ; *cond.*, surfaces for occipital condyles ; *f.tr.*, vertebrarterial canal ; *n.s.*, neural spine ; *od.*, surface for odontoid process ; *sp.f.*, foramen for first spinal nerve ; *t.p.*, transverse process. $\frac{1}{4}$ nat. size.

This atlas differs from that of the Dinocerata in being much wider, and in having longer transverse processes and a less convex neural arch. From the atlas of *Elephas* it differs in its much longer transverse processes, less convex arch, less developed spinous tuberosities, and smaller vertebrarterial canal. In

Elephas also the upper ends of the surfaces for the axis project inwards so as to form a constriction of the opening of the vertebra, separating the neural canal from the lower part occupied by the odontoid process of the axis.

In the *axis vertebra* (text-fig. 9) the odontoid process (*od.p.*) is blunt and rounded, and its base extends from the upper to the lower surface of the centrum. Its extreme end is rounded, with a slight ridge on its upper surface. The posterior half of its lower surface is occupied by a sharply-defined surface for articulation with the ventral bar of the atlas (*v.fac.*); this surface is gently convex from side to side. On either side of the odontoid there is a deep groove separating it from the main surfaces of articulation for the atlas (*at.*). These are roughly triangular in outline, the angles being rounded; they are inclined to the long axis of the column at an angle of about 45°, and are gently convex except close to the inferior

Text-fig. 9.
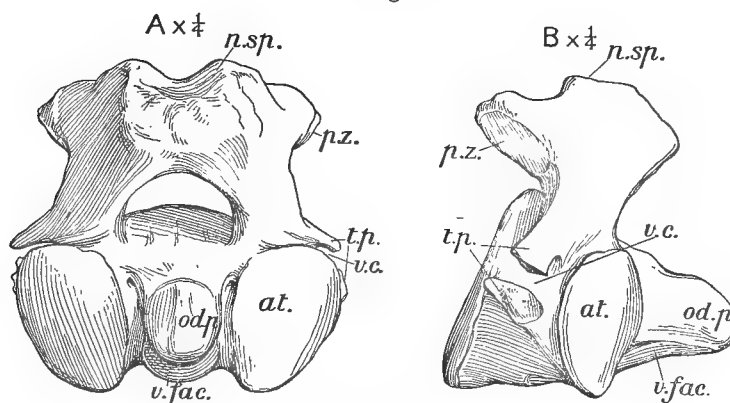
Axis vertebra of *Arsinoitherium zitteli*: A, from front; B, from right side.

at., surface for atlas vertebra; *n.sp.*, neural spine; *od.p.*, odontoid process; *p.z.*, posterior zygapophyses; *t.p.*, diapophysis and parapophysis forming transverse process; *v.c.*, vertebrarterial canal; *v.fac.*, ventral facet of odontoid process. ¼ nat. size.

angle, where there is a slight concavity. The upper edges of these atlantal surfaces are separated from the base of the neural arch by a deep groove. The pedicles of the arch are wide, and its upper portion is very massive; the neural spine (*n.sp.*) is represented by a great tuberous mass of bone, which forms a single median prominence on the front of the arch, but posteriorly is divided into two by a large median depression. The posterior zygapophyses (*p.z.*) are large; their upper surface is roughened, and their articular facets consist of a larger, nearly circular, outer portion, looking nearly directly downwards, and a smaller inner face looking inwards and downwards. The posterior face of the centrum is very large, and its upper border sometimes forms a prominent rim rising somewhat above the level of the rest of the upper surface. It is very slightly concave and is oval in outline, with its

ventral border produced downwards into a pair of blunt hypapophysial prominences. The transverse process (*t.p.*) is perforated by a vertebrarterial canal (*v.c.*); the dorsal bar is slender and is continuous above with the outer edge of the neural arch; the ventral bar is much larger, and its base is elongated so that it arises from almost the whole length of the side of the centrum.

From the large series of vertebræ preserved in the Museum at Cairo it has been possible to make up a set of cervicals with some degree of certainty; at the same time, owing to the great variability in size of the animals from which they were derived and the circumstance that so far no associated specimens have been found, the following account of the successive vertebræ must be taken as provisional, and subject to revision if at any time an associated series should become available for description.

The most notable characteristic of the cervicals as a whole is the shortness of their centrum compared to its great width and height. The neck must have been as short and massive as in the Elephants, and the movements of the head much restricted.

In the third cervical (text-fig. 10, A) the centrum is roughly quadrate in outline with broadly rounded angles. Its neural border is nearly straight, and the ventral surface bears a pair of blunt hypapophysial ridges. Both the anterior and posterior faces are slightly concave, and the body is very short in proportion to its width and height, the length (thickness) of the middle of the centrum being only 3·3 cm., while its width is 13·6 cm. and its height 11 cm. The pedicles of the neural arch are stout, but its upper portion is thin, except towards the summit, where a **W**-shaped thickening represents the neural spine (*n.sp.*). The zygapophyses are large and their articular faces nearly flat. The anterior zygapophyses (*a.z.*) bear on their outer side blunt metapophyses. The vertebrarterial canal (*v.c.*) is enclosed by a comparatively thin diapophysis (*dp.*) above and a much stouter parapophysis (*pp.*) below. This latter arises from the lower part of the side of the centrum. After enclosing the canal these processes again diverge into a small upwardly projecting process and a much larger one which is directed downwards and backwards.

The fourth cervical (text-fig. 10, C, D) is much like the last, except that (1) the arch slopes a little forwards, (2) the spine is higher, (3) the diapophysial bar of the vertebrarterial canal is wider and straighter.

The fifth cervical (text-fig. 10, B) is generally similar to the fourth, but differs in the following respects :—(1) the upper part of the arch is more slender and slopes more forwards, (2) the diapophysis is still larger and ends in a large tuberosity, (3) the vertebrarterial canal is smaller and rounder, (4) the ventral process of the transverse process (*t.p.*) is much elongated and projects considerably below and behind the centrum.

The sixth differs from the last in having shorter parapophysial processes. A

E 2

pair of hypapophysial prominences is present, and the neural spine is represented by a **W**-shaped thickening.

In the last cervical (text-fig. 10, E) the slightly biconcave centrum is still short, somewhat more so dorsally than ventrally ; it is oval in outline. The neural spine is represented by a blunt ridge. Behind the pedicle of the neural arch there is a deep groove running down from the neural canal behind the transverse process, which is here imperforate and has a blunt tuberous extremity. On the

Text-fig. 10.
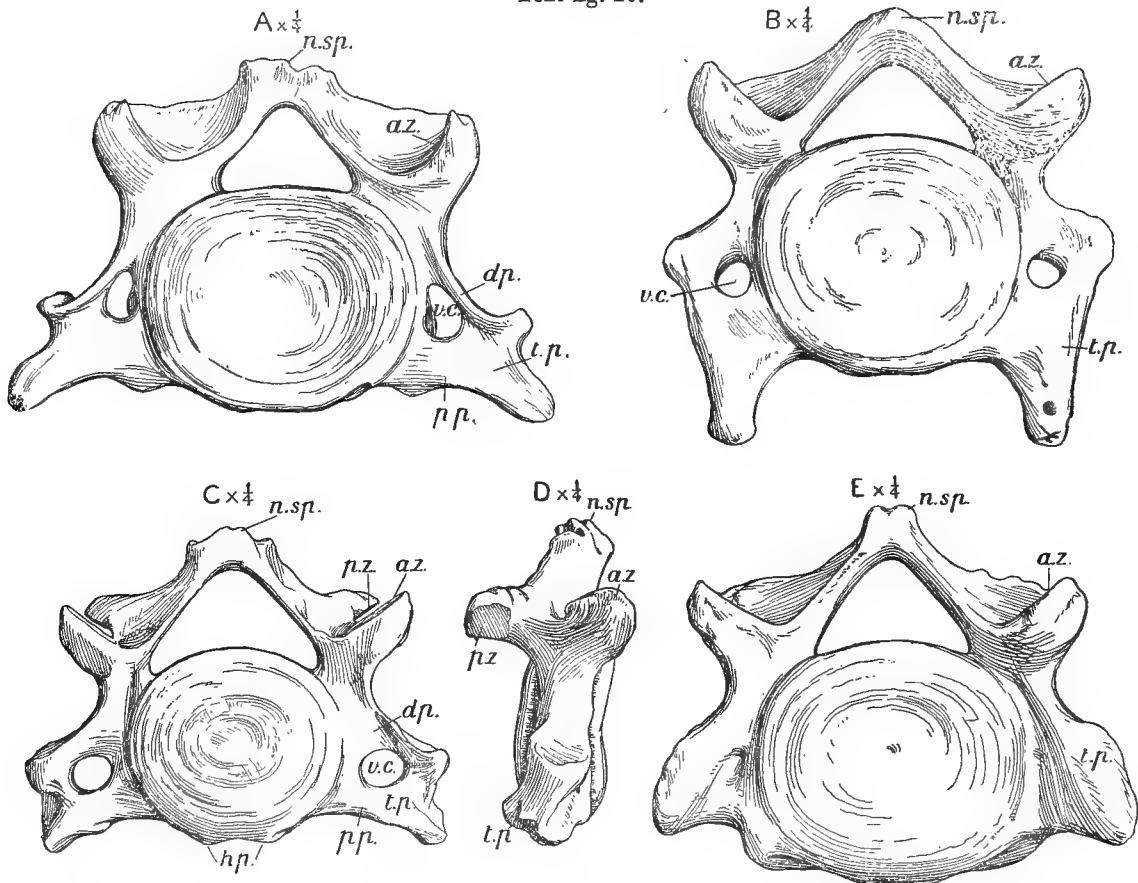
Cervical vertebræ of *Arsinoitherium zitteli* : A, third cervical, from front ; B, fifth cervical, from front ; C, fourth cervical, from front ; D, ditto, from right side ; E, seventh cervical, from front.

a.z., anterior zygapophyses ; *dp.*, diapophysial bar ; *hp.*, hypapophyses ; *n.sp.*, neural spine ; *pp.*, parapophysial bar ; *p.z.*, posterior zygapophyses ; *t.p.*, transverse processes ; *v.c.*, vertebrarterial canal.   ¼ nat. size.

hinder border of the centrum near its ventral angles is a pair of facets for the heads of the first pair of ribs. These facets are continuous posteriorly with the posterior face of the centrum and look outwards, backwards, and downwards.

The thoracic series is not completely known. In the anterior region (text-fig. 11) the centrum is wider than high ; its anterior face is flat, while the posterior face is

slightly concave. The transverse processes are large knobs with rib-facets (*t.f.*) on their antero-lateral surfaces. The anterior zygapophyses (*a.z.*) are placed very low, little above the level of the top of the centrum. The neural arch rises into a high backwardly directed neural spine (*n.sp.*), the anterior face of which is formed by two

Text-fig. 11.
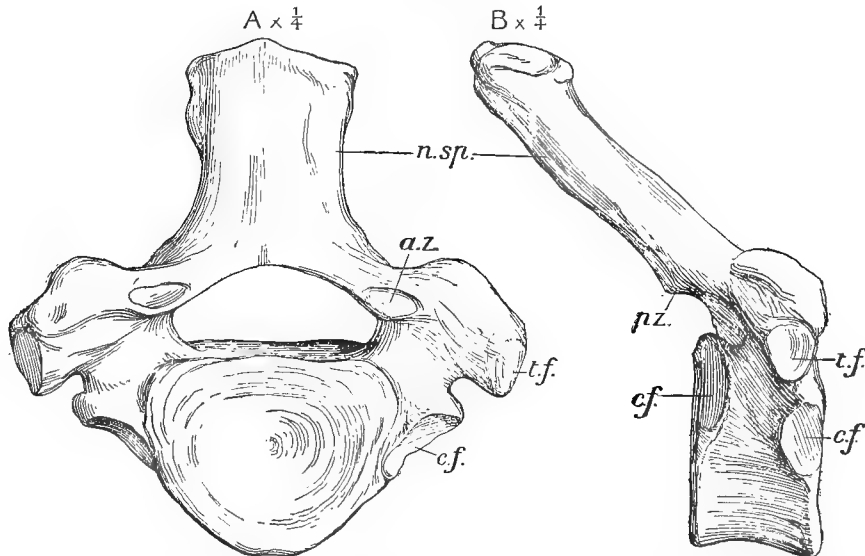
Anterior thoracic vertebra of *Arsinoitherium zitteli*: A, from front; B, from right side.
a.z., anterior zygapophysis; *c.f.*, capitular facet; *n.sp.*, neural spine; *p.z.*, posterior zygapophysis; *t.f.*, tubercular facet.   ¼ nat. size.

Text-fig. 12.
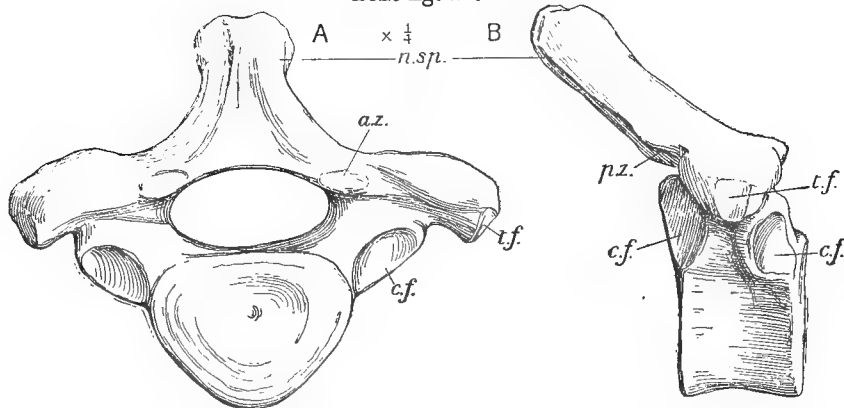
Middle thoracic vertebra of *Arsinoitherium zitteli*: A, from front; B, from right side.
Lettering as in text-fig. 11.   ¼ nat. size.

surfaces meeting at a sharp angle, while the posterior face is concave; towards the summit the spine tends to become bifid. The anterior capitular facets (*c.f.*) are placed low down on the sides of the centrum, the posterior ones higher up.

Further back in the series (text-fig. 12) the body of the centrum becomes

deeper, while the oval capitular facets (*c.f.*) are higher up and partly borne on the base of the arch, the anterior being somewhat lower than the posterior. The transverse processes are larger and more massive, and each bears a well-marked tubercular facet (*t.f.*) on its outer end. The neural spine is very high and broad; it slopes strongly backwards, and its anterior face is convex from side to side, while its posterior is deeply concave. The anterior border of the neural arch is deeply concave from side to side, so that in a dorsal view of the vertebra much of the neural surface of the centrum is exposed. At the same time the arch overhangs the posterior border of the centrum to a great extent. The anterior zygapophyses (*a.z.*) are mere shelf-like surfaces on the anterior border of the arch, and the posterior zygapophyses (*p.z.*) form facets on the lower surface of the posterior border.

In the posterior thoracic (text-fig. 13) the spine (*n.sp.*) is a low and backwardly-directed crest, and, as in the middle region, the anterior border of the arch is very
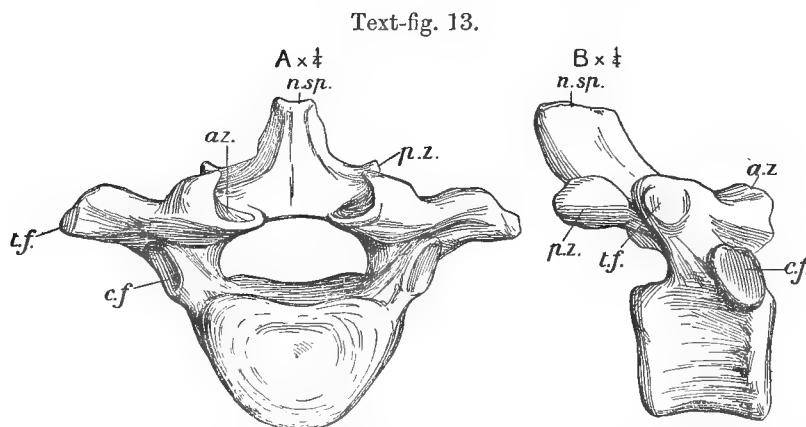
Text-fig. 13.

Posterior thoracic vertebra of *Arsinoitherium zitteli*: A, from front; B, from right side.
Lettering as in text-fig. 11. $\frac{1}{4}$ nat. size.

concave, while the posterior border overhangs to a corresponding extent. The anterior zygapophyses (*a.z.*) are now concave from side to side, and external to them there are prominent metapophyses connected by a ridge with the stout, somewhat backwardly-directed, transverse processes. The outer ends of the transverse processes bear small tubercular facets (*t.f.*). The posterior zygapophyses (*p.z.*) are prominent and convex from side to side. The capitular facets (*c.f.*) are nearly circular and are borne on short processes rising from the side of the neural arch above the level of the neural surface of the centrum.

Still further back the centrum is deeper in proportion to its width, and the transverse processes are more prominent and less massive, while the neural arch is still lower.

In the lumbar region the vertebræ become much depressed, till in the hinder

portion the centrum may be nearly twice as wide as it is high; at the same time it becomes somewhat more elongated. The neural border of the centrum is straight and the neural arch is low and wide. The zygapophysial surfaces are cylindrical and the neural spine is low and projects considerably behind the centrum, while at the same time the anterior border of the arch leaves the anterior half of the neural surface of the centrum exposed. The transverse processes are broad from before backwards, and in the anterior region they are narrow from above downwards, but as they are followed backwards they become larger and more massive.

In the whole of the large collection of vertebræ in the Museum at Cairo there is not a single example of the sacrum, nor does any such occur in the collection in the British Museum. On the other hand, there are a considerable number of vertebræ of the form shown in text-fig. 14: these greatly resemble the lumbar vertebræ, except that the lateral processes are very large and massive, and bear at their extremities broad, roughened, nearly triangular surfaces (il.s.), apparently

Text-fig. 14.
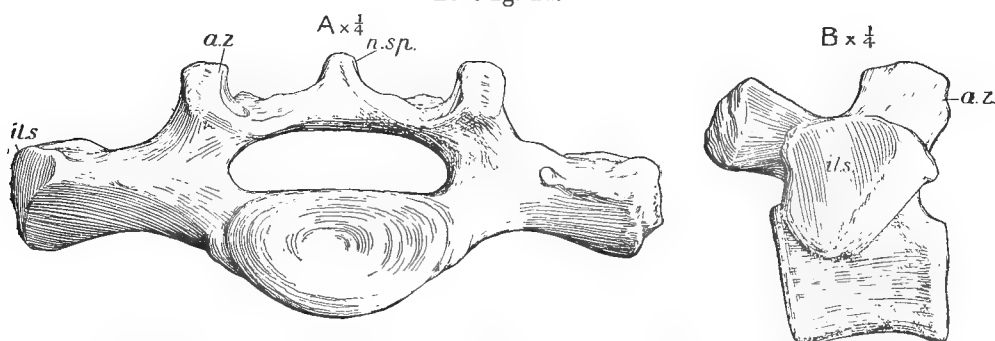
Sacral (?) vertebra of *Arsinoitherium zitteli* : A, from front; B, from right side.

a.z., anterior zygapophysis; *n.sp.*, neural spine; *il.s.*, iliac surface.

for union with the ilium. These vertebræ are believed to be the anterior sacrals. Another somewhat different type was probably the second sacral: in this the centrum is even more depressed than in the last, and its ventral surface is almost in the same plane as the ventral surface of the lateral processes, which are very long and terminate in a surface which looks somewhat backwards. The fact that, so far as at present known, the sacrals do not unite as usual to form a sacrum is especially remarkable in an animal of such size and weight. Of course, it is possible that a true sacrum may yet be found, but considering the usual solidity of that structure it is very curious that in so large a collection no specimen should occur, while a score or more examples of the atlas and axis have been obtained.

The anterior caudals have a very depressed centrum, with broad, flat, rather long, transverse processes. The neural arch is low and situated on the posterior half of the centrum. Further back the caudal centra become more cylindrical, with short

transverse processes situated near their anterior end.   In the anterior caudals the
anterior and posterior faces of the centrum are inclined backwards.

The exact number of vertebræ in the different regions of the vertebral column
is as yet unknown.

A considerable number of scattered *ribs* have been found.   The anterior ribs are
short and expand below into a large blade.   The articulation is double and the
capitular surface has distinct anterior and posterior facets.   In the mid-dorsal region
the head is large and prominent ; here also it has two facets making an obtuse angle
with one another, the anterior being the smaller.   The tubercle is comparatively
small.   The blade is flat behind and convex in front, with a slight groove along the
inner (anterior) margin.

The *sternum* is unknown.

Fore Limb.—The general form of the *scapula* is shown in text-fig. 15.   It will be
seen that the prescapular fossa is much smaller than the postscapular : it is about
the same width throughout, owing to the fact that the anterior (coracoid) border (*c.b.*)
of the bone is nearly parallel with the spine (*s.*).   The postscapular fossa is very
large : anteriorly, it is gently concave and is overhung by the spine which slopes
somewhat backwards ;   towards the suprascapular border (*ss.b.*) the surface is somewhat
convex.   The upper part of the coracoid border (*c.b.*) is slightly convex and is
separated by a deep bay or notch from the coracoid process (*c.*).   The suprascapular
border (*ss.b.*) consists of two convex portions, the smaller anterior one being over the
prescapular fossa, the larger posterior over the postscapular ;   the two are separated by
a shallow concavity above the origin of the spine.   The upper posterior angle of
the bone is prolonged considerably backwards and is rounded.   The glenoid border
(*g.b.*) is concave, becoming more deeply so towards the glenoid cavity (*g.c.*).   The
coracoid process (*c.*) is stout and blunt, and is not separated from the anterior
angle of the glenoid cavity, the articular surface running on to its posterior face.
The glenoid cavity (*g.c.*) is an elongated oval (text-fig. 15, B), the long axis of which
is antero-posterior, in which direction it is deeply concave, forming nearly a quarter
of a circle.   Transversely there is scarcely any concavity, so that the articulation
with the humerus is almost cylindrical (see description of the head of the humerus
given below).

The spine (*s.*) arises close to the superior border, and increases gradually in height
towards the glenoid cavity, about three centimetres above which its base terminates.
The superior border of the spine is prolonged downwards into a blunt acromion
process (*a.*) which slightly overhangs the glenoid cavity.   The end of this process,
and indeed the whole of the free edge of the spine, is thickened and roughened.
As a whole, the spine is inclined somewhat backwards.   The suprascapular border
is completed by an epiphysial cap, much roughened and rounded externally.

The inner face of the scapula (subscapular fossa) is concave in front of, and behind,

the line marking the base of the spine, a little in advance of which there is a roughened ridge. In some specimens there are two or three rough parallel ridges on the inner face of the bone, apparently corresponding with the ribs, or with the intervals between the ribs, against which the bone rests.

The scapula of *Elephas* differs from that just described in the following points :— (1) the extreme narrowness of the prescapular fossa ; (2) the presence of a

Text-fig. 15.
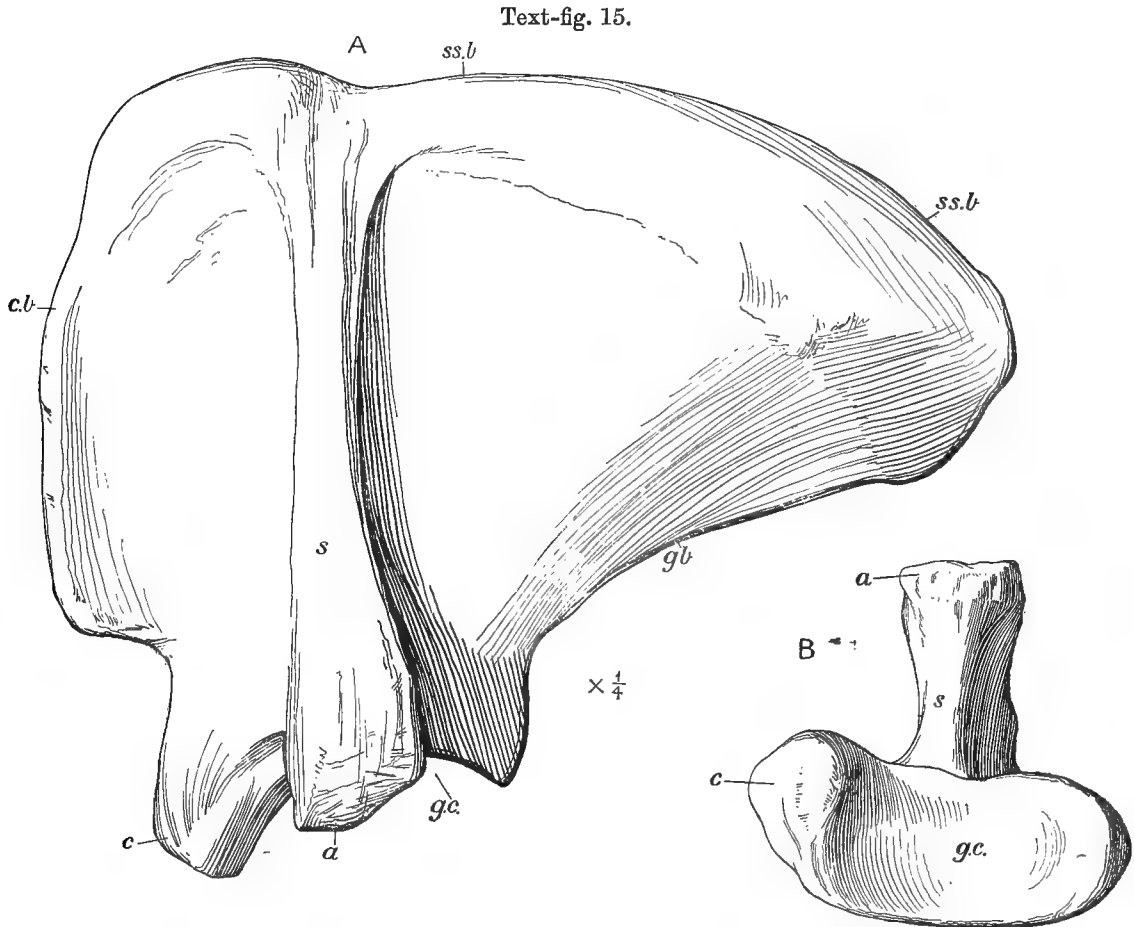
Left scapula of *Arsinoitherium zitteli* : A, outer face ; B, articulation.

a., acromion ; *c.*, coracoid process ; *c.b.*, coracoid border ; *g.b.*, glenoid border ; *g.c.*, glenoid cavity ; *s.*, spine ; *ss.b.*, suprascapular border.   ¼ nat. size.

backwardly projecting process on the middle of the spine ; (3) the sharp angulation of the suprascapular border above the origin of the spine, the portion of the border above the prescapular fossa being inclined to the portion above the postscapular at an angle of about 100 degrees ; (4) the totally different form of the coracoid border and coracoid process.

In the scapula of *Uintatherium* the postero-superior angle is not produced

backwards as in the present specimen; moreover, as in the Elephant, the supra-scapular border is sharply bent above the origin of the spine, the portion in front making an angle of 65 degrees with that behind. The coracoid process is also quite dissimilar, while the spine inclines forwards rather than backwards and the prescapular fossa is smaller.

The *humerus* (text-fig. 16) differs very considerably both from that of *Elephas* and also from that of the Dinocerata. Its most striking general characteristic is the great antero-posterior compression of its shaft and distal end. The head (*h.*) is large and much more convex antero-posteriorly than from within outwards, so that it almost forms part of a cylinder. The head is most prominent posteriorly. The inner (lesser) tuberosity (*l.t.*) is small and its inner face flattened. The outer (greater) tuberosity (*g.t.*) is large and forms a very prominent crest projecting considerably in front, but is not continued down the face of the shaft as a well-marked ridge, such as occurs in *Uintatherium*, nor is it so massive as in *Elephas*. The bicipital groove (*b.g.*) is broad and not very distinct. Beneath it the shaft is strongly compressed from before backwards, and about the middle of its length it bears on its outer border a prominence (*d.*) formed by the great development of the deltoid crest for a short distance. From this prominence a short ridge runs obliquely across to about the middle of the shaft. The coronoid fossa (*c.f.*) is very shallow; it is bordered internally by a broad rounded ridge running up towards the lower end of the oblique deltoid ridge above mentioned. The outer border is the inner edge of the prominent supinator ridge (*s.r.*), which, though much less developed than in *Elephas*, is much more so than in *Uintatherium*. The outer condyle (*o.c.*) is large, but does not project far posteriorly; the inner condyle (*i.c.*) also is very large, and is produced backwards into a prominent projecting flange. The olecranon fossa (*o.f.*) is broad and shallow, and the surface of the whole shaft above it is strongly concave from side to side, owing to the backward projection of the condyles.

The trochlear surface for articulation with the bones of the forearm is divided by a shallow depression into an outer and less convex portion (*tr.o.*) articulating with the radius and ulna, and an inner more convex portion (*tr.i.*) articulating almost entirely with the ulna, the inner surface of the radius being very small (see radius).

The bones of the forearm are separate (text-fig. 19, p. 40): in their proportions they are short and stout, and the ulna is very much larger than the radius, as in the Proboscidea. In their general form these bones approach very nearly to those of *Elephas*, and differ widely from those of the Dinocerata. Fortunately, in one instance at least, an ulna and part of a radius were found associated with undoubted *Arsinoitherium* remains, with no intermingling of *Palæomastodon* bones, in such a way as to leave no doubt as to the correctness of their reference to the present genus. Moreover, the size and massiveness of some specimens, as well as the large number found, point in the same direction.

Text-fig. 16.
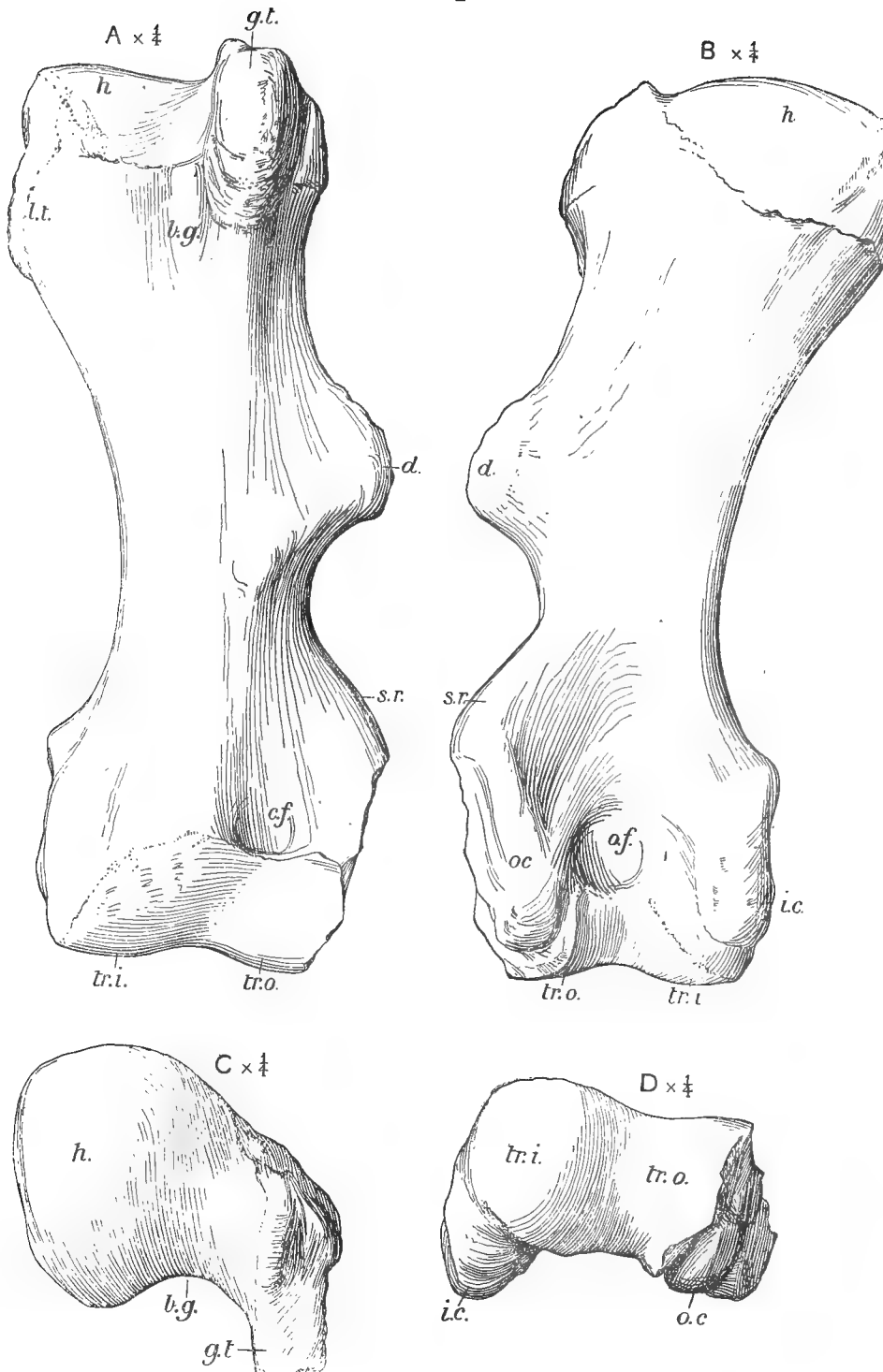
Left humerus of *Arsinoitherium zitteli* : A, from front ; B, from back ; C, proximal end ; D, distal end.

b.g., bicipital groove ; *c.f.*, coronoid fossa ; *d.*, deltoid process ; *g.t.*, greater tuberosity ; *h.*, head ; *i.c.*, inner condyle ; *l.t.*, lesser tuberosity ; *o.c.*, outer condyle ; *o.f.*, olecranon fossa ; *s.r.*, supinator ridge ; *tr.i.*, inner trochlea ; *tr.o.*, outer trochlea.   ¼ nat. size.

In its general form the *radius* (text-figs. 17, 18, 19) is much like that of *Elephas*, but is shorter and stouter. The proximal articulation is an elongated oval in outline, its transverse diameter being to the antero-posterior diameter as 3 to 1. The surface is slightly concave from before backwards, and for the outer two-thirds (*o.*), which help to form the articulation for the outer half of the humeral trochlea, it is concave from side to side also. The inner third (*i.*), which forms a small part of the surface for the inner half of the trochlea of the humerus, is nearly flat, and this portion is bent downwards so as to look upwards and inwards. The articulation

Text-fig. 17.
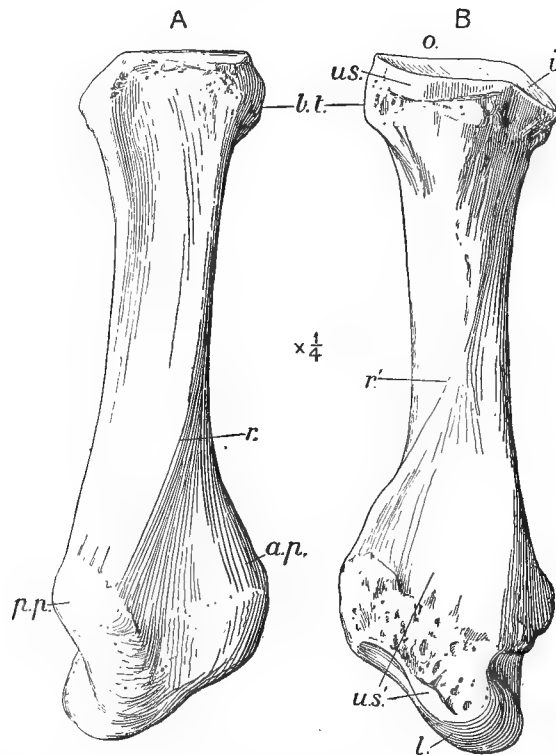
Left radius of *Arsinoitherium zitteli* : A, from front ; B, from back.

a.p., anterior prominence; *b.t.*, bicipital tuberosity; *i.*, inner portion of proximal articulation; *l.*, articulation for lunar; *o.*, outer portion of proximal articulation; *p.p.*, posterior prominence; *r.*, anterior ridge; *r.'*, posterior ridge; *u.s.*, proximal surface for ulna; *u.s.'*, distal surface for ulna.   ¼ nat. size.

of the radius with the humerus does not extend across the whole width of the ulnar surface as in *Uintatherium*, but the relations of the two bones in this respect are almost exactly as in *Elephas*.

On the outer side of the posterior face of the bone, immediately beneath the outer portion of the humeral surface, there is an elongated facet (*u.s.*) for articulation with the ulna, and beneath this the surface of the bone is greatly roughened for some centimetres down, showing that its union with the ulna was very close and

rigid. Immediately beneath the antero-external angle of the upper end there is a prominent bicipital tuberosity (*b.t.*). Beneath this the shaft contracts rapidly, and its slenderest point is about one-third of its total length from the proximal articulation. Here the anterior face is slightly concave from side to side, while the posterior is convex with a median ridge (*r.'*). Distally a great expansion of the bone occurs. The sharp antero-external border of the shaft is continued down the outer face (*r.*) (that is, outer as regards the ulna) of the expansion, and terminates in a large roughened prominence (*p.p.*) which is situated at the junction of the shaft and epiphysis and is separated from the posterior portion of the articulation by a well-marked depression. The inner edge of the shaft is continued down as the posterior border of the distal expansion and becomes widened out into a roughened surface. Lastly, the ridge (*r.'*) above mentioned as occurring in the middle of the posterior surface, runs forwards and is prolonged into a great flange-like expansion (*a.p.*), the anterior edge of which forms the front border of this part of the bone, and is continued down to the distal articulation. The ulnar side of the expanded portion of the bone is concave and was closely applied to the inner face of the distal end of the ulna, for union with which there is also a narrow facet along the lower edge of the bone (see figure, the lower of the two lines from *u.s.'*).

The distal articulation, though much smaller than that of the ulna, is of considerable antero-posterior extent; posteriorly it consists of a large rounded head (*l.*) which passes anteriorly into a concave surface looking downwards and somewhat outwards. The inner (preaxial) portion of the head is marked off from the rest by a very faint ridge, and is the comparatively small surface for articulation with the scaphoid. The remainder articulates with the inner portion of the lunar (*l.*). The general form of this distal articulation is very similar to that of the radius of *Elephas*, which differs only in the following points:—(1) the posterior portion of the articulation is more cylindrical and less ball-like in form, owing to the lesser degree of convexity in a transverse direction; (2) the anterior part of the articulation is smaller, less concave, and less clearly marked off from the posterior part. The line of division between the scaphoid and lunar surfaces is the same in both cases. In *Elephas* the radial articulation with the carpus is much larger compared with the ulnar portion than in *Arsinoitherium*.

The distal end of the radius of *Uintatherium* is of very different form: it consists of two concave surfaces, one for the scaphoid and the other for the pre-axial part of the lunar, separated by a sharp ridge. The distal end of the radius of *Barytherium* is almost identical with that of *Uintatherium*.

In the *ulna* (text-figs. 18, 19) the olecranon process (*ol.*) is very large and greatly thickened posteriorly, so that its upper end forms a roughened mass of bone which projects somewhat to the outer, but still more to the inner side, which is also the higher. The articulation for the humerus is triradiate; the upper (olecranon)

lobe is nearly vertical and does not extend so high up as the upper end of the olecranon process. Of the two horizontal surfaces the inner (*i.*) is much the larger and is oval in outline, its antero-posterior diameter being slightly greater than the transverse; it is concave in all directions. The outer (*o.*) is the smaller and is semicircular in outline, the diameter of the semicircle looking forwards and inwards and marking the line of union with the radius, with which the bone unites in a narrow vertical surface (*r.s.*). Immediately beneath the transverse articulation is

Text-fig. 18.
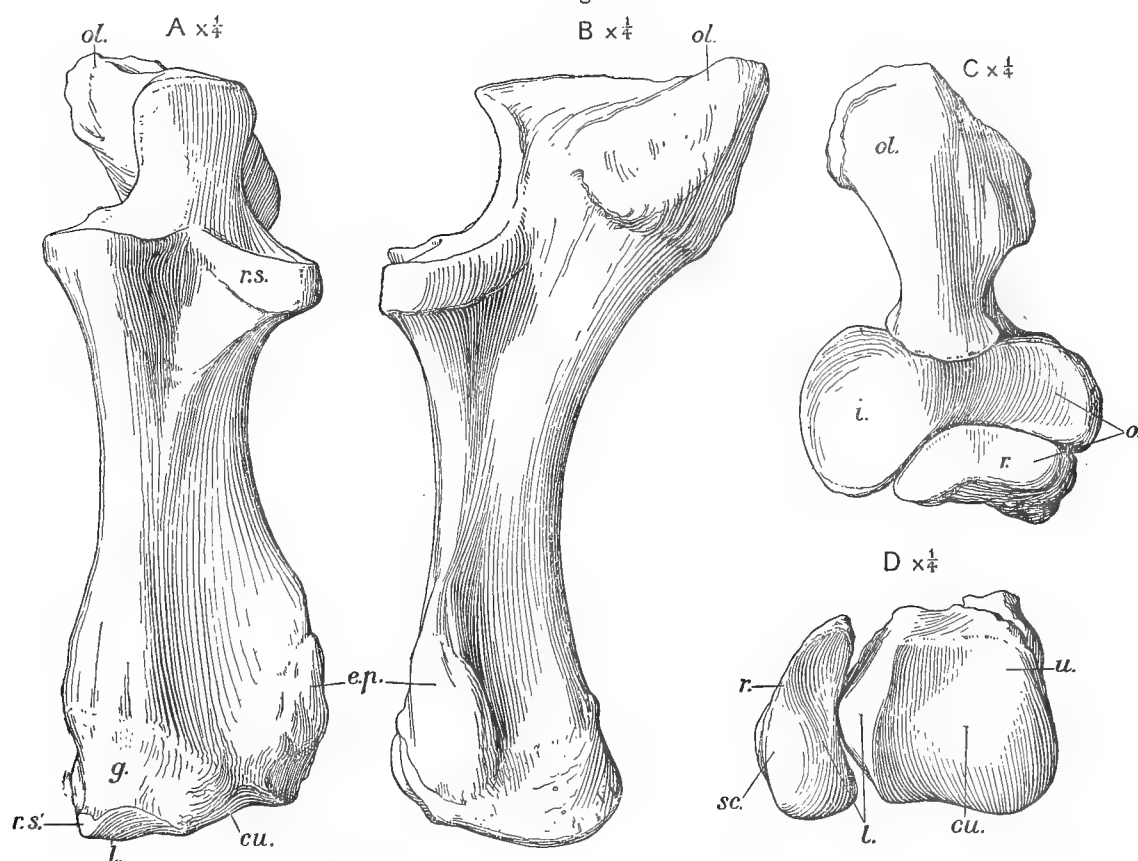
Left ulna of *Arsinoitherium zitteli*: A, from front; B, from outer side; C, proximal end (with radius); D, distal end (with radius).

cu., surface for cuneiform; *e.p.*, external prominence; *g.*, groove above distal articular end; *i.*, inner surface for humerus; *l.*, surface for lunar; *o.*, outer surface for humerus; *ol.*, olecranon process; *r.*, radius; *r.s.*, proximal surface for radius; *r.s.'*, distal surface for radius; *sc.*, surface for scaphoid; *u.*, ulna. ¼ nat. size.

a deep fossa which receives the head of the radius. The shaft of the bone is triangular in section, the posterior angle being continuous with the hinder border of the olecranon process. The shaft is also curved somewhat backwards and inwards. Towards the distal end, which is considerably enlarged, the inner border

of the bone widens out to a broad surface, so that the lower end of the bone immediately above the articulation is quadrate in section. The articular surface is marked off from the shaft by a roughened groove (*g.*); the surface itself is concave both from before backwards and from side to side in front, but posteriorly it is strongly convex from before backwards, and forms a sort of trochlear surface which extends slightly on to the posterior face of the bone. Nearly the whole of this articular surface (text-fig. 18, D) is for the cuneiform (*cu.*), with perhaps a slight posterior contact with the pisiform; but adjoining it and on its inner side there is another comparatively small surface (*l.*) looking inwards and downwards, which articulates with a facet of the lunar. This distal articulation is much like that of the elephant ulna, but, as in the case of the radius, it is more extended antero-posteriorly, apparently indicating that the foot was more mobile in that direction than in the modern Proboscidea. The radius is closely applied to the inner face of the lower end of the ulna, which also bears a small facet (*r.s.'*) for that bone along its lower edge.

This ulna differs from that of *Elephas* in being much shorter and stouter, in having its distal articulation wider from before backwards, and in forming a larger proportion of the carpal joint compared with the radius.

It differs from the ulna of *Uintatherium* in being stouter, in not articulating with the radius across the whole width of the humeral joint, in having an olecranon process which projects farther back but rises less above the articulation, in widening towards the distal end, and in forming a very much larger share of the carpal articulation.

The structure of the *carpus* (text-figs. 19–24) is very difficult to determine with certainty, owing to the want of associated series of bones and the great variability in size of the individuals to which isolated specimens belonged. Moreover, the similarity of the feet to those of the Proboscidea introduces another element of doubt into the determination of scattered carpal and tarsal bones; at the same time the extreme rarity of any bones that can be definitely referred to *Palæomastodon* (for instance, only a single specimen of the calcaneum has yet been found) makes it highly probable that by far the larger number of the carpals and tarsals found belong to *Arsinoitherium*, and in any case the larger and more massive specimens may be referred to that animal with a considerable degree of confidence. Further assistance is derived from the fact that in a few cases carpals have been found under such circumstances as to leave no doubt that they are those of *Arsinoitherium*. The best of these associated series (M. 8470) is one which includes the distal epiphysis of the ulna, a scaphoid, an unciform and a fourth metacarpal of the left side, and the distal half of the radius and the os magnum from the right. These all show signs of having belonged to a young animal, and were, in fact, found associated with portions of a young skull with milk-teeth *in situ*, no remains of *Palæomastodon* occurring in the neighbourhood.

In consequence of these difficulties the following account of the carpal structure must be regarded as more or less provisional, but nevertheless, except in matters of detail, it is probably fairly accurate.

Speaking generally the carpus (text-fig. 19) is very similar to that of *Elephas*,

Text-fig. 19.
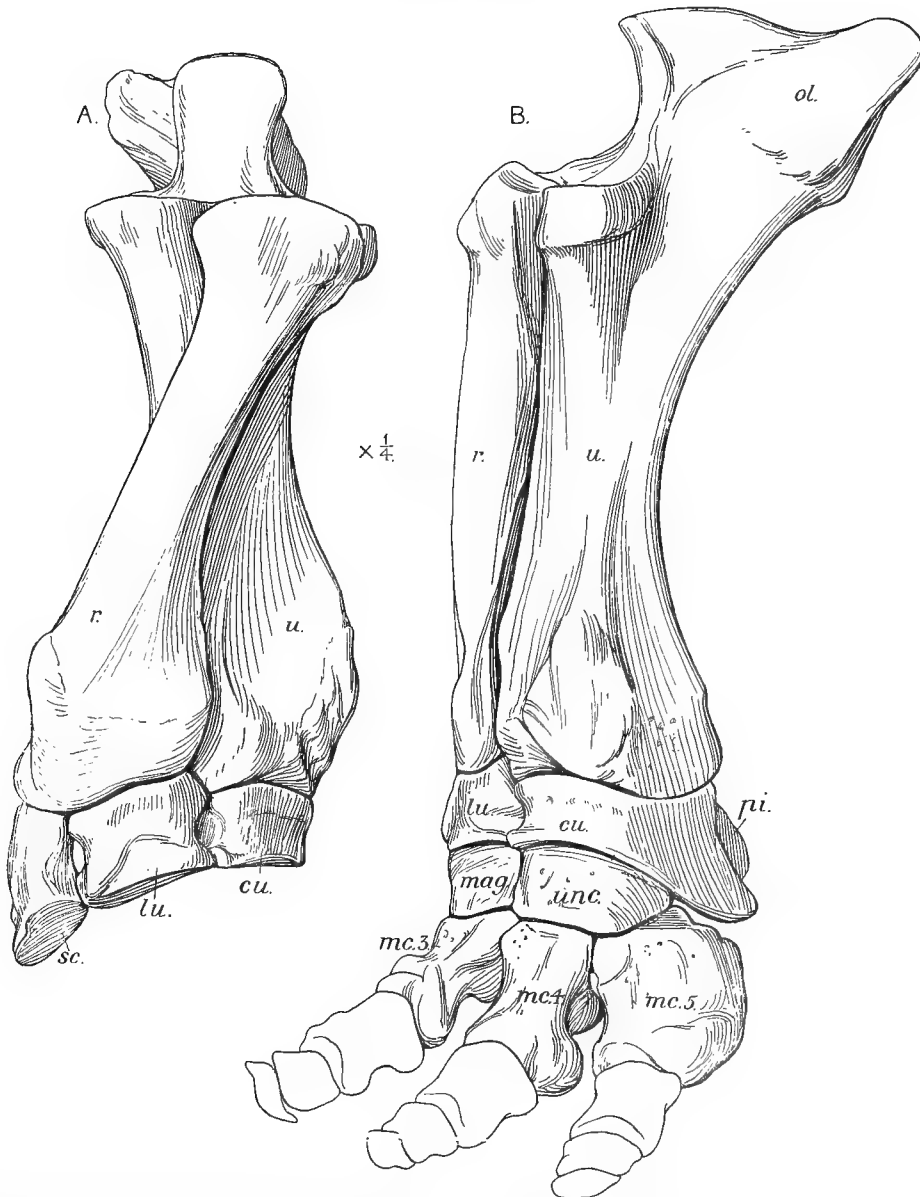
Left forearm and manus of *Arsinoitherium zitteli*: A, forearm and proximal row of carpals from front; B, forearm, carpals, and metacarpals from outer side.

cu., cuneiform ; *lu.*, lunar ; *mag.*, magnum ; *mc. 3, mc. 4, mc. 5*, third, fourth, and fifth metacarpals ; *ol.*, olecranon process ; *pi.*, pisiform ; *r.*, radius ; *sc.*, scaphoid ; *u.*, ulna ; *unc.*, unciform.

which it resembles far more closely than it does that of the Dinocerata. The chief differences from the carpus of *Elephas* seem to be dependent on the circumstance, that in *Arsinoitherium* the distal articulation of the ulna is still larger in proportion to that of the radius. Weithofer (Morph. Jahrb. vol. xiv. p. 507) has shown that the peculiar condition of the carpus of the Elephant, in which the lunar extends preaxially so as to overlap the trapezoid, is due to the preponderance of the share taken by the ulna in the formation of the wrist-joint. In *Arsinoitherium* this is carried still farther, so that the cuneiform extends inwards over the magnum. Whether or not as in *Elephas* the lunar overlapped the trapezoid is uncertain, but probably it did so at least anteriorly. In other Ungulates in which the radial portion of the articulation becomes the larger, the direction in which the proximal row of carpals becomes displaced upon the distal is the opposite one.

Text-fig. 20.
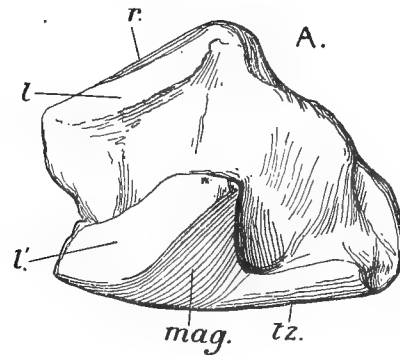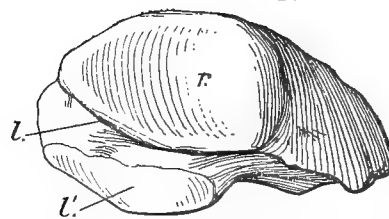
Left scaphoid of *Arsinoitherium zitteli*: A, lunar face ; B, proximal end.
l., *l.'*, upper and lower facets for lunar ; *mag.*, facet for magnum ; *r.*, surface for radius ;
tz., facet for (?) trapezoid. ½ nat. size.

The *scaphoid* (text-fig. 20) is greatly compressed from side to side and widens out considerably in a fore-and-aft direction from above downwards. The proximal end is occupied by a concave surface (*r.*) for articulation with the postero-internal convex portion of the end of the radius. This surface is roughly oval in outline, rather broader posteriorly than anteriorly, and with a somewhat flattened outer (postaxial) border, immediately beneath which there is a narrow surface (*l.*) for articulation with

the upper edge of the lunar. The distal end is occupied by a greatly elongated articular surface (*tz.*), slightly convex in all directions, which probably articulated with both the trapezium and trapezoid. Anteriorly the outer (postaxial) border of this surface is connected with two other facets, of which the anterior one (*l.'*) is a flat elongated surface looking outwards and downwards for union with the lower facet of the lunar, while the other (*mag.*) lying immediately behind the last is triangular in outline, and looks downwards and backwards, and apparently united with the postero-internal angle of the upper surface of the magnum, as is the case in *Elephas*. Both the outer and inner faces of the bone, where not occupied by articular facets, are greatly roughened and pitted.

The form of scaphoid here described and figured is definitely known to be that

Text-fig. 21.
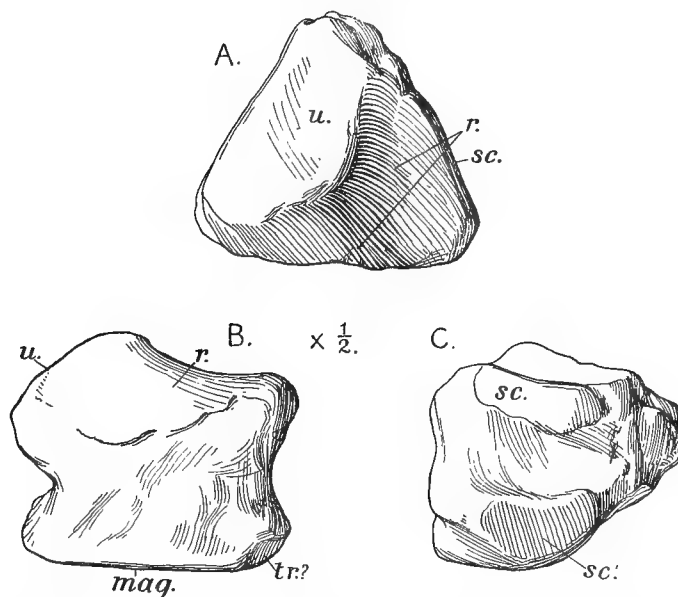
Right lunar of *Arsinoitherium zitteli*: A, from above; B, from front; C, scaphoid face.
mag., facet for magnum; *r.*, surface for radius; *sc.*, *sc.'*, upper and lower surfaces for scaphoid;
tr.?, facet for trapezoid; *u.*, surface for ulna. ½ nat. size.

of *Arsinoitherium*, but at the same time it is very like that of *Elephas*, and its relations to the neighbouring bones, so far as determinable, are similar. This scaphoid differs from that of *Elephas* in the following respects :—(1) its proximal articular surface is concave, owing to the stronger convexity of the portion of the radial head with which it articulates; (2) the lower surface for the lunar is shorter from before backwards and at the same time deeper; (3) the distal articulation is much longer from before backwards, extending considerably behind the triangular surface for the magnum; the whole distal end of the bone is, in fact, much more expanded than in *Elephas*.

The *lunar* (text-fig. 21) here described is presumed to belong to *Arsinoitherium*,

because its surfaces agree exactly with those of the radius and ulna of that animal and also with those of the scaphoid just described. The proximal surface of the bone is divided into two articular facets by an antero-posterior ridge. The smaller (postaxial) surface (*u.*) is for the ulna: it is very slightly convex in front and gently concave behind: its outline is roughly semicircular, the diameter of the circle being represented by the straight postaxial border, beneath which there is a very narrow facet for union with the upper edge of the cuneiform. The rest of the proximal surface (*r.*) articulates with that part of the radial head that is not received by the scaphoid; it is roughly triangular and is concave posteriorly and internally, but convex in front. The inner (preaxial) face of the bone bears two surfaces (*sc., sc.'*) for union with the scaphoid: one of these (*sc.*) along the upper border is long and narrow, while the other (*sc.'*) on the lower side is shorter and broader, and the two are separated by a deep groove. There is also a similar groove on the outer face, separating the upper and lower facets for the cuneiform. The distal surface (*mag.*), which is triangular in form, is gently convex from before backwards and articulates almost entirely with the magnum, but there is some evidence that near its antero-external angle it slightly overlapped the trapezoid (*tr.* ?).

This bone differs from the lunar of *Elephas* to a considerable extent, mainly on account of the larger portion of its upper surface that articulates with the ulna. In *Elephas* the ulnar facet is quite small and is confined to the anterior half of the bone, looking much more outwards than upwards, so that very little of the weight transmitted to the foot through the ulna is borne by the lunar.

The *cuneiform* (text-fig. 22) is, on the whole, much like that of *Elephas,* but its articulation with the ulna (*ul.*) is larger, extending farther outwards, and this surface is gently convex internally, but concave externally, with a raised outer angle. The surface for the pisiform (*pi.*) is nearer the inner (preaxial) side of the posterior face of the bone than in *Elephas*. It is nearly quadrate in outline, and its upper edge joins the posterior border of the ulnar surface: in *Elephas* this surface is triangular. Postero-externally the lower edge of the bone is produced downwards and backwards into a strong hook-like process. The distal articular surface is very gently convex from before backwards and concave from side to side; externally it extends outwards for a considerable distance on the ventral face of the process just described. A narrow strip of this surface occupying its inner (preaxial) side is marked off from the rest by a very slight groove: this seems to have overlapped and articulated with the magnum, as mentioned above in the general remarks on the carpus. The remainder of the surface articulated with the unciform. On the inner (lunar) side of the bone there are two facets for union with the lunar (*l.*)—a broader one along the upper edge and a narrower one along the lower, which projects considerably beyond the upper, from which it is separated by a groove.

The *pisiform* (text-fig. 22, *pi.*) is tongue-shaped. Its free end is rounded and

it bears on its upper surface a prominent knob. The proximal end, which is a little wider than the distal, is entirely occupied by an oblong facet for articulation with the cuneiform; connected with the upper edge of this surface there is another very narrow facet extending across the whole width of the bone and marking its point of contact with the ulna. Connected with the ventral border of the cuneiform facet there is a rather irregular rounded surface, somewhat roughened and apparently resulting from the occasional contact with the upper face of the posterior process of the cuneiform.

Text-fig. 22.
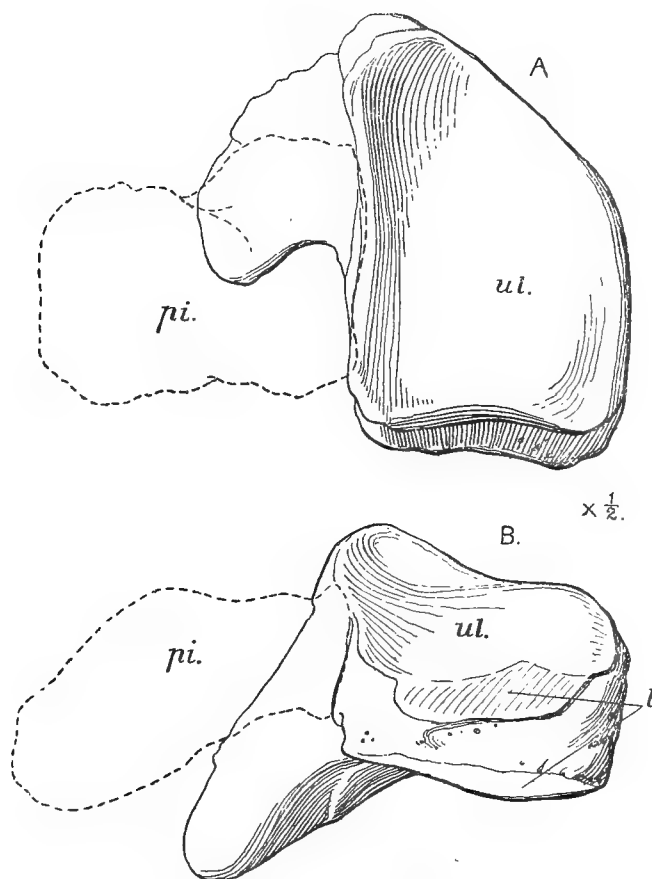
Left cuneiform and pisiform of *Arsinoitherium zitteli*: A, from above; B, lunar face.
l., facets for lunar; *pi.*, pisiform; *ul.*, surface for ulna. ½ nat. size.

The *trapezium* and *trapezoid* are not certainly known.

The *magnum* (text-fig. 23) is quadrate in section anteriorly, but posteriorly it narrows considerably at least on its ventral side. The upper surface is gently concave in front, but posteriorly is raised into a considerable convexity, the postero-internal slope of which supplied a surface for union with the scaphoid (*sc.*). Most

of the rest of this surface articulated with the lunar (*lu.*), though, as above mentioned, a narrow strip on the outer side was probably overlapped by the cuneiform; in no specimen of the magnum, however, have actual traces of this overlap been observed. The surfaces for the trapezoid on the one hand, and for the unciform (*unc.*) on the other, are similar: each consists of a facet which extends the whole depth of the bone in front, but is confined to the upper half posteriorly, the ventral portion of the posterior part of the bone being pinched up into a rounded and backwardly

Text-fig. 23.
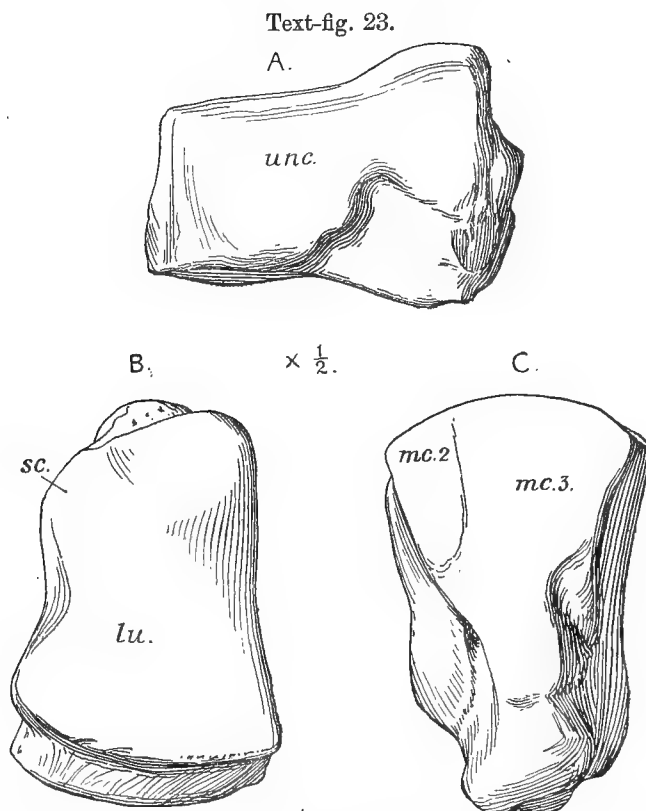
Left magnum of *Arsinoitherium zitteli*: A, unciform face; B, from above; C, from below.

lu., facet for lunar; *mc.* 2, *mc.* 3, facets for the second and third metacarpals; *sc.*, facet for scaphoid; *unc.*, facet for unciform.   ½ nat. size.

projecting knob.   The distal surface (*mc.* 2 and *mc.* 3) is nearly triangular, the posterior angle extending on to the narrowed posterior region just referred to.   In some specimens a small area at the antero-internal angle (*mc.* 2) of this surface is marked off from the rest, and indicates that the articulation of the second metacarpal, in some cases at least, extended slightly on to the magnum.

The *unciform* (text-fig. 24) is a wedge-shaped bone, the base of the wedge being the inner surface articulating with the magnum (*mag.*), the facet for which is nearly flat and extends the whole depth of the bone in front, but is confined to the upper

half at the back.   The proximal surface for the cuneiform (*cu.*) is concave antero-
posteriorly and convex from side to side.   Distally the bone bears two large surfaces
for the fourth and fifth metacarpals, and a much smaller inner surface for the outer
facet of the slightly displaced third metacarpal.   The surface for the fourth
metacarpal is somewhat concave and looks directly downwards; that for the fifth is
convex and looks downwards and outwards, almost joining that for the cuneiform
externally, making with it the acute angle which is the thin edge of the wedge.
The bone is deeper posteriorly than anteriorly.

   The *metacarpals* (text-fig. 19, p. 40) were short and stout and much enlarged at their
articulations.   The first is unknown, but, judging from the size of the distal articulation
of the scaphoid, probably little reduction had taken place on this side of the foot.

Text-fig. 24.
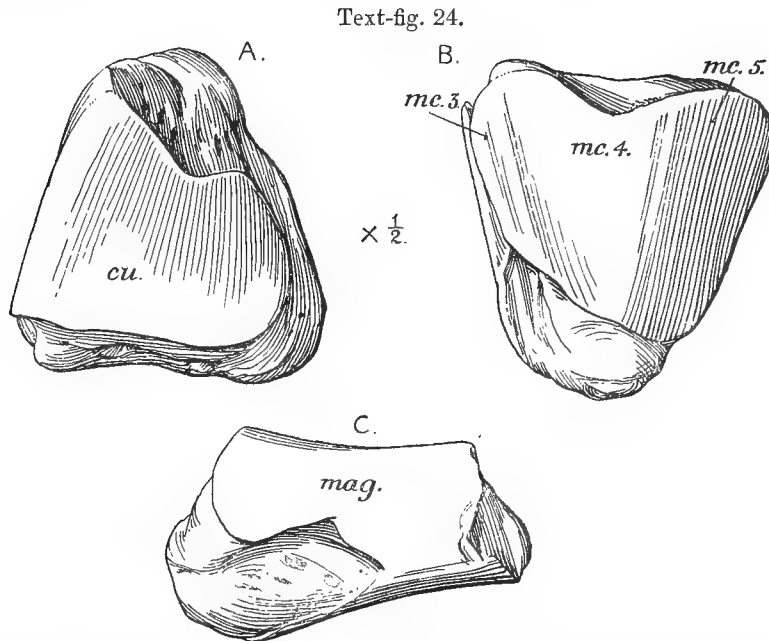
Left unciform of *Arsinoitherium zitteli*: A, from above; B, from below; C, inner (preaxial) face.
cu., facet for cuneiform; *mag.*, facet for magnum; *mc.* 3, *mc.* 4, *mc.* 5, facets for the third,
fourth, and fifth metacarpals.   ½ nat. size.

The second is likewise unknown, but it had on its postaxial side a small surface for
articulation with the magnum, as is shown by the presence of the corresponding facet
on that bone.   The third articulated mainly with the *magnum*, but had a slight
overlap on the *unciform* at least anteriorly.   The fourth and fifth articulated with
the unciform, and in some cases (*e. g.*, C. 7968) the fifth seems also to have had a
surface of contact with the *cuneiform* (text-fig. 25, *cu.*).   The posterior face of the
upper end of the metacarpals seems in all cases to be produced backwards into a
strong roughened prominence.

Hind Limb.—The best example of the *pelvis* is a complete specimen in the Cairo Museum (C. 8413), and it is upon this that the following description and figures (text-figs. 26, 27) are founded.

The ilia (*il.*) are immensely expanded bones, of which the gluteal surface is slightly convex except towards the superior angle, which is somewhat everted so that the outer surface there becomes concave. The pelvic (inner) surface is slightly concave, except towards the upper border, where the everted portion just referred to bears a deeply hollowed surface for union with the sacral vertebræ. The superior angle formed by the meeting of the superior border (*crista ilii, c.i.*) with the posterior is almost a right angle. In front the *crista ilii* sweeps round into the anterior border, which is greatly thickened, broadly convex, and terminates below in the prominent external angle (*e.a.*), which, like the superior angle, is capped by a large rough epiphysis, that on the lower angle (*e.a.*) being the larger. The acetabular border (*a.b.*) is concave, and just before reaching the acetabulum (*a.*)

Text-fig. 25.
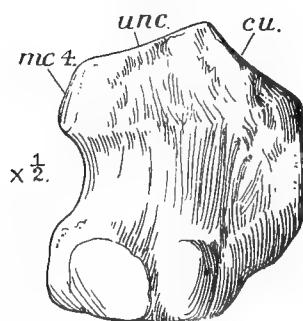
Fifth left metacarpal of *Arsinoitherium zitteli.*

cu., surface of contact with cuneiform ; *mc.* 4, facet for fourth metacarpal ; *unc.*, facet for unciform.
½ nat. size.

it is interrupted by a roughened notch, probably for the attachment of the *rectus femoris* muscle.

The inner border running down from the superior angle is concave except in its upper portion opposite the sacral facet, where it is straight; a little abve the level of the glenoid cavity it divides into an anterior ridge continuous below with the anterior edge of the pubis, and a posterior ischial ridge, which runs back to the ischial tuberosities. The surface between these two ridges is deeply concave. The acetabulum (*a.*) is oval, its long axis corresponding with the long axis of the *os innominatum.* The pit for the *ligamentum teres* is very deep and extends upwards beyond the middle of the cavity; posteriorly the pit opens on the ischial surface by a deep notch in the border of the glenoid cavity.

The anterior border of the united pubes (*pu.*) is slightly concave, while the posterior

Text-fig. 26.
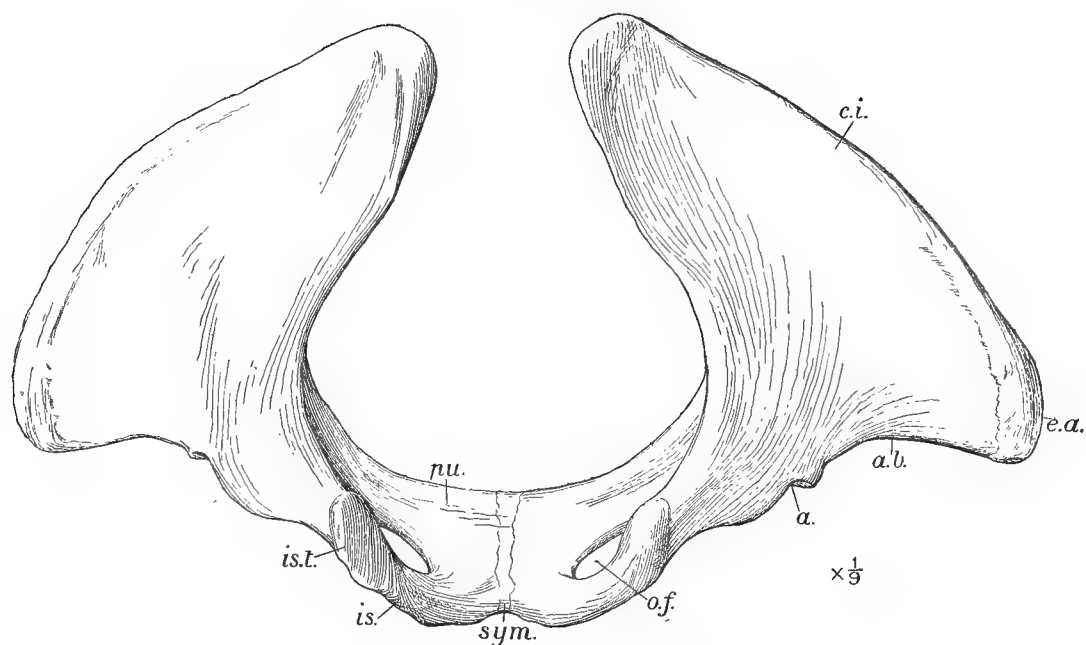
Pelvis of *Arsinoitherium* (?) *zitteli*, from back.

a., acetabulum ; *a.b.*, acetabular border ; *c.i.*, crista ilii ; *e.a.*, external angle of ilium ; *is.*, ischium ; *is.t.*, ischial
tuberosity ; *o.f.*, obturator foramen ; *pu.*, pubis ; *sym.*, symphysis. $\frac{1}{9}$ nat. size.

Text-fig. 27.
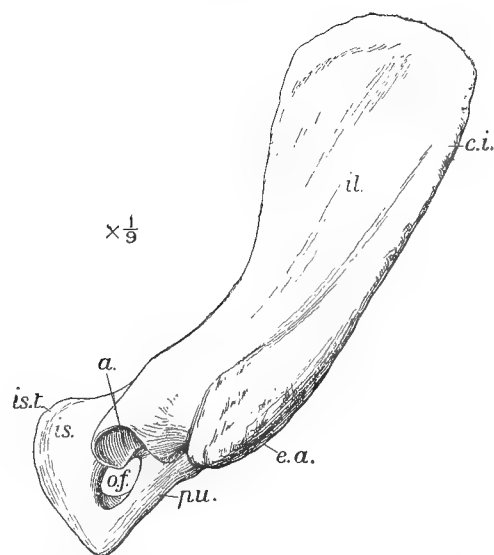
Pelvis of *Arsinoitherium* (?) *zitteli*, from right side.

il., ilium ; other lettering as in last figure. $\frac{1}{9}$ nat. size.

border of this bone runs up and becomes continuous with the inferior edge of the cotylar notch, the other edge of which is continuous with the antero-inferior border of the ischium, so that the notch actually opens into the upper end of the obturator foramen. The angle of the ischial tuberosity (*is.t.*) is nearly right; the border of the bone behind the angle and the angle itself are covered by a roughened epiphysial cap. The hinder border of the united ischia is slightly concave, and the bones themselves are flattened near the angle and rounded near the symphysis. The pubis (*pu.*) is a broader thin bar of bone; it is slightly concave above and convex below; it widens out towards the symphysis (*sym.*). The obturator foramen (*o.f.*) is an elongated oval, the outer end of which, as already noticed, is continuous with the cotylar notch.

The pelvis of *Uintatherium* differs from that just described in the following points :—(1) the *crista ilii* is much more convex in outline; (2) the surfaces for the sacral vertebræ are much more prominent and strongly marked; (3) the symphysis is less massive and the obturator foramen is wider; (4) the ischia and pubes are rather stouter and the ischial tuberosities are more developed; (5) there is a deep fossa on the visceral surface nearly opposite the acetabulum, whereas in *Arsinoitherium* this is only slightly marked.

In *Elephas* the form of the ilia is more like that described and figured, but the pubes and ischia, particularly the latter, are much wider, so that the symphysis is much longer and consists of distinct pubic and ischial portions united by a narrow bar. One result of this is, that the ischial portion of the pelvis projects much farther behind the acetabulum than in *Arsinoitherium*. In *Elephas* also the sacral surfaces are better marked and the ischial tuberosities more prominent.

The *femur* (text-fig. 28) is remarkable for the great antero-posterior compression of the shaft and for the flatness of its posterior face, the outer border of which forms a thin sharp edge.

The head (*h.*) is very large and nearly hemispherical; it looks upwards and somewhat outwards, and its posterior border is crossed by a deep groove for the *ligamentum teres* (*n.l.t.*). The great trochanter (*g.t.*) is compressed antero-posteriorly, and does not rise so high as the head; its posterior face is slightly concave, while anteriorly it forms a considerable rugose prominence. The lesser trochanter (*l.t.*) is inconspicuous and close beneath the head. The shaft, as already mentioned, is extremely compressed from before backwards, and its posterior surface is nearly flat. The anterior face is convex towards the inner side, but externally it is nearly flat and meets the posterior surface so as to form a thin sharp outer border, which, near its middle point, is slightly convex, the convexity being apparently the representative of the third trochanter : the inner border of the shaft is rounded. The condyles (*i.c.*, *o.c.*), which are relatively small, are subequal and are separated by a narrow but deep fossa (*i.n.*). Above the condyles

Text-fig. 28.
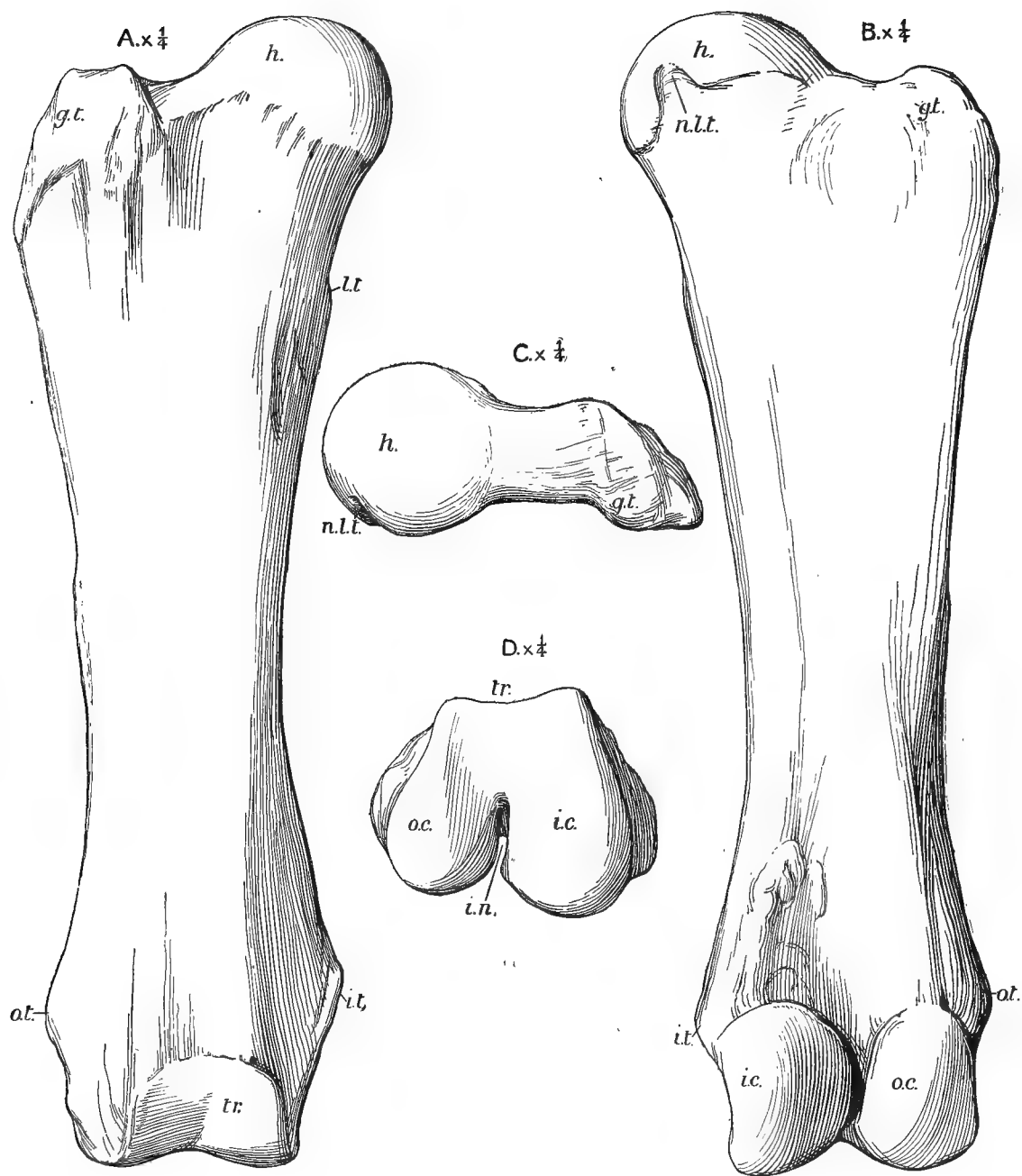
Right femur of *Arsinoitherium zitteli*: A, from front; B, from back; C, upper end; D, lower end.

g.t., greater trochanter; *h.*, head; *i.c.*, inner condyle; *i.n.*, intercondylar notch; *i.t.*, inner tuberosity; *l.t.*, lesser trochanter; *n.l.t.*, notch for *ligamentum teres*; *o.c.* outer condyle; *o.t.*, outer tuberosity; *tr.*, trochlear surface. $\frac{1}{4}$ nat. size.

there is on either side of the bone a prominent tuberosity (*i.t.*, *o.t.*). The posterior surface of the shaft immediately above the condyles is slightly concave from side to side, the concavity being bordered by ridges running upwards and inwards from the tuberosities. The lower end of the bone is much narrower than the upper end.

The femur of *Uintatherium* differs in the following points:—(1) it is not so much compressed from before backwards, and at the same time it is considerably narrowed from side to side near its middle; (2) there is a small but prominent lesser trochanter; (3) the hinder surface of the great trochanter is hollowed by a digital fossa; (4) the distal articular end is relatively larger.

The femur of *Elephas* differs from that just described in the following points:— (1) the neck is much longer; (2) the great trochanter does not rise nearly so high and its posterior face is excavated by a deep digital fossa; (3) the shaft is not compressed to anything like the same degree, and its posterior face is not so much flattened; (4) the distal articulation is relatively larger.

Text-fig. 29.
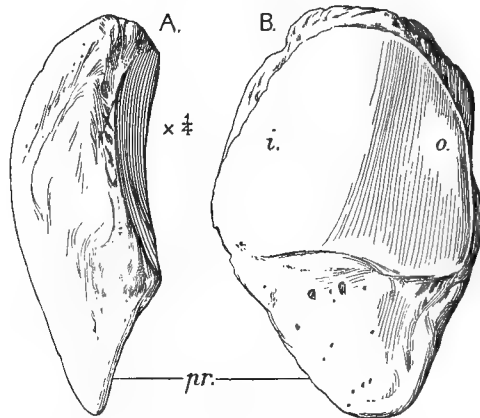
Right patella of *Arsinoitherium zitteli*: A, from inner side; B, from articular face.

i., inner surface for femur; *o.*, outer surface for femur; *pr.*, distal process. ¼ nat. size.

The *patella* (text-fig. 29) is much like that of *Uintatherium*. The surface for the outer condyle (*o.*) of the femur is smaller than that for the inner (*i.*); both are gently concave from above downwards, and very nearly flat from side to side. Below the articular surface the bone is produced downwards into a blunt triangular process (*pr.*). The anterior face as usual consists of a greatly swollen and roughened mass of bone.

The *tibia* (text-fig. 30) is a short stout bone considerably expanded towards the articulations. The facets for the condyles of the femur are deeply concave. The inner (*i.*) is much the larger and is oval in outline, the long axis being antero-posterior. The outer (*o.*) is smaller and more nearly circular, and its long axis is from within outwards: in front of it and to the outer side of the anterior

portion of the inner facet the surface of the bone slopes strongly downwards towards the not very prominent but massive cnemial crest (*cn.*).   Immediately beneath the postero-external angle of the proximal end of the bone is a broad facet (*f.*) for union with the upper end of the fibula.   Beneath the cnemial crest the shaft is trihedral; its posterior face is nearly flat, the antero-external first concave, then towards the middle of the bone flat, the antero-internal rounded. The distal end of the bone is expanded laterally, so that it is nearly twice as wide in that direction as from before backwards.   The greater portion of the distal

Text-fig. 30.
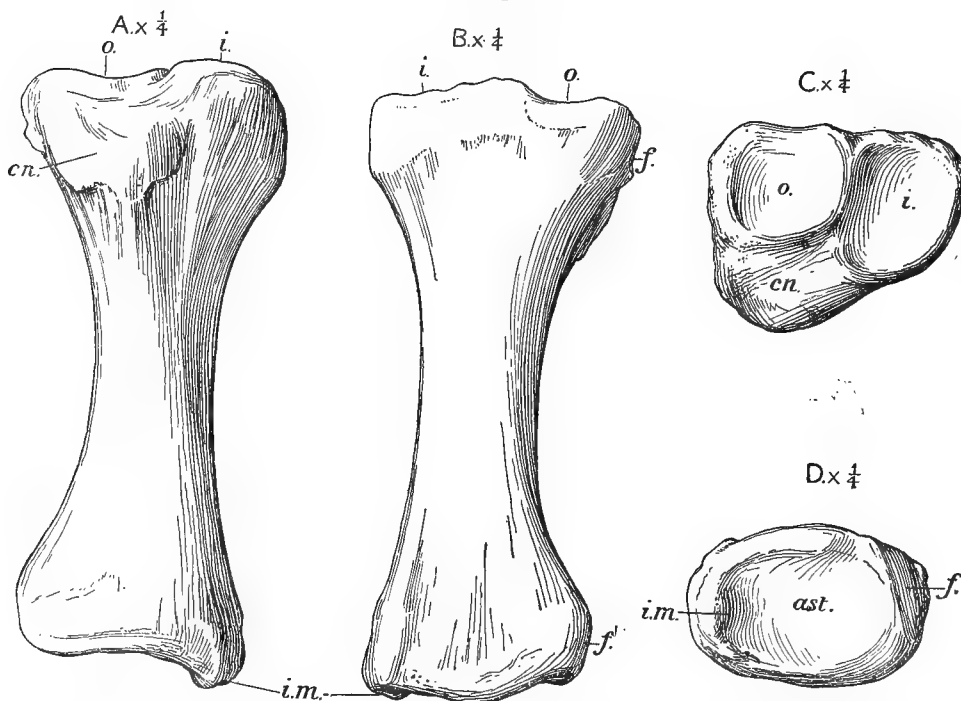
Right tibia of *Arsinoitherium zitteli*: A, from front; B, from back; C, proximal end; D, distal end.

ast., surface for astragalus; *cn.*, cnemial crest; *f.*, surface for proximal end of fibula; *f.'*, surface for distal end of fibula; *i.*, inner surface for femur; *i.m.*, internal malleolus; *o.*, outer surface for femur. ¼ nat. size.

end is occupied by the slightly concave surface for the astragalus (*ast.*).   This is produced somewhat downwards into a point posteriorly and much more strongly internally, where it runs down on to the face of the blunt internal malleolus (*i.m.*). External to the astragalar surface, and separated from it by a slight ridge, is a roughly semicircular facet (*f.'*) looking downwards and outwards, for union with the expanded lower end of the fibula.

The tibia is extremely like that of the Dinocerata (except that the femoral facets are more unequal in size), and differs from that of *Elephas* in being shorter and

stouter, having a larger cnemial crest and a more regularly concave astragalar surface.

The *fibula* (text-fig. 31) possesses a slender strongly-curved shaft with expanded articular ends. The upper end bears on its tibial face (*t.'*) a flattened or even slightly concave facet for union with the tibia; the outer face is swollen and roughened, and is partly divided into two by a longitudinal groove. The shaft is slender and is

Text-fig. 31.
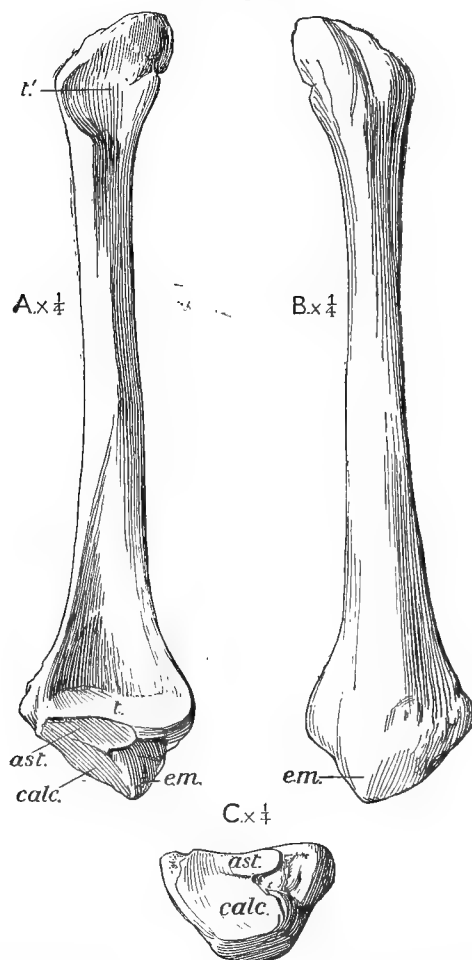
Left fibula of *Arsinoitherium zitteli* : A, inner (tibial) face ; B, outer face ; C, distal end.

ast., surface for astragalus ; *calc.*, surface for calcaneum ; *e.m.*, external malleolus ; *t.*, distal tibial surface ; *t.'*, proximal tibial surface. ¼ nat. size.

compressed from before backwards, bearing on its inner face a longitudinal ridge; it is strongly curved, the convexity being on the tibial side. The distal third of the shaft is greatly expanded and deeply concave, being closely applied to the outer side of the distal portion of the tibia. Distally this deep concavity is closed by

a shelf-like projection bearing on its upper surface a facet (*t.*) for articulation with the fibular facet of the tibia above described. Beneath this facet the distal portion of the fibula forming the external malleolus projects considerably, and its outer face is swollen and roughened, while its inner, nearly triangular surface bears two facets almost in the same plane. Of these facets the upper (*ast.*) is the smaller and articulates with the astragalus, so that when the tibia and fibula are in their natural position with regard to one another the astragalar facets of the two bones form a continuous concave surface. The lower and larger facet (*calc.*) articulates with the large fibular facet of the calcaneum, which lies immediately external to the ectal facet for the astragalus. The astragalar and calcaneal facets of the fibula are only separated by a slight ridge.

The fibula, particularly its distal portion, is extremely like that of *Elephas*. In both there is the same concavity of the inner face of the distal end, the prominent facet for articulation with the tibia, and an almost identical arrangement of the surfaces for the astragalus and calcaneum. The fibula of *Uintatherium* is different in all these particulars, more especially in the very small size or even complete absence of the calcaneal facet; it should, however, be remarked that in the earlier Amblypoda, e. g. *Coryphodon*, the calcaneal articulation of the fibula is well developed, and this is no doubt a primitive feature.

Examples of the *astragalus* (text-fig. 32, 2 A, 2 B, 2 C) are among the most numerous of the bones found in these deposits, and it is remarkable that of the very large number collected nearly all are of the form now described and referred to *Arsinoitherium* on the following grounds :—(1) their large size and massive structure; (2) the agreement of their articular surfaces with those of the tibia above described and with the most common form of calcaneum; (3) the presence of articular surfaces for both cuboid and navicular excluding the possibility of this type of astragalus belonging to *Palæomastodon*, of which, moreover, the calcaneum and probably the astragalus are known.

From these considerations it will be seen that the astragalus now described may be regarded with confidence as that of *Arsinoitherium*. The proximal articulation for the tibia (text-fig. 32, *tib.*) is gently convex from before backwards, and very slightly concave from side to side. Posteriorly there is a notch (*n.*), but there is no perforation as in some of the Dinocerata. The articulation does not extend farther back on the inner than on the outer side. On the outer side is the fibular surface (*fib.*) looking outwards and somewhat upwards, and passing above into the tibial surface.

On the inner side the main tibial surface is continuous with an inner face looking inwards and upwards, and supplying a surface for the articulation of the internal malleolar process of the tibia. Beneath and behind this surface the postero-internal angle of the bone forms a prominent tuberosity. The surfaces for the calcaneum

are the ectal (*ec.*), which is the smaller and is convex from before backwards, and the sustentacular (*sus.*), which is much larger, flat anteriorly and concave behind.

Text-fig. 32.
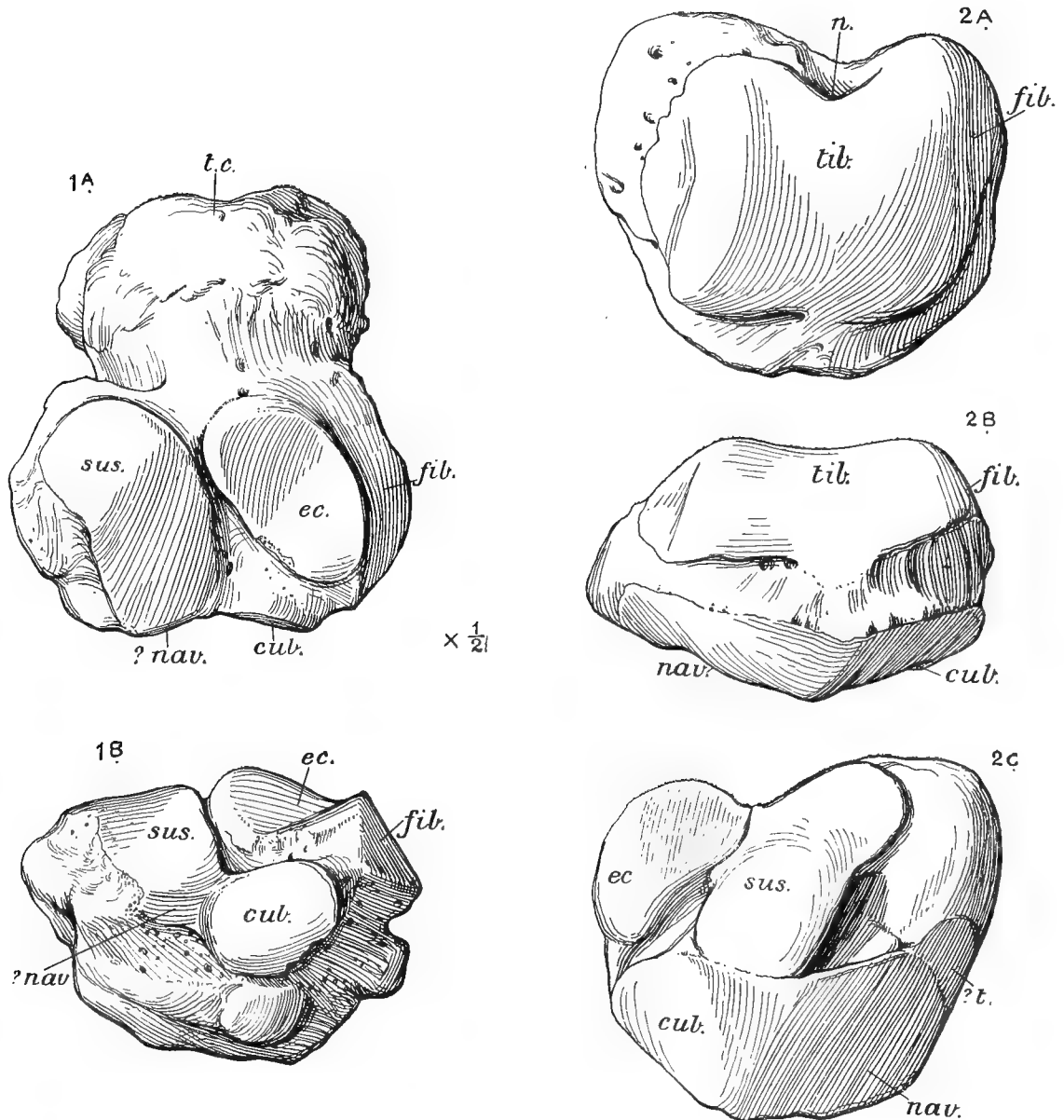
Left calcaneum and astragalus of *Arsinoitherium zitteli* : 1 A, calcaneum from above ; 1 B, distal surface of calcaneum ; 2 A, tibial surface of astragalus ; 2 B, anterior view of astragalus ; 2 C, distal surface of astragalus.

cub., facet for cuboid ; *ec.*, ectal facet ; *fib.*, fibular facet ; *n.*, notch in hinder border of tibial surface ; *nav.*, navicular facet ; *sus.*, sustentacular facet ; *? t.*, facet for tibiale ; *t.c.*, tuber calcis ; *tib.*, surface for tibia. ½ nat. size.

These two facets are separated from one another posteriorly by a narrow groove, and anteriorly by a deep fossa. There is also a deep fossa lying to the inner side of the anterior part of the sustentacular facet. Anteriorly this surface joins that for the cuboid (*cub.*), making an angle of about 100° with it.

The cuboid surface (*cub.*) is about one-third of the whole distal articulation. It is gently convex in all directions, and is separated from the navicular surface by a slight oblique ridge. The navicular surface (*nav.*) occupies nearly all the rest of the distal face of the bone; it is strongly convex from side to side, and slightly so from before backwards. Internally it is continuous with a small facet (? *t.*), which may indicate the existence of a distinct *tibiale* such as occurs in some Amblypoda. On the anterior face of the bone the lower edge of the tibial surface is separated from the upper edge of the cuboid-navicular surface by an interval of about 2 to 3 cm., in which the surface is concave from above downwards.

This astragalus, though superficially similar to that of *Elephas*, differs from it fundamentally. Among the points of difference are :—(1) articulation with cuboid and consequent different form of the distal surface; (2) much larger surface for fibula; (3) presence of a large and somewhat concave surface for the internal malleolus (in the early Proboscidea this seems to have been present, see below); (4) wide difference in the form and proportions of the two calcaneal facets; in *Elephas* the ectal facet, in *Arsinoitherium* the sustentacular, is much the larger.

The likeness to the astragalus of the Amblypoda is somewhat greater, particularly in the presence of both cuboid and navicular facets. But the form of the calcaneal facets is different, and the posterior notch is slightly marked, while in the Amblypoda it may even be converted into a foramen.

The *calcaneum* (text-fig. 32, 1 A, 1 B) is a very short stout bone somewhat like that of the Dinocerata. The *tuber calcis* (*t.c.*) is very short and thick, and terminates posteriorly in a great rugose mass of bone. The ventral surface is greatly swollen at the sides, but in the middle line there is a deep concavity. There are two oval, obliquely-arranged facets for articulation with the astragalus. Of these the ectal (*ec.*) is concave from before backwards, while the inner (sustentacular) facet (*sus.*), which is much the larger, is flat in front and convex behind, owing to the deflection of its hinder portion. The two surfaces are separated posteriorly by a deep narrow cleft which, towards the front, becomes wider and deeper. The anterior edge of the sustentacular surface forms the upper border of a small facet lying at right angles to it (? *nav.*), and probably indicating that there was a small articulation with the navicular. The cuboid facet (*cub.*) is small and oval, its upper inner angle being continuous with the small navicular facet just described. Beneath the navicular and cuboid articulations is a valley bounded below by a rugose and swollen border. The fibular facet (*fib.*) is large; it looks outwards and upwards, and is convex from before backwards, while its upper border meets the ectal facet in a sharp

angle. When the astragalus and calcaneum are articulated their fibular facets form an almost continuous convex surface.

The calcaneum differs from that of *Elephas* in (1) its much shorter and stouter form, (2) the much smaller size of the cuboid surface, (3) in having the sustentacular facet for the astragalus larger than the ectal. Probably the foot approached the plantigrade condition more nearly than is the case in *Elephas*.

The calcaneum in the Dinocerata is somewhat more similar, but has the astragalar facets more nearly equal in size and convex, and the sustentacular portion of the bone is more prominent.

The *navicular* (text-fig. 33) is of great width and at the same time is very short. Its proximal surface (*ast.*) for the astragalus is gently concave. The distal surface is divided into three facets : of these the inner (*c.*1) is slightly convex and extends nearly to the hinder border of the bone ; the middle (*c.*2) is depressed, slightly

Text-fig. 33.
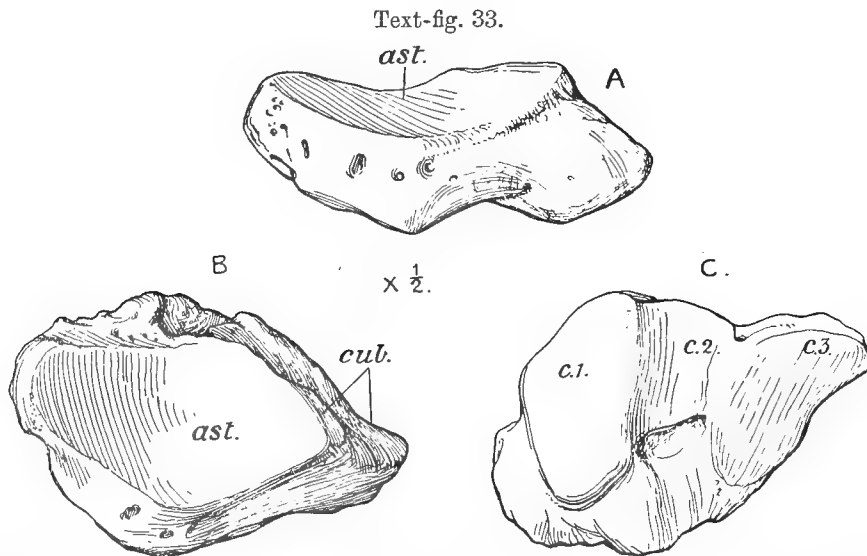
Left navicular of *Arsinoitherium zitteli*: A, from front ; B, from above ; C, from below.
ast., facet for astragalus ; *c.*1, *c.*2, *c.*3, surfaces for the cuneiforms ;
cub., facets for cuboid. ½ nat. size.

concave from side to side, and is limited posteriorly by a deep pit ; the outer (*c.*3) projects considerably below the others, so that this region of the bone is much deeper than the rest, with the surface roughly triangular in outline. These three facets must have articulated with the three cuneiforms, none of which are known : the ectocuneiform must have been a very small element. The outer (cuboid) face of the bone bears along its upper edge a well-marked facet for the cuboid (*cub.*), and there seems to have been a less distinct facet for the same bone on the lower border.

I

This bone differs widely from the navicular of *Elephas* in articulating with the cuboid by its outer face only, and not being interposed between that bone and the astragalus. From the navicular of the Amblypoda it differs mainly in the depth and prominence of the ectocuneiform region, which is such that the outer face of the navicular articulates with the cuboid by both its upper and lower edge. In *Uintatherium* and *Coryphodon* the navicular articulates with the upper edge of the cuboid only and the lower portion of the inner side of that bone joins the ectocuneiform. It may be suggested that it is just possible that in the bone here described and figured the ectocuneiform may be fused with the navicular, but there is no actual trace of such a fusion having taken place in any specimen examined.

Text-fig. 34.
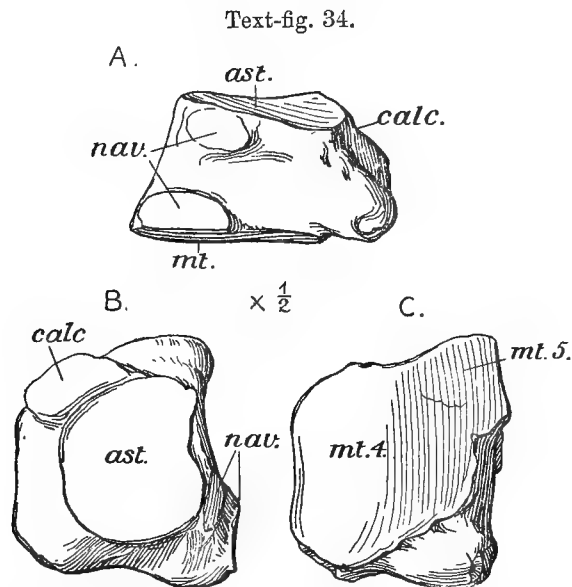
Right cuboid of *Arsinoitherium zitteli*: A, navicular face; B, from above; C, from below.
ast., facet for astragalus; *calc.*, facet for calcaneum; *mt.*, *mt.* 4, *mt.* 5, facets for the metatarsals; *nav.*, facets for navicular. ½ nat. size.

The form of the bone which is regarded as the *cuboid* of this animal is shown in text-fig. 34. The proximal surface (*ast.*), which articulates with the outer third of the distal end of the astragalus, is nearly flat and almost circular in outline, only the navicular border being somewhat flattened. Connected with the postero-external angle of the astragalar surface is a small facet (*calc.*), looking backwards, outwards, and upwards, for articulation with the calcaneum. The inner face of the bone bears two small facets (*nav.*) for union with the navicular, one on the upper border, the other on the lower, the two being separated by a deep groove. The distal surface is gently convex; in front it is slightly bilobate (*mt.* 4, *mt.* 5) and clearly articulated with two metatarsals; and the postero-internal angle is produced into a blunt tuberosity.

This bone is entirely unlike the Proboscidean cuboid. It is more like the cuboid of *Uintatherium*, but differs from that in several respects—*e. g.* in the much smaller size of the calcaneal facet.

The *metatarsals* are not definitely known, but the collections include a number of short and very massive metapodials which probably belong to the hind foot of this animal. Two of these are shown in text-fig. 35 Of these one (2 A, 2 c) probably belongs to a middle digit. Its proximal articulation (2 A) is gently convex from before backwards, but does not extend quite to the hinder surface of the bone, which is produced posteriorly into a large tuberosity. In front the proximal articulation is

Text-fig. 35.
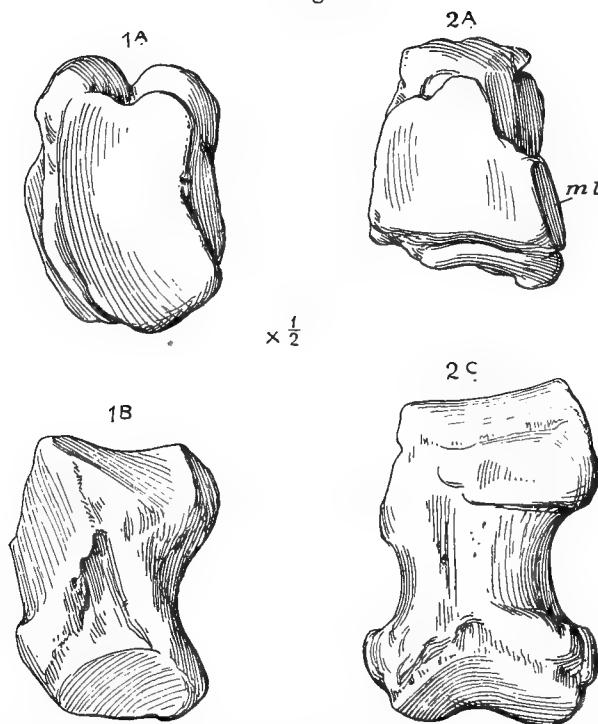
Metatarsals of *Arsinoitherium zitteli* : 1 A, proximal end of lateral metatarsal; 1 B, same specimen from front; 2 A, proximal end of middle metatarsal; 2 c, same specimen from front.

mt., facet for adjacent metatarsal. ½ nat. size.

produced considerably to one side, probably the post-axial, and bears a facet for articulation with the next metatarsal (*mt.*). The shaft of the bone is slightly contracted. The distal articulation is wide and consists of two surfaces, both convex from above downwards and concave from side to side and meeting at an angle on the distal end of the bone. The anterior and larger of these surfaces articulated with the first phalange and is limited above by a groove, above which is a strong rugose ridge extending across the whole face of the bone and produced laterally into tuberosities. The smaller posterior surface no doubt supported a sesamoid or a pair of sesamoids.

Text-fig. 36.
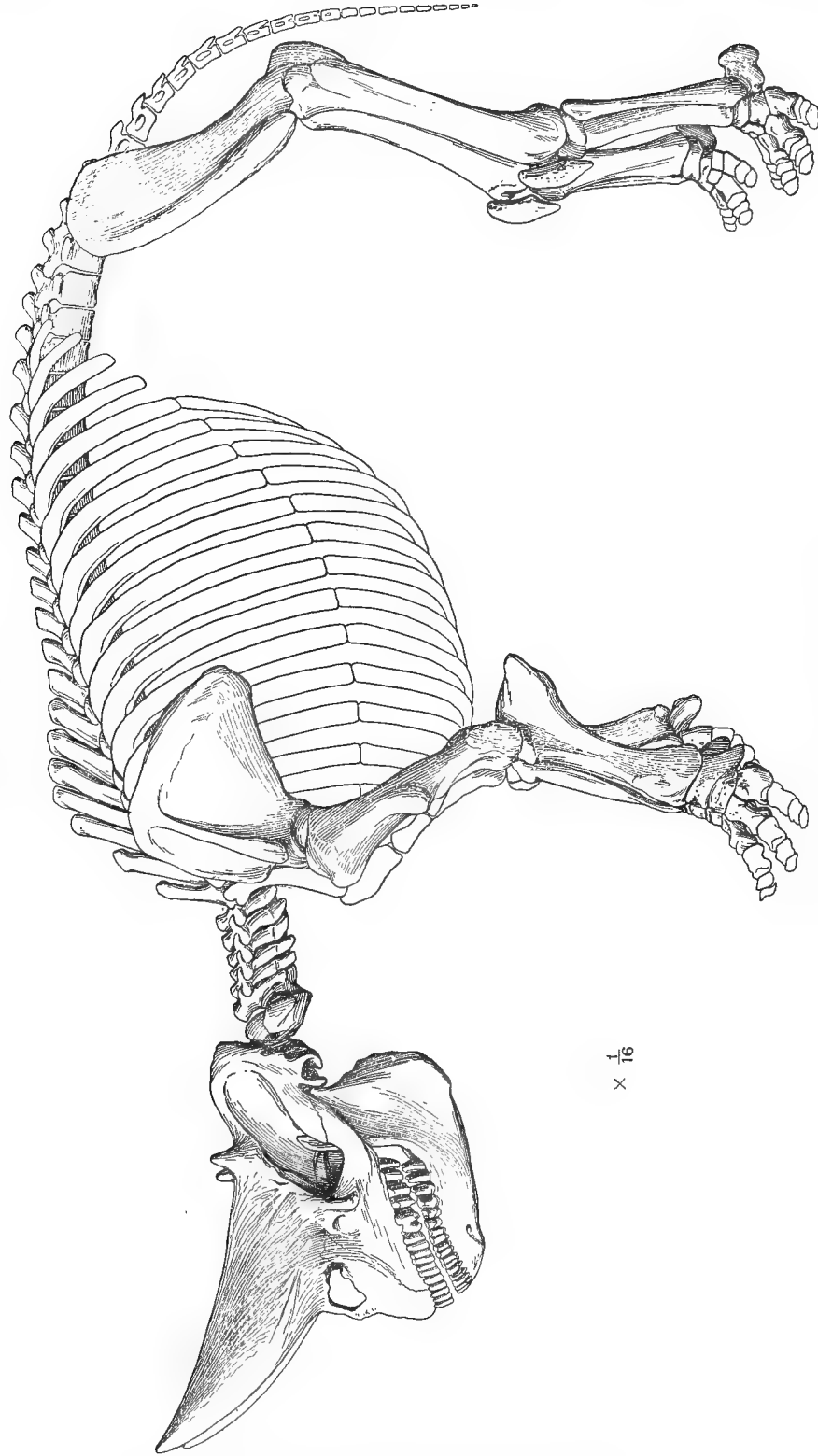
Restored skeleton of *Arsinoitherium zitteli*. $\frac{1}{16}$ nat. size.

The unshaded portions are not represented in the collections.

$\times \frac{1}{16}$

The other specimen (1 A, 1 B) seems to be a lateral metatarsal. It is shorter and stouter than the last, and is distinctly convex towards the median axis of the foot. Its proximal surface is convex from before backwards and slightly concave from side to side. Posteriorly it is produced backwards into a pair of blunt tuberosities. The outer face is occupied by swollen roughened ridges. The distal articulation is similar to that described on the other metatarsal, except that the posterior surface is distinctly bilobate and no doubt bore a pair of sesamoids.

The *phalanges* are unknown.

Text-fig. 37.

× $\frac{1}{16}$
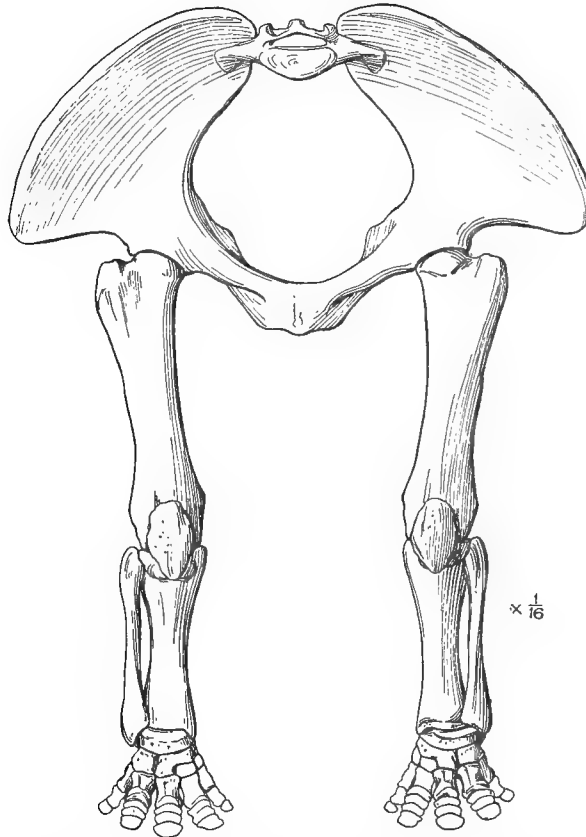
Pelvis and hind limbs of *Arsinoitherium zitteli*.
The first and second metacarpals and the phalanges are restored. $\frac{1}{16}$ nat. size.

From the large mass of material in London and Cairo it has been possible to attempt a restoration of the entire skeleton, and the result is shown in text-fig. 36. The chief parts of the skeleton remaining incompletely known are the sternum, ribs, posterior caudals, and the phalanges: these are distinguished in the figure by being left without shading. With these exceptions it is probable that the figure gives a fairly accurate idea of the general form and proportions of the whole skeleton

of *Arsinoitherium*, though in the absence of associated series there may be some doubt about the exact proportions of the limb-bones. Text-fig. 37 is a view of the pelvis and hind limb seen from the front, and shows the great width of the pelvis, the proportions of the femur and tibia, and the structure of the tarsus. Both the figures are about one-sixteenth natural size, the animal having stood about 1·76 metres (about 5 ft. 9 in.) at the withers and measured about 2·96 metres (9 ft. 9 in.) from the snout to rump.

The determination of the systematic position of the Barypoda is rendered specially difficult from the circumstance that *Arsinoitherium*, the only member of the group at present known, is a highly specialised terminal form of a series of which the earlier terms are still undiscovered. Nevertheless some attempt may be made to refer this animal to its place in the system, for although in many respects so specialised, in others it retains primitive characters, and even where the degree of specialisation is great, as in the case of the teeth, it may still be possible to arrive at a fairly clear idea of the conditions that must have existed in the earlier types.

From the account of the skeleton given above it will be seen that there is no doubt that the Barypoda form a subdivision of the Ungulata, belonging to that section of the order including the Elephants, Hyracoids, and Amblypoda, to which the collective name Subungulates is sometimes applied. To determine the relations of the Barypoda with the other Ungulates comparison must be made with (1) the Proboscidea, (2) the Amblypoda, (3) the Hyracoidea, and (4) some of the South-American Ungulates. The last of these comparisons is necessary because Ameghino has suggested that the Ethiopian and S.-American regions were closely connected in the later Cretaceous and early Tertiary times, and he considers that many of the main groups of Ungulates (*e. g.* the Hyracoids and Proboscidea) originated in S. America and subsequently migrated into Africa. It is not possible or desirable to discuss these questions fully here, but some allusion must be made to them.

Comparison of *Arsinoitherium* with the Proboscidea shows that in the structure of the skull, in the form of the molars, and in the persistence of the complete series of teeth without diastemata it differs entirely from any member of that suborder. In the skeleton, on the other hand, there are some similarities, but these seem to be merely parallel modifications due to great size and weight in the two groups, while, on the other hand, differences of such fundamental importance exist (*e. g.* in the structure of the tarsus) that any possibility of close relationship may be excluded.

Comparison with the Amblypoda shows that many points of resemblance in the skeleton exist, but, as in the case of the Proboscidea, these are probably nearly all the results of parallel evolution and are modifications depending mainly on increasing bulk and weight. On the other hand, the great similarity of the structure of the tarsus in the two cases cannot be so explained, but is probably a primitive character derived from similar Condylarthrous ancestors in the two cases. In the skull the

presence of horns in the two suborders does not seem to be a character of much importance, for they differ both in situation and character and, moreover, are found in many other groups. On the other hand, the skulls differ widely in the form of the occipital surface, the arrangement of the external auditory meatus, the form of the premaxillæ and of the anterior palatine foramina. The mandible is very unlike in the two groups, particularly in the form of the angular region.

In the dentition of the Amblypoda the following important differences may be noticed :—(1) the upper incisors are small and weak and the canines large and tusk-like ; (2) there is a diastema behind the canine in both jaws ; (3) the cheek-teeth are relatively small and are brachyodont ; (4) in wear the upper teeth tend to give **V**-shaped surfaces. In a former paper (Geol. Mag. [5] vol. i. 1904, p. 158) the present writer suggested that possibly the hypsodont molars of *Arsinoitherium* might have been derived from some form of Amblypod tooth, but further consideration has shown that this is almost impossible. Moreover, the great differences above referred to show that the two groups are very widely separated.

Comparison with the Hyracoidea is very difficult on account of the small size of the modern representatives of the group and our complete ignorance of the skeleton of the large extinct forms. In the early Hyracoidea there is a tendency for the anterior teeth (incisors, canine, and premolars) to form a continuous series, the anterior pair of incisors being more or less enlarged and separated from one another in the middle line by a short interval, as in *Arsinoitherium*. The molars are brachyodont, but their pattern is such that if there were an increase in height accompanied by an increasing infolding of the outer wall, they might give rise to a type of tooth very similar to the molars of *Arsinoitherium*, as was explained above. Since, however, these early brachyodont Hyraces are contemporaries of *Arsinoitherium*, it is not suggested that they are closely related ; but the circumstance that they both seem to have originated in the same region lends some probability to the belief that they may have had a common ancestry in the late Secondary or earliest Tertiary period.

Dr. Ameghino has suggested in a letter that *Arsinoitherium* may be related to the Toxodontia, but in spite of some superficial resemblances such a relationship does not seem at all probable. We may mention only two of the many important differences between the two types : (1) the structure of the molars seems to be totally dissimilar, and it is very difficult to see how the two types can be connected with one another ; (2) the structure of the tarsus is very different in the two cases, that of the Toxodontia apparently showing the cuboid in articulation exclusively with the calcaneum.

It is to be hoped that remains of earlier members of the Barypoda may be found in the Lower Eocene beds of Egypt, and that by these the question of the affinities of the group may be definitely settled.

Arsinoitherium zitteli, Beadnell.

[Frontispiece; Plates I.–V.; text-figs. 1–37.]

1902. *Arsinoitherium zitteli*, H. J. L. Beadnell, *op. cit.* pls. i.–v.
1903.   „   „   figs. of skull, Geol. Mag. [4] vol. x. pls. xxiii., xxiv.
1904.   „   „   C. W. Andrews, Geol. Mag. [5] vol. i. p. 157.

Type Specimen.—Skull, three-parts grown, probably of male (Pl. III. figs. 1, 1 A); Geological Museum, Cairo.

The type species, with mandible attaining a length of about 55 cm.; the length of the three upper posterior premolars and the molars together about 25·5 cm.

This is a species of very variable proportions, known by several skulls and numerous other parts of the skeleton, nearly all found isolated. Its remains are only distinguishable from those of the larger species, *A. andrewsi*, by their size, and it is possible that some of the specimens catalogued here (*e. g.* the pelvis no. C. 8413) may really belong to the latter form. Among the adult skulls there are two types distinguished by the form of the great nasal horns, namely, (i) those in which the horns are very large, trihedral, and sharply pointed, probably referable to males (Pl. I.); and (ii) those in which the horns are much shorter, somewhat rounded, and irregularly ossified at their tips, probably referable to females (Beadnell, *op. cit.* pls. iii., v.).

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north and north-west of Birket-el-Qurun.

C. 8130 *. Skull of a three-parts-grown animal: the type specimen figured by Beadnell in 'A Preliminary Note on *Arsinoitherium zitteli*, Beadn., from the Upper Eocene Strata of Egypt,' pls. i., ii., vi. (Cairo, 1902); also on Pl. III. figs. 1, 1 A. The dimensions are given on pp. 69, 70. The age of the animal is indicated by (1) the rounded horn-tips, (2) absence of prenasal bar, (3) anterior lobe of *m.* 3 only just coming into wear.

M. 8463 *. Skull and mandible together with a rib of an adult animal, probably a male. The skull is figured in the Geol. Mag. [4] vol. x. pls. xxiii., xxiv., also on Pls. I., II., with the ends of the horns and part of the right side of the skull restored in plaster, the restored portions being indicated by dotted lines: *i.* 1, *i.* 3, *c.*, and *pm.* 1 are wanting on both sides; the last molar is moderately worn. The mandible is figured on Pl. IV. figs. 1, 1 A, and was found in actual contact with the skull: *i.* 1, *i.* 3, and *pm.* 1 are wanting on the left side, *i.* 1, *i.* 2, *i.* 3, *c.*, and *pm.* 1 on the right. The dimensions of this skull and mandible are given on pp. 69, 70.   *Presented by W. E. de Winton, Esq., 1903.*

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* The numbers with C prefixed are those of specimens in the Geological Museum, Cairo; numbers with any other letter indicate that the specimen is in the British Museum.

C. 8128. Skull of an adult animal, probably a male, very similar to last, but with horns and most of rest of skull complete; teeth anterior to *pm.* 2 wanting. On the whole this is the most nearly complete skull at present known. The dimensions are given on pp. 69–70. Figured in Frontispiece.

M. 8407. Posterior portion of an adult skull wanting whole of left side in front of occipital region; the right side is well preserved as far forwards as the base of the large horn.

C. 9353. Upper portion of a skull in which the anterior horns curve away from one another at a wider angle than usual, and have more sharply angulate upper inner borders. The distance between the horn-tips is 42 cm. Other dimensions of this skull are: width above auditory meatus 31·3 cm.; length from condyles to tips of horns 80 cm.; width of skull-roof 10·4 cm.

M. 8379. Anterior portion of an adult skull, probably of a female. Figured by Beadnell, *op. cit.* pls. iii., iv., v. The horns are much smaller and straighter than in M. 8463 or C. 8128, and are irregularly ossified at the summit. The last molar is well worn and the prenasal bar fully ossified. Of the teeth, *i.* 1, *i.* 2, *i.* 3, *c.*, *pm.* 1, and *pm.* 2 are wanting on the left side; on the right *pm.* 3 also is missing. The height from the tip of the snout to the summit of the horns is 55 cm.; length of molar series, 19·5 cm.; length of *pm.* 3–4 together, 6·5 cm. The whole of the skull behind a vertical plane passing in front of the right frontal horn and behind the left is wanting.

Presented by the Egyptian Government, 1903.

C. 8256. Portion of the nasals forming posterior side of horn at fork. This specimen shows the median longitudinal buttress and the smaller transversely arranged ridges running at right angles to it.

M. 8830. A similar specimen to the last.   *Presented by the Egyptian Government*, 1904.

C. 8794. Posterior portion of skull. From the cranial cavity of this specimen the cast numbered M. 9087 was made.

C. 7805. Skull of a young individual, figured on Pl. III. figs. 2, 2 A, 2 B. Most of the sutures remain open and are shown in the figures. The ends of the front horns are rounded, the prenasal bar is unossified, the posterior molar is uncut, and the much-worn molariform last milk-molar is still in place. This tooth is 4·9 cm. long (outside measure); *m.* 1 is 5·5 cm. long: the germ of the last molar is still quite imperfect. Dimensions given on pp. 69–70.

M. 8800. Skull of a young individual somewhat smaller, but at the same time older than last (C. 7805). On the left side, the zygomatic arch, the maxilla, and the teeth have been restored, likewise the tip of the left nasal horn. The last milk-molar seems to have been replaced, and the last molar, though in a much more advanced condition than in C. 7805, was still uncut. The prenasal bar is absent. The sutures are obscure, owing to the condition of preservation. Dimensions given on pp. 69–70.

Presented by the Egyptian Government, 1904.

M. 8470. Numerous portions of a young skull associated with a portion of a mandible with *m.* 1 and *m.* 2 and some well-preserved upper and lower teeth. Of these an upper incisor is figured on Pl. V. figs. 1, 1 A; an anterior left upper *pm.* (? *pm.* 2), figs. 3, 3 A; a right upper *pm.* (? *pm.* 3), fig. 2; a left upper *m.* 3, figs. 6, 6 A, 6 B; also a left lower

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molar, figs. 4, 4 A. With these there were also associated the distal epiphysis of a left ulna, the distal half of a right radius, a left scaphoid, a left unciform, a left fourth metacarpal, and a right magnum. *Presented by W. E. de Winton, Esq.*, 1903.

M. 8475. Upper portion of skull of very young animal showing parieto-frontal suture and anterior border of the frontals. This specimen also shows that the great frontal sinus is continued into the frontal (posterior) horn. There is no trace of the occipito-parietal or inter-parietal sutures. *Presented by W. E. de Winton, Esq.*, 1903.

M. 8462 a. Right maxilla with the molars and last two premolars preserved : *m.* 3 is well worn, the animal being old. The base of the zygomatic process is preserved ; the antorbital foramen is smaller than in most specimens. The length of the molars is 18·2 cm., that of the two premolars 7·5 cm. This maxilla may belong to the same individual as the mandible M. 8462 *b.* *Presented by W. E. de Winton, Esq.*, 1903.

C. 7843. Palate and cheek-teeth of a young individual in which *pm.* 4 is just being cut and *pm.* 3 is slightly worn ; *m.* 3 and one of the anterior incisors of the right side are just appearing. The base of the zygomatic process and the antorbital foramen are preserved.

C. 7912. Left maxilla of a young individual in which *pm.* 4 and the hinder column of *m.* 2 are slightly worn. The length of *m.* 1 and *m.* 2 together is 10·2 cm. ; length of *pm.* 2–*pm.* 4, 8·4 cm.

C. 7844. Right maxilla with *pm.* 2–*pm.* 4 and *m.* 1–*m.* 3. Last molar just cut, but not in wear. Length of *m.* 1–*m.* 2 is 10·2 cm. ; length of *pm.* 2–*pm.* 4 is 8·4 cm.

C. 8253. Left maxilla rather older than the last, *m.* 2 being more worn. The posterior column of *m.* 3 is missing. The length of *m.* 1–*m.* 2 is 11·6 cm. ; length of *pm.* 2–*pm.* 4 is 8·6 cm.

M. 8801. Portion of left maxilla with the molars and *pm.* 4 *in situ.* The posterior column of *m.* 3 not yet in wear. Length of molar series about 15·5 cm.
Presented by the Egyptian Government, 1904.

M. 8802. Portion of right maxilla with *m.* 2 and *m.* 3, the posterior lobe of the latter just coming into wear. *Presented by the Egyptian Government,* 1904.

M. 8472. Portion of left maxilla and anterior end of jugal ; the antorbital foramen is preserved. One tooth, probably the last milk-molar, is *in situ* ; above and a little in front of this is the fossa, in which lay the germ of *pm.* 4 or *pm.* 3. The milk-molar is entirely molariform ; the length of the inner side of the crown is 4·2 cm.
Presented by W. E. de Winton, Esq., 1903.

M. 8471. Portion of left maxilla with three teeth *in situ*, probably *mm.* 2, *mm.* 3, and *mm.* 4 : *mm.* 1 and a milk-incisor are also preserved. *Mm.* 4 is much less worn than in the last specimen ; both it and *mm.* 3 are molariform. *Mm.* 2 consists of an outer wall, two transverse crests, and a well-developed cingulum on the antero-internal border ; *mm.* 1 consists of an outer wall composed of two elements and united anteriorly by a slight transverse crest with the strongly developed cingulum. The incisor is a small, cylindrical, slightly spatulate tooth without a cingulum. The lengths of the milk-molars are :—*mm.* 1, 1·9 cm.; *mm.* 2, 2·3 cm. ; *mm.* 3, 3·3 cm.; *mm.* 4, 4·1 cm. Figured on Pl. V. figs. 5, 5 A, and text-fig. 7. *Presented by W. E. de Winton, Esq.*, 1903.

C. 8252. Portion of right maxilla with the four milk-molars *in situ*. This specimen is slightly larger than the last, but otherwise closely similar.

C. 9436. Portion of right maxilla similar in age to the last, with *mm*. 2 and *mm*. 3 *in situ*.

M. 8826. Portion of left maxilla somewhat younger than M. 8472, with *mm*. 4 and *mm*. 3 *in situ*, and the parts of the germ of the premolar replacing the latter. If this interpretation be correct, the height of the crown of *mm*. 4 is very remarkable, the hypsodont condition being quite as pronounced as in the permanent molars. Thus the width of the posterior column of *mm*. 4, which is already somewhat worn, is about 3 cm., its height in a straight line 7·7 cm.   *Presented by the Egyptian Government, 1904.*

M. 8474. Left premaxilla of young individual showing the germs of *i*. 1 and *i*. 2.
Presented by W. E. de Winton, Esq., 1903.

M. 8539. Plaster cast of the cranial cavity of the skull numbered M. 8463 (text-fig. 5).
Made in the British Museum.

M. 8540. Plaster casts of two cranial cavities of skulls in the Cairo Museum.
Made in the Geological Museum, Cairo.

M. 9087. Plaster cast of cranial cavity of an imperfect skull numbered C. 8794.
Made in the British Museum.

C. 8802. Nearly complete adult mandible in which the posterior column of *m*. 3 is considerably worn. The anterior premolar, canine, and incisors are wanting, and the front of the symphysial region is incomplete. The posterior end of symphysis is beneath anterior column of *m*. 2. The ventral border of the horizontal ramus is strongly convex. Length about 51 cm., height to top of coronoid process 32 cm., length of molar series 18 cm., united length of last three premolars 8·1 cm.

C. 8129. Nearly complete adult mandible. This specimen is mounted with the nearly complete skull C. 8128, the posterior portion of the left ramus being restored. All the teeth in front of *pm*. 2 are wanting. Length 55·5 cm., height to top of coronoid 36·5 cm.; depth of ramus beneath last molar 9·3 cm.; length of molar series about 18 cm.; length of last three premolars about 10 cm. Figured in Frontispiece.

M. 8408. Left ramus of mandible, symphysial region much worn, and all teeth except *m*. 3 lost. Length 55 cm., height to top of coronoid process 29·7 cm.

M. 8462 b. Left ramus of mandible with symphysis : premolars and molars *in situ*.
Presented by W. E. de Winton, Esq., 1903.

M. 8821. Right ramus of mandible of a rather old individual, *m*. 3 being much worn. Anterior end of symphysial region imperfect, and all teeth in front of *pm*. 2 wanting. Length of ramus about 50 cm., height to top of coronoid 33 cm.; depth of ramus beneath *m*. 3, 9 cm. (approx.); length of molar series 16·8 cm.; length of the three posterior premolars 8·5 cm.   *Presented by the Egyptian Government, 1904.*

C. 8904. Imperfect ramus of mandible in which the last molar has just been cut. Teeth anterior to *pm*. 3 wanting. The symphysis extended back to the level of the posterior lobe of *pm*. 4. Length of *m*. 1 and *m*. 2 together about 10 cm.

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C. 8906. Left ramus of mandible with the symphysis, but incomplete posteriorly : *m.* 3 has just been cut. On the left side the first incisor is present; this is a one-rooted, laterally compressed tooth, the crown of which wears to a flat, somewhat crescent-shaped surface, behind which there is a large shelf-like pit bordered posteriorly by the cingulum. On the right side of the symphysis, *i.* 2, *i.* 3, *c.*, and *pm.* 1 are present : they are all laterally compressed, single-rooted teeth, each with a cingular ridge on the inner face, and all wearing to one height. The symphysis extends to beneath posterior end of *pm.* 4. Length of *m.* 1 and *m.* 2 together about 10·8 cm. ; length of three posterior premolars 8·5 cm.

C. 8240. Imperfect left ramus of mandible with anterior column of *m.* 3 just appearing. Length of *m.* 1 and *m.* 2 together is 10·8 cm.

M. 8803. Portion of left mandibular ramus with *pm.* 4 and the molars, the last column of *m.* 3 appearing. Basal length of *m.* 1 and *m.* 2 together 12 cm.

Presented by the Egyptian Government, 1904.

M. 8409. Portion of a right ramus of mandible.

M. 8380. Imperfect right ramus of mandible with symphysis. Teeth in front of *pm.* 2 wanting. Length of molar series 16·5 cm. ; length of three posterior premolars 9 cm. Symphysis extends back to beneath anterior end of *m.* 1.

Presented by the Egyptian Government, 1902.

C. 8923. Right and left rami of mandible crushed together and wanting the hinder portion : *m.* 3 fully cut and its anterior column in wear. On the right side the teeth in front of *pm.* 2 are wanting; on the left *m.* 3 is also missing. Length of the molar series 16 cm., length of the three posterior premolars 7·6 cm.

C. 7891. Right and left rami of mandible, similar to last but uncrushed. Length of molar series 18·2 cm., length of last three premolars 8·5 cm.

C. 9254. Imperfect mandible of a rather old individual, wanting the hinder portion of the right ramus : *m.* 3 is greatly worn; *pm.* 1, *c.*, and *i.* 1, *i.* 2, *i.* 3 are wanting. Length of the molar series 15 cm. ; length of *pm.* 3 and *pm.* 4, 6 cm. The symphysis extends back to beneath the anterior column of *m.* 2.

C. 9255. Imperfect mandible, rather younger than last. The ascending ramus is wanting on both sides : *m.* 3 just coming into wear. Length of the molar series 16 cm.; length of *pm.* 3 and *pm.* 4, 6 cm. The symphysis extends back to beneath the posterior column of *m.* 1.

M. 8824. Portion of mandible of a young individual with remains of teeth, probably the two posterior milk-molars, beneath which, however, there are no traces of replacing teeth.

Presented by the Egyptian Government, 1904.

M. 8381. Right ramus of a young mandible with two teeth.

Presented by the Egyptian Government, 1903.

C. 9241. Portion of young mandible with (?) *mm.* 3, *mm.* 4, *m.* 1, but, as in last, no trace of replacing teeth beneath the milk-teeth. The lengths of the teeth are : *mm.* 3, 2·2 cm. ; *mm.* 4, 2·8 cm. ; *m.* 1, 4·1 cm. The posterior portion of this jaw, including the coronoid, is nearly complete ; height at coronoid 18·2 cm.

C. 8288. Symphysis and front of rami of a young mandible about the same age as last, and with the same teeth *in situ*. The lengths of the teeth are : *mm.* 3, 2·8 cm. ; *mm.* 4, 3·3 cm.; *m.* 1, 3·8 cm. The symphysis extends to beneath the front of *mm.* 4 ; its length is about 8 cm.

M. 8822. Fragment of right ramus of mandible with *mm.* 3 and portions of *mm.* 4 *in situ* ; *mm.* 2 is represented by its broken roots, and in front of it the crown of *pm.* 1 is just appearing. This tooth is placed very obliquely in the jaw, and must gradually rotate into its normal position as the growth of the mandible allows it room to do so.

Presented by the Egyptian Government, 1904.

M. 8823. Anterior portion of right ramus of very young individual similar to M. 8822. In this also the crown of *pm.* 1 is just appearing, and is here placed almost transversely. In front of it are the alveoli of the canine and three incisors. Behind is the broken base of *mm.* 2. The symphysis extended back as far as the posterior end of *mm.* 2, and the mental foramen is beneath the anterior column of the same tooth.

Presented by the Egyptian Government, 1904.

M. 8410. Left upper molars.

M. 8825. Nearly unworn upper *m.* 3.   *Presented by the Egyptian Government*, 1904.

C. 8942. Upper *m.* 3 slightly worn.

C. 8943. Upper *m.* 2 with inner wall just formed, showing the roots.

M. 8382. Right upper molar, much worn, showing roots.

Presented by the Egyptian Government, 1902.

M. 8804 a. Right upper molar, much worn, showing roots. Figured on Pl. V. figs. 8, 8 A.

Presented by the Egyptian Government, 1904.

M. 8804. Right upper molar, rather less worn than last. Figured on Pl. V. fig. 7. This specimen and the last are very large, and may belong to *Arsinoitherium andrewsi.*

Presented by the Egyptian Government, 1904.

C. 9236. Two well-preserved right upper molars.

C. 8291. Two upper molars considerably smaller than usual, possibly indicating the existence of a smaller species.

C. 7921. Right upper premolar.

Dimensions (in centimetres) of skulls of *Arsinoitherium zitteli* :—

	1. C. 8128.	2. M. 8463.	3 (type). C. 8130.	4. C. 7805.	5. M. 8800.
Length from condyles to tip of snout	80	77	74	. . . .	65·5
,, ,, ,, horn	109·4	100	78·4	73·4	64
,, ,, ,, small horn . . .	42	38	38·9	36	32·7
Width of roof at narrowest (between temporal fossæ)	11·4	13	9·7	10·4	12
,, at zygomatic arch	35·6	33·5	31·6	28·3	31 app.
Greatest width of occipital surface	25·7 app.	26 app.	24·6	21	20
,, ,, between tips of small horns . . .	25·4 app.	24·5	23·2	17·1	17 app.
,, ,, of the combined bases of the large horns	24·5	27	24·6	21	16·8
,, ,, of each horn at base (antero- posterior)	18	22	15·2	14 app.	13·4

Dimensions (*continued*) :—

	1. C. 8128.	2. M. 8463.	3 (type). C. 8130.	4. C. 7805.	5. M. 8800.
Greatest width of each horn at base (side to side) .	16	14·5	11·5	10·3	8·2
,,　　,,　above auditory opening	35	33	31	28	27 app.
Length from basion to posterior border of palate .	36·9	36	34	31·4	30
,,　　,,　tip of snout	74	70	68·5	?	61
Length from border of palate to tip of snout . .	38·5	35	35·3	?	33
Height from tip of snout to end of large horns . .	78	72	59	?	39
,,　angle of pterygoids to roof of skull 　　between small horns	38·5 app.	34	32·7 app.	30·5	25·5
Width between outer angles of condyles	23·9	24	21 app.	20·6	16
,, of foramen magnum	7	10	8	7·5	6·6
Height of foramen magnum	4·5	5·5	5·5	4·7	4·6
Distance between tips of large horns	32	37	25	18·5 (restored).	19·5 app.
Length from fork to tip of large horns	39	40·5	21	15·6	13·0
,,　upper edge of nasal opening to tips of 　　large horns	60	53	35·7	26·2	19·4

The dimensions (in centimetres) of the teeth in these skulls are :—

	C. 8128.	M. 8463.	C. 8130 (type).	C. 7805.	M. 8800.
Length of molar series (outside of crown) . . .	16·8	16·5	16·7	. .	. .
,,　　pm. 2–pm. 4　　,,　　,,　. . .	8·6	9·3	8·6	. .	8·7
,,　　pm. 2–m. 3　　,,　　,,　. . .	25·4	25·7	25·5	. .	. .
,,　　　,,　(basal length)	28	28·5	?	. .	. .
,,　　m. 3 in mid-line	4+	4·4	?	uncut.	. .
,,　　m. 2	6·7	5·8	4+	6·5	5·4
,,　　m. 1	5·2	5·3	5·2	5·2	5·5
,,　　pm. 4	3·1	3·2	. .	mm. 4, 4·9	3·2
,,　　pm. 3	2·5	2·8	. .	. .	2·8
,,　　pm. 2	2·4	2·6	2·6	. .	2·6

The dimensions (in centimetres) of the mandibles mounted with C. 8128 and M. 8463 respectively are :—

	C. 8129.	M. 8463 (associated).
Total length	55·5	52·5
Height at coronoid	36·5	31·5
Width of condyles	11·0	10·2
,,　ascending ramus	21·7	17
Depth of ramus at m. 3	9·3	8·2
Total width between posterior angles	. .	29·5
Length of symphysis	. .	18
Width between upper ends of coronoid processes . . .	. .	17·5
Antero-posterior length of crown of m. 3	5·5	5·2
,,　　,,　　,,　m. 2	6·5	6·2
,,　　,,　　,,　m. 1	5·5	5
,,　　,,　　,,　pm. 4	3·9	3
,,　　,,　　,,　pm. 3	3·2	2·8
,,　　,,　　,,　pm. 2	2·7	2·6

C. 8060. Atlas vertebra associated with the type skull. In this specimen the lateral surfaces for the axis are roughly triangular, their inner sides bounding the broad notch for the odontoid being straight and nearly vertical. Condylar cups broad and deeply concave, extending up to the level of the neural arch and down to the ventral bar.

M. 8387. Atlas. *Presented by the Egyptian Government,* 1902.

C. 8064, C. 8262, C. 8973, C. 9087. Four specimens of the atlas.

C. 8077. Atlas with incomplete transverse processes.

M. 8816. Atlas with right transverse process imperfect. Figured, with process restored, text-fig. 8.
Presented by the Egyptian Government, 1904.

M. 8460, M. 8494. Two specimens of the atlas. *Presented by W. E. de Winton, Esq.,* 1903.

M. 8816 a. Atlas of small individual. Lateral facets for axis more quadrate than usual.
Presented by the Egyptian Government, 1904.

The dimensions (in centimetres) of some of the above specimens are given in the following table :—

	C. 8060.	M. 8387.	C. 8262.	C. 8077.	M. 8816.	C. 9087.
Width at transverse processes	31+	43·6	47·4	..	42	39·5
„ condylar cups	23	24 app.	20·2	19	21·5	23·7
„ surfaces for axis	18·7	19	17	16	16·5	18·3
Extreme height	15·8	18	15·7	12·6	16·7	15·8
Antero-posterior width of transverse processes	5·8	8	8·5	5·2	7·3	7·7
Length of neural arch	6·5	8·4	7·7	5	6·1	8·3

C. 7888. Large and nearly perfect axis. The odontoid is very short and stout. Transverse process perforated by large vertebrarterial canal; paired hypapophysial tuberosities on postero-ventral border of centrum.

M. 8815. Axis, large specimen with broken transverse process.
Presented by the Egyptian Government, 1904.

M. 8388. Axis, rather smaller than last. *Presented by the Egyptian Government,* 1902.

M. 8839. Axis of small individual. *Presented by the Egyptian Government,* 1904.

M. 8411. Axis wanting transverse processes. Figured in text-fig. 9.
Presented by W. E. de Winton, Esq., 1903.

C. 7810, C. 8086, C. 8990. Three specimens of the axis.

C. 8072. Axis, a small specimen with a relatively smaller and less massive odontoid process.

The dimensions (in centimetres) of some of the above axes are given in the following table :—

	C. 7888.	C. 7810.	C. 8086.	M. 8815.	M. 8388.	M. 8411.
Height to summit of arch	21·3	18·5	18·1	18	17·5	17·3
Width of anterior end	20 app.	19·9	19·5	18	17	17·5
„ of posterior end	14	14·5	13·1	13	13	13·5
„ at transverse processes	32	..	26	..	..	..
Length (along ventral surface to tip of odontoid process)	15	14·8	14·1	15·5	14·8	13·7

In addition to the atlas and axis numbered C. 8064 and C. 7888, the following series of vertebræ

has been selected from the collection at Cairo as forming an approximately complete vertebral column. Owing, however, to the great variation in size in individuals of the present species it was impossible to make a very satisfactory set, and it is not even certain that some of the smaller vertebræ may not belong to *Palæomastodon*. Only the discovery of an associated series can make it possible to settle definitely the structure of the vertebral column and the number of vertebræ composing its different regions. The description given above (pp. 27–32) is founded on this series, and the figures also are, for the most part, taken from vertebræ composing it. The numbers of the vertebræ behind the cervical region are only approximate.

C. 8303. Third cervical vertebra (text-fig. 10, A).

C. 9097. Fourth cervical vertebra.

C. 8294. Fifth cervical vertebra (text-fig. 10, B).

C. 9083. Sixth cervical vertebra.

C. 9082. Seventh cervical vertebra (text-fig. 10, E). No vertebrarterial canal. Rib-facets on hinder face at ventral outer angle of centrum.

The dimensions (in centimetres) of these cervicals are given in the following table :—

	C. 8303.	C. 9097.	C. 8294.	C. 9083.	C. 9082.
Greatest width of centrum	13·6	14·5	13	13	13 5
„ height „	11	11	11·3	11	11
Length of centrum (in middle)	3·3	4·7	4·7	6	5
Height to top of arch	18	17·1	17·5	..	18·7
Width at transverse processes	29	..	21·5	..	23·5
Height of neural canal	4	4	4·3	..	5

C. 9089. Anterior thoracic vertebra. Spine higher than in last cervical.

C. 8270. Anterior thoracic vertebra. At this point there is probably a gap in the series.

C. 7806. Thoracic vertebra (text-fig. 11). Spine very high, broad.

C. 8316. Thoracic vertebra belonging to a smaller individual than the last.

C. 9215. Thoracic vertebra of a small individual. Neural spine shorter than in last.

C. 9091. Thoracic vertebra (text-fig. 12). Centrum is somewhat narrowed ventrally. Broad, flattened, transverse processes, with oval flat rib-facets (*t.f.*) towards the front of their outer ends. Neural spine (*n.sp.*) strongly inclined backwards, upper end slightly bifid.

The dimensions (in centimetres) of the last six vertebræ are given in the following table :—

	C. 9089.	C. 8270.	C. 7806.	C. 8316.	C. 9215.	C. 9091.
Height of centrum	10	10·2	10·5	8·2	8·2	7·7
Width „	13·7	13·5	12·5	11	10	10·3
Length (on ventral side)	6·5	7·4	6·8	..	6	6·5
Height to top of neural spine . . .	22+	.	27	24	26·2	19·7
Width at transverse processes . . .	24	..	26·7	..	26	25·6

Behind C. 9091 there seems to be a gap in the series, in which the neural spines shortened, the capitular rib-facets moved higher up, and the zygapophyses became cylindroid. This type of vertebra is shown in text-fig. 13.

C. 8096. Thoracic vertebra (text-fig. 13).

C. 8097, C. 9085. ? Thoracic vertebræ.

C. 7886, C. 8277, C. 8286, C. 9077, C. 9106. Thoracic vertebræ.

C. 9228. Thoracic vertebra (? last).

The dimensions (in centimetres) of the thoracic vertebræ enumerated above are :—

	C.8096.	C.8286.	C.9077.	C.8277.	C.8097.	C.9085.	C.7886.	C.9228.
Width of anterior face of centrum .	11	10·8	11·4	10	11	10	11	11·6
Height „ „ .	6·6	6·7	6·4	7·5	9	8	7·7	7·4
Length of ventral border of centrum.	7	8·5	7·7	7·2 ?	8·3	8·2	7	7
Height to top of neural arch . . .	17·4	18·2	16·1 ?	?	18·2	18	18·2	18·2

C. 8776, C. 9036, C. 9100. Lumbar vertebræ.

C. 9220. ? Sacral vertebra.

C. 9092. ? Anterior sacral vertebra (text-fig. 14).

C. 9093. Second sacral vertebra.

The dimensions (in centimetres) of these lumbar and sacral vertebræ are :—

	C. 9100.	C. 8776.	C. 9036.	C. 9220.	C. 9092.	C. 9093.
Width of anterior face of centrum . .	12·4	11	12·7	11·3	12·2	11·4
Height „ „ . .	7·5	7·5	6·7	6	6·7	5·2
Ventral length of centrum	7·8	8·8	8	7·1	7·5	8·4
Height to top of neural arch	20	..	13·5	13·4	13 app.	10
Width at transverse processes	23·6	25·5	30 app.	36	35	36

C. 7881. Anterior caudal vertebra.

C. 7887. Caudal vertebra.

C. 9109. Posterior caudal vertebra.

The dimensions (in centimetres) of these caudal vertebræ are :—

	C. 7881.	C. 7887.	C. 9109.
Width of front of centrum	6·3	4 ?	3·3
Height „ „	3·5	3 ?	3
Height to top of neural arch	5	..	..
Width at transverse processes	16+	..	6
Length of centrum	6·2	5·5	4·3

Other vertebræ in the Cairo Museum are :—

C. 8309. Cervical vertebra, probably the third. Width of centrum 12·5 cm., length 4·9 cm.

C. 7811. Cervical vertebra, probably the fourth. Width of centrum 11·3 cm., length 4·6 cm.

C. 8302. Cervical vertebra, probably the fifth. Width of centrum 11·6 cm., length 4 cm.

These three vertebræ, C. 8309, C. 7811, and C. 8302, have been placed with the atlas and axis numbered C. 8990 and C. 8973 respectively.

In addition to the atlases and axes above enumerated, the following vertebræ are in the British Museum :—

M. 8840.　Three specimens of a cervical vertebra, probably the third.

　　　　　　　　　　　　　　　Presented by the Egyptian Government, 1904.

M. 8817.　Cervical vertebra, probably the fourth (text-fig. 10, C, D).

　　　　　　　　　　　　　　　Presented by the Egyptian Government, 1904.

M. 8495.　Cervical vertebra, probably the fifth.　Wanting part of the neural arch and the

　　　　transverse process on one side.　　　*Presented by W. E. de Winton, Esq.,* 1903.

M. 8495 a.　Imperfect cervical vertebra.　　　*Presented by W. E. de Winton, Esq.,* 1903.

M. 8389.　Last cervical vertebra, wanting neural arch.

　　　　　　　　　　　　　　　Presented by the Egyptian Government, 1902.

M. 8841.　Anterior thoracic vertebra.　　　*Presented by the Egyptian Government,* 1902.

M. 8841 a.　Anterior thoracic vertebra, wanting neural spine.

　　　　　　　　　　　　　　　Presented by the Egyptian Government, 1902.

M. 8496.　Thoracic vertebra, posterior to last.　Neural spine imperfect.

　　　　　　　　　　　　　　　Presented by W. E. de Winton, Esq., 1903.

M. 8841 b.　Thoracic vertebra, posterior to last.　Neural spine imperfect.

　　　　　　　　　　　　　　　Presented by the Egyptian Government, 1904.

M. 8841 c.　Imperfect thoracic vertebra, posterior to the last.

　　　　　　　　　　　　　　　Presented by the Egyptian Government, 1904.

M. 8841 d.　Thoracic vertebra, posterior to the last.　*Presented by the Egyptian Government,* 1904.

M. 8818.　Thoracic vertebra, posterior to the last.　*Presented by the Egyptian Government,* 1904.

C. 8433.　Nearly perfect left scapula (text-fig. 15).

M. 8874.　Plaster cast of the last specimen.　　　　*Made in the British Museum.*

C. 8434.　Left scapula.

M. 8469.　Left scapula, wanting antero-superior portion.

　　　　　　　　　　　　　　　Presented by W. E. de Winton, Esq., 1903.

M. 8391.　Glenoid portion of scapula.　　　*Presented by the Egyptian Government,* 1902.

The dimensions (in centimetres) of these specimens are given below :—

	C. 8433.	C. 8434.	M. 8469.	M. 8391.
Length of suprascapular border	50·2	54·3	..	..
„　from antero-superior angle to end of coracoid process	40·7	44·3 app.	..	..
„　from posterior angle to glenoid cavity . .	36	37	37	..
Height of spine	11·5	..	11·5	..
Length of glenoid cavity	14·4	15	16	14·2
Width of glenoid cavity . .　. . . . . .　. .	8	9·2 app.	9	7·7
„　neck of scapula	20·2	20·4	20·5	19·5

C. 8150, C. 8155, C. 8855, C. 9243. Right humeri.

M. 8819, M. 8820. Left humeri.   *Presented by the Egyptian Government*, 1904.

M. 8392 a, M. 8392 b. Left humeri.   *Presented by the Egyptian Government*, 1902.

C. 8159, C. 8841, C. 8852, C. 9202. Left humeri.

The dimensions (in centimetres) of some of the humeri enumerated above are :—

	C.8155.	C.9243.	C.8150.	C.8855.	C.8841.	C.8852.	M.8819.	M.8820.	M.8392 a.	M.8392 b.
Extreme length	57·8	57·5	54·2	53	61·5	55	53·8	52	52·5	50
Width of head	14	12·8	12·4	12·5 app.	14·9	11·8	12·3	11·5	12+	11·4
„ distal articulation	15·5	16·4	15·1	13·8	16·9	13·7	14+	14·2	14·3	13·6
„ middle of shaft	13	12·4	12	12·3	13·3	11·5	10·6	9·9	9·8	10·1
Greatest width at distal end (with supinator ridge)	21·3	23·2	23·5	22·2	24·1	21·5	21·0	18·1	18·6	19·5

C. 8891. Right radius.

C. 7812, C. 8175, C. 8177, C. 8882, C. 8888. Left radii.

M. 8393. Left radius and distal half of another specimen.

Presented by the Egyptian Government, 1902.

M. 8805–06. Left radii.   *Presented by the Egyptian Government*, 1904.

The dimensions (in centimetres) of the radii enumerated above are :—

	C.8891.	C.7812.	C.8882.	M.8806.	M.8393.	C.8177.	M.8805.	C.8175.	C.8888.
Length	38·5	41	40·2	37·5	36·8	36·5	36	33·3	30
Width of proximal articulation	8·7	10	9·3	9·9	8·3	8·5	8·8	8·5 app.	7·3
„ distal articulation	11·6	9·5	11·0	11·4	10·8	10·3	10·2	9·5	7·9

M. 8807–8. Right ulnæ.   *Presented by the Egyptian Government*, 1904.

M. 8394 a, M. 8394 b. Right ulnæ.   *Presented by the Egyptian Government*, 1902.

C. 8186, C. 8863. Right ulnæ.

M. 8458. Cast of left ulna (C. 8864 a).

C. 8066, C. 8179, C. 8183, C. 8861, C. 8864, C. 8864 a. Left ulnæ.

M. 8809. Left ulna.   *Presented by the Egyptian Government*, 1904.

C. 8148. Young right ulna, wanting distal epiphysis.

M. 8824. Young right ulna, wanting distal epiphysis.

Presented by the Egyptian Government, 1904.

The dimensions (in centimetres) of some of the ulnæ enumerated above are :—

	C. 8863.	M. 8394 b.	M. 8808.	M. 8394 a.	C. 8186.	C. 8861.	C. 8066.	C. 8183.	M. 8809.
Total length including olecranon	49·1	44·3	42·0	44·3	37	50·5	48·3	44·1	44
Length from proximal articulation to distal end . . .	36·5	34·2	31·8	34·2	28	37·3	36	33	33·3
Width of proximal articulation	18	14·5	14·5	14·5	13·7	14·8	?16·7	12·3	15·5
,, distal articulation .	11·4	10·2	9·5	10·2	9·5	10·3	11	. .	12·1
,, middle of shaft (side to side)	10·3	7·4	8·1	7·4	7·2	8·2	9·5	7·2	7·7

M. 8470. Left scaphoid, associated with the skull &c. of the same number (see above) (text-fig. 20).
Presented by W. E. de Winton, Esq., 1902.

M. 8836. Left scaphoid. *Presented by the Egyptian Government, 1904.*

C. 7944, C. 9003, C. 9013. Left scaphoids.

The dimensions (in centimetres) of the above scaphoids are :—

	M. 8470.	M. 8836.	C. 7944.	C. 9013.	C. 9003.
Length of posterior border	8·5	10	7	8·6	8·6
,, proximal articulation	5	6	4·7	5·1	5·5
,, distal articulation	8·5	8·5	6·7	7 app.	7·5

C. 8936. Right lunar (text-fig. 21).

C. 8390. Right lunar.

M. 8404. Left cuneiform (text-fig. 22). *Presented by the Egyptian Government, 1902.*

M. 9095. Imperfect right and left cuneiforms. *Presented by the Egyptian Government, 1904.*

M. 9096. Small left cuneiform. *Presented by the Egyptian Government, 1904.*

C. 9012. Right cuneiform.

C. 8106, C. 9037, C. 7955. Cuneiforms.

M. 9097. Left pisiform. *Presented by the Egyptian Government, 1904.*

C. 7948, C. 7991, C. 8370, C. 9310. Pisiforms.

M. 8470. Right magnum, associated with portions of skull of the same number (see above).
Presented by W. E. de Winton, Esq., 1903.

M. 9098. Right magnum of larger individual. *Presented by the Egyptian Government, 1904.*

C. 9435. Left magnum of very large individual (text-fig. 23).

M. 8421. Right magnum.

M. 8405. Left magnum.

C. 8093, C. 8406. Two specimens of the magnum.

M. 8470. Left unciform associated with portions of skull of the same number (see above) (text-fig. 24). *Presented by W. E. de Winton, Esq., 1903.*

M. 9099. Left unciform. *Presented by the Egyptian Government, 1904.*

M. 9100. Two right unciforms. *Same history.*

C. 7943, C. 9031, C. 9048. Unciforms.

M. 8421, M. 8837. ? Trapezoids.

C. 7946, C. 7981, C. 8397, C. 9040, C. 9431. ? Trapezoids.

M. 8470. Fourth metacarpal, associated with the skull &c. of the same number (text-fig. 19).

Presented by W. E. de Winton, Esq., 1903.

M. 9101. Fifth metacarpal (text-fig. 19).

C. 7968. Fifth metacarpal (text-fig. 25).

M. 9102. Two fifth metacarpals.

M. 8403. ? Third metacarpal.

C. 7947, C. 7974, C. 7978, C. 8343, C. 8407, C. 9063, C. 9274. ? Third metacarpals.

C. 8405, C. 9237. ? Second metacarpals.

The collection in Cairo also includes numerous other specimens of metacarpals.

C. 8413. Pelvis of very large individual (? *A. andrewsi*). This specimen is quite complete and is figured (text-figs. 26, 27) and described (pp. 47–49).

M. 8812. Pelvis of a smaller individual. *Presented by the Egyptian Government,* 1904.

M. 8395. Right os innominatum. *Presented by the Egyptian Government,* 1903.

M. 8492. Right ilium. *Presented by the Egyptian Government,* 1903.

The Cairo Museum also contains several other more or less nearly perfect pelves of this species.

The dimensions (in centimetres) of the two most nearly complete pelves are :—

	C. 8413.	M. 8812.
Greatest width between outer angles of ilia	127·7	111
,, ,, of ilium (from upper to outer angle of crista)	74·5	60·5
Width between upper (sacral) angles of ilia	16	10
,, of pelvic opening	48	41·5
Length of ischio-pubic symphysis	16·7	11·5
Long diameter of obturator foramen	15·2	14·7
Short ,, ,, ,,	7·5	6·2
Length from symphysis to ischial tuberosity	24	23·5
Long diameter of acetabulum	12·4	11·4
Short ,, ,,	9·6	9·9
Distance between the centres of the acetabula	61	50
Width of ilium immediately above acetabulum	16·9	15·1
,, pubis at middle of obturator foramen	7·4	4·7
,, ischium ,, ,, ,,	5·8	5·5
Length from posterior end of symphysis to upper angle of ilium	67	57
Distance between ends of the ischial tuberosities	37·3	29

C. 8859. Right femur (text-fig. 28).

M. 8810, M. 8811. Right femora. *Presented by the Egyptian Government,* 1904.

C. 8146, C. 8149. Right femora.

C. 7928, C. 7933, C. 8148. Left femora.

M. 8466. Left femur. *Presented by W. E. de Winton, Esq., 1903.*

M. 8396. Small femur and upper half of another specimen.

Presented by the Egyptian Government, 1902.

The dimensions (in centimetres) of the above femora are :—

	C. 8859.	M. 8811.	C. 8149.	M. 8810.	C. 8146.	C. 8148.	M. 8466.	C. 7933.	C. 7928.
Length	75	68	59	57·8	53·3	75·8	71·9	66·3	58·5
Diameter of head	12·2	11·5	10·8	9	9·2	12	13·4	12	10·7
Width of middle of shaft .	13·7	11·4	10·2	9·6	8·7	13·2	13·6	11	10
„ proximal end of bone	25	21·5	19·7	15·5	17	22·5	23·3	21	21
„ distal articulation	13·7	14·5	12·5	11	10·6	14	15·1	12·7	. .
„ supracondylar expansion . . .	18	17	15·5	14·2	13·1	17·5	18·8	16·5	16

M. 8400, M. 9106. Right patellæ.

C. 9006, C. 9022, C. 9030, C. 9244. Right patellæ.

M. 8400 a, M. 8488, M. 8838. Left patellæ. *Presented by the Egyptian Government, 1903.*

C. 7960, C. 8373, C. 9025. Left patellæ.

The dimensions (in centimetres) of some of these patellæ are :—

	M. 9106.	C. 9006.	C. 9030.	M. 8400 a.	C. 9025.
Length	19·8	17·2	16·5	17·3	15·5
„ of articular surface	10·4	8	9·1	?	7·6
Width	10·5	10·4	10·0	10·4	9·7

M. 8397 a. Right tibia. *Presented by the Egyptian Government, 1902.*

C. 8171, C. 8874, C. 8878, C. 8880. Right tibiæ.

C. 8165, C. 8876–7. Left tibiæ.

M. 8397 b. Left tibia. *Presented by the Egyptian Government, 1902.*

M. 8813–14. Left tibiæ. *Presented by the Egyptian Government, 1904.*

The dimensions (in centimetres) of the above tibiæ are :—

	C. 8874.	C. 8878.	C. 8171.	C. 8880.	C. 8877.	C. 8165.	M. 8813.	M. 8814.	C. 8876.
Length	39·9	37·7	32·9	28·6	42	41·5	38·7	33·8	33
Width of proximal end .	15	14·3	11·5	11·9	16·3	15·7	15·5	14·9	18
„ distal end . .	14	11·8 app.	9·2	9·5 app.	9 (?)	13·3	13·5	13	11·7
„ middle of shaft .	7·9	7·1	5·5	5·8	8·5	8·5	6·6	6·5	6·9

M. 9107. Left fibula. Length 41 cm., width of distal end 9·3 cm.

Presented by the Egyptian Government, 1904.

C. 8889. Right fibula. Length 37·7 cm., width of distal end 7·5 cm.

M. 9108. Cast of the above specimen.

M. 8859. Distal ends of two fibulæ.   *Presented by the Egyptian Government, 1904.*

M. 8402, M. 8844 (2), M. 9103. Right astragali.   *Presented by the Egyptian Government, 1904.*

C. 8398, C. 8403, C. 9027, C. 9054. Right astragali.

M. 8402 a, M. 8488, M. 8844 a, M. 9104. Left astragali, the first figured in text-fig. 32, 2.
Presented by the Egyptian Government, 1904.

C. 8382, C. 9016, C. 9029. Left astragali.

The dimensions (in centimetres) of some of the above astragali are :—

	C. 8398.	C. 9027.	M. 8402 a.	M. 8844.	M. 9104.	C. 9054.
Greatest width of tibio-fibular surface	11·8	11·4	10·5	10	9·2	8·6
„ „ naviculo-cuboid surface	12·4	?	10·6	10·5	8·8	9
„ „ calcaneal surfaces	10·4	10·2	9·4	9·5	8·2	8
„ „ the bone as a whole	13·4	11·2	10·5	11·5	10	10
Thickness from middle of tibial surface to middle of calcaneal surface	6	6·6	6·1	6	4·8	5·4

M. 8843. Left calcaneum of very large size.   *Presented by the Egyptian Government, 1904.*

C. 9041, C. 9062. Left calcanea of very large size.

C. 9033, C. 9267. Left calcanea.

M. 8843 a, M. 9105. Left calcanea, the second figured in text-fig. 32, 1.

C. 9267. Left calcaneum.

C. 7949. Right calcaneum of large size.

C. 7980, C. 7994, C. 9266. Right calcanea.

The dimensions (in centimetres) of some of the above calcanea are :—

	M. 8843.	C. 9041.	C. 9062.	C. 9267.	M. 9105.	M. 8843 a.
Extreme length	15	14·7	14·1	11·2	11	8·9
Width of astragalo-fibular surface	13·5	12·5	12·9	10 (?)	13	11·5
„ cuboid surface	3·8	3·7	3·6	..	3·6	3
Height to top of astragalar surface	10	10	9·8	6	9·2	8

It is probable that some of the largest of these calcanea belong to *A. andrewsi*.

M. 8421. Left navicular (text-fig. 33).

C. 9017. Left navicular.

C. 7969. Right navicular.

The dimensions (in centimetres) of two of these naviculars are :—

	M. 8421.	C. 7969.
Width of astragalar surface	8·0	5·5
Greatest depth	4·0	3·5
Width of distal surface	10·8	8·5

M. 8405.   Right cuboid (text-fig. 34).   *Presented by the Egyptian Government*, 1904.

C. 8327.   Right cuboid.

M. 8834.   Left cuboid.   *Presented by the Egyptian Government*, 1904.

C. 9024.   Left cuboid.

C. 7971, C. 9036, C. 9059.   Cuboids.

The dimensions (in centimetres) of some of these cuboids are :—

	C. 8327.	C. 7971.	M. 8405.	M. 8834.
Width of astragalar surface	5·2	4·7	4·5	4·3
,, distal end of bone	6·6	5·2	6·5	5·8
Greatest depth	4·0	..	4·3	3·7

C. 9051.   (?) Middle metatarsal (text-fig. 35, 2).

C. 9273.   Lateral metatarsal (text-fig. 35, 1).

M. 8413.   Middle metatarsal.

M. 8403 (2).   Middle metatarsals.   *Presented by the Egyptian Government*, 1902.

M. 8403 a. Lateral metatarsal.   *Presented by the Egyptian Government*, 1902.

C. 9061.   ? Metatarsal.

Arsinoitherium andrewsi, Lankester.

[Plate IV. figs. 2, 3 ; text-fig. 38.]

1903. *Arsinoitherium andrewsi*, E. R. Lankester, The Sphere, Sept. 1903, quoted in Geol. Mag.
[4] vol. x. p. 531.

1904.   ,,   ,,   C. W. Andrews, Geol. Mag. [5] vol. i. pl. vi. figs. 1–3.

Type Specimen.—A left maxilla with *pm.* 2–*m.* 3 and the associated mandible with *i.* 2–*m.* 3, three cervical vertebræ, the distal half of a left humerus (text-fig. 38), and a right ulna ; British Museum.

This species is distinguished from *A. zitteli* by its much greater size, its dimensions being nearly half as large again. The mandible attains a length of about 73 cm. ; the length of the three posterior upper premolars and the molars taken together is 34·5 cm. The lower premolars appear to have their crowns somewhat more compressed from within outwards than is the case in the type species, otherwise the dentition is closely similar in the two forms. The enormously massive humerus has its condyles rather more strongly developed than in the other species, and the flattening of the posterior face of the femur seems to be even more strongly marked.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

Text-fig. 38.

× ¼.
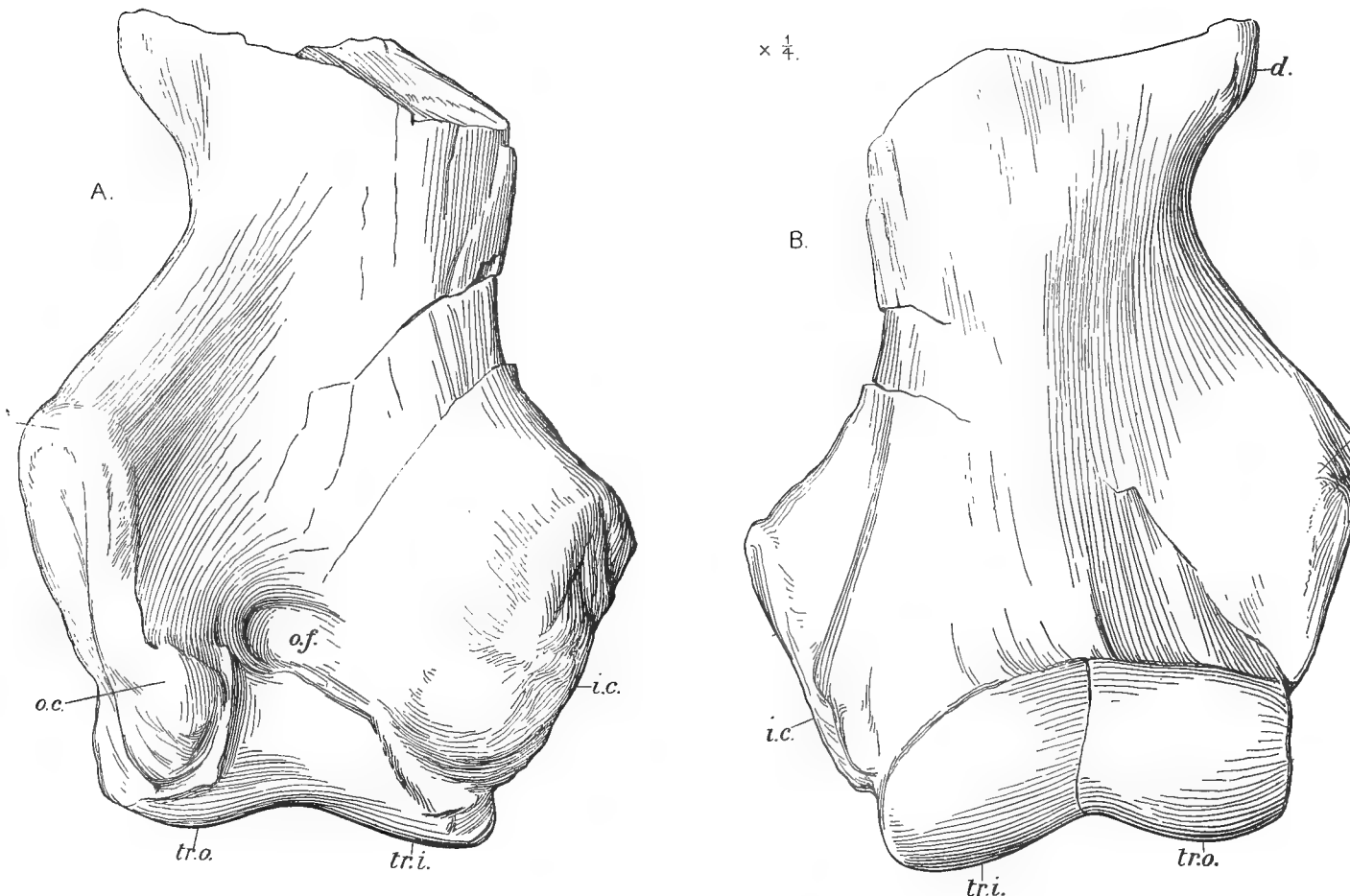
Left humerus of *Arsinoitherium andrewsi*: A, from behind; B, from front.

d., deltoid crest; *i.c.*, inner condyle; *o.c.*, outer condyle; *o.f.*, olecranon fossa; *s.r.*, supinator ridge; *tr.i.*, inner trochlea; *tr.o.*, outer trochlea. ¼ nat. size. (*Cf.* text-fig. 16 of the humerus of *A. zitteli* drawn on the same scale.)

M. 8461. The left maxilla, mandible, middle cervical, posterior thoracic, and lumoar vertebræ, distal half of left humerus, and imperfect right ulna; the type specimens, described by Lankester, *loc. cit. supra*. The teeth were figured in the Geol. Mag. [5] vol. i. pl. **vi.** figs. 1–3; see also Pl. IV. figs. 2, 3, and text-fig. 6. The dimensions (in centimetres) of the teeth are:—

	Upper.	Lower.
m. 3	7+	8·2
m. 2	7+	7·8
m. 1	7·2	6·9
pm. 4	4·1	4·1
pm. 3	3·7	3·6
pm. 2	3·5	3·4
pm. 1	?	2·5

M

The length of the upper teeth from *pm.* 2 to *m.* 3 is therefore about 34·5 cm. against about 26 cm. in *A. zitteli.* The length of the lower molar series is 23·5 cm., that of the lower premolars 14 cm. The total length of the mandible is 73 cm., its height at coronoid 43·5 cm.; width of the condyle 12·1 cm.; width of ascending ramus 22·5 cm.; depth of ramus behind *m.* 3, 11·2 cm.; length of symphysis 21·5 cm.

The almost complete cervical vertebra has a centrum which is very short in proportion to its other dimensions. Its measurements are: width of centrum 18·5 cm.; height of ditto 15·2 cm.; length of ditto 4·8 cm. The posterior thoracic and lumbar vertebræ have both lost their anterior epiphyses, indicating that the animal was comparatively young, an inference that is confirmed by the slight degree of wear of the third molar in both jaws. The dimensions (in centimetres) of the thoracic vertebra are: width of centrum 16·2; height of centrum 10·5; length of centrum without anterior epiphyses 8·2; height to tip of neural spine 24+; width at transverse processes 37. The same measurements in the case of the lumbar vertebra are 15·6, 10·8, 9·4, 30, 31·8. The dimensions of the enormously massive humerus are: width of shaft at narrowest 18; greatest width of distal expansion 34·5; width of distal articulation 23. In form this humerus (text-fig. 38) differs very little from that of the smaller species, except that the condyles are somewhat more prominent.

The length of the ulna is 60 cm. Its inner face is imperfect.

Presented by W. E. de Winton, Esq., 1903.

M. 8462. Back of skull and axis vertebra found in association. The dimensions (in centimetres) of the skull are: width above auditory opening 41; width of roof between temporal fossæ 18·5; width between outer angles of occipital condyles 24+; width of foramen magnum 9·5; height of ditto 6·5.

A maxilla and mandible (M. 8462 *a, b*) found near this skull seem to be too small to belong to the same species; thus in the maxilla the length of the molar series is only 17 cm., about the same as in *A. zitteli.*

The dimensions (in centimetres) of the axis are: length along ventral surface to tip of odontoid 17·8; width of proximal end 20·3; width of posterior face 16.

Presented by W. E. de Winton, Esq., 1903.

M. 8467. Left femur. The dimensions (in centimetres) of this specimen are: length 80; greatest width of upper end 28; diameter of the head 13·5; width of middle of shaft 16·3; greatest width of distal end 20·3; width of distal articulation 15·7.

Presented by W. E. de Winton, Esq., 1903.

As above remarked, it is probable that bones of this species may be included amongst those referred to *A. zitteli:* *e. g.* the large pelvis (C. 8413) described and figured above may belong here.

Suborder *HYRACOIDEA*.

Ungulates with plantigrade feet and a centrale in the carpus. The axis of the limb passing through the third digit; the first and fifth digits reduced in varying degrees. The radius and ulna complete and separate, at least in the young. No entepicondylar foramen in the humerus, and no clavicle. The femur with a small third trochanter; tibia and fibula complete and separate, at least in the young; fibula articulating with astragalus. The dentition heterodont and diphyodont. In the earlier forms here described the full eutherian dentition is present, and the premolars are simpler than the molars; in the later forms the dentition is more or less reduced by the loss of the canines and some of the incisors, and the posterior premolars at least are molariform. In all the anterior pair of upper incisors are enlarged and grow from a persistent pulp.

Till within the last few years this remarkable and very isolated group of Ungulate mammals was quite unknown in the fossil state. In 1898, at the Cambridge Meeting of the International Zoological Congress, Professor H. F. Osborn read a short paper on a skull from the Lower Pliocene of Samos in the Stuttgart Museum, which he showed to have belonged undoubtedly to a large Hyracoid, to which he gave the name *Pliohyrax kruppi*. This paper, illustrated by a plate, was subsequently published in the Proceedings of the Congress. Osborn regarded *Pliohyrax* as being an aquatic or semi-aquatic form. It possesses three pairs of upper incisors, the first being large trihedral teeth, much as in the later forms. The others are in contact with one another and with the canine, so that the molars, premolars, canine, and the two incisors on either side form a continuous series. Meanwhile Schlosser * pointed out that a mandible with the cheek-teeth from the Lower Pliocene of Pikermi, described by Gaudry under the name of *Leptodon græcus*, is in fact also a Hyracoid, and he drew attention to an almost complete lower jaw from Samos preserved in the Palæontological Museum at Munich. This specimen Schlosser considered to belong to the same species and possibly even to the same individual as the Stuttgart skull described by Osborn. Still later, Dr. Forsyth Major † described another skull from Samos, preserved in the British Museum, regarding this as also belonging to Gaudry's species, which he showed must be called *Pliohyrax græcus*, the name *Leptodon græcus* having the priority, but the generic term *Leptodon* having been previously employed.

* Schlosser, "Ueber neue Funde von *Leptodon græcus*, Gaudry, und die systematische Stellung dieses Säugethieres," Zool. Anzeig. xxii. (1899) pp. 378 and 385; A. Gaudry, 'Animaux Fossiles et Géologie de l'Attique,' 1862, p. 215, pl. xxxiv. figs. 1, 2.

† Forsyth Major, "The Hyracoid, *Pliohyrax græcus* (Gaudry), from the Upper Miocene of Samos and Pikermi," Geol. Mag. [4] vol. vi. 1899, p. 547.

The occurrence of Hyracoids in Samos and Pikermi, associated with an African type of fauna including such forms as *Orycteropus* and giraffe-like animals, pointed strongly to Africa as the early home of these animals, as was suggested by Osborn, Stehlin, and others. The correctness of this view is now amply proved by the discovery in the Upper Eocene beds of Egypt of a number of Hyracoids, some of them of considerable size. Unfortunately, at present only the teeth and portions of the skull are known, and these throw little or no light on the vexed question of the affinities of this most peculiar group of mammals; in fact, it is most remarkable that at a period so remote as the Upper Eocene so little difference from the modern types existed that, so far as can be seen, the Hyraces were almost as distinct from other groups of mammals as they are at the present day. The only point of importance in which these earlier forms are more primitive, is in the possession of premolars which are all simpler than the molars. The presence of a talon in the posterior upper and lower molars seems to be of no special significance, since its absence in the later forms is a recently-acquired character, the roots that supported this posterior lobe still remaining and in some cases traces of the talon itself of the last lower molar being preserved.

It is to be hoped that remains of members of the order may be found in the Middle Eocene beds, so that some light may be thrown on the relationship of this with other groups. All that can be said at present is, that in Upper Eocene times in the Ethiopian Region the Hyracoidea formed a very important factor in the fauna.

Family SAGHATHERIIDÆ.

Hyracoids which possess the full eutherian dentition in the upper jaw. The anterior incisors modified to form trihedral rootless tusks; *i.* 1 and *i.* 2 separated from one another and from the teeth in front by diastemata. Canines premolariform and in contact with the anterior premolar. Cheek-teeth brachyodont; premolars simpler than the molars; a talon to the last lower molar.

Genus SAGHATHERIUM, Andrews & Beadnell.

[Prelim. Note on some new Mammals from the Upper Eocene of Egypt, p. 5 (Survey Department, Cairo, 1902).]

Hyracoids of small and medium size. Postero-internal cusp scarcely at all developed in the premolars, even in *pm.* 4. Incisors with only one root.

Saghatherium antiquum, Andrews & Beadnell.

[Plate VI. fig. 6 ; Plate VII. figs. 4, 5.]

1902. *Saghatherium antiquum*, Andrews & Beadnell, *loc. cit.*, fig. 4.

Type Specimen.—Portions of a skull, including a considerable part of the roof and the maxillæ, that of the right side containing the molar and premolar series (Pl. VII. figs. 4, 5) ; Geological Museum, Cairo.

The type species, with molar-premolar series measuring 5·7 cm. in length.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

Skull (Pl. VII. figs. 4, 5).—From the portion of the skull-roof preserved, it can be seen that there was a well-marked sagittal crest which bifurcated some distance behind the orbits, the strong temporal ridges thus constituted running outwards and becoming continuous with the hinder border of the very prominent supraorbital processes (*so.p.*). The temporal ridges are borne on the parietals (*pa.*), the suture between those bones and the frontals running in front of the ridges on the roof of the skull, and only crossing them at the base of the supraorbital processes. In modern Hyraces this suture is usually situated still more anteriorly, so that the whole or part of the supra-orbital processes is formed by the parietals, a most unusual condition, towards which, however, these Eocene forms thus show a distinct tendency. In the fossil the end of the postorbital process is broken away on either side, so that it is not possible to determine with certainty whether the orbit was closed behind or not ; but the probability is that it was, for not only is the broken end of the process of considerable thickness, but there is on the jugal also the broken end of a postorbital process of considerable size. The supraorbital region of the frontals is very broad and flat ; it overhangs the orbit to a great extent as in *Hyrax* (*Procavia*).

The floor of the orbit is formed mainly by the maxilla, but the stout jugal extends forwards, forming its inferior border, and, as already mentioned, bore a postorbital process, here broken away. The posterior border of the zygomatic process of the maxilla arises just opposite the hinder lobe of the last molar. In *Hyrax* it is further forwards, about opposite the front of the second molar. The hard palate seems to have extended further back than in the recent forms, and reached the level of the posterior end of the last molar ; in *Hyrax* it terminates about opposite the end of the second molar. The palatine forms a considerable part of the hinder region of the palate, and there is a pair of small posterior palatine foramina. The rest of the skull is too fragmentary for description.

Dentition (Pl. VII. fig. 4).—The molars and premolars of the right side are in an excellent state of preservation. Immediately in front of *pm.* 1 is the broken base of a two-rooted tooth, the canine (*c.*), which, judging from other specimens, must have been premolariform. Its hinder root is large and transversely elongated, the anterior

small and circular in section. The cheek-teeth are somewhat more brachyodont than in the recent Hyraces, even than in *Procavia (Dendrohyrax) dorsalis*. In general structure the molars are very similar to those of the species just referred to; but, on the other hand, the premolars are widely different from those of all recent forms in being much simpler than the molars. In the following description, when comparison is made with recent forms, the brachyodont types like *Dendrohyrax* are intended unless it is otherwise stated.

The upper molars (Pl. VI. fig. 6; Pl. VII. fig. 4) consist essentially of a complexly-folded ectoloph and a pair of internal pyramidal cusps, from the antero-external angles of which ridges run towards the parastyle and mesostyle respectively. These ridges may include rudimentary intermediate cusps, the protoconule and metaconule. In an advanced state of wear these ridges become continuous with the wear-surface of the ectoloph. The ectoloph is composed of five elements, the styles, especially the parastyle (*ps.*), being well developed. The main outer cusps (antero-external and postero-external, *a.e.* and *p.e.*) form projections both internally and also on the outer face of the ectoloph in the valleys between the styles. There is just a trace of the cingulum on the outer face of the tooth; it is more pronounced on the inner half of the anterior face and is also present on the inner face between the antero-internal and postero-internal (*a.i.* and *p.i.*) cusps. The last molar is the largest, its size being increased by the presence of a small posterior lobe formed by the metastyle (*mts.*) and a ridge forming the hinder border of the tooth, and probably including the hypostyle (*hs.*). Both the metastyle and this ridge are supported by separate roots. In recent Hyracoids the last molar is smaller than *m.* 2, owing mainly to the absence of this posterior lobe; but it is interesting to notice that in most of the last upper molars of recent forms examined by me the hinder border of the tooth is supported by two or more small and evidently degenerating roots, which seem to have persisted after the elements they originally supported have disappeared. It will be shown below that the same thing has happened even more clearly in the case of the last lower molar, the talon of which has disappeared in recent forms, though the root persists. In the first and second molars the metastyle is small and is crowded against the middle of the anterior face of the tooth behind, but there are still traces of the hypostyle ridge. Owing to the large size of the parastyle the molars imbricate slightly on their outer side.

The upper premolars (*pm.* 1–4) are all simpler than the molars; in recent forms the three posterior at least are molariform, and in the Pliocene *Pliohyrax* the last at least is so. It is difficult to correlate the cusps in these rather peculiar premolars with those of the molars. Their ectoloph is composed of three elements, of which that occupying the extreme antero-external angle of the tooth seems to belong to the cingulum, and is equivalent to the parastyle. Behind this are two other cusps separated from the parastyle and from one another by furrows; of these the anterior

is the larger; they seem to be the protocone and tritocone of Scott's nomenclature. The most peculiar feature of these teeth is, that from the postero-external cusp a ridge runs along the posterior border of the tooth, and when worn gives rise to a surface continuous with the ectoloph. It seems probable that this posterior ridge belongs to the cingulum, and may include elements equivalent to the metastyle and hypostyle; it does not seem to be comparable to the metaloph of the molars. The antero-internal cusp is large and **V**-shaped, the anterior arm of the **V** running forwards and outwards towards the parastyle, while the posterior arm extends outwards and backwards to the postero-external cusp, and seems to include a distinct element. It is probably from the increase in size of the latter, and of a minute cusp here situated immediately behind the inner end of the antero-internal cusp, that the metaloph of the molariform premolar of the later forms has arisen. At the same time it should be observed that in *Megalohyrax* the premolars are much more nearly similar in plan to the molars than in *Saghatherium*, and the change there required to convert the posterior premolar into a tooth similar to the anterior molar would be a slight one. The minute postero-internal cusp above referred to can be seen in the second, third, and fourth premolars, but is largest in the last. The anterior premolar differs somewhat from the others. Its outer wall, as in them, consists of three elements, viz. a large parastyle forming the anterior angle of the tooth, and behind this a protocone and tritocone. From the last-named a ridge, apparently composed of two cusps (? metastyle and hypostyle), forms the posterior border of the tooth. The antero-internal angle of the tooth is occupied by a large cusp (deuterocone) borne on a separate root. In the type specimen, in front of the anterior premolar are the broken roots of the canines (*c.*); the larger posterior root is oval in section, the anterior nearly circular. The series of cheek-teeth, as a whole, forms a curved line. The two last premolars are wider from within outwards than from before backwards; the second is nearly square.

No specimen of the mandible in which the teeth of the symphysial region are preserved is known; but in one in which the symphysis is present the roots or the alveoli of these teeth can be seen, and from these it appears that there were probably three pairs of procumbent incisors, of which $i. 1$ and $i. 2$ were larger than $i. 3$. All form a closed series and were not separated by any interval from those of the opposite side. The canine was a one-rooted tooth separated by a very short diastema from the anterior premolars. The two anterior premolars are each borne by two transversely oval roots; the third and fourth by three roots, of which two are anterior, while the third or posterior one is transversely elongated. In no specimen is the crown of the first premolar preserved. The other premolars each consist of a pair of **V**-shaped columns, the anterior arms of the **V**'s being much the longer; the posterior arms are placed almost transversely across the crown. At the anterior end of the anterior **V** there is a small tubercle which projects backwards and partly closes the opening of the **V**. This seems to be the parastylid of Osborn's

nomenclature. There is also a larger tubercle at the posterior end of the anterior **V**, which likewise projects backwards; this is the metastylid. There is a slightly developed cingulum on the two posterior premolars.

The lower molars are very similar to the premolars, but the column developed at the inner end of the hinder arm of the posterior **V** (the entoconid) is larger, as also is the metastylid. The third molar has a large talon with a sharp raised edge surrounding a deep fossa; this is supported by a large root. In the recent Hyracoids the talon has disappeared or is represented by a mere rudiment, but the root seems to be always present though of very small size, its function having been lost.

C. 8635. Right and left maxillæ and portions of skull. The type described and figured in 'A Preliminary Note on some new Mammals from the Upper Eocene of Egypt,' p. 5, fig. 4; also on Pl. VII. figs. 4, 5. The dimensions (in centimetres) of these specimens are :—

Width of skull-roof at the supraorbital processes . . . . . 56·0
Length of tooth-series (molars, premolars, and canine) . . . 6·2
　　　" 　molar and premolar series . . . . 5·7
　　　" 　molar series . . . . 3·4
　　　" 　premolar series . . . . 2·5
Greatest width of $m.\,3$ . . . . 1·4
　　　" 　length 　" 　. . . . . 1·5

M. 8878. Plaster casts of the above specimens. 　　　*Made in the British Museum.*

C. 10057. Two right upper molars, $m.\,2$ and $m.\,3$, the latter only slightly worn. Figured on Pl. VI. fig. 6. The width of $m.\,3$ is 1·2 cm., its length 1·4 cm.

M. 9221. Plaster cast of the above specimen. 　　　*Made in the British Museum.*

C. 8631. Fragment of maxilla with $m.\,1$, $m.\,2$, and part of $m.\,3$.

M. 8869. Three left upper molars. The width of $m.\,3$ is 1·1 cm., its length 1·3 cm.; length of molar series 2·9 cm. 　　　*Presented by the Egyptian Government, 1904.*

C. 8819. Portion of the base of a skull probably referable to this species or to *S. magnum*. This specimen includes the *basis cranii*, together with the glenoid region of the squamosal; the tympanic has been lost.

C. 8106 b. Right ramus of mandible with molars and premolars. The lengths of the teeth (in millimetres) in this specimen are: $m.\,3$, 14; $m.\,2$, 10; $m.\,1$, 8; $pm.\,4$, 7; $pm.\,3$, 6; $pm.\,2$, 6; $pm.\,1$, 5.

C. 8106 a. Portion of left ramus of mandible with $pm.\,4$ and $m.\,1$–3. The lengths of these teeth (in millimetres) are: $m.\,3$, 15; $m.\,2$, 10; $m.\,1$, 9; $pm.\,4$, 7.

M. 8868a. Right ramus of mandible with $m.\,1$–3 and $pm.\,2$–4. The lengths of these teeth (in millimetres) are: $m.\,3$, 15; $m.\,2$, 11; $m.\,1$, 9; $pm.\,4$, 7; $pm.\,3$, 6; $pm.\,2$, 5. 　　　*Presented by the Egyptian Government, 1904.*

M. 8399. Left ramus of mandible of a slightly smaller individual with $m.\,1$–3 and $pm.\,4$. 　　　*Presented by the Egyptian Government, 1902.*

Saghatherium minus, Andrews & Beadnell.

1902. *Saghatherium minus*, Andrews & Beadnell, Prelim. Note on some new Mammals from the Upper Eocene of Egypt, p. 7.

Type Specimen.—A right maxilla with the molars ; Geological Museum, Cairo.

This species, which is known only from an imperfect right maxilla with the molars *in situ*, is much smaller than *S. antiquum*, but in the structure of the molars it is apparently identical with the larger form. The length of the molar series is about 20 mm. as compared with 34 mm. in *S. antiquum*.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

C. 10011. Right maxilla with teeth. Type specimen. The dimensions (in millimetres) of the teeth are :—

	Length.	Width.
m.1	5	5
m.2	7·5	6·5
m.3	9	7

Length of the molar series 20 mm.

M. 8582. Plaster cast of the above specimen.   *Made in the British Museum.*

Saghatherium magnum, Andrews.

[Plate VI. figs. 3, 4.]

1904. *Saghatherium magnum*, C. W. Andrews, Geol. Mag. [5] vol. i. p. 214.

Type Specimen.—Right maxilla containing all the cheek-teeth (Pl. VI. fig. 3); British Museum.

A species in some respects intermediate between *S. antiquum* and *Megalohyrax minor*, not only in size but also in some points in the structure of the teeth.

The length of the molar and premolar series together is 7·1 cm., that of the molar series alone 3·9 cm.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) ; north of Birket-el-Qurun.

The last molar of this species differs from that of *S. antiquum* in having a less developed metastyle and consequently a less prominent posterior lobe. The other molars do not differ notably from those of the smaller species, except that the cingulum is rather more strongly developed. The premolars, which are greatly worn, do not seem to differ from those of *S. antiquum* except that *pm.* 1 is more quadrate in outline. The canine succeeds the anterior premolar without any interval, and consists of a small anterior cusp (parastyle) and a triangular blade which, from the presence of a slight vertical fold in the outer wall of the tooth, may perhaps

N

be regarded as consisting of two elements (*a.e.* and *p.e.*) imperfectly divided; the postero-internal angle of the tooth forms a greatly worn shelf-like projection. In this tooth, as in the premolars, the enamel of the ectoloph is very thick, so that in wear it forms a prominent cutting-edge. The suture between the maxilla and premaxilla crosses the outer edge of the alveolar border immediately in front of the canine and runs on to the face—at first upwards, then backwards. On the inner side of the alveolar border the suture runs forwards, the maxilla apparently sending a process forwards beneath the premaxilla, somewhat like that described in *Mœritherium.* As in the latter genus, this peculiarity is probably correlated with the presence of enlarged tusk-like incisors. Immediately in front of the suture is the alveolus of a single-rooted third incisor, the crown of which must have been in contact with that of the canine, so that it actually formed one of the series of cheek-teeth, which thus consists of three molars, four premolars, a canine, and the last incisor. About 4 mm. in front of this is a smaller alveolus for the second incisor. Anterior to this the alveolar border becomes concave and widens out to the socket of the great trihedral first incisor. Of this tooth, unfortunately, only the base is preserved: it is triangular in section and probably grew from a persistent pulp. The convexity on the side of the face caused by its alveolus can be traced back to the level of the first premolar. The antero-external and antero-internal faces are covered with enamel, but this is absent from the posterior face. In short, it may fairly be said that, except for the presence of the two small posterior incisors, the premaxilla and its tusk-like tooth are practically identical in form with those of the modern Hyrax, and there is no clue to the manner in which this curious modification arose.

The lower teeth are similar to those of *S. antiquum*, except that the meta- and ento-stylids are more strongly developed (see Pl. VI. figs. 4, 4 A).

M. 8398. Right maxilla and premaxilla with molars, premolars, canine, and the base of the first incisor: *i. 2* and *i. 3* are represented only by their alveoli. The type specimen described in Geol. Mag. [5] vol. i. p. 214; figured in Geol. Mag. [4] vol. x. p. 340, fig. 2, as *S. antiquum*; also on Pl. VI. figs. 3, 3 A. The dimensions (in centimetres) of this specimen are:—

Length of tooth-series (molars, premolars, canine) . . . . 7·8
     ,,   premolar series . . . . 3·2
     ,,   molar series . . . . 3·9
     ,,   *m.* 3 . . . . 1·7
     ,,   *m.* 2 . . . . 1·5
     ,,   *m.* 1 . . . . 1·0
     ,,   *pm.* 4 . . . . 1·0
     ,,   *pm.* 3 . . . . ·9
     ,,   *pm.* 2 . . . . ·8
     ,,   *pm.* 1 . . . . ·8
Total length of the specimen is 10·1 cm.

M. 8868. Portion of right ramus of mandible with the molars and three posterior premolars. Figured Pl. VI. figs. 4, 4 A. The dimensions of the specimen (in centimetres) are : length of *m.* 3, 1·9 ; *m.* 2, 1·1 ; *m.* 1, ·95 ; *pm.* 4, ·7 ; *pm.* 3, ·7 ; *pm.* 2, ·55.

C. 8057. Portion of right ramus of mandible with the premolars (*pm.* 2, and *pm.* 3 incomplete), *m.* 1, *m.* 2, and part of *m.* 3. Length of premolar series 2·6 cm. Length of *m.* 2, 1·2 cm. ; *m.* 1, ·9 cm. ; *pm.* 4, ·8 cm. Depth of mandibular ramus beneath front of *m.* 3, 4 cm.

C. 8106. Portion of a mandibular ramus of an old individual : *m.* 3 has a large crescentic talon and is much worn. The lengths (in centimetres) of the teeth are : *m.* 3, 1·8 ; *m.* 2, 1·2 ; *m.* 1, 1·9 ; *pm.* 4, ·8.

Saghatherium majus, sp. nov.

[Plate VI. fig. 5.]

Type Specimen.—Portion of right maxilla containing the canine, the first premolar, and the greater part of the second premolar ; British Museum.

An imperfectly known species provisionally referred to this genus, intermediate in size between *Saghatherium magnum* and *Megalohyrax minor.* Length of *c.* + *pm.* 1, 2, 4 cm. (in *S. magnum*, 2·2 cm.) ; of *pm.* 1, 2, 2·7 cm. (in *M. minor*, 3 cm.). Teeth considerably narrower than in *M. minor*, owing to the slight development of the inner cusp and of the postero-internal shelf.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

M. 8434. Anterior portion of right maxilla with the canine, first premolar, and the greater part of the second premolar. Type specimen. The canine is almost unworn ; it consists of a fairly high sharp main cusp, and a small anterior cusp, from which the cingulum, which is strongly developed, runs round the inner face of the tooth to its posterior angle. The outer half of *pm.* 1 is similar, but here there is a strongly developed antero-internal cusp and a postero-internal heel. *Pm.* 2 is incomplete, but it can be seen that it had a large antero-internal cusp and a postero-internal cusp on the cingulum. The lengths of the three teeth (in centimetres) are : *c.* 1·3 ; *pm.* 1, 1·4 ; *pm.* 2, 1·4. Total length of the three, 4 cm.

C. 10010. Right upper *m.* 2, probably of this species, figured on Pl. VI. fig. 5. This molar is very like that of *Megalohyrax minor*, but is smaller and has the outer main cusps forming slightly greater projections on the ectoloph. The length of the ectoloph is 1·85 cm., in *M. minor* 2·6 cm., and in *Saghatherium magnum* 1·4 cm., so that there can be no doubt that this, like the other specimen, indicates the existence of another species intermediate in size between *S. magnum* and *M. minor*, and to this the name *Saghatherium majus* may also be applied. Length 1·9 cm., width 1·9 cm.

M. 8453. Plaster cast of the above specimen.   *Made in the British Museum.*

M. 8879. Posterior portion of right ramus of mandible with the greatly worn *m.* 2 and *m.* 3 *in situ.* The length of *m.* 2 is 1·3 cm., that of *m.* 3, 1·7 cm. ; the depth of the ramus beneath *m.* 3 is 4 cm.

Genus **MEGALOHYRAX**, Andrews.

[Geol. Mag. [4] vol. x. (1903), p. 340.]

Hyracoids of large size. The postero-internal cusp of the posterior premolars well developed, at least in *pm.* 4. In some species the two posterior incisors have two roots.

Megalohyrax eocænus, Andrews.

[Plate VI. figs. 1, 2; text-fig. 39.]

1903. *Megalohyrax eocænus*, C. W. Andrews, Geol. Mag. [4] vol. x. p. 340, fig. 1.

Type Specimen.—Right maxilla with the canine, premolars, and molars (Pl. VI. fig. 2); British Museum.

The type species, in which the length of the molar and premolar series together is 16·2 cm., that of the molars alone 8·6 cm.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

Dentition (Pl. VI. fig. 2).—The teeth are brachyodont and form a slightly curved series, which, so far as the molars and premolars are concerned, is traversed from end to end by a well-marked valley lying between the ectolophs of the teeth on the one hand and the inner cusps on the other.

In the upper molars the ectoloph is **W**-shaped, the parastyle and mesostyle being strongly developed, while the metastyle seems to have been wanting except in the last molar. In this tooth there is a small posterior lobe formed by the metastyle (*mt.s.*) and hypostyle (*h.s.*), but it is much smaller than in *Saghatherium* and the tooth is consequently more quadrate in outline. Behind the parastyle and mesostyle in *m.* 3 and behind the mesostyle at least in *m.* 2 there are small accessory styles (*ac.s.*) on the cingulum: these have been observed in this species only. The main cusps of the ectoloph (*a.e.* and *p.e.*) are **V**-shaped and form no projection on the outer wall of the tooth. The inner cusps are large and wear to a **V**-shaped surface, the anterior arms of the **V**'s running outwards and forwards to the parastyle and anterior end of the postero-external cusp respectively. The cingulum is slightly developed on the inner half of the anterior face and on the anterior half of the inner side of the tooth.

The premolars are all simpler than the molars. The outer half of *pm.* 4 is wanting, but *pm.* 3 is complete. Its ectoloph is composed of three elements, an anterior parastyle (*ps.*) and a pair of subequal cusps separated externally by a slight fold. On the outer side of the tooth there is a small tubercle on the cingulum, most probably the mesostyle (*ms.*). The inner half of the tooth consists of a large antero-internal cusp exactly similar to the antero-internal cusp of the molars and like it giving a **V**-shaped surface in wear. Behind this on the extreme edge of the postero-

internal angle of the tooth is a small element, which is larger in *pm.* 4 than in *pm.* 3, and absent in the other premolars, in which the postero-internal angle of the tooth forms a shelf-like surface bordered by the cingulum.

The canine is much worn, but seems to consist of a single blunt cusp borne on two roots. Its posterior border is in contact with the anterior premolar. In front of the canine the edentulous alveolar border of the maxilla extended for some distance.

The width of the palate between the last premolars is 6·4 cm., and anteriorly it must have been very concave from side to side.

Skull (Pl. VI. fig. 1 ; text-fig. 39).—A premaxilla (C. 10009) of extraordinary form (Pl. VI. figs. 1, 1 A), bearing a large tusk-like anterior incisor and the alveoli of two other teeth, may be ascribed with considerable confidence to the present species. This specimen was originally referred provisionally to the problematical *Phiomia* *, but subsequently it was placed in its present position and a figure showing its probable relationship with the maxilla of *M. eocænus* was given †. The bone consists mainly of a socket for the great rootless incisor-tusk (*i.* 1) which curves round almost in an arc of a circle. The anterior border of the bone immediately above the base of the tooth is rounded and continues so for some distance up : it then becomes sharp-edged and the inner face is marked by a rough surface for union with another bone—the nasal. The actual hinder border is broken away. The outer face is rendered strongly convex in its upper portion by the socket of the great tusk-like incisor, but beneath this it is concave from above downwards, the bone thinning suddenly towards the alveolar border. The inner face beneath the surface for the nasal is marked by two broad shallow grooves and its lower edge is roughened for union with the overlapping maxilla. The palatine process (*pl.p.*) is a short stout projection which united in the middle line with its fellow of the opposite side ; the sutural surface is deepest behind ; it does not extend quite so far forwards as the anterior border of the tooth, but projects some distance behind its posterior angle.

The great first incisor (*i.* 1) is a rootless tooth, the socket of which perhaps extended even into the maxilla. It is triangular in section, one angle being anterior but rather nearer to the outer than the inner side, the outer face being narrower than the inner. The anterior faces of the tooth are both enamel-covered, the enamel being marked by slight longitudinal striæ. Both these faces are convex on the whole, but are marked by a slight longitudinal groove in the middle, that on the antero-external face being the best marked. The posterior face is without enamel ; its wear-surface extends from the sharp tip of the tooth to within a short distance of the alveolar border. Immediately behind the socket of this tooth there is a deep depression formed by the converging edges of the alveolus which meet and form the

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* Andrews and Beadnell, 'A Preliminary Note on some new Mammals from the Upper Eocene of Egypt' (Cairo, 1902).

† Geol. Mag. [4] vol. x. 1903, p. 340, fig. 2.

thin alveolar border. About 2·5 centimetres behind the large tooth are two small alveoli for a double-rooted incisor (*i.* 2), and behind this again the remains of another double-rooted tooth, the third incisor (*i.* 3). The presence of these peculiar double-rooted incisor-teeth seems to show that the same causes, whatever they may be, which gave rise to a double-rooted premolariform canine also affect the two posterior incisors, so that all the teeth behind the first incisor practically form a series of cheek-teeth.

Comparison of this premaxilla and its contained tusk with the premaxilla and incisor of a recent Hyracoid show that, as in *Saghatherium magnum*, the two are closely similar in most respects. The presence of the two posterior incisors is just what might be expected in this early form, the remarkable thing being not the difference between the Eocene forms and recent types but their great resemblance, which shows that, so far as the front of the skull is concerned, the older forms were almost as peculiar as the modern ones.

Among the specimens collected by Mr. Beadnell in 1903 is the cranial portion of a skull (text-fig. 39) which, from its resemblance to the corresponding part of the skull of *Saghatherium antiquum*, may reasonably be referred to a Hyracoid, and from its size most probably belongs to the present species.

The occipital condyles (*cond.*) are large and sharply truncated at their upper border. The foramen magnum (*f.m.*) is roughly quadrate in outline. Above and external to the condyles there is on either side a deep depression separating them from the strongly developed paroccipital processes (*p.p.*) which project below their level. The occipital surface widens out a little above the condyles and its upper border forms the middle portion of a high prominent lambdoidal crest, which is continued downwards and outwards on to the squamosal and is continuous with the upper edge of the zygomatic process of that bone. Just below the lambdoidal crest the occipital surface bears in the middle line a roughened ridge flanked by two smaller lateral ones ; this portion of the surface slopes somewhat backwards. Between the upper edge of the paroccipital process and the squamosal there is a slit-like foramen lying immediately beneath the lambdoidal crest ; laterally and external to the slit the anterior face of the paroccipital region of the exoccipital is closely apposed to the posterior face of a nearly vertical ridge of the squamosal, the two limiting a well-marked groove. Between the just-mentioned vertical ridge and the upper border of the zygomatic process is a triangular area, at the bottom of which the auditory opening must have been ; the anterior border of this depression is formed by a prominent postglenoid process (*pgl.*).

There is a strong sagittal crest (*s.c.*) running forwards from the lambdoidal ridge till it bifurcates. The temporal ridges (*p.orb.*) thus formed run out on to the posterior borders of the supraorbital processes. The brain-case is strongly rounded and slightly contracted a little behind the orbits. The frontal region (*fr.*) is very broad and flat, and closely resembles the same portion of the skull of *Saghatherium* and *Hyrax* (*Procavia*).

The basal portion of the skull is greatly crushed, but it can be seen that the condyles nearly meet below in the middle line; in front of them the basioccipital bears on either side a sharp ridge; anteriorly the basicranial axis is much contracted. The glenoid surface, formed entirely by the squamosal, is very broad and flat.

Text-fig. 39.
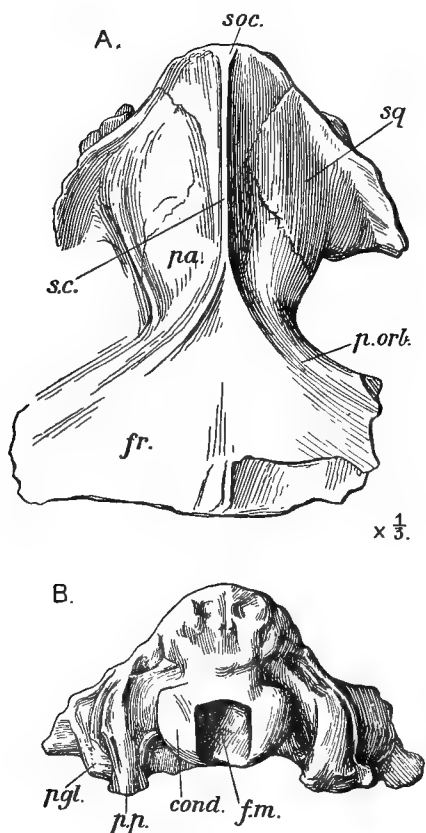
Posterior portion of skull of ? *Megalohyrax eocænus*: A, from above; B, from behind.

cond., occipital condyles; *f.m.*, foramen magnum; *fr.*, frontals; *pa.*, parietals; *pgl.*, postglenoid process; *p.orb.*, temporal (postorbital) ridge; *p.p.*, paroccipital process; *s.c.*, sagittal crest; *soc.*, supraoccipital; *sq.*, squamosal. ⅓ nat. size.

Comparison of this skull with recent forms shows that, not only in the shape of the frontal region but also in that of the paroccipital processes and their relations to the squamosal, as well as in the structure of the glenoid surface, it is very like the skull of *Hyrax (Procavia) validus*.

M. 8502. Right maxilla with canine, premolars, and molars. The type specimen described and figured in the Geol. Mag. [4] vol. x. (1903), pp. 339–341, fig. 1, and also on Pl. VI. fig. 2. On the whole the teeth are in a good state of preservation, but portions of the ectoloph

of *pm.* 4, *m.* 1, and *m.* 2 have been broken away, and *m.* 3 is not quite complete posteriorly. The dimensions (in centimetres) of this specimen are :—

Length of tooth-series (canine, premolars, and molars) . . . 17·8

„   molar series . . . . 8·6

„   premolar series . . . . 7·6

	Length.	Width.
m. 3	3·7	3·5
m. 2	3·7 app.	3·2
m. 1	3·0	2·5
pm. 4	. .	1·9
pm. 3	2·5	2·1
pm. 2	2·3	1·8
pm. 1	1·8	1·8
c.	1·8	1·2

C. 10009. Left premaxilla with *i.* 1 and the sockets of *i.* 2 and *i.* 3. Described and figured by Andrews and Beadnell in 'Prelim. Note on some new Mammals from the Upper Eocene of Egypt,' pp. 4–5, fig. 3, where it was provisionally referred to *Phiomia serridens.* Also figured on Pl. VI. fig. 1. The dimensions (in centimetres) of this specimen are :—

Length of premaxilla, so far as preserved . . . . 12·0

Depth of premaxilla beneath *i.* 2 . . . . 5·0

Length of palatine process . . . . 2·8

Length of tusk (incomplete posteriorly) in straight line . . . 14·0

„   „   projecting from alveolus . . . . 5·0

Antero-posterior diameter of tusk at alveolus . . . . . . 2·2

Lateral diameter of tusk at alveolus . . . . 1·4

M. 8144. Plaster cast of the last specimen.   *Made in the British Museum.*

C. 8801. Posterior portion of greatly crushed skull, probably belonging to this species or to *M. minor* (text-fig. 39).   The dimensions (in centimetres) are :—

Width of condyles . . . . 4·9

„   at base of zygomatic process of squamosal . . . . 15·0

„   (greatest) of brain-case . . . . .7·0

Approximate width between supraorbital processes 16

M. 8872. Plaster cast of the above specimen.   *Made in the British Museum.*

Megalohyrax minor, Andrews.

[Plate VII. figs. 1, 2, 3.]

1904. *Megalohyrax minor*, C. W. Andrews, Geol. Mag. [5] vol. i. p. 213.

Type Specimen.—Left maxilla with the molar and premolar series preserved (Pl. VII. fig. 1) ; Geological Museum, Cairo.

The length of the molar and premolar series together is 13 cm., that of the molars alone 7·5 cm.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

Upper Dentition (Pl. VII. fig. 1).—Except in their smaller size the upper molars of this species closely resemble those of *M. eocænus*, the only notable differences being the absence of the small accessory styles of the outer face of m. 1 and m. 2, and the fact that the main outer cusps form slight projections on the ectoloph. The premolars, on the other hand, differ more considerably from those of the larger species, the chief point of difference being that they are more simple. Thus in *pm.* 4 there is a fairly well-developed postero-internal cusp, but it is smaller than in the corresponding tooth of *M. eocænus*, and the tooth is less quadrate in outline. In *pm.* 3 the postero-internal cusp is practically absent and its position is occupied by a shelf-like projection ; the same is the case with the other premolars. In *pm.* 1 the antero-internal cusp also is much smaller than in *M. eocænus*, and approximates in form to the canine of that species. In fact, each of the premolar teeth of the present species resembles the next tooth in front of it in *M. eocænus*, rather than the corresponding tooth.

It can be seen that the posterior border of the zygomatic process of the maxilla is about opposite the hinder lobe of *m.* 3.

Lower Dentition (Pl. VII. figs. 2, 3).—The collection at Cairo includes portions of the right and left rami of a mandible which probably belongs to this species and possibly to the same individual as the type specimen. The portion of the left ramus preserved contains the two anterior incisors (fig. 3, *i.* 1, *i.* 2), the third and fourth premolars, and the first and second molars. The right half (figs. 2, 2 A) includes the three posterior premolars and the molars. Unfortunately, the two rami do not join, some fragments of bone being wanting, and in the left ramus the alveolar border is incomplete between the second incisor and the third premolar, so that the exact dental formula cannot be determined. The incisors (fig. 3), of which, probably, only two pairs were present, are of somewhat peculiar form, and in the present specimen they are considerably worn. The crowns are broad and spatulate, and in the case of the anterior one (*i.* 1) somewhat flattened on the anterior face. The wear-surface in each forms a narrow band along the whole of their upper edge. They show no trace of the peculiar pectinate form seen in the incisors of the recent Hyraces, but it is by no means impossible that this may have existed in the unworn tooth.

The cheek-teeth (fig. 2), so far as known, form a closed series. The molars consist of two crescents : the postero-internal end of the anterior crescent terminates in a cusp (*ai.*) which is joined posteriorly with another small cusp, which partly closes the opening of the posterior crescent. This cusp is the metastylid (*msd.*), and is strongly developed in all the teeth from the third premolar back. In *pm.* 2 it is not present. The third molar has a small talon (*t.*) giving a crescentic surface in wear. The cingulum is fairly well developed on the outer side of the last premolar and in the molars.

The mandibular ramus is massive and does not deepen so rapidly from before backwards as in the other members of the group. The symphysis is short and extends to the level of the posterior lobe of *pm.* 2. Its ventral surface is marked by a slight prominence, behind which, and forming the ventral border of the mandible for a short distance, is a strong ridge for the attachment of a powerful muscle (? the mandibular): the same arrangement is very well marked in *Hyrax (Procavia)*. The ascending ramus is broad ; its inner border is formed by a ridge continuous with the alveolar border, while the outer rises on the outer face of the ramus beneath *m.* 3. The inner border, about 3 cm. above the talon of *m.* 3, turns sharply outwards and joins the outer border to form the thin anterior edge of the coronoid process : exactly the same arrangement may be seen in the mandible of *Hyrax (Procavia)*. At the bottom of the fossa thus formed behind the last molar, a foramen opens into a passage, the other aperture of which is on the inner face of the posterior portion of the jaw.

C. 8818. Left maxilla with molars and premolars. Type specimen described in the Geol. Mag. [5] vol. i. (1904) p. 213. Figured on Pl. VII. fig. 1. The dimensions (in centimetres) of the specimen are : length of *m.* 3, 2·9 ; *m.* 2, 2·6 ; *m.* 1, 2·1 ; *pm.* 4, 1·7 ; *pm.* 3, 1·5; *pm.* 2, 1·4 ; *pm.* 1, 1·5. The total length of the molar-premolar series is 13, that of the molar series alone 7·5.

M. 8870. Plaster cast of the above specimen.

C. 8822-3. Portions of a mandible including the greater part of the right ramus with *pm.* 2-4 and *m.* 1-3, and the anterior portion of the left ramus with part of the symphysis containing *pm.* 3-4, *m.* 1-2, and in front two incisors, probably *i.* 1 and *i.* 2. Figured on Pl. VII. figs. 2, 3. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
m. 3	3·3	2
m. 2	2·3	1·8
m. 1	1·9	1·6
pm. 4	1·8	1·6
pm. 3	1·6	1·4
pm. 2	1·7	1·1

Length of series from *pm.* 2–*m.* 3 inclusive, 12·7 cm. The widths of the crowns of the incisors are : *i.* 1, 1·4 cm.; *i.* 2, 1·6 cm.

M. 8871. Plaster casts of the above specimens.

M. 9220. Left ramus of mandible with *m.* 2-3, *pm.* 3, and part of *pm.* 4.

Suborder *PROBOSCIDEA.*

Bones of skull, particularly those of the cranial region, with a strong tendency to the great development of the diploë; an alisphenoid canal; no condylar foramen. Molars lophodont, passing from a bilophodont, brachyodont type in the earliest forms to a very hypsodont condition with numerous transverse crests in the later. Second upper incisors enlarged to form tusks. Feet, where known, pentadactyl and digitigrade with taxeopod structure: a centrale in the carpus, at least in the young. No entepicondylar foramen in the humerus. Radius and ulna, tibia and fibula complete and separate from one another. No third trochanter in the femur. Astragalus articulating distally with the navicular only. Calcaneum with large fibular facet.

Family MŒRITHERIIDÆ.

Comparatively small animals about as large as the Tapir. Skull with greatly elongated cranial region, the orbits being placed far forwards and the nares nearly terminal; probably a small proboscis was present. More than one pair of incisors in upper and lower jaws: molars quadritubercular and bilophodont.

Genus MŒRITHERIUM, Andrews.

[Tageblatt des V. Internationalen Zoologen-Congresses, No. 6, p. 4, Berlin, 1901 (Verhandlungen, p. 528).]

Dental formula :—$i. \frac{3}{2}$; $c. \frac{1}{0}$; $pm. \frac{3}{3}$; $m. \frac{3}{3}$.

The second incisors in both jaws greatly enlarged and tusk-like. The last premolar not bilophodont; molars bilophodont.

This genus is represented by several species, of which *Mœritherium lyonsi* is the type. It is found in both the Middle and Upper Eocene deposits of the Fayûm.

Skull (Pl. VIII.; Pl. IX. fig. 1; Pl. X. figs. 3, 4; text-fig. 40).—The following description of the skull is founded mainly upon a nearly complete specimen (Pl. VIII.; Pl. IX. fig. 1) belonging to a young individual, in which the second incisors and third molars are still uncut. This skull (C. 7867) is from the Upper Eocene beds, but does not seem to differ in structure from the less nearly perfect specimens from the Qasr-el-Sagha beds (Middle Eocene). In some cases references will be made to some of these other specimens when they supply more satisfactory information on any point.

In its general form the skull is long and somewhat depressed, with very strong and

prominent zygomatic arches.   The cranial region is nearly twice as long as the facial region.   The dorsal surface is straight or very slightly concave from before backwards, the highest portions of the skull-roof being the point of junction of the lambdoidal and sagittal ridges posteriorly and the nasals anteriorly.   The anterior prominence is probably due to the deepening of the premaxillæ and maxillæ, resulting from the great enlargement of the second pair of incisors.   The orbit is very small and is open

Text-fig. 40.
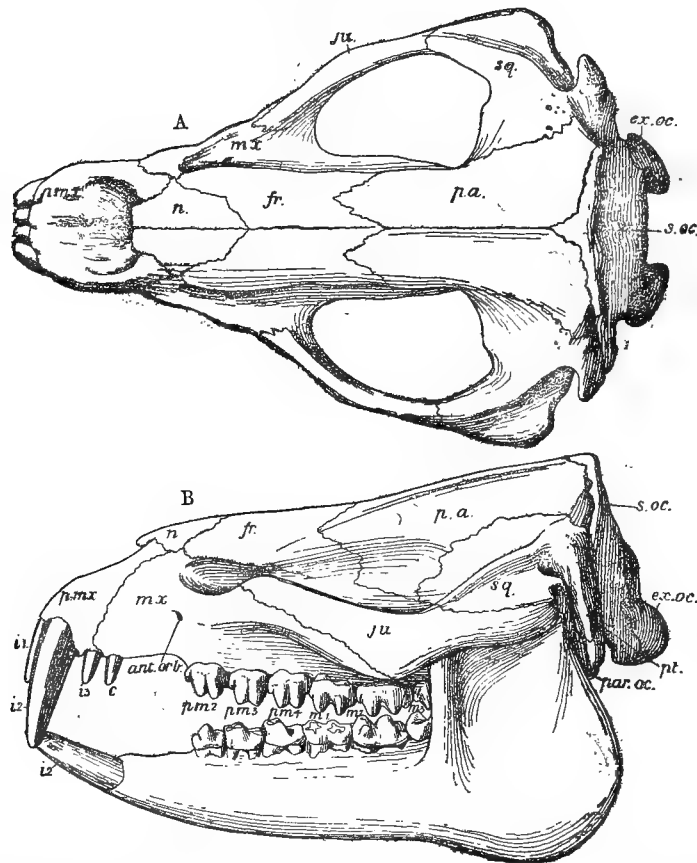
Restored skull and mandible of *Mœritherium lyonsi*: A, from above; B, from left side.

ant.orb., antorbital foramen; *ex.oc.*, exoccipital; *fr.*, frontal; *ju.*, jugal; *mx.*, maxilla; *n.*, nasal; *pa.*, parietal; *p.mx.*, premaxilla; *pt.*, post-tympanic process of squamosal; *s.oc.*, supraoccipital; *sq.*, squamosal.   *i.* 1, *i.* 2, *i.* 3, incisors; *c.*, canine; *pm.* 2, *pm.* 3, *pm.* 4, premolars; *m.* 1, *m.* 2, *m.* 3, molars.   About $\frac{1}{5}$ nat. size.

posteriorly; the postorbital process of the jugal is fairly well marked, but that of the frontal is practically obsolete.   The large anterior nasal opening is situated near the end of the snout, but is widely separated from the alveolar border, the premaxillæ being greatly deepened to carry the large incisors (Pl. IX. fig. 1 and Pl. X. fig. 3).   The internal narial opening in this specimen is opposite the front of the still uncut

third molar, but in older skulls in which this tooth has come into wear the opening is opposite its hinder end. The palate is narrow and the cheek-teeth are arranged in straight and parallel series.

The *basioccipital* (Pl. VIII. fig. 1 A, *bo.*) is broad and regularly convex from side to side, at least posteriorly. Anteriorly the crushing that has been undergone obscures both the form of the bone and its relations to the *basisphenoid*, nor are these points better seen in other specimens. Posteriorly it is deeply notched by the ventral border of the foramen magnum, and laterally it forms the lower ends of the occipital condyles. External to the basioccipital is a large foramen, in part no doubt the *foramen lacerum posterius* (*f.l.p.*) ; the postero-internal angle of this opening forms a notch at the point of union of the basioccipital and exoccipital bones, probably representing the condylar foramen.

The *exoccipitals* (*exo.*) are very large, and the condyles are strongly convex from above downwards, but less so from side to side. Above the condyles and over the foramen magnum the bones rise nearly vertically, meeting in the middle line in a suture about 3 cm. long, thus excluding the supraoccipital from the foramen. Laterally and ventrally the exoccipital forms the inner and lower portion of a great flange of bone, of which the outer part is formed by the squamosal. This plate of bone adds greatly to the width and depth of the occipital surface of the skull, and its ventral angle is the equivalent of the paroccipital process of the exoccipital (*p.p.*). In the later type, *Palæomastodon* (Pl. XII. fig. 1), the exoccipital region is drawn out in such a way that the condyles project to a much greater degree behind the occipital surface, which slopes forwards instead of being nearly vertical. At the same time the flange of bone just described is, as it were, pulled out to form the surface lying between the hinder border of the glenoid cavity and the occipital condyles, which surface is likewise constituted by the squamosal and the paroccipital portion of the exoccipital (see Pl. XII. fig. 1, *p.p.*). In fact, the differences between this region of the skull in *Mœritherium* and *Palæomastodon* are just such as would be produced, if the skull of the former consisted of a plastic material and the condyles were pulled backwards so as to lengthen the interval between them and the glenoid surface. As will be pointed out in the description of the skull of *Palæomastodon*, the paroccipital process is there represented by a blunt tuberosity only.

The *supraoccipital* (*soc.*) is a large somewhat shield-shaped bone. Its upper border, forming the upper portion of the lambdoidal crest, is nearly semicircular in outline. At its summit the bone is greatly thickened (Pl. VIII. fig. 1), and sends forwards a triangular process between the hinder ends of the parietals, but there does not appear to be any separate interparietal. The occipital surface is raised in the middle line into a vertical ridge, on either side of which there is first a slight concavity and then a convexity: this median ridge with its accompanying lateral depressions is the predecessor of the great depression and ridge for muscle-attachment found in

Palæomastodon and the later Proboscidea. The supraoccipital, together with that portion of the exoccipitals above the *foramen magnum,* forms a sort of escutcheon-shaped area, which projects a little behind the rest of the occipital surface formed by the exoccipital-squamosal plate above referred to. One peculiar feature is, that between the lower end of the lambdoidal border of the supraoccipital and the occipital region of the squamosal, a small triangular process of the parietal is interposed, this bone thus assisting in the formation of the occipital surface (Pl. VIII. fig. 1 B, *pa.*, and Pl. X. fig. 4 A, *pa.*).

The *squamosal* (*sq.*) is a very large and massively constructed bone, in which it appears that the development of the diploë, carried to such a high pitch in later types, has already begun; and on the upper surface of the bone above the auditory opening there are several foramina (Pl. VIII. fig. 1, *for.*) communicating with the interior, just as in *Palæomastodon*: this inflation of the squamosal is especially well shown in the type skull of *M. gracile* (Pl. XVII. fig. 2). The posterior portion of the bone forms the outer part of the occipital surface: internally it unites with the exoccipital, but it is excluded from contact with the supraoccipital by the process of the parietal above referred to. This post-tympanic region of the squamosal forms the posterior wall of the external auditory meatus (Pls. VIII., IX. fig. 1, *e.a.m.*), and closes it ventrally by uniting with the posterior edge of the glenoid surface, just as in *Palæomastodon* and the later Proboscidea. The lower border of the post-tympanic process (*pty.*) extends considerably below the glenoid surface and forms a sort of spurious postglenoid process; internally it is wedged between the glenoid surface and the paroccipital process of the exoccipital. Superiorly the squamosal unites with the parietal, the suture with which runs down to about the middle of the temporal fossa, but, owing to the condition of that part of the skull, cannot be traced further. The zygomatic process is large and projects strongly on the side of the skull. It is triangular in section: the upper edge is continued upwards on to the side of the skull, forming the lower portion of the lambdoidal ridge; the outer edge turns inwards and forms the posterior border of the glenoid surface. This surface is very large, extending from the outer edge of the zygomatic process inwards almost to the level of the pterygoid processes. It is concave from side to side and strongly convex from before backwards, particularly anteriorly. A portion of its antero-external border is formed by the hinder end of the jugal. The posterior portion of the glenoid surface is borne upon the shelf-like projection, of which the upper surface forms the floor of the auditory opening.

The *tympanic* is so much crushed and obscured by matrix that neither it nor the foramina in its neighbourhood can be described.

The *parietals* (*pa.*), as already described, send back a short process on to the occipital surface on either side. Above they unite with the supraoccipital, which sends a process between them for some distance. In front of this they meet one another in the middle line and form a not very prominent sagittal crest for some

distance; but towards their anterior end they again diverge, and the sagittal crest also divides into the feebly marked supratemporal ridges, which are continued forwards on the frontals, terminating in the neighbourhood of the orbits. Ventrally the parietals unite behind with the squamosals and probably with the alisphenoid; farther forwards with the frontals, which they overlap anteriorly to a considerable extent in a sort of squamous suture.

The *frontals* (*fr.*) are large bones which meet in the middle line, forming the flat roof of the skull between the obscure supratemporal ridges, which terminate over the small orbits, though there are no distinct postorbital processes. Anteriorly the frontals are separated by the nasals, which run back for some distance between them; they end in front in a rounded point about on a level with the anterior border of the orbits, and are separated from the premaxillæ by a short interval, owing to the fact that the nasal sends down a process which joins the maxilla. The *lachrymal* cannot be made out in any specimen examined, this region being usually very badly preserved. In one case there is on the edge of the orbit a small tubercle presumably borne on the lachrymal, but there is no evidence of a lachrymal foramen.

The *nasals* (*na.*) are fairly large bones, which run back some distance between the frontals. As they pass forwards they widen out, till at their widest point they form a short suture with the maxillæ. In front of this they again narrow between the upper ends of the premaxillæ. Anteriorly they terminate in bluntly rounded ends, which slightly (about 7 mm.) overhang the anterior narial opening. The difference between this region of the skull in *Palæomastodon* and *Mœritherium* seems to be due to the shifting back of the nares (consequent on the development of the proboscis) in the former, which leads to the reduction of the nasals and the carrying back of the facial processes of the premaxillæ till their upper ends meet the frontals and exclude the nasals from contact with the maxillæ.

The *premaxillæ* (*pmx.*), which together form the broad blunt snout, are chiefly remarkable for the depth and solidity of their alveolar region, resulting from the great enlargement of the tusk-like second incisors. The chief consequence of this modification is, that the floor of the narial cavity is raised much higher above the level of the alveolar border than usual, and the distance between it and the palate is greater. In the skull figured in Pl. VIII., a portion of the anterior region of these bones overlying the median pair of incisors is broken away, but in another specimen the upper surface of this anterior region is seen to be deeply grooved in the middle line, the depth of the groove being increased by the presence of prominent ridges on either side of it; outside these again, and separated from them by slight depressions, are the prominences formed by the large alveoli of *i.* 2. The upper surface of the bones forms the floor of the nasal cavity, which, owing to the shortness of the nasals, is exposed for some distance. The presence of the ridges and grooves on the front of the snout may indicate that there was a mobile upper lip or short proboscis requiring

extensive muscle-attachments. The facial processes of the premaxillæ form the lateral borders of the nasal opening ; above they expand slightly and unite in suture with the nasals. The suture with the maxilla runs downwards and forwards and crosses the alveolar border immediately behind *i.* 3. The palatal region is almost completely concealed by the forward prolongations of the maxillæ, which will be referred to below.

The *maxillæ* (*mx.*) are very large and greatly elongated elements ; their palatine plates are narrow and their alveolar borders are straight and parallel with one another. Posteriorly the palatine plates are separated by the palatines, which, in the specimen figured on Pl. VIII., extend forwards as far as the level of the anterior crest of *m.* 1. It appears, however, that some change in the relative position of the palatines and the molar series takes place as the hinder molars come into position, for in another specimen, in which the last molar is in wear, the anterior end of the palatines is opposite *m.* 2, and the posterior border of the palate opposite the hind lobe of *m.* 3. Anteriorly the maxillæ send forwards plates of bone beneath the palatine surface of the premaxillæ, extending almost up to the sockets of the anterior incisors. This same peculiarity may be seen in the later Proboscideans, in which the anterior prolongations of the maxillæ may actually help to form part of the hinder border of the alveoli of the tusks, to the support of which they greatly contribute. There seems to be a single elongated anterior palatine vacuity, lying between the premaxillæ and the slightly divergent anterior prolongations of the maxillæ. The facial portion of the maxilla meets the nasal above, thus cutting off the frontal from the premaxilla by a short interval. The relations with the lachrymal cannot be made out, but the union with the frontals forms a long straight suture running downwards and backwards ; its posterior end is obscure in all specimens. The zygomatic process arises considerably above the alveolar border ; its base is very long, its anterior end being considerably in front of the anterior premolar (*pm.* 2), the posterior opposite the hinder border of *pm.* 4. Anteriorly the process is perforated by a large antorbital foramen (Pl. IX. fig. 1, *a.o.f.*), which opens on the face immediately over the anterior end of *pm.* 2. Above it forms the floor of the orbit in front, and behind it is overlapped by the jugal. The free portion of the zygomatic process is short and stout.

The *jugal* (*ju.*) is large and forms the greater part of the zygomatic arch. Posteriorly it runs back beneath the zygomatic process of the squamosal as far as the glenoid cavity, in the formation of which it takes a small share. In front of this the bone curves gently downwards, and anteriorly it overlaps the zygomatic process of the maxilla, with which it unites in a long suture, nearly straight externally, but >-shaped on the inner face of the arch. The anterior extremity of the bone, together with the underlying maxilla, forms a small postorbital projection, which marks the posterior limit of the orbit, which was very small.

The *palatines* (*pl.*), as above described, form the hinder portion of the hard

palate, and extend forwards in the specimen figured in Pl. VIII. as far as the front of $m.1$. At their anterior end there is a pair of small posterior palatine foramina (not shown in the figure). The hinder edge of the palate is greatly thickened; so also are the vertical plates, which, with the pterygoids, bound the mesopterygoid fossa. It seems possible that these bones helped to form the inner wall of the cavity in which the uncut germ of $m.3$ lies in the specimen figured in Pl. VIII. The internal narial opening is about as deep as wide, and in its roof the *vomer* can be seen extending back to about the level of the hinder border of the palate. The *pterygoids* are too much crushed and broken for description; it appears that their thickened posterior angle was about opposite the anterior edge of the glenoid cavity.

Several casts of the cranial cavity have been obtained. The best of these, taken from a skull (M. 8898) which lacks most of the facial region, is figured (text-fig. 41). The brain is much larger in proportion to the bulk of the animal than is usually the case in the Eocene Mammalia, *e. g.* the Amblypoda; and it is possible that the early tendency towards a considerable cerebral development shown in these primitive Proboscidea is one of the causes why the group has survived and flourished through so long a period.

The olfactory lobes ($o.l.$) are large and pedunculate. They project forwards entirely in advance of the cerebral hemispheres, which are divided into anterior and posterior portions by a broad lateral groove (the pseudosylvian of Elliott Smith), which runs downwards and forwards ($p.$). The anterior (frontal) lobes ($f.l.$) are broad, rounded externally, and somewhat compressed from above downwards. The posterior (temporal) lobes ($t.l.$) project considerably beyond the frontal lobes both laterally and ventrally; they are comparatively narrow from before backwards. Posteriorly the temporal lobes are separated (in the cast) from the cerebellum by a deep fossa. In the Mastodons and Elephants there is the same division of the hemisphere into anterior and posterior lobes by a deep depression (text-fig. 42), but in these later forms the temporal lobes have become greatly enlarged and project much more both ventrally and laterally, while the frontal portions of the hemispheres are more bent down and the olfactory lobes to a great extent lie beneath them. These changes seem to be correlated, at least in part, with the general shortening-up of the skull.

The cerebellum ($cb.$) is comparatively small and narrow from before backwards; it is entirely uncovered by the hemispheres. The ventral surface of the brain is not well shown in the cast, but the position of the pituitary body and the bases of the fifth pair of nerves can be made out.

Various other details of less importance can be observed, but these need not be referred to fully here, as Dr. Elliott Smith is preparing a memoir on this brain-cast. In the section relating to the Sirenia, some account will be given of the remarkable likeness between the brain now described and that of *Eosiren*, another piece of evidence of the close relationship of the Sirenia with the Proboscidea.

P

Upper Dentition.—There are three pairs of incisors. The first pair (Pl. X. fig. 3, *i.* 1) are in close contact in the middle line ; they are comparatively small, downwardly directed, prismatic teeth, each implanted in the premaxilla by a long backwardly curved root. Their transverse diameter is roughly ·8 cm. The second incisors (*i.* 2) form great downwardly directed tusks. Their anterior face is strongly convex, the posterior slightly flattened ; the tooth as a whole is strongly curved and tapers somewhat towards the root, which, in the adult at least, is closed. There is an oblique

Text-fig. 41.
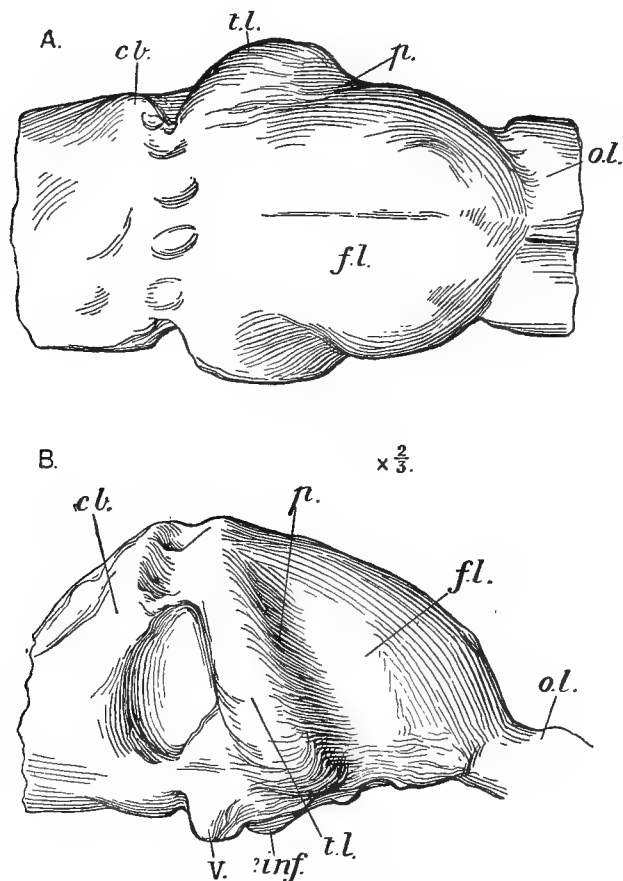
Cast of the cranial cavity of *Mœritherium lyonsi*: A, from above ; B, from right side. *cb.*, cerebellum ; *f.l.*, frontal lobe ; *inf.*, pituitary body ; *p.*, pseudosylvian depression ; *o.l.*, olfactory lobe ; *t.l.*, temporal lobe ; V., base of fifth nerve. ⅔ nat. size.

wear-surface on the posterior side of the crown. No sufficiently well-preserved specimen has been found to show whether the enamel-covering was complete or not. In one skull these tusks project some 4·8 cm. from the jaw, but as their ends are broken off above the commencement of the wear-surface, it is probable that when complete they protruded at least half as far again ; in this specimen the antero-

posterior diameter of the base of the tusk is about 2·8 cm., the lateral diameter the same. The third incisor (*i.* 3) was a small tooth, nearly circular in section, and situated immediately behind the tusk, just internal to its outer angle. This tooth is represented by its alveolus only in all specimens examined; the antero-posterior

Text-fig. 42.
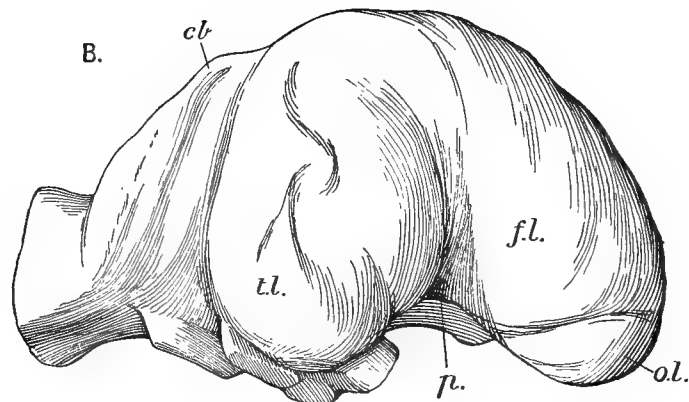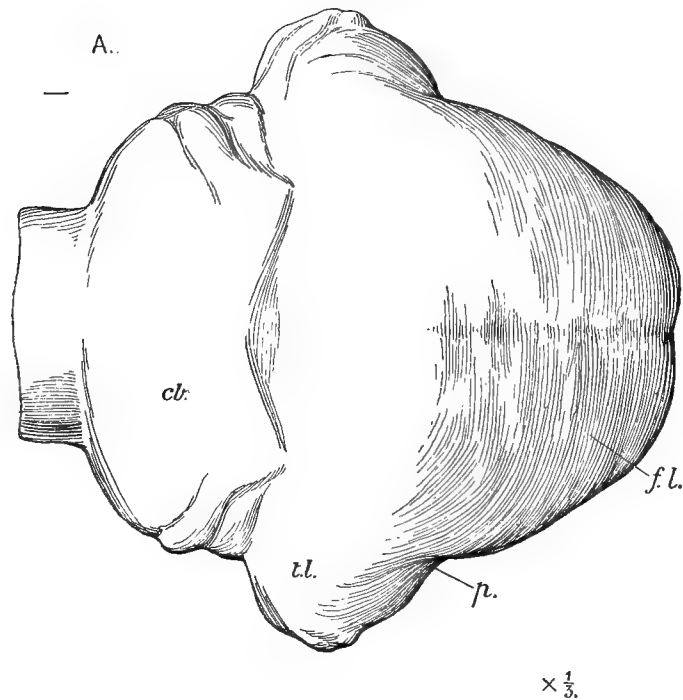
Cast of the cranial cavity of *Mastodon americanus*: A, from above; B, from right side.

cb., cerebellum; *f.l.*, frontal lobe; *p.*, pseudosylvian depression; *o.l.*, olfactory lobe; *t.l.*, temporal lobe. ⅓ nat. size.

diameter was about 1·3 cm. The canine (Pl. VIII. fig. 1 A, c.) is also known only from its alveolus, which is situated immediately behind and a little to the inner side of the socket of i. 3, which it resembles both in shape and size.

Behind the canine there is a short diastema (about 2·5 cm.). The next tooth, pm. 2 (Pl. IX. fig. 4), is roughly triangular in outline with one angle directed forwards. The crown consists of an outer row of cusps and a postero-internal shelf-like projection. The blade consists of two main cusps (a.e., p.e.) closely united and placed somewhat obliquely : of these the anterior (a.e.) is continued inwards as a transverse ridge to the inner border of the crown, where it passes into the cingulum. In front of these main cusps, and forming the anterior angle of the tooth, is a small but prominent cusp, apparently the parastyle (p.s.). Behind the main cusps also there is a small accessory cusp. The postero-internal portion of the tooth forms a broad slightly concave shelf with a raised border formed by the cingulum, which is well developed and crimped along the whole of the inner side of the tooth.

The next premolar (pm. 3) differs mainly from that just described in the presence of a large antero-internal cusp (deuterocone), which (a.i.), together with the antero-external cusp (a.e.), forms a transverse ridge. The parastyle (p.s.) is present, as also is the posterior accessory cusp. In the specimen figured in Pl. IX. fig. 4 the postero-internal shelf is much abraded, the enamel being completely worn through. The last premolar (pm. 4) is similar, but of somewhat smaller size than pm. 3.

The molars are bilophodont, each transverse crest consisting of a higher and somewhat pointed outer cusp and a lower, blunter and more worn, inner cusp. The postero-internal cusp has a tendency to be prolonged backwards into a small blunt lobe, which in wear gives rise to the pattern shown in m. 1 (Pls. VIII. fig. 1 A, X. fig. 2). This seems to be the beginning of the gradual addition of successive transverse ridges to the posterior end of the tooth so characteristic of the suborder. The cingulum is very well developed on the anterior and internal faces of the teeth. The enamel is marked by a sculpture consisting of numerous irregular grooves : these are especially marked on the cingulum, to which, in some cases, they give a beaded appearance. This sculpture is best developed in the molars of M. gracile, in which also the cingulum is especially well marked (Pl. XVII. fig. 3).

Mandible.—The horizontal rami of the mandible (Pl. X. figs. 1, 1 A) are very stout and massively constructed. The outer face is strongly convex from above downwards, the inner face nearly flat. The spout-like symphysis is long and broad ; its ventral surface is evenly convex from side to side, while the upper surface is concave in the same direction and was continuous anteriorly with the upper surface of the procumbent incisors. The mental foramen (m.f.) is situated beneath pm. 3 and somewhat nearer the ventral than the dorsal border. The thickened anterior edge of the very wide ascending ramus arises on the outer side of the jaw about opposite the anterior lobe of m. 3. It slopes somewhat forwards, and from its upper

end the superior border runs upwards and backwards at right angles to it, so that the very short coronoid process (*cor.*) does not rise above the articulation. The condyle itself (*cond.*) is elongated from within outwards and short from before backwards; it is convex in both directions and is wider on the outer than on the inner side, which is supported on a flange or buttress of bone arising from the inner face of the ascending ramus. From the condyle the posterior border runs downwards and backwards in a wide sweeping curve, forming the broadly rounded angular region which projects somewhat below the ventral border of the horizontal ramus. The outer face of the ascending ramus between the thickened anterior border and the buttress which bears the condyle is deeply concave, the bone being very thin.

Lower Dentition.—There are two pairs of incisors (Pl. X. figs. 1, 1 A, *i.* 1, *i.* 2). These teeth are procumbent and directed forwards, their upper surface forming a continuation of the spout-like upper face of the symphysial region of the mandible. The first incisors are much the smaller, and are closely crowded together between the second pair. They seem to have been prismatic teeth with very long crowns and roots; their transverse width would be about 2·5 cm. The second incisors are a pair of large tusks, which seem to have been more or less triangular in section near the top of the crown, but ovate further down. No well-preserved examples have been found *in situ* in the jaw, but two specimens which may be regarded as these teeth are here noticed. One of them is a young tooth in which wear has just commenced; the upper face of its crown is concave from side to side, the inner face flat, while the ventral face is convex and meets the upper face externally in an angle forming the sharp outer edge of the crown, which is chisel-shaped, but thicker internally than at its outer side. The wear-surface is nearly at right angles to the long axis of the tooth; it is narrow, but as wear proceeded would increase in depth till towards the base of the crown it would be such as is found in the second older tooth referred to below. The crown is covered with enamel, of which the surface is finely sculptured with vermiculate markings below and irregular longitudinal ridges above. The enamel extends much further down the upper and lower faces of the crown than on the sides. In the older tooth the wear-surface is broad, flat, and oval in outline; it is slightly inclined to the long axis of the tooth, and on the inner and outer sides has already passed below the level of the enamel-covered surface, so that the enamel forms two separate bands, one on the upper, the other on the lower face. The root is very long and slightly curved, with a longitudinal groove on the concave side. At this stage, at any rate, the root was closed.

The third incisor, canine, and first premolar are wanting in the mandible.

The anterior premolar (Pl. IX. figs. 3, 3 A, *pm.* 2) is comparatively small, and narrow from side to side. It consists of a large main cusp, in front of which there is a small tubercle which may belong to the cingulum. Behind there is a large talon rising in

the middle into a longitudinal ridge, such that when the tooth is worn the resulting wear-surface of the main cusp is continued back on this median elevation of the talon.

The next tooth (*pm.* 3) is larger and especially wider; it also consists of a high anterior portion and a posterior talon. The anterior part is composed of three cusps, one of which forms the antero-internal angle of the tooth, while behind this the other two imperfectly separated cusps form a transverse ridge. In wear, the abraded surface of the antero-internal cusp is continuous with that of the outer one of the transverse pair, and this again unites with the surface of the talon, which has a ridge towards its outer side, rising into a tubercle posteriorly.

The last premolar (*pm.* 4) is wider, and its anterior cusp is less distinctly developed than in *pm.* 3. On the other hand, the inner cusp of the transverse pair is much larger and more prominent. The talon also bears a more distinct postero-external cusp. In the third and fourth premolars the cingulum is slightly developed on the outer and posterior sides; on the latter it forms the raised edge of the talon.

The first molar (Pl. IX. fig. 2, *m.* 1) consists essentially of a pair of transverse ridges, each composed of a pair of tubercles and a small talon. The inner tubercles are somewhat higher and sharper than the outer, which are the most worn. There is a tendency to form small tubercles in the valley between the two main ridges, connecting the inner ends of the outer tubercles. The talon consists of a blunt tubercle nearly in the middle line, and a smaller, often obscure, cusp on the inner side. In the third molar (*m.* 3) the talon is much larger, the main cusp being larger and tending to become subdivided into two, while the inner cusp also is prominent, so that in this tooth the talon forms a third transverse ridge. This third molar is extremely similar to the corresponding tooth in some mandibles of *Palæomastodon*, while *m.* 1 and *m.* 2 differ considerably, owing to the small development of the third lobe; but at the same time the differences are merely of degree and not of structure. The cingulum is well developed on the outer side of the lower molars.

Of the milk-dentition only the last lower milk-molar is known. This is well shown in a portion of the right ramus of a young mandible (text-fig. 43), in which *mm.* 4 and *m.* 1 are well preserved, and beneath the former the crown of *pm.* 4 is present. *Mm.* 4 is much like the permanent molars; it is bilophodont with a small talon forming the rudiment of a third ridge.

Vertebral Column.—The vertebral column of *Mœritherium* is fairly completely known. In several cases vertebræ have been discovered associated with portions of skulls and teeth that can be definitely determined as belonging to *M. lyonsi*; and in addition to these an almost complete vertebral column has been found associated with a very imperfect skull which is undoubtedly that of a species of *Mœritherium*, though whether of *M. lyonsi* or not is uncertain. The vertebræ known to belong to *M. lyonsi* will be described first.

In the *atlas* (Pl. XI. fig. 1) the deep cups for the occipital condyles (*cond.*) in correlation

with the form of the latter are narrower from side to side than is generally the case, so that the outline of the articulation with the skull is more nearly circular than usual. The condylar cups are separated above by a slight emargination of the anterior border of the massive neural arch and ventrally by a somewhat smaller emargination of the ventral bar. The neural arch at about the middle of its length is raised into a very prominent transverse ridge, from the anterior border of which smaller and less prominent ridges run outwards and forwards to the upper angles of the condylar cups. Behind the ridge the surface of the arch slopes smoothly down to its concave posterior border. Externally to the outer ends of the above-mentioned

Text-fig. 43.
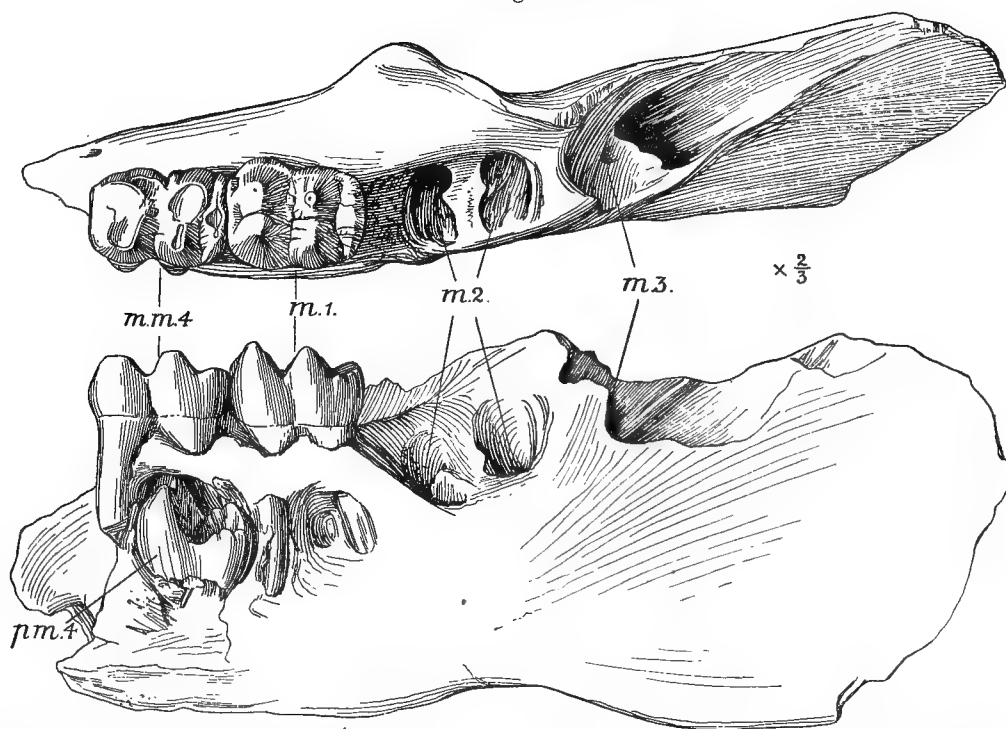
Part of right ramus of an immature mandible of *Mœritherium lyonsi*, showing *pm*. 4 *in situ* beneath *mm*. 4. $\frac{2}{3}$ nat. size.

lateral ridges the arch is perforated obliquely by the foramen for the first spinal nerve. The transverse processes (*t.p.*) are rather small and are directed upwards and backwards at their outer ends; they do not appear to be perforated by the vertebrarterial canal. Anteriorly the base of the transverse process is separated from the neural arch by a notch. The nearly flat surfaces for the axis (*a.t.*) form an angle of about 45° with the axis of the vertebral column; dorsally they are widely separated by the neural arch, and ventrally by a much shorter interval occupied by the ventral bar, which is

produced backwards in the middle line into a blunt hypapophysis and bears on its upper surface a fairly well-defined surface for the odontoid process.

In the *axis* (Pl. XI. fig. 2) the neural spine (*n.sp.*) is high and directed backwards; its sharp anterior border is convex and the thickened posterior border bears a deep fossa for the attachment of ligaments. The neural canal is high and its floor broad with a median elevation, which is continuous anteriorly with the upper surface of the odontoid. This process (*o.d.*) is relatively large, somewhat laterally compressed, and bears on its ventral surface a well-defined surface for articulation with the atlas. From the hinder border of the odontoid a hæmal ridge runs back along the centrum and deepens and widens considerably posteriorly, so that the hinder articular surface of the centrum is much deeper than broad and is produced downwards into a sort of hæmapophysis. The slightly convex surfaces for articulation with the atlas project laterally beyond the rest of the centrum to a considerable extent. Near the posterior border of the centrum there is a small transverse process perforated by the vertebrarterial canal; the small upper pedicle rises from the base of the neural arch, the larger ventral one from the centrum. The posterior zygapophyses (*p.z.*) are oval in outline.

The rest of the cervical series is not completely known. In the middle cervicals (? 3rd or 4th, Pl. XI. fig. 3) the centrum is relatively short; its articular ends are slightly concave in the middle, with a broad thickened border; and the concavity is greatest on the posterior surface. There is a slight hæmal ridge which deepens somewhat behind. The neural spines (*n.sp.*) are short, pointed, and backwardly directed processes. The large transverse processes are perforated at their base by a canal (*v.c.*) and are bifid at their extremities, the upper process being very small and directed upwards, the lower forming a large downwardly directed flange. The zygapophyses are very large. The posterior cervical differs from that just noticed in the fact that the spine is higher, while the downwardly directed flange is greatly enlarged and has a thickened ventral border. In the anterior dorsals (Pl. XI. fig. 4) the centrum is short, the anterior articular surface is oval and concave in the middle, while the posterior surface is also oval and slightly concave; externally it passes into a pair of facets (*c.f.*) for the heads of the ribs. There is a hæmal ridge. The transverse processes (*t.p.*) are short and stout : on their outer ends there is a deeply concave facet (*t.f.*) looking outwards and downwards for the tubercle of the rib. The neural spine is a high, pointed, and backwardly directed process.

A nearly complete vertebral column (C. 10005), associated with a very imperfect skull, was collected from the Middle Eocene beds, and has already been mentioned as undoubtedly belonging to a species of *Mœritherium*, possibly even to a large individual of *M. lyonsi*. Considering both the size and some differences in details of structure in such vertebræ as can be compared, it seems advisable to refer to this specimen as *Mœritherium* sp. until sufficient evidence is available either to justify regarding it as belonging to a new species or definitely relegating it to *M. lyonsi*. The vertebræ

of this column are :—the atlas, the last cervical, nineteen thoracic (in this series there is a gap, one vertebra at least being missing), four lumbars, and four sacrals.

On the whole, the atlas is like that of *M. lyonsi* described above, but differs in several minor points. Thus the transverse spinous ridge of the neural arch is wider ; the anterior border of the arch is less concave ; the transverse processes differ slightly in form and are more upturned ; the surfaces for the axis are deeper from above downwards and less extended from side to side. Some of these differences may be merely apparent and the result of abrasion or distortion.

In the last cervical the centrum bears a fairly well-marked hypapophysial ridge ; its articular ends are oval in outline, the long axis being transverse, and are slightly concave in the middle. The transverse processes are large, rising partly from the centrum and partly from the arch ; they are stout, and somewhat thickened at the obliquely truncated end. The arch is high and is prolonged upwards into a prominent neural spine. There is no trace of an articular surface for the head of the first rib.

In the first thoracic vertebra the centrum is of much the same shape as the last cervical, but the broad blunt hypapophysial ridge is almost restricted to the anterior end. The transverse processes are stout and short, terminating in a deeply concave rib-facet, looking downwards and forwards. The anterior edge of the transverse process is produced into a shelf-like projection of bone, which is continuous internally with the anterior edge of the neural arch and bears on its upper surface the broad and flat anterior zygapophyses. The neural arch is broader than in the last vertebra and the pointed neural spine slopes strongly backwards. There is a slight cup for a rib-head on the upper angle of the anterior face of the centrum, and a much deeper and more sharply defined cup on the upper angle of the posterior face.

The second thoracic is closely similar, but the tubercular facet of the transverse process looks directly downwards instead of downwards and forwards. At the same time the anterior shelf-like projection becomes smaller, and there is the first trace of a tuberosity on the upper side of the end of the process, which becomes larger till about the eighth thoracic. In this vertebra, owing to shortening, the transverse process seems to pass into the metapophysis which is largely developed in the following thoracic vertebræ.

The following five vertebræ (text-fig. 44) are generally similar, but the transverse processes become shortened and the hæmal ridge is wanting. Furthermore, in 4–7 the oval posterior capitular facet (*c.f.*) becomes very strongly concave and bordered by a prominent rim. In these first seven dorsals the neural spines (*n.sp.*) are comparatively slender, terminate in a point, and slope strongly backwards. In the eighth dorsal the form of the spine is transitional to the short broad type found in the posterior thoracic region. In this vertebra also the anterior capitular facet is merely a shallow concavity lying beneath and in front of the very short transverse process, which bears a small

slightly convex facet (*t.f.*) for the tubercle of the rib. The posterior capitular facets, as in the vertebræ in front, are deeply concave and sharply defined. The metapophysial process (*m.*) above referred to is large, and in the following two (9 and 10) vertebræ forms a prominent forwardly-projecting point which overhangs the anterior zygapophyses (*a.z.*). The eleventh thoracic is very similar, but the transverse process merely

Text-fig. 44.
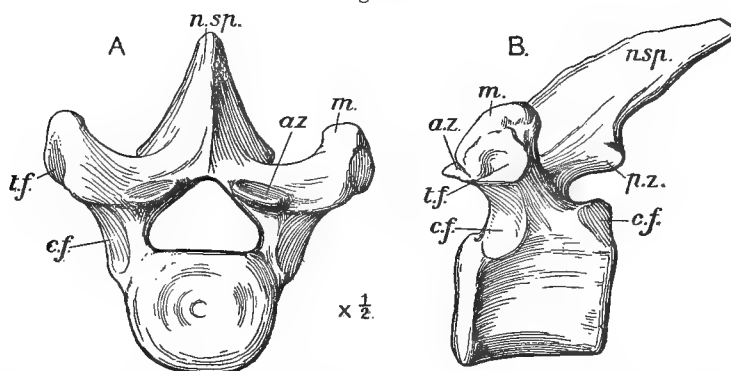
Anterior dorsal vertebra of *Mœritherium*: A, from front; B, from left side.

a.z., anterior zygapophysis; *c.f.*, capitular facet; *m.*, metapophysis; *n.sp.*, neural spine; *p.z.*, posterior zygapophysis; *t.f.*, tubercular facet. ½ nat. size.

Text-fig. 45.
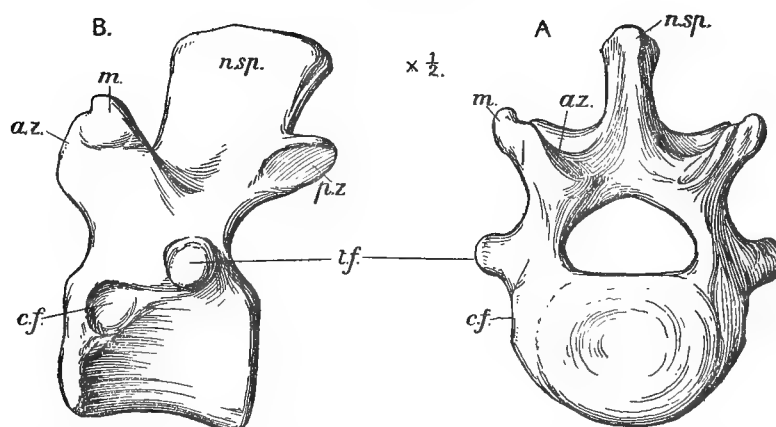
Middle dorsal vertebra of *Mœritherium*: A, from front; B, from left side.

Letters as in last figure. ½ nat. size.

forms a blunt prominence; the posterior capitular facet is extremely small, and looks almost directly backwards, while the anterior is more distinct, and forms a shallow concavity below and in front of the transverse process.

In the succeeding thoracic vertebræ (text-fig. 45) the head of each rib articulates with one vertebra only, by a deeply concave surface (*c.f.*) situated on the side of the centrum immediately below and in front of the short blunt transverse process (*t.f.*), on to the base of which the facet may be continued, at least in 12–13. It is doubtful whether the ribs of this region had any tubercular articulation with the transverse processes. In this region also (12–19) the centrum is considerably wider than high, while the neural spine (*n.sp.*) becomes gradually wider and shorter, and is only slightly inclined backwards. The metapophyses (*m.*) form quite prominent pointed processes.

The lumbar vertebræ (text-fig. 46) are four in number. Their centra become still wider in proportion to their height and have a nearly straight upper border. The transverse processes (*t.p.*) are again large, and arise on a level with the top of the centrum; in the two posterior lumbars they seem to have been pointed at their extremities. In the form of the neural spine (*n.sp.*) and the metapophyses (*m.*) these vertebræ are much like the posterior thoracic.

Text-fig. 46.
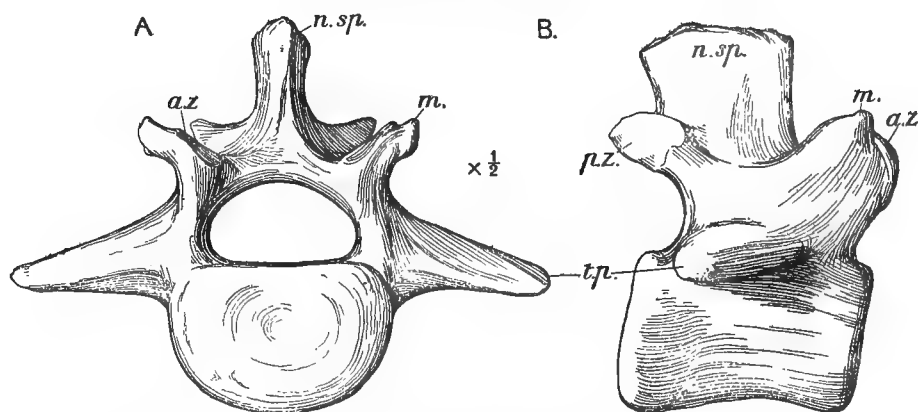
Lumbar vertebra of *Mœritherium* : A, from front; B, from right side.

t.p., transverse process; other letters as in text-fig. 44. ½ nat. size.

The sacrum (text-fig. 47) consists of three fused vertebræ, the centra of which are low and broad, the shape of their articular ends being a transversely elongated oval. The metapophyses, forming prominent forwardly directed processes, are well developed on the anterior zygapophyses (*a.z.*). The neural spines (*n.sp.*) are low and broad. The pleurapophyses are broad and stout; they unite at their outer ends, being separated only by nearly circular interosseous foramina (*io.f.*). On their fused outer ends they bear a long iliac surface (*il.s.*) which looks obliquely upwards in front and directly outwards posteriorly. The ventral surface of the sacrum is nearly flat, except near the edges of the iliac surfaces, where it is somewhat deflected. The posterior surface of the last of the fused sacrals is deeply concave. The following vertebra should perhaps

Text-fig. 47.
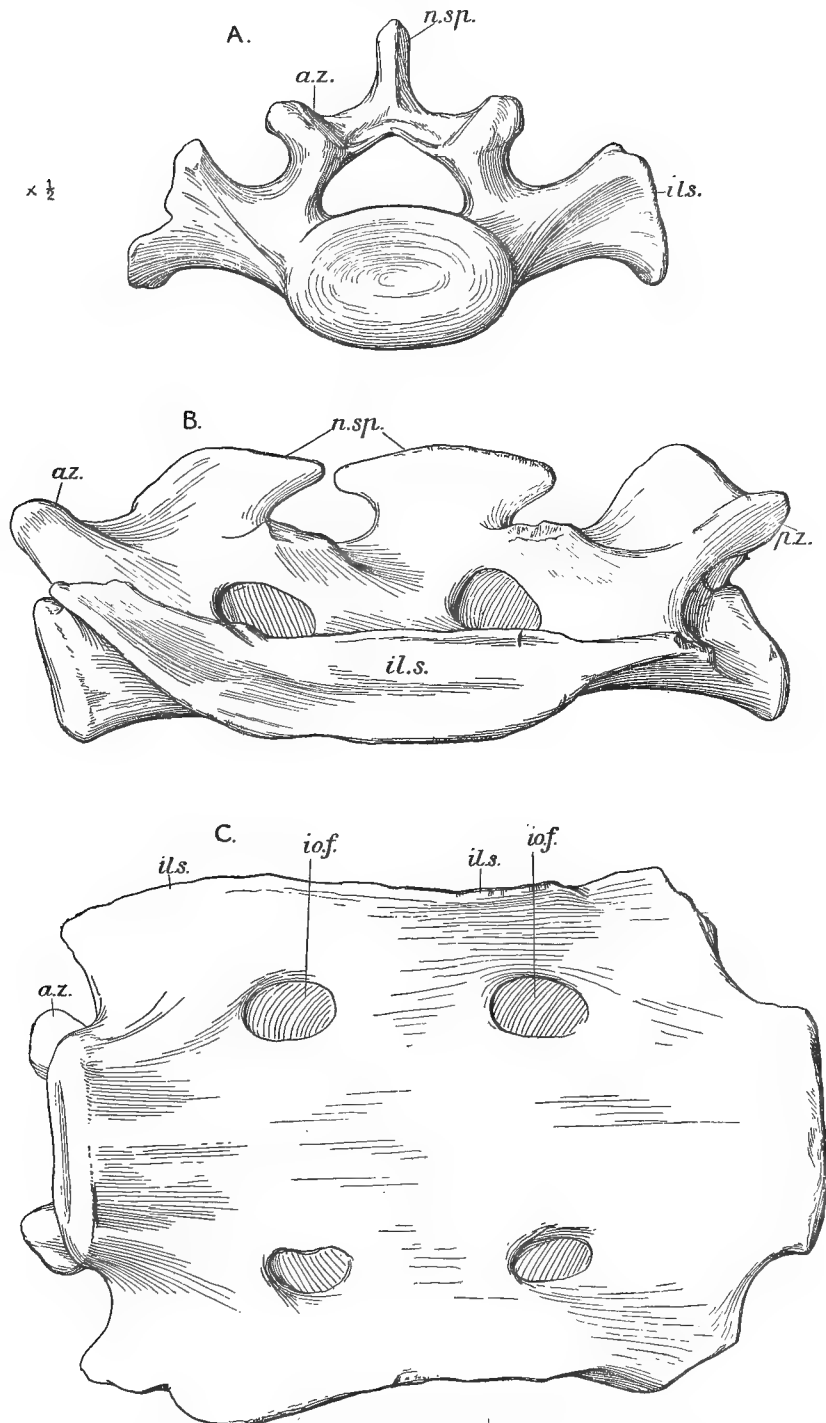
Sacrum of *Mœritherium*: A, from front; B, from left side; C, from below.

a.z., anterior zygapophysis; *io.f.*, interosseous foramen; *il.s.*, iliac surface; *n.sp.*, neural spine; *p.z.*, posterior zygapophysis.   ½ nat. size.

be regarded as a free sacral rather than as a caudal. The centrum is depressed, and its ventral face only slightly convex from side to side, passing externally into the broad transverse processes. The anterior end of the centrum is convex, and slopes somewhat forwards; the posterior end is much higher in proportion to its width : this vertebra is, in fact, intermediate in form between the sacrals and caudals. These latter are not known in the present specimen, but in another, much less nearly complete, column several are preserved. Their centra are laterally compressed, particularly behind, so that while the anterior face of the centrum is nearly circular, the posterior is a vertically elongated oval. The neural arch seems to have been confined to the posterior half of the centrum. There are short downwardly directed transverse processes towards the anterior end. Posteriorly the ventral border bears facets for chevrons, which, in some cases at least, were **V**-shaped.

Fore Limb.—The scapula, the humerus, and the proximal portion of the ulna only are known. No complete specimen of the *scapula* has yet been found. The best example (from the left side) is figured in Pl. XI. fig. 5. The glenoid cavity (*g.c.*) is oval in outline, and the articular surface is continued forwards on to the posterior surface of the large and prominent coracoid process (*c.*). Anteriorly this process bears a rough ridge, which passes above into the coracoid border (*c.b.*). This border is concave below, but is incomplete above; it seems, however, to have curved forwards so that the upper part of the blade was wide. The glenoid border (*g.b.*) is gently curved backwards ; the suprascapular region is broken away. The spine (*s.*) originates about 2·5 cm. from the glenoid cavity ; it forms a prominent backwardly inclined flange, parallel with the glenoid border ; it cannot be seen whether or not there was an acromion. The postscapular fossa is narrow but deep, and overhung by the spine ; the prescapular fossa is wider and more open. This scapula, in the backward sweep of its blade, presents some approach to the Sirenian type, and in the large size of the coracoid process and the form of its coracoid border is similar to the scapula of *Barytherium* described below.

In the *humerus* (Pl. XI. fig. 6) the head (*h.*) projects strongly backwards and inwards ; it is much more strongly convex from before backwards than from side to side. The greater tuberosity is large and rises to about the same level as the head. Externally it is flattened, internally it forms the outer border of a broad bicipital groove, the inner side of which is formed by the small but still well-defined lesser tuberosity. The shaft is chiefly remarkable for its extreme lateral compression. The narrow flat anterior surface is continuous above with the flattened face of the greater tuberosity ; lower down it passes into the inner face of the bone, its prominent outer border forming the deltoid crest (*d.*), from which a rounded ridge runs obliquely across the anterior face of the bone to the inner end of the distal articular surface, so that the whole bone when seen from the front appears to have a slight spiral twist. The inner condyle (*i.c.*) is very large and projects below the rest of the bone ; it is not perforated by an entepicondylar

foramen, but there is a deep fossa lying between the condyle and the olecranon fossa (*o.f.*), which also is very deep. The outer condyle is comparatively small; from it the edge of the bone is continued up as a narrow backwardly directed flange, which dies away just below the middle of the shaft; distally this ridge forms the outer border of the olecranon fossa, and higher up the sharp outer border of the expanded distal end of the bone, which above the olecranon fossa is strongly concave from side to side. The edge also is in part the equivalent of the supinator ridge, and the large development of this and of the inner condyle indicates that the limb was capable of extensive movements of pronation and supination not found in the more specialised Ungulates. The distal articulation is divided into an outer and an inner lobe by a shallow depression; above the outer trochlea the front of the bone is occupied by a well-marked coronoid fossa (*c.f.*).

The proximal end only of the *ulna* is known (Pl. XI. fig. 7). The olecranon process (*ol.*) is large, thickened at the extremity, and rises high above the articulation; it is not directed backwards to any great extent, but merely continues upwards the long axis of the shaft. The sigmoid notch is deeply concave, the upper part of the articulation being considerably prolonged forwards. The lower portion of the humeral surface is deeply bilobate; the radius seems to have been in contact with the outer lobe only. Beneath the articulation on the anterior face of the bone towards the outer side there is a deep depression (*r.*) for the radius.

Hind Limb.—The *pelvis* (Pl. XI. figs. 9, 9 A; text-fig. 68, D) differs widely from that of the later Proboscidea, owing mainly to the narrowness of the ilium. The *crista ilii* (*c.i.*) is short and almost at right angles to the sacral and acetabular borders, which are parallel with one another. The outer angle of the *crista* forms a blunt projection. The sacral surface is very long, extending over the anterior three-fourths of the sacral border; it is gently convex from above downwards, and from its position and antero-posterior extent it shows that the long axis of the ilium is nearly parallel with that of the vertebral column. The acetabular border is gently concave in its anterior two-thirds; posteriorly it seems to divide on either side a strongly marked pit (? for the *rectus femoris* muscle) lying immediately above and in front of the rim of the acetabulum. The gluteal surface is slightly concave from side to side; the pelvic (inner) surface is nearly flat. On the ventro-internal face of the ilium is a prominence (ileo-pectineal), from which there runs back a ridge continuous with the anterior border of the pubis (*pu.*). The acetabulum (*a.*) is horseshoe-shaped, the very prominent raised rim being interrupted postero-inferiorly by a wide notch, which leads into the large pit for the ligament, and opens externally on the surface of the ischium. The *pubis* (*pu.*) is for the most part broken away in all the specimens examined: this seems to be the consequence of the slenderness of the free portion of this bone. The *ischium* (*is.*) is much stouter and

continues back the long axis of the ilium. Where this bone forms the outer boundary of the *obturator foramen* it is trihedral, but posteriorly it flattens out into a broad and comparatively thin plate, of which the upper outer angle (*tuber ischii*) is very prominent (*is.t.*). The posterior border is somewhat convex. Internally the bone is produced into a process forming the posterior boundary of the *obturator foramen*, and so thin that in no specimen does it remain unbroken, so that nothing is known as to the form and extent of the symphysis.

The peculiar interest of this pelvis lies in its great resemblance to that recently figured by Abel* as belonging to the Sirenian, *Eotherium œgyptiacum*, Owen (text-fig. 68, C), a species occurring in the somewhat earlier white limestone of the Mokattam Hills. In this pelvis there is the same straight and narrow ilium, the same greatly expanded ischium, and an acetabulum of almost exactly similar form. Unfortunately, in no specimen of the pelvis of *Mœritherium* is the pubis well preserved, but it was clearly comparatively thin and weak. The chief differences between the two pelves seem to be : (1) so far as can be ascertained from Abel's figure and description, the sacral surface is less distinctly developed in *Eotherium* ; (2) the position of the fossa for the attachment of the *rectus femoris* muscle is a little different ; (3) the obturator foramen is rounder in *Eotherium*. Nevertheless, the similarity of the two pelves is such that if that described by Abel is without doubt Sirenian (and it seems highly improbable that it is anything else), then it may fairly be suggested that *Mœritherium* and *Eotherium*, both occurring in the same region (the one the most primitive Proboscidean, the other occupying the same position with regard to the Sirenia), are in fact closely related, and had a common ancestor in early Tertiary times, probably in the Lower Eocene. It is interesting to note that the acetabulum of *Eotherium* indicates the presence of a large functional femur, so that the animal must have been less exclusively aquatic than the later Sirenia. Furthermore, in the rather later beds in which the remains of *Mœritherium* are found there is a Sirenian *Eosiren*, in which the pelvis (text-fig. 68, B) is already almost as much reduced as in the later *Halitherium* (text-fig. 68, A) ; the adoption of a completely aquatic life having apparently led to a very rapid reduction of the pelvis and hind limb through disuse, while the terrestrial, probably swamp-loving, *Mœritherium* retains the more primitive type of pelvis, which, by the widening of the gluteal and pelvic surfaces, and the consequent lengthening of the crista ilii, became the broad pelvis of the larger Proboscideans.

The head of the *femur* (Pl. XI. fig. 8, *h.*) is large, rounded, and pedunculate ; its posterior surface bears a deep pit for the *ligamentum teres* (*l.t.*) ; it is separated

* O. Abel, "Die Sirenen der mediterranen Tertiärbildungen Oesterreichs," Abhandlungen der k.-k. geologischen Reichsanstalt, vol. xix. pt. 2, pl. vii. fig. 1 (Vienna, 1904).

from the great trochanter (*g.tr.*), which rises slightly above it, by a shallow rounded notch. The lesser trochanter (*l.tr.*) is a very prominent ridge of bone forming the inner border of the large digital fossa. From the most prominent point of the inner trochanter a slight ridge runs obliquely to the base of the great trochanter, dividing the fossa into an upper and lower section. The middle portion of the shaft is roughly triangular in section, the outer angle forming a roughened ridge, which is the only representative of the third trochanter. Below this point the shaft is oval in section, the flattening being antero-posterior. The trochlear surface is small, and the ridge forming its outer border somewhat the more prominent. Both condyles are small; the outer is somewhat the larger, though at the same time the inner projects a little beyond it. Posteriorly the condyles are separated by a deep and narrow intercondylar fossa. The posterior surface of the shaft immediately above the condyles is slightly concave from side to side.

In its straightness, in the relatively small size of its articular ends, and in the absence of an inner trochanter, this femur is not unlike that of the later Proboscidea; and while the presence of a depression for the insertion of the *ligamentum teres* is a point of difference between it and most of the later members of the group, a deep and similarly situated pit occurs on the head of the femur of *Palæomastodon*.

Mœritherium lyonsi, Andrews.

[Plates VIII.–XI.; text-figs. 40–47.]

1901. *Mœritherium lyonsi*, C. W. Andrews, Tageblatt des V. Internationalen Zoologen-Congresses Berlin, No. 6, p. 4 (Verhandlungen, p. 528, 1902); Geol. Mag. [4] vol. viii. pp. 403–406, fig. 2.
1903.   „   „   C. W. Andrews, Phil. Trans. vol. 196 B, pp. 113–117, figs. 14–17.
1904.   „   „   C. W. Andrews, Geol. Mag. [5] vol. i. pp. 109–112, fig. 1.

Type Specimen.—Mandible associated with upper molars and a dorsal vertebra (Pl. X. figs. 1, 1 A); Geological Museum, Cairo.

The type species, in which the length of the mandible is about 32 cm., and that of the molar and premolar series 17·2 cm.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene) and Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 10000. Upper molars, mandible, and a dorsal vertebra. The mandible is the type of the species described in the 'Tageblatt des V. Internationalen Zoologen-Congresses,' no. 6, p. 4 (Berlin, 1901); also described and figured in Geol. Mag. [4] vol. viii. (1901) pp. 403–5,

fig. 2 *c* ; also Pl. X. fig. 1. The vertebra is figured on Pl. XI. fig. 4. Middle Eocene. The dimensions (in centimetres) of the mandible and lower teeth are :—

Total length 32
Height of condyle above inferior border . . . . 15·3
Length of molar and premolar series . . . . 17·2

	Length.	Width.
pm. 2	2·2	1·6
pm. 3	2·3	2·1
pm. 4	2·5	2·3
m. 1	2·65	2·45
m. 2	3·5	3
m. 3	4·2	3

M. 8146. Plaster cast of the above specimen. *Made in the British Museum.*

C. 7867. Nearly complete skull of a young individual in which the second incisor and last molar are not yet cut. The description of the skull given in this volume is founded mainly upon this specimen, which is figured on Pl. VIII. and Pl. IX. fig. 1. Upper Eocene. The approximate dimensions (in centimetres) of this skull are :—

Greatest length from end of condyles to tip of snout . . . 35
Length from hinder border of palate to tip of snout 21
,, summit of occiput to tip of snout 32
Greatest width at zygomatic processes of squamosal . . . . 22·7
,, of occipital surface . . . . 17·4
,, of supraoccipital escutcheon . . . . 9·7
Height of occipital surface above *foramen magnum* . . . . 8·7
Width between outer angles of condyles . . . . 9·3
,, of skull-roof at temporal fossa 6
,, ,, orbits . . . . 6·6
,, of glenoid surface . . . . 7·3
,, of palate between *m*. 1 . . . . 3·3
,, of foramen magnum . . . . 4·2
Length of premolar series . . . . 7·3

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	2·7	2
pm. 3	2·5	2·8
pm. 4	2·1	2·8
m. 1	3	2·6
m. 2	3·2	2·9

M. 8875. Plaster cast of the above specimen. *Made in the British Museum.*

M. 9225. Skull, very slightly crushed and nearly complete, with the exception of the zygomatic arches : the nasals are well preserved and terminate anteriorly in points which overhang the narial opening. The vertical plates of the pterygoids are thick and appear to have a descending plate of the alisphenoid fused on their outer face; there is an alisphenoid canal opening anteriorly into a groove running upwards and forwards, as in *Palæo-*

mastodon. The teeth are for the most part represented by their bases only. Middle Eocene.   The dimensions (in centimetres) of this specimen are :—

Greatest length from end of condyles to tip of snout   .   .   .   37
Length from hinder border of palate to tip of snout   .   .   .   23
   ,, summit of occiput to tip of snout . . . . .   34·7
Greatest width of occipital surface   .   .   .   .   15·5
Height of occipital surface above *foramen magnum*   .   .   .   .   7·5
Width of skull-roof at temporal fossæ   .   .   .   .   6·5 app.
Length of molar and premolar series .   .   .   .   15·2
  ,, premolar series   .   .   .   .   6·7
  ,, molar series   .   .   .   .   8·5

Presented by Baron Franz Nopcsa, 1905.

C. 10002. Portions of large skull.   Described and figured in Geol. Mag. [4] vol. viii. (1901) p. 404, figs. 2 A, 2 B ; also Pl. X. figs. 3, 4.   Middle Eocene.   The dimensions (in centimetres) of this specimen are :—

Greatest width at zygomatic processes   27
   ,, of occipital surface   .   .   .   .   19·4
Height of occipital surface above *foramen magnum*   .   .   .   .   7·7
Width between orbits.   .   .   .   .   6·5
Length of broken tusk (*i.* 2)   .   .   .   .   4·6 +
Width of broken tusk (*i.* 2), side to side .   .   .   .   2·8
  ,,   ,, before backwards.   .   .   .   .   .   2·8
Length of premolar series   .   .   .   .   6·8 app.

M. 8192. Plaster casts of the above specimen.   *Made in the British Museum.*

M. 8905. `Portion of skull, including the right maxilla.   Middle Eocene.

Presented by the Egyption Government, 1904.

M. 8904. Anterior portion of skull, showing the sockets of the incisors.   Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8906. Imperfect skull, teeth not preserved.   The length from the summit of the occiput to the tip of the snout is 32 cm., that from the hinder border of the palate to the same point about 21·5 cm.   Middle Eocene. *Presented by the Egyptian Government, 1904.*

M. 8884. Palatal region of skull with molars and premolars.   Upper Eocene.   The dimensions (in centimetres) are :—

Length of premolar series   7
Width of palate opposite *m.* 1 .   .   .   .   3·6

	Length.	Width.
pm. 2	2·5	2
pm. 3	2·5	2·8
pm. 4	2·2	2·7
m. 1	2·9	2·5
m. 2	3·3	2·8

Presented by the Egyptian Government, 1904.

C. 8847. Portion of the palatal region of the skull with *pm.* 3, *pm.* 4, *m.* 1, and *m.* 2 well preserved on the right side.   The base of the zygomatic process of the maxilla is over the premolars. Upper Eocene.   The dimensions (in centimetres) are :—

Length of *m*. 2 . . . . 3·2

    ,,   *m*. 1 . . . . 2·9

    ,,   *pm*. 4 . . . . 2·1

    ,,   *pm*. 3 . . . . 2·6

M. 8898. Posterior portion of skull from which the cast of the brain-case M. 9116 was made. Middle Eocene.

M. 9116. Cast of cranial cavity of last specimen (text-fig. 41).   *Made in the British Museum.*

M. 9117. Plaster cast of the cranial cavity of the imperfect skull C. 10002.

                                                               Made in the British Museum.

C. 8831. (?) Much-worn lower tusk (second incisor), showing the wear-surface truncating the summit nearly at right angles and the very long but closed root, grooved above. Total length 13 cm.; width of crown 2·8. Upper Eocene.

C. 8832. (?) Crown of a similar but much less worn tooth. The crown is covered with a thick enamel which extends furthest down on the upper and lower faces; wear-surface at present a narrow band at right angles to long axis. Width of crown 2 cm. Upper Eocene.

C. 7910. (?) Upper tusk (second incisor), greatly curved; root closed; wear-surface on posterior side of crown. Length in straight line 12·5 cm.; width of crown 2·6 cm. Upper Eocene.

M. 8500. Right upper premolars and *m*. 1 of a large individual. The size of the teeth is somewhat exaggerated by the cracking and slight displacement of the enamel (not shown in figure). The premolars are figured in Pl. IX. fig. 4. Upper Eocene. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	2·6	2·2
pm. 3	2·6	3·2
pm. 4	2·2	2·9
m. 1	3·1	2·7

Length of the premolar series 7·5.

                                   Presented by W. E. de Winton, Esq., 1903.

C. 10001. Upper molars and premolars found close to type. Described and figured in Geol. Mag. [4] vol. viii. (1901) p. 404, fig. 2 A : also Pl. X. fig. 2. Middle Eocene. The dimensions (in centimetres) of these teeth are :—

	Length.	Width.
pm. 2	2·7	2·3 app.
pm. 3	2·65	2·95
pm. 4	2·3	2·75
m. 1	2·9	2·7
m. 2	2·6 (?)	2·35

M. 8147. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 8112. Right upper premolar. Upper Eocene.

M. 8907. Portions of upper and lower jaws with imperfect teeth, axis, and two other cervical vertebræ, some imperfect dorsals, and a fragment of a pelvis. Middle Eocene.

                                   Presented by the Egyptian Government, 1904.

M. 9114. Two posterior left upper molars. Middle Eocene. The dimensions (in centimetres) of these teeth are :—

	Length.	Width.
m. 2	3	2·8
m. 3	3·2	2·8

M. 8902. Third upper molar. Figured Pl. X. fig. 5. Middle Eocene.

Presented by the Egyptian Government, 1904.

C. 8808. Nearly complete mandible, incisors and *pm.* 2 broken away. Upper Eocene. The dimensions (in centimetres) of this specimen are :—

Total length (not including incisors)	32·8
Horizontal width of ascending ramus	16·5
Length of molar series	9·9
„ premolar series	7·1

M. 8885. Anterior portion of mandible, showing symphysis and right ramus with *pm.* 3–4 and *m.* 1–2. Upper Eocene. The dimensions (in centimetres) of this specimen are :—

Length of symphysis . . . . 9·5 app.

	Length.	Width.
pm. 3	2·8	1·8
pm. 4	2·5	2·1
m. 1	2·8	2·1
m. 2	3·4	2·7

Presented by the Egyptian Government, 1904.

M. 8898. Portion of mandible. Middle Eocene.   *Presented by the Egyptian Government*, 1904·

M. 8894. Portions of mandibles. Middle Eocene.   *Presented by the Egyptian Government*, 1904.

M. 8901. Portion of left ramus of mandible with premolars. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8895. Fragment of skull and anterior portion of mandible with much weathered incisors. Middle Eocene.   *Presented by the Egyptian Government*, 1904.

C. 8127. Portion of right ramus of mandible with *pm.* 2–4 in perfect preservation. Figured on Pl. IX. fig. 3. Upper Eocene. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	2·3	1·1
pm. 3	2·5	1·7
pm. 4	2·4	2

Length of premolar series 7.

C. 7838. Posterior portion of the left ramus of the mandible, showing the last milk-molar with the germ of *pm.* 4 beneath it ; *m.* 1 is just in wear. *M.* 2 and *m.* 3 are represented by the alveoli only, and probably *m.* 3 had not yet emerged (text-fig. 43). Upper Eocene. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
mm. 4	2·6	1·8
pm. 4	2·2	..
m. 1	2·7	2·1

M. 9233. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 8832. Crown of second lower incisor.

C. 8801. Worn second lower incisor.

M. 8501. Right and left lower molars and premolars in nearly perfect preservation. The teeth of the right side are figured on Pl. IX. fig. 2. Upper Eocene. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	2·6	1·4
pm. 3	2·7	1·9
pm. 4	2·4	2·1
m. 1	3	2·2
m. 2	3·2	2·6
m. 3	4	2·8

Length of premolar series 7·3. Length of molar series 9·9.

Presented by W. E. de Winton, Esq., 1903.

M. 9118. Lower molars and premolars. Middle Eocene.

M. 8900. Portions of upper and lower dentition greatly worn. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8914. Skull and vertebral column, incomplete and badly preserved.

Presented by the Egyptian Government, 1904.

M. 8909. Atlas vertebra. Figured Pl. XI. fig. 1. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8909 a. Atlas vertebra. Middle Eocene. *Presented by the Egyptian Government, 1904.*

C. 9073. Atlas vertebra. Upper Eocene.

C. 10059. Axis vertebra. Figured Pl. XI. fig. 2. Middle Eocene.

M. 8915. Three imperfect axis vertebræ. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8899. Cervical vertebra and fragments of skull. Vertebra figured Pl. XI. fig. 3. Middle Eocene. *Presented by the Egyptian Government, 1904.*

M. 9227. Imperfect cervical vertebra. Middle Eocene. *Presented by Baron Franz Nopcsa, 1905.*

M. 8903. Two imperfect dorsal vertebræ. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8908. Two imperfect dorsal vertebræ. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 8921. Imperfect dorsal vertebræ. Middle Eocene.

Presented by the Egyptian Government, 1904.

M. 9226. Dorsal vertebræ. Middle Eocene. *Presented by Baron Franz Nopcsa, 1905.*

M. 9228. Dorsal vertebra. Upper Eocene. *Presented by Baron Franz Nopcsa, 1905.*

M. 8917. Dorsal and sacral vertebræ, much weathered. Middle Eocene.

Presented by the Egyptian Government, 1904.

C. 10053. Lumbar vertebra. Middle Eocene.

C. 10035. Imperfect sacrum. Middle Eocene.

C. 10020. Dorsal vertebræ, scapula (Pl. XI. fig. 5), portions of femur, and pelvis. Middle Eocene. The dimensions (in centimetres) of the scapula so far as preserved are :—

Length from coracoid process to postero-superior angle	21
„ of glenoid surface in straight line	5·8
Width of glenoid surface in straight line	4

M. 8918. Fragments of scapulæ. Middle Eocene. *Presented by the Egyptian Government*, 1904.

C. 7962–3. Pair of well-preserved humeri. Upper Eocene. The dimensions (in centimetres) are :—

Length	26
Width of head	4·2
Antero-posterior width at deltoid crest	5·2
Width of distal articular surface	4·5
„ distal end at condyles	7·6

M. 8910. Portions of two humeri. Middle Eocene. *Presented by the Egyptian Government*, 1904.

M. 8916, M. 9115. Imperfect humeri. Middle Eocene.

M. 8861. Distal portion of humerus. Upper Eocene. *Presented by the Egyptian Government*, 1904.

M. 8931. Left humerus. Figured Pl. XI. fig. 6. Middle Eocene. The dimensions (in centimetres) of this specimen are :—

Length	24
Antero-posterior width at deltoid crest	5
Lateral width at same point	2·4
Width of distal articular surface	4·6
„ distal end at condyles	7·2

Presented by the Egyptian Government, 1904.

M. 8911. Proximal end of ulna. Figured Pl. XI. fig. 7. Middle Eocene.

M. 8911 a. Proximal ends of two ulnæ. Middle Eocene.

M. 8920. Portions of pelves. Middle Eocene.

M. 8932. Right femur. Figured Pl. XI. fig. 8. Middle Eocene. The dimensions (in centimetres) of this specimen are :—

Length	27
Width of proximal end	7·5
Diameter of head	3·5
Width of middle of shaft	3·3
„ distal end	5·2

C. 10004. Left femur. Middle Eocene. The approximate dimensions (in centimetres) are :—

Length	26·8
Width of proximal end	7
Diameter of head	3·5
Width of middle of shaft	3·2
„ distal end	?

M. 8920 a. Upper end of tibia. Middle Eocene.

Mœritherium gracile, Andrews.

[Plate XVII. figs. 1–3.]

1902. *Mœritherium gracile*, C. W. Andrews, Geol. Mag. [4] vol. ix. p. 292.

Type Specimen.—An imperfect skull (Pl. XVII. figs. 1, 2), including the palatal region, associated with cervical, dorsal, and lumbar vertebræ; Geological Museum, Cairo.

This species is distinguished from *M. lyonsi* by its comparative lightness of structure, the narrowness of the palate, the smaller size of the upper molars and premolars, particularly of *m.* 3, the strong development of the cingulum in these teeth, and by the considerable inflation of the cranial region of the squamosal, which apparently contains extensive air-sinuses.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

C. **10003.** Cranial and palatal regions of skull with some vertebræ. Type specimen described in Geol. Mag. [4] vol. ix. p. 292. Figured on Pl. XVII. figs. 1, 2. The palatal portion (fig. 1) shows very well the great enlargement of *i.* 2, the extension forwards of the maxilla (*mx.*) beneath the premaxilla (*pmx.*), the presence of a median anterior palatine vacuity, the relatively small size of the teeth, particularly of the third molar (*m.* 3). The cranial region (fig. 2) shows the comparative narrowness of the supraoccipital escutcheon (*soc.*) (*cf.* Pl. X. fig. 4 A) and the inflation of the upper part of the squamosal (*sq.*). The dimensions (in centimetres) of this specimen are :—

Distance from anterior end of snout to hinder border of palate . 21
Width of palate opposite *m.* 2 . . . . 2·8
Approximate width of supraoccipital escutcheon . . . . . . 8·6
Total width of occipital surface . . . . 18·6

The dimensions of the teeth are :—

	Length.	Width.
pm. 2	2·2	1·8
pm. 3	2	2·3
pm. 4	2	2·1 (?)
m. 1	2·3	2·3
m. 2	2·4	2·5
m. 3	2·8	2·4

Length of molar and premolar series 13·7.
Length of molar series 7·5. Length of premolar series 6·2.

The vertebræ belonging to this skull include the centra of the axis and the five posterior cervicals (two having part of the arch preserved), an anterior dorsal with part of the arch, also five other dorsal and two lumbar centra.

The form of the axis, so far as it is preserved, is similar to that of the axis of *M. lyonsi*. The centra of the posterior cervicals are oval in outline and slightly

concave at both ends. The transverse processes of all except the seventh are perforated by a vertebrarterial canal, and on the anterior ones there is a strong hypapophysial ridge on the hinder end of the centrum.

The anterior dorsal has an oval biconcave centrum ; the external angles of the posterior face bear concave facets for the capitulum of the rib ; the transverse process is stout and short and bears a large downwardly-directed tubercular facet, strongly concave from before backwards. The other dorsal centra have a straight neural border and are strongly convex below. The lumbar centra are similar, and bear on their sides strong flattened transverse processes.

	Height of anterior face.	Width of ditto.	Length of centrum.
Atlas.	..	7·5	6·5 (with odontoid).
Last cervical	3·3	3·5	2·6
Anterior dorsal	3·3	3·8	2·8
Posterior dorsal	3·8	5·5 app.	3·8
Lumbar.	3·8	4·7	3·8

M. 8191. Plaster cast of palatal region of type skull.   *Made in the British Museum.*

M. 8912. Left upper molars. Figured on Pl. XVII. fig. 3. These teeth show the well-developed cingulum and the peculiar sculpturing of the enamel. The dimensions (in centimetres) are :—

	Length.	Width.
m. 1.	2·5	2·1
m. 2.	2·7	2·3
m. 3.	2·8	2·5

Presented by the Egyptian Government, 1904.

M. 9229. Centrum of axis with odontoid.   *Presented by Baron Franz Nopcsa*, 1905.

Mœritherium trigonodon, Andrews.

[Plate IX. fig. 5.]

1904. *Mœritherium trigodon*, C. W. Andrews, Geol. Mag. [5] vol. i. p. 112.

Type Specimen.—Posterior portion of right ramus of mandible (Pl. IX. fig. 5); British Museum.

This species is distinguished by the form of the posterior lower molar, which narrows posteriorly, the talon consisting almost entirely of one large tubercle ; also by the rapidity with which the teeth decrease in size from behind forwards.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

M. 8499. Posterior portion of right ramus of mandible with the molars. Type specimen described in Geol. Mag. [5] vol. i. p. 112. Figured Pl. IX. fig. 5.

The characters of the teeth are as follows :—

M. 1 is a bilophodont tooth with a small posterior lobe ; each transverse crest consists of two tubercles. Most of the outer half of the tooth is wanting ; the inner half consists of a high anterior cusp and a somewhat lower posterior one, separated by a deep valley.

M. 2 also wants a great part of its inner half. It is similar to *m.* 1 except that there is a posterior lobe consisting of a large blunt tubercle, which lies immediately behind the outer tubercle of the posterior crest. These two teeth are much like the corresponding ones of *M. lyonsi* ; but *m.* 1 is smaller in proportion to *m.* 2, and similarly *m.* 2 is smaller in proportion to *m.* 3.

M. 3 is quite unworn ; it differs considerably from *m.* 3 of *M. lyonsi.* Like the other molars, it consists of two transverse ridges with a talon. The transverse ridges are placed somewhat obliquely ; the anterior one consists of a high pointed outer tubercle and an inner one which is partially divided into two. In the posterior crest the outer half again consists of a high pointed tubercle, but the inner half here consists of two subequal tubercles. The talon is composed of a large tubercle lying in the same line as the outer tubercles of the crests, and on its inner side there are several small tubercles ; on its outer side the cingulum is well developed. The talon as a whole is triangular in outline, its posterior angle being on the outer side of the tooth. In *M. lyonsi* (Pl. IX. fig. 2 ; Pl. X. fig. 1), on the other hand, the talon is much wider and consists of an outer and inner tubercle which form a broad crest, thus converting the tooth into a trilophodont one. This difference in the talons appears to justify the separation of the present form as a distinct species at least, and not improbably further material will show that a new genus must be established. The enamel of the whole tooth is raised into irregular ridges and small tuberosities. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
m. 1	2·6	?
m. 2	3·2	?
m. 3	4	2·4

The length of the molar series is 9·8 cm.

Mœritherium sp.

C. 10005. Nearly complete vertebral column with very imperfect skull. Vertebræ described above (pp. 112–117), and some of them figured (text-figs. 44–47). This specimen may be merely a large individual of *M. lyonsi.* Middle Eocene.

Family PALÆOMASTODONTIDÆ.

In the skull the nasals shortened and the external nares somewhat shifted back from the end of the snout.   Mandible with elongated spout-like symphysis, projecting beyond the skull.   A single pair of large incisors (*i.* 2) in both upper and lower jaws. Upper incisors in form of downwardly-directed tusks, with a band of enamel on their outer side; lower incisors procumbent and continuing forwards the upper surface of the spout-like symphysis.   Premolars replacing milk-molars in both upper and lower jaws; molars with not less than three transverse ridges.

This family includes the Eocene genus *Palæomastodon* and the Miocene *Tetrabelodon*, possibly also the problematical *Phiomia*.   The species range in size from little larger than *Mœritherium* to nearly as large as the existing Indian Elephant.

Genus PALÆOMASTODON, Andrews.

[Tageblatt des V. Internationalen Zoologen-Congresses, No. 6, p. 4, Berlin, 1901
(Verhandlungen, p. 528, 1902).]

Skull with sagittal crest; nares just in front of orbit.   Dental formula :—
i. $\frac{1}{1}$; *c.* $\frac{0}{0}$; *pm.* $\frac{3}{2}$; *m.* $\frac{3}{3}$.   Last premolar bilophodont; molars trilophodont.   Neck more elongated than in *Elephas*; limb-bones, so far as known, much like those of the later Proboscidea.

This genus is at present known only from the Upper Eocene Fluvio-marine beds of the Fayûm, where it is represented by several species, the type being *Palæomastodon beadnelli*.   The several species are distinguished by (1) difference of size; (2) the form of the symphysis and its position with regard to the anterior premolars; (3) the degree of development in the last lower molar; (4) the degree of development of secondary tubercles in the molars.

The Skull (Pls. XII., XIII.; text-figs. 48, 49 A).—Though differing widely in general appearance and in many details from that of the later Elephants, the skull is nevertheless typically Proboscidean in all essential points of structure, and may be described in short as that of a very dolichocephalic Elephant.   Some of the more obvious differences between it and the skull of *Elephas* are :—(1) the relatively small though still considerable development of the bone cells and sinuses in the upper and hinder region of the cranium; (2) in correlation with the last character the presence of a sagittal crest, which extends to a point about over the middle of the temporal fossa, where it divides into two supratemporal ridges, which run forwards and outwards and probably terminated in the postorbital processes of the frontal; (3) the elongation of the *basis cranii* and particularly also of the palatal region,

this latter, of course, being connected with the persistence through life of most of the molar and premolar series (viz., *pm.* 2, 3, 4, and *m.* 1, 2, 3), which are brachyodont and exhibit the mode of succession common in the more generalised Ungulates. Other points will be referred to in the detailed account of the structure of the skull.

The specimen now described (Pl. XII.; text-figs. 48, 49 A) is fully adult, the last

Text-fig. 48.
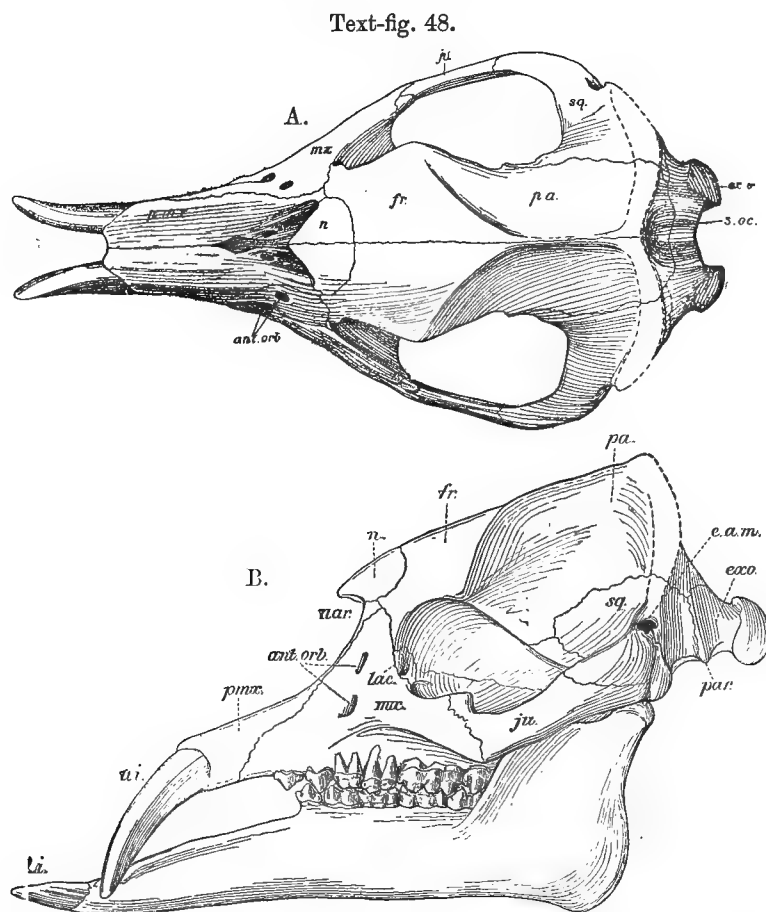
Semi-diagrammatic figure of the skull and mandible of *Palæomastodon*:
A, skull from above; B, skull and mandible from side.

ant.orb., antorbital foramina; *e.a.m.,* external auditory meatus; *exo.,* exoccipital; *fr.,* frontal; *ju.,* jugal; *lac.,* lachrymal; *l.i.,* lower incisor; *mx.,* maxilla; *n.,* nasal; *nar.,* external nares; *pa.,* parietal; *par.,* paroccipital process; *pmx.,* premaxilla; *s.oc.,* supraoccipital; *sq.,* squamosal; *u.i.,* upper incisor. About ⅛ nat. size.

molar being already considerably worn, and the sutures in some cases closed, so that it is difficult or impossible to determine their position.

The *basioccipital* (text-fig. 49 A, *boc.*) is fused with the exoccipitals, so that its exact limits cannot be made out. It is deeply notched behind by the lower border of the foramen magnum, and probably formed a small part of the inner ends of the occipital

s 2

condyles. Its body is keeled ventrally and it unites with the basisphenoid at about the level of the glenoid cavity for the mandible : the line of union with the *basisphenoid* (*bsp.*) is marked by a fairly prominent transverse ridge. The lateral border of the median limb is separated from the anterior border of the lateral portion by a sharp notch, through which the hypoglossal nerve probably passed, there being, as in the later Proboscidea, no condylar foramen.

With the possible exception of a small portion of their inner ends, the whole of the occipital condyles are formed by the *exoccipitals* (*exo.*). The condyles themselves are much larger and project further behind the skull than in *Elephas*, in which their articular surface seems to look mainly downwards and to project very little beyond the rest of the exoccipital bones. Here, on the other hand, the condyles are so sharply marked off from the rest of the bone as to be almost pedunculate. Their articular surface extends far on to the dorsal surface, and they are very strongly convex from above downwards—in fact, roughly speaking, they may be said to form about two-thirds of the surface of a cylinder—and at the same time they are slightly convex from side to side. From the form of the condyles, therefore, it would appear that the range of movement allowed to the skull in an up-and-down direction must have been very great, while that from side to side was comparatively restricted.

The *foramen magnum* (*f.m.*) is oval in outline and does not look downwards so much as in *Elephas*, mainly owing to the fact that the posterior border of the basi-occipital is less deeply notched. Ventrally and laterally the surface of the exoccipitals runs forwards in a gentle curve to join the post-tympanic flange (*pty.*) of the squamosal. On the ventral surface near the union with the squamosal the exoccipital bears a blunt prominence (*pp.*), which is the only representative of the paroccipital process, and is therefore homologous with the thin plate-like ventral process of the bone described in the skull of *Mœritherium*. The upper portion of the bone above the condyles and the foramen magnum slopes forwards, and the two elements meet in the middle line, separating the supraoccipital from the foramen magnum by a distance of about 5 centimetres.

The precise boundaries of the *supraoccipital* (*soc.*) are indistinct. In the middle line it, like the upper portion of the exoccipitals, is inclined forwards ; above it is hollowed out by a great median fossa, the floor of which is greatly roughened and is obscurely divided into halves by a slight median ridge. This fossa is one of the most characteristic peculiarities of the skull of the later Elephants, but in *Palæomastodon* it is far more sharply defined, probably, for the most part, on account of the smaller development of the cellular tissue of the rest of the bone. The sides of the fossa are formed by broadly rounded vertical ridges. The superior and supero-lateral portions of the bone occupying the position of the lambdoidal crest are unfortunately broken away, but it can be seen that in conjunction with the neighbouring squamosals and parietals the body of the bone is excavated by a series of large cellular cavities,

resulting from the great development of the diploë.   These cavities communicate with the exterior by perforations of the outer table of the bone (*for.*).   One of the largest of the openings is in the parietal, close to its junction with the squamosal and in the same vertical plane as the auditory meatus : the occurrence of similar openings in the skull of *Mœritherium* has been referred to.

The *squamosal* (*sq.*) is a very large bone and forms the whole of the lateral prominence at the posterior part of the skull.   Posteriorly it unites with the exoccipital and above with the supraoccipital and parietal.   In the specimen upon which this description is founded the upper portion is broken away, but it can be seen that it helped to form the lower part of the massive lambdoidal crest which runs down from the top of the skull to just above the auditory meatus, and that it is greatly thickened by the development of extensive air-sinuses.   The posterior part of the bone which unites with the exoccipital behind forms a broad and deep post-tympanic flange (*pty.*), which, by meeting the posterior border of the glenoid surface, closes the external auditory meatus (*e.a.m.*) below.   Externally the inferior edge of this post-tympanic process projects a little below the glenoid surface, forming a sort of false postglenoid process, but internally the border of the articular surface is more prominent and projects below it.   In this inner portion it is possible that a narrow wedge of the tympanic bone may be interposed between the post-tympanic flange and the glenoid surface.   This latter is very large and extends very high up in front ; it is gently concave from side to side and broadly convex from before backwards.   This region differs considerably from that found in the later Elephants, in that the convexity of the glenoid surface continues up to the post-tympanic process, so that there is not, as in *Elephas*, a deeply concave area beneath the auditory meatus and behind the glenoid convexity (see text-fig. 49).   The inner end of the articular surface forms a large prominence, to the inner side of which there is a deep fossa mainly excavated in the tympanic and referred to more fully in the account of that element.   The outer side of the lateral prominence was prolonged forwards into a stout zygomatic process articulating with the jugal, which apparently extended beneath it nearly as far back as the hinder edge of the articular surface, of which it probably formed the outer part.   In the later Elephants, owing to the great development of air-cells both in the squamosal itself and more especially in the surrounding bones, the zygomatic prominence is much less marked, and, in fact, the whole zygomatic arch is of much less importance.   From the inner end of the glenoid surface the suture between the squamosal and the alisphenoid runs forwards for some distance, the squamosal having a somewhat greater extension on the side of the skull than in the recent Elephants.   Anteriorly the squamosal joins the frontal for a short distance, and superiorly it meets the parietal in a nearly straight suture running downwards and forwards.

The *tympanic* (text-fig. 49, *ty.*) is much less swollen than in *Elephas* and is a compressed mass of bone bounded posteriorly by the *foramen lacerum posterius* (*f.l.p.*)

and the exoccipital, internally by the basioccipital and basisphenoid, and anteriorly by the alisphenoid, the *foramen lacerum medium* (*f.l.m.*), and perhaps the pterygoid. Externally the bone seems to send a narrow wedge-shaped process between the post-tympanic process and the inner end of the glenoid surface, thus helping to

Text-fig. 49.
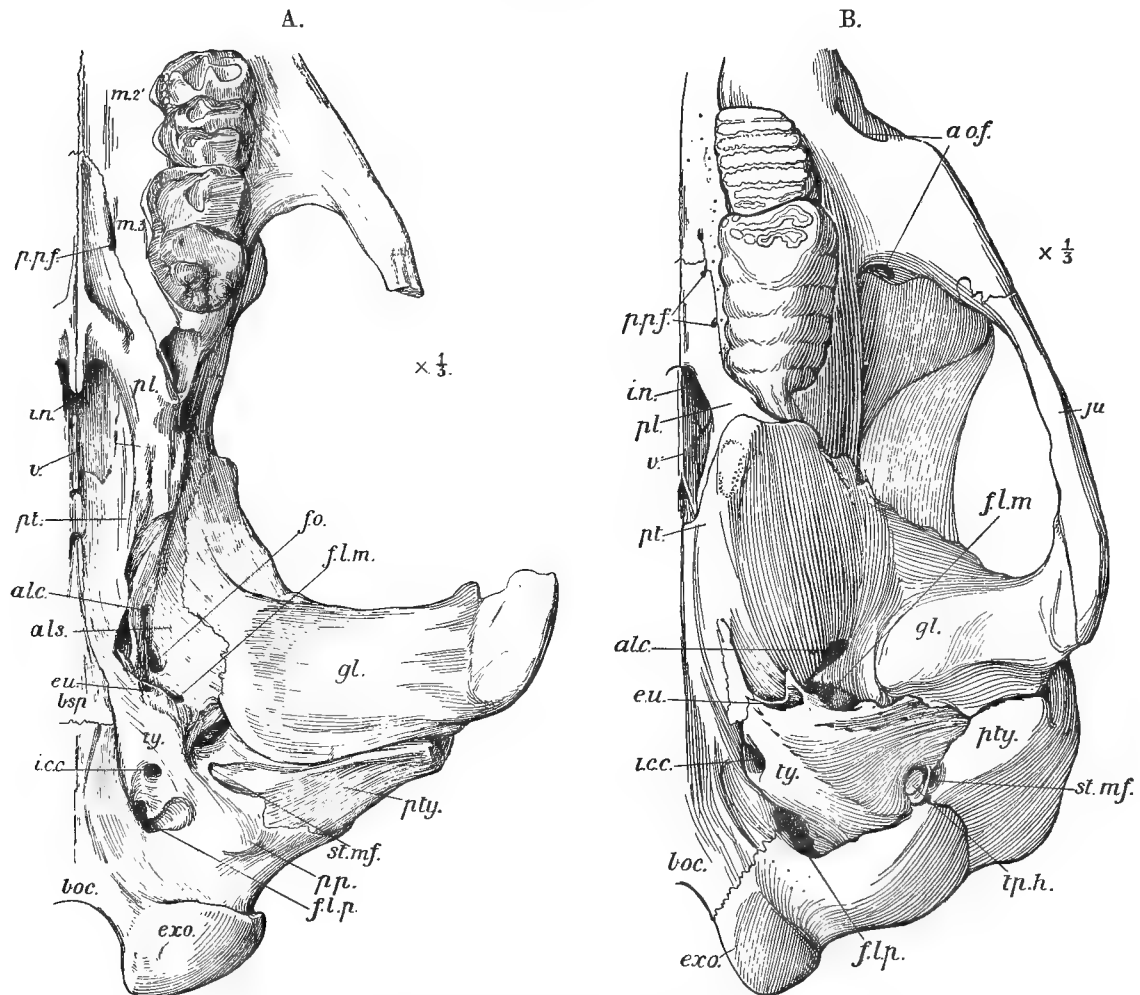
The base of the skull and part of the palate of: A, *Palæomastodon*; B, *Elephas*.

al.c., alisphenoid canal; *als.*, alisphenoid; *a.o.f.*, antorbital foramen; *boc.*, basioccipital; *bsp.*, basisphenoid; *eu.*, eustachian opening; *exo.*, exoccipital; *f.l.m.*, foramen lacerum medium; *f.l.p.*, foramen lacerum posterius; *f.o.*, foramen ovale; *gl.*, glenoid surface for mandible; *i.c.c.*, foramen for internal common carotid; *i.n.*, internal nares; *ju.*, jugal; *m.* 2, *m.* 3, second and third molars; *pl.*, palatine; *p.p.f.*, posterior palatine foramen; *pp.*, paroccipital process; *pt.*, pterygoid; *pty.*, post-tympanic process of squamosal; *st.mf.*, stylo-mastoid foramen; *tp.h.*, tympano-hyal; *ty.*, tympanic; *v.*, vomer. ⅓ nat. size.

form the floor of the inner end of the external auditory meatus. In front of this the bone is excavated by the deep fossa referred to above; this seems to have opened into

the skull and has in its posterior wall a foramen, the stylomastoid (*st.mf.*) ; in front of and internal to this foramen the tympano-hyal (*tp.h.*) seems to have been situated. Between this fossa and the basioccipital the bone is perforated by a large foramen for the internal common carotid (*i.c.c.*). In front the bone is produced forwards and inwards into a sharp-pointed process lying along the basisphenoid and having on its inner side the opening of the eustachian canal (*eu.*). The anterior end of this process is continuous with the ridge formed by the posterior end of the pterygoid. The antero-external face forms the hinder border of the *foramen lacerum medium* and unites with the alisphenoid.

The *parietals* (*pa.*) are unfortunately incomplete posteriorly, where, however, they must have united with the supraoccipital above and with the squamosal below: they helped to form the thick lambdoidal ridge, in which, as above described, large air-sinuses communicating with the exterior by means of several foramina (*for.*) were developed. The parietals are only slightly convex from above downwards and incline towards one another at an angle of about 77°, meeting in a strong sagittal crest (*s.c.*), of which there is no trace in the modern Elephants. This peculiarity emphasises the primitive character of this skull compared with that of *Elephas*, in which the temporal fossæ are separated by a broad expanse of skull-roof, flat or slightly convex, but with no trace of sagittal crest: the difference being in the main due to the fact that the development of the spongy diploë, carried to such an enormous extent in *Elephas*, is here only beginning and does not yet extend much beyond the occipital region. About opposite the anterior angle of the squamosal the sagittal crest divides into the supratemporal ridges, which diverge and no doubt terminated on the post-orbital processes, but unfortunately the whole of the upper part of the skull from about 7 centimetres in front of the origin of the supratemporal ridges is broken away in the specimen here described, and in the young example from which the account of the front of the skull is taken these ridges are scarcely at all developed. Anteriorly the parietals unite with the frontals, but in the present specimen only the lower portion of the suture can be observed; from this it appears that the frontals meet the squamosals, so that the parietals are excluded from contact with the alisphenoid.

The *frontals*, *nasals*, and *premaxillæ* are wanting in the specimen upon which this description is based and will be described below from another example.

The *alisphenoid* (text-fig. 49, *als.*) may be described as a triradiate bone. Its posterior portion forms the anterior boundary of the *foramen lacerum medium*, on either side of which it unites with the tympanic: externally it joins the squamosal, the suture with which runs just internal to the inner edge of the glenoid surface. This posterior portion is perforated by the large *foramen ovale* (*f.o.*) and further forwards by the posterior opening of the alisphenoid canal (*al.c.*). The upper limb of the bone unites posteriorly with the squamosal, and for a short distance above with the frontals. Its anterior border, together with that of the lower limb, forms the prominent crest-like

outer wall of the deep groove, at the bottom of which the *foramen lacerum anterius* (*f.l.a.*), the *foramen rotundum*, and the optic foramen open.   This groove is continued downwards and forwards almost to the angle of the pterygoids and upwards on the frontals, probably terminating, as in *Elephas*, at the postorbital process: in the recent form the upper limb of the alisphenoid is relatively small, while the ventral or pterygoid wing is greatly expanded, owing to the great size of the molar sockets, which it, together with the pterygoid with which it is fused, embraces.   In *Palæomastodon* the pterygoid wing of the alisphenoid is a comparatively narrow tongue of bone closely applied to and, in the adult, fused with the outer face of the pterygoid, and perhaps to a small extent in front with the palatine (Pl. XII. fig. 1, *al.*).   The upper end of this portion of the alisphenoid is perforated by the alisphenoid canal (*al.c.*), the posterior opening of which, as already described, lies a little below and in front of the *foramen ovale*; while the anterior opening is at the bottom of the deep groove above referred to, and beneath the *foramen lacerum anterius*, with which probably the *foramen rotundum* also opened.   The boundaries between the alisphenoid and *orbitosphenoid* cannot be determined.   The optic foramen, which no doubt perforated the orbitosphenoid as usual, lies at the bottom of the groove some distance above and in front of the *foramen lacerum anterius*, and a shallow groove marking the course of the optic nerve runs forwards from it to the orbit.   The lower limit of the orbitosphenoid is obscure, but it appears to have united with the upper edge of the orbital plate of the palatine and perhaps also with the maxilla.

The exact form of the *pterygoid* (*pt.*) is difficult to make out.   As usual it forms the posterior part of the lateral wall of the mesopterygoid fossa, embracing the basisphenoid above and dying away as a ridge which is continuous posteriorly with the anterior end of the tympanic; its outer face is for the most part concealed by the adherent pterygoid plate of the alisphenoid, but on the inner side the suture with the palatine can be seen to run upwards and backwards from the posterior angle of the vertical palatine plates to the basisphenoid.

The posterior vertical portion of the *palatine* (*pl.*) forming the side of the mesopterygoid fossa is considerably thickened; posteriorly it joins the pterygoid in the manner already described, above it meets the vomer which extends back considerably behind the level of the hard palate, and together the two bones conceal the anterior part of the basisphenoid and the rest of the anterior part of the basis cranii.   In front the bone becomes still more thickened, so that where its horizontal plate meets its fellow of the opposite side they together form not only a strong backwardly-directed process, but also a large paired downwardly-projecting tuberosity, and from this the line of union of the bones is continued forwards as a strong cristiform ridge which extends throughout their whole length and on to the maxilla in front.   The anterior end of the palatine plates is about opposite the hinder lobe of the second molar.   The suture with the maxillæ is transverse in front, then it runs backwards and outwards, being

interrupted opposite the front lobe of the last molars by a pair of elongated apertures, the posterior palatine foramina (*p.p.f.*). The upper edge of the palatine seems to extend up into the side of the skull above the maxilla, where it joins the lower edge of the orbitosphenoid.

The *vomer* (text-fig. 49, *v.*), as already remarked, extends backwards considerably behind the level of the posterior border of the hard palate and forms a long **V**-shaped crest along the roof of the nasal canal.

In this specimen the upper portion of the *maxilla* (*mx.*) is broken away in front, so that its relations in that direction cannot be determined. The alveolar region is very long and almost straight, there being only a very slight outward convexity; it bears six cheek-teeth (three premolars and three molars). The base of the zygomatic process is long and nearly parallel with the alveolar border, from which it is separated by an interval of about 3 cm.: the anterior end is about opposite the front of *m.* 3. The upper surface is concave and forms the lower border and floor of the orbit. Anteriorly it is perforated by the antorbital foramen, which, judging from the young skull described below, had two openings on the face—a lower larger one preserved in the present specimen, and a smaller upper one here broken away. The much smaller size of the antorbital foramen in *Palæomastodon* compared with that seen in *Elephas*, is no doubt due to the fact that in the older form the proboscis was still comparatively small.

Behind the orbit there is a small upwardly directed process of the zygoma, marking the anterior limit of the jugal, which sends forwards a long process overlapping the maxilla and helping to bound the orbit. The form of the suture between the *jugal* (*ju.*) and the *maxilla* (*mx.*) will be best understood by examination of the figure (Pl. XII. fig. 1). The palatine plates of the maxilla are rather narrow and together form a palate which is gently arched from side to side; posteriorly they are separated by the palatines as above described. Behind the last molar the bone is greatly thickened by sinuses, so that, although the dentition is still of a perfectly normal type, the increase in the size of the hinder part of the maxilla, which is carried to such an enormous extent in the later forms, in which the teeth are greatly enlarged, has already begun to manifest itself. Superiorly the bone appears to unite with the orbitosphenoid in a straight suture running forwards and downwards. The anterior portion of the orbital region is wanting. The maxilla, as might be expected from the character of the dentition, differs widely from that seen in the Elephants. The chief differences are: (1) the much greater relative length of the bone; (2) its smaller depth consequent upon the brachyodont character of the teeth. These features are especially noticeable posteriorly, where, except for the development of the sinuses in the bone behind *m.* 3, there is no trace of the enormous increase in size in all dimensions, but especially in depth, which has taken place in *Elephas* in consequence of the immense size of the posterior molars and their mode of

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succession. The differences between the palatines and pterygoids in the earlier and later types are of course dependent on the same causes.

The anterior portion of the skull, particularly the upper portion, is completely wanting in the large specimen on which the above description is for the most part founded; but another specimen (Pl. XIII.) supplies the necessary information concerning this region. It is the anterior portion of a skull of a very young individual in which the milk-teeth are still in use; it includes the whole of the frontals as far back as considerably behind the postorbital processes, the nasals, premaxillaries, lachrymals, and most of the maxillæ, including the zygomatic process, also the palate as far back as the level of the middle of the zygoma. There are two teeth *in situ* on one side and three on the other; they are probably *mm.* 2, 3, 4, and will be described below. The crushed base of one of the milk-tusks is preserved in the socket. As will be shown below, this specimen in the shortening of the nasals and the shifting backwards of the narial opening supplies a beautiful illustration of the approximation towards the later Proboscidean type found in this genus. In the relations of the bones to one another it precisely resembles *Elephas*.

The right *frontal* (*fr.*) is mostly broken away, but the left is better preserved, and although its actual junction with the parietal cannot be observed, nevertheless little can be wanting from its hinder border. Together the upper part of the combined frontals in the interorbital and part of the postorbital regions forms the gently convex skull-roof. In this young specimen scarcely any trace of the supratemporal ridges (the divided sagittal crest) can be seen, but it is evident that they ran on to the postorbital processes. External to these ridges in the postorbital region the frontals run down into the temporal fossæ, and are strongly convex from above downwards. The postorbital processes are blunt prominences, from each of which a ridge runs downwards and backwards, separating the orbit from the temporal fossa. Ventrally this ridge must have been continuous with that formed by the free edge of the alisphenoid described above. In front of the postorbital processes the frontals form a well-defined upper rim to the orbit, and anteriorly they unite in suture with the maxillæ, lachrymals, premaxillæ, and nasals, their general relationships to the neighbouring bones being exactly as in *Elephas*.

The *lachrymal* (*lac.*) is a small bone wedged between the frontal and maxilla, and grooved below by the upper surface of the antorbital canal. It is perforated by a large foramen which lies within the border of the orbit; above the foramen and on the rim of the orbit there is a small but prominent tubercle.

The *nasals* (*na.*) are short bones which already approximate very nearly in form to those of *Elephas*. Together they project in a blunt point over the nasal aperture. Posteriorly they are together roughly semicircular in outline and unite for the greater part of their width with the frontals, but externally to these with the premaxillæ.

The *premaxillæ* (*pmx.*) send up a long tongue of bone along the sides of the nasal opening, thus completely shutting out the maxillæ from any share in its border. Anteriorly they are prolonged forwards, forming a projecting snout, on either side of which are the alveoli of the large incisor tusks, which must have projected forwards and somewhat downwards. Here the only trace of teeth is a portion of the crushed base of one of the tusks (*i.*), probably of the milk-series; this tooth seems to have been enamel-clad on the outer side only. On the palate the premaxillæ seem to have appeared to a very small extent only, but the precise division between them and the maxillæ cannot be made out. The upper surface of the conjoined bones is slightly concave from side to side, the first indication of the form so characteristic of the later Proboscidea. Posteriorly their median suture opens for a short distance in a sort of cleft (? for the mesethmoid cartilage), on either side of which they are perforated by a small foramen. The floor of the nasal cavity is much more in the same straight line with the upper surface of the anterior part of the premaxillæ than in *Elephas*, and the premaxillary portion of the snout, as a whole, is relatively much longer and narrower. The nasal opening (*nar.*), looked at from the front, is quadrate in outline; its upper posterior angle lies considerably in front of the orbit and only a little behind the level of the facial opening of the antorbital foramen. In *Elephas*, on the other hand, the great difference is that the nasal opening is largely behind the anterior border of the orbit, and the whole facial region is much shortened up.

The *maxillæ* (*mx.*) are not completely preserved posteriorly. In front the facial portion extends up the side of the face to the level of the top of the nasal opening, and helps to form the anterior border of the orbit. The base of the zygomatic process is perforated by a large antorbital canal, which opens on the face by two foramina (*a.o.f.*)—the upper small, the lower much larger. The process itself is stout; it forms the lower border of the orbit, but posteriorly the postorbital process is actually formed by the anterior end of the overlapping jugal (*ju.*) above described. The palate is fairly broad and is slightly arched; it narrows in front, where the maxillæ seem to run forwards beneath the premaxillæ as in other Proboscideans.

A restoration of the whole skull founded upon the two specimens above described is given in text-fig. 48 (p. 131).

Upper Dentition (Pl. XII. figs. 1, 1 A; Pl. XIV. fig. 2).—In the upper jaw there are seven teeth on each side: viz., an incisor (*i.* 2), three premolars, and three molars. The first molar is always much smaller than the others.

The incisor is a large, laterally compressed, downwardly directed tusk, sometimes with a slight spiral twist; the anterior edge is rounded, the posterior sharper. There is a broad band of enamel on the outer face. One nearly complete specimen measures 25·3 cm. long in a straight line. Behind the tusk there is a diastema of at least 9–10 cm.

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The anterior premolar (*pm.* 2) is a simple, blunt, somewhat laterally compressed cone, of which the anterior slope is much shorter than the posterior. This latter is worn into a broad flat surface looking slightly inwards. There are no accessory cusps, but the cingulum is fairly well developed, especially on the inner side, where it is often somewhat crenulated or divided into small separate prominences. The next tooth (*pm.* 3) consists of a larger outer and a somewhat smaller inner cusp arranged transversely. There is a small postero-internal cusp, lying behind and closely connected with the inner main cusp: this posterior cusp may sometimes be nearly absent. The cingulum is well developed, especially on the anterior and posterior faces of the tooth, where it forms small projections. The last premolar (*pm.* 4) is a bilophodont tooth, each crest consisting of a pair of cusps—the outer higher and more compressed, the inner more rounded and coming into wear first. The inner cusps in this premolar already show a tendency towards a **V**-shape, the point of the **V** being turned inwards; this form is the consequence of the presence of obscure and imperfectly separated tubercles on the antero- and postero-external sides of the inner tubercles. The anterior accessory tubercle of the front **V** and the posterior accessory tubercle of the posterior **V** become fused with the cingulum of the anterior and posterior ends of the tooth respectively. The other accessory tubercles form a bridge across the main transverse valley. The cingulum is well developed on the ends and outer side of the tooth, where it is strongly crenulated.

The molars *m.* 1 and *m.* 2 are trilophodont, each ridge being composed of a pair of cusps similar to those described as occurring in *pm.* 4, the chief difference being that in *m.* 1 and *m.* 2 the posterior accessory tubercle of the last inner cusp is larger and, by its union with the posterior border of the tooth, forms the first trace of a fourth transverse ridge. The cingulum is well developed, particularly on the inner side of *m.* 2. The last molar may be said to consist of two transverse crests and a talon. The anterior accessory tubercles of the inner cusps are especially well developed. The talon consists of three tubercles, of which the innermost is much the largest, and the outer two are sometimes imperfectly divided. The crenulated cingulum is well developed, particularly on the anterior and inner faces.

The above account of the upper teeth applies to specimens referred provisionally to *P. beadnelli*, but which may probably belong to *P. wintoni*: this applies to both the skull figured on Pl. XII. and to the upper teeth figured on Pl. XIV. fig. 2. The species being founded mainly on the form of the mandible and of the last lower molar, it will not be possible, in most cases, to determine the skulls and upper teeth with certainty till specimens have been found associated with the mandibles.

Upper Milk-dentition (Pl. XIII.).—The upper milk-teeth are preserved in the specimen upon which the account of the front of the skull is founded. In this, in addition to remnants of the base of the milk-incisor, there are on the left side three

other teeth (Pl. XIII. fig. 1 B), which are regarded as being *mm.* 2, 3, 4, while on the right only the two anterior ones are preserved.

Mm. 2 consists of a large main cusp, laterally compressed and having a small accessory cusp on its posterior edge. The cingulum is well developed on the front of the tooth, where it forms a small cusp; it is also present on the inner side, and forms the edge of the prominent postero-internal angle of the tooth.

Mm. 3 is a somewhat elongated tooth, wider behind than in front. Its anterior angle is formed by a cusp of the cingulum. The rest of the tooth is bilophodont, each transverse ridge consisting of a pointed outer cusp (scarcely at all worn in the present specimen) and a rounded lower inner cusp (here much worn). There seems also to have been a posterior cusp forming a sort of small talon and becoming continuous in wear with the postero-internal main cusp. The cingulum is present on the front of the tooth, at the inner end of the transverse valley, and on the outer side of the posterior half of the tooth.

Mm. 4 is trilophodont: the anterior ridge is composed of an outer sharper cusp and a blunter inner one; the other ridges are similar, except that the outer cusp is somewhat compressed from before backwards. The anterior angle of the tooth is formed by a projection of the cingulum, which also appears at the inner ends of the transverse valleys and on the hinder end and the posterior half of the outer side.

Mandible (Pl. XIV. fig. 3; text-figs. 48, 53, 54).—The mandible is very long and must have projected a considerable distance in advance of the skull.

The symphysis (Pl. XIV. fig. 3, *sym.*) is greatly elongated and somewhat decurved: its upper surface forms a spout-like groove bordered by the sharp edentulous alveolar border; the groove is deepest in the middle, but with the rest of the symphysis widens out towards the sockets of the incisors, the upper faces of which continue the spout-like surface forwards. Ventrally the symphysis is deeply channelled in the middle line between the alveoli of the incisors.

Immediately beneath the third premolar (the first here present), which is situated at a varying distance behind the posterior end of the symphysis in the different species, the horizontal ramus deepens considerably; it is flat on the inner face and strongly convex from above downwards externally. The ascending ramus arises from the outer face of the jaw, its anterior border being opposite the anterior lobe of the last molar. This anterior border slopes slightly backwards and terminates above in a very small backwardly curved coronoid process (text-figs. 53, 54, *cor.*). Behind this the upper border of the ascending ramus is gently concave as far as the condyle (*cond.*), which is rather higher than the coronoid process and is slightly convex from side to side and very strongly so from before backwards. From it a broad rounded thickening runs down to the posterior end of the alveolar border, and this ridge is most strongly marked on the inner face, where immediately beneath it, and midway between the end of the molar series and the hinder border of the jaw, there is the very

large round opening of the dental canal. Beneath this ridge the angular region is thin, concave on the inner face, and convex externally; the angle itself is broadly rounded. On the outer face of the jaw, a little below and in front of the condyle, there is a prominent rounded surface for the attachment of a powerful muscle. The ascending ramus, as a whole, is slightly inclined backwards.

Lower Dentition (Pl. XIV. figs. 1, 3, Pl. XV. fig. 1; text-figs. 50, 53, 54).—The lower incisors (Pl. XIV. fig. 3) are straight procumbent teeth, probably representing *i.* 2 of the full series. Ventrally they are convex from side to side, dorsally concave; the outer and inner borders are nearly straight and parallel in the unworn portion. The anterior end is worn above, so as to produce a chisel-shaped surface convex in outline; the enamel covering the ventral face is comparatively thick, while on the dorsal face it is very thin and in some cases perhaps wanting. The outer edge of the tooth is comparatively thin, the inner much thicker. The two teeth are in close contact in the middle line and their concave upper surfaces together form a forward continuation of the spout-like symphysis. The ventral face is usually marked by a series of broad shallow longitudinal grooves.

Only two premolars (text-figs. 53, 54) are present in the lower jaw. Of these *pm.* 3 is a comparatively small laterally compressed tooth consisting of a large pointed main cusp, which in some cases gives some indication of comprising two united elements: behind this there is a small obscure cusp and on the anterior and posterior ends of the tooth the cingulum forms slight projections. In the type specimen of *P. beadnelli* this tooth is missing. *Pm.* 4 is much more complex, being a bilophodont tooth, each crest consisting of a pair of subequal cusps. There is also a small but distinct intermediate cusp lying between and uniting the inner ends of the two outer main cusps. On the middle of the anterior end of the tooth is a closely adpressed cusp belonging to the cingulum, and towards the outer side of the posterior end a similar but much smaller element. The peculiarities of these premolars and their differences from the corresponding teeth of *Mœritherium* seem to be the consequence of two distinct influences—one the tendency to the reduction and loss of the anterior members of the series, the other the tendency to the increasing complication of the posterior ones. The consequence of these influences is that *pm.* 2 has disappeared altogether, *pm.* 3 is reduced in relative size and simpler than the corresponding tooth in *Mœritherium,* while *pm.* 4 is bilophodont and much more molariform than in the earlier genus.

The molars (Pl. XV. fig. 1; text-figs. 50, 53, 54) are all trilophodont, differing only in the several species in the degree to which the main cusps become subdivided and in the complication of the talon of *m.* 3. The anterior molar is much smaller than those behind. The following description refers especially to the type species, *P. beadnelli,* the differences in the other species being noted below.

The molars are trilophodont, each crest consisting of a pair of tubercles, of which

the outer one is the more rounded and always much more worn than the inner, which is higher and somewhat compressed from before backwards. The outer cusps, particularly the anterior ones, often give a roughly **V**-shaped surface in wear, the point of the **V** being turned outwards: this results from the presence of small and slightly developed accessory tubercles connected with the inner side of the main outer cusps. In the case of the anterior cusp the front accessory tubercle is fused with the cingulum, while the posterior one partly fills the valley between the first and second ridges. In the last molar the posterior accessory tubercle of the last outer main cusp is larger and is connected with the cingulum, forming a small and slightly developed talon. In some other species this is much larger, and the

Text-fig. 50.
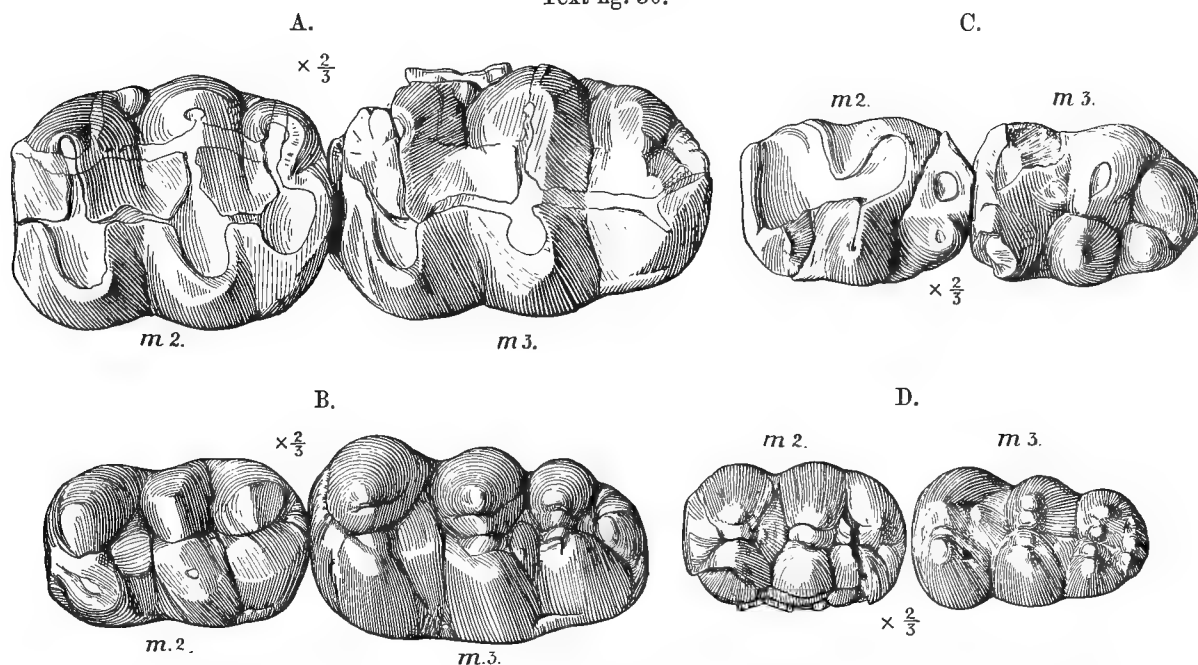
The second and third lower molars of: A, *Palæomastodon beadnelli* (left side); B, *P. wintoni* (left side); C, *P. parvus* (right side); D, *P. minor* (right side). All ⅔ nat. size.

accessory tubercles are better developed. The cingulum is only slightly developed: in some cases it forms small blunt tubercles opposite the inner ends of the transverse valleys (see Pl. XV. fig. 1, *m*. 2).

Vertebral Column.—The vertebral column in the present genus is not well known, because the absence of specimens occurring definitely associated with portions of the skull and mandible, together with the intermingling of vertebræ of other Ungulates of similar size, makes it almost impossible to determine isolated vertebræ. In the case, however, of highly characteristic vertebræ like the atlas and axis, some degree of certainty may be attained. These two vertebræ are here described from specimens

found in the immediate neighbourhood of the type mandible of *P. beadnelli*, and from their size probably referable to that species. Other specimens differing only in their smaller dimensions will be found mentioned in the Catalogue, where they are referred provisionally to other species.

The *atlas* of *P. beadnelli* (Pl. XV. fig. 3) is of very large size, equalling the same vertebra in a small Indian Elephant. The condylar cups (*cond.*) for the occipital condyles are deep; they are wide dorsally, but narrow considerably towards their lower end. The articular surface for the skull is rather wider and lower than in *Mastodon* or *Elephas*, in which the long axis of the condylar cups is nearly vertical. The arch forms a low nearly straight bar, which bears on its dorsal surface a median transverse ridge (*n.sp.*) separating an anterior rugose surface for the attachment of muscles from a nearly smooth posterior one. Anteriorly the base of the arch is perforated by a foramen for the transmission of the first spinal nerve. In *Elephas* and *Mastodon* the arch is more elevated and shorter from side to side. The ventral bar is likewise longer and straighter than in those genera, though some species of *Mastodon* (e. g., *M. americanus*) approach the present form in this respect. The notch for the odontoid process (*od.*) is broader and shallower than in *Mastodon*, *Elephas primigenius*, and *E. maximus*, in which it is comparatively narrow and deep; *E. africanus* resembles *Palæomastodon* most nearly in this respect. The distinct separation of the odontoid notch from the neural canal distinguishes the atlas in this genus from that of *Arsinoitherium*. The posterior surface for union with the axis differs widely from the form seen in the atlas of other Proboscidea. In these the lateral surfaces for articulation with the centrum of the axis are continuous both with that for the lower surface of the short blunt odontoid process and with one another beneath it. In *Palæomastodon*, on the other hand, the two lateral surfaces, which make only a small angle with the transverse plane, are distinct from one another and are not continuous with the odontoid facet, which is a cylindrical surface on the upper face of the ventral bar; this latter bears on its postero-ventral border a blunt hypapophysial process. The transverse processes (*t.p.*) are about the same size as in the Indian Elephant; they are perforated at their base by a foramen (*v.c.*) which is much smaller than that found in the atlas of *Mastodon* and *Elephas*. The upper pedicle of the transverse process is much wider than the ventral one; the anterior face of the transverse process looks downwards and forwards. On the whole, this vertebra approaches very nearly to the atlas of the Elephant, differing from it mainly in (1) the form and relations of the surfaces for articulation with the axis; (2) the smaller size of the vertebrarterial canal; (3) the more oval outline of the surface for articulation with the skull.

The *axis* (Pl. XVI. figs. 1, 1 A) differs much more widely from the modern Proboscidean type than does the atlas, and at the same time approximates more nearly to the form seen in some Ungulates (e. g., *Hippopotamus*) with necks of moderate length. The odontoid process (*od.*) is large and somewhat compressed laterally; its ventral

border is in the same line with the hypapophysial ridge on the centrum: on its lower surface it bears an oval facet for articulation with the ventral bar of the atlas, this facet being sharply defined and separated from the lateral articular surfaces, which are oval in outline and make an angle of about 115° with the long axis of the odontoid process. The centrum is very long compared with that of the later Proboscidean axis; it bears a median hypapophysial ridge, which deepens posteriorly in such a way that the posterior articular surface is greatly deepened ventrally. There are small transverse processes (*t.p.*) perforated at their base by a large vertebrarterial foramen. The neural arch is very high, but the precise outline of the spine (*n.sp.*) cannot be determined, owing to the imperfection of the specimens; it can be seen, however, that it was high and broad, and overhung the arch both before and behind. A smaller axis vertebra, in which the neural spine is nearly complete, shows that it consisted of two plates meeting in front at an acute angle and enclosing posteriorly a deep fossa for the insertion of muscles or ligaments. This axis differs from the ordinary Proboscidean type in the following points :—(1) the large size of the odontoid process, which in the later forms is reduced to a mere knob with its articular surface continuous with that of the centrum which extends beneath it; (2) the much greater length of the centrum; (3) the less massive, but much higher, neural spine. On the other hand, it is very similar to that of *Mœritherium*. The neck in *Palæomastodon* was probably considerably longer and more mobile than in the later Proboscidea.

Fore Limb.—An incomplete left *scapula* collected in the same locality as the type mandible is the only evidence of that bone yet discovered. It is very closely similar to the scapula of *Elephas*, differing only in the rather slighter prominence of the coracoid process and in widening out less rapidly posteriorly above the glenoid cavity, the whole blade being probably rather less expanded above than in *Elephas*. The glenoid cavity is an elongated oval, the prescapular fossa is extremely narrow, and the process projecting backwards from the middle of the spine in *Elephas* here seems to be situated a little nearer the glenoid end.

In the case of the *humerus* (Pl. XVI. figs. 2, 2 A) also the only specimen that can be definitely determined as belonging to *Palæomastodon beadnelli*, was collected near the type mandible. In its general character this bone is like that of the later Proboscideans, but is somewhat stouter and broader in proportion to its length, and approaches more nearly some specimens of the humerus of *Mastodon* with which it has been compared. It is also very similar to the humerus figured by de Blainville ('Ostéographie,' Atlas, vol. v. pl. xiii., *Elephas*) as that of *Tetrabelodon angustidens*. The deltoid crest (*d.*) is greatly developed and strongly bent over to the outer side of the bone. The very prominent and well-marked supinator ridge (*sp.r.*) is shorter than in the Elephants, though still very large; its flat outer surface is slightly inclined to the long axis of the shaft. The inner trochlea is much larger than the outer, and, in fact, seems to be larger proportionately than in the Elephants; but in

this respect also it approximates to a humerus of *Mastodon* with which it has been compared.   The olecranon fossa (*o.f.*) is just as in *Elephas*, and the distal view of the lower end of the humerus is almost precisely like that of a humerus of *Elephas meridionalis* figured by Adams ('British Fossil Elephants,' pl. xvi. fig. 3).

Hind Limb.—In the same locality was found a portion of a right *os innominatum* consisting of the acetabulum and the acetabular ends of the pelvic bones.   This specimen differs in no important respect from the same region of the pelvis of the later Proboscidea, while, on the other hand, it is very unlike what is seen in the pelvis of *Arsinoitherium*, the only other animal with which confusion would be likely.   The very large acetabulum is perhaps a little more circular in outline than in *Elephas*, and at the same time the cotylar notch is wider and the pit for the *ligamentum teres* is deeper. The ischium is much more flattened and thinner than in *Elephas* and its postero-superior border forms a prominent crest-like ridge.   The pubis is like that of *Elephas*. The upper end of the *obturator foramen* is like that of the African Elephant and is not, as in the Indian Elephant and the Mammoth, marked off into a sort of notch by a projecting point of bone.   This specimen differs from the pelvis of *Arsinoitherium* in the following points :—(1) the acetabulum is nearly circular in outline, in *Arsinoitherium* it is oval ; (2) the cotylar notch is much broader and the pit for the ligament larger and deeper ; (3) the *obturator foramen* seems to have been relatively much larger ; (4) the ischium is broader, thinner, and flatter.   In short, it may be said that this specimen differs from the pelvis of *Arsinoitherium* in almost exactly the same respects as does the pelvis of *Elephas*.

A *femur* (Pl. XVI. figs. 3, 3 A) from the same locality is the only specimen of that bone in the collections of Cairo and London that is definitely Proboscidean in character and can be referred to *Palæomastodon*—a circumstance which still further emphasises the extraordinary rarity of bones of the skeleton of that animal.   The head is nearly hemispherical ; it rises considerably above the great trochanter and bears a deep pit for the *ligamentum teres* (not shown in figure) in the middle of its posterior half.   The neck, which is directed obliquely upwards, is greatly compressed from before backwards.   The head (*h.*) rises less above the great trochanter than in *E. africanus*, but more than in *E. maximus*.   The great trochanter (*g.t.*) is developed to about the same extent as in the femur of *Mastodon* ; the smaller is represented by a slight ridge.   The digital fossa is merely a shallow concavity, dying away distally on the flat posterior surface of the upper half of the shaft.   In its middle portion the hinder face of the shaft is convex and is produced outwards into a prominent ridge (*t.t.*), which seems to represent the third trochanter ; this is also developed to some extent in the Mammoth femur, but scarcely at all in the recent Elephants.   In a femur of *Tetrabelodon angustidens* figured by de Blainville ('Ostéographie,' Atlas, vol. v. pl. xiii., *Elephas*) this ridge is well developed, but is rather lower down the shaft than in *Palæomastodon*.   At the distal end of the bone

the condyles (*i.c., o.c.*) are subequal, as in *E. maximus*; they are separated by a deep intercondylar fossa, which extends into the inner face of the condyles and is crossed obliquely by a ridge running down from the upper inner end of the outer condyle. The trochlear surface is too much broken in this specimen for description.

A left *tibia* (Pl. XVI. figs. 4, 4 A) from the same locality is, on the whole, like that of the Elephant. It is, however, rather more slender in the shaft, and the distal articulation differs in several important points. At the proximal end the articular surfaces are somewhat more obliquely placed than in *Elephas*, the inner facet (*i.*) being somewhat more elevated with regard to the outer (*o.*); the two facets are of nearly equal size. The upper end of the cnemial crest (*cn.*) is slightly more prominent in proportion to the thickness of the shaft than in the Elephant, and both in this and in the other points mentioned there seems to be a greater likeness to the tibia of *Tetrabelodon*. On the middle of the front of the shaft there is a vertical groove-like depression for the insertion of a muscle. The distal end differs from that of the tibia of *Elephas* in the following points:—(1) the internal malleolus (*i.m.*) is much more prominent and is sharply bounded on its astragalar side by a well-defined groove; (2) the astragalar surface is more strongly concave from before backwards and posteriorly is produced downwards into a prominent point near its inner side; (3) the surface for the fibula is smaller and situated further back. The whole surface indicates that the tibial face of the astragalus was narrower and more convex from before backwards and interlocked much more closely with the tibia than in *Elephas*; the broad, gently convex, tibial surface of the astragalus in the later Proboscidea not being a primitive character of the group. Immediately above the internal malleolus there is on the postero-internal face of the shaft a short deep groove, bounded internally by a strong ridge: this is wanting in the tibia of *Elephas*.

No bones of the foot were found with the limb-bones just described, but a single *calcaneum* (text-fig. 51), from some distance off, so nearly resembles in essential characters the calcaneum of the later Proboscideans, more particularly of the Lower Miocene *Tetrabelodon angustidens*, that it may be safely referred to *Palæomastodon*, and from its large size probably belongs to *P. beadnelli*.

As might be expected in an animal considerably more lightly built than *Elephas*, the calcaneum is more elongated, the *tuber calcis* (*t.c.*) especially being less short and stout. In its general proportions this calcaneum more nearly resembles that of *Tetrabelodon angustidens*; but even in this Lower Miocene form the bone is already considerably shorter and stouter. There is a large fibular facet much like that seen in the calcaneum of *Elephas*, except that, instead of narrowing gradually from before backwards, it terminates posteriorly abruptly in a nearly vertical border; it is convex from before backwards and looks upwards and outwards. Of the two surfaces for the astragalus the ectal (*ec.*) is the larger; it is nearly flat, only rising a little towards the anterior part of its outer border, where it meets the upper edge of the fibular surface.

The sustentacular facet (*sus.*) is separated from the ectal posteriorly by a deep groove which enlarges anteriorly into a deep fossa; this surface is convex from before backwards and anteriorly it is continued forwards and outwards as a narrow strip along the top of the anterior edge of the above-mentioned fossa, and in front of this it is continuous with the small surface for the navicular which meets it at about a right angle. The sustentaculum, as a whole, is prominent and sharply defined. The cuboid surface (*cub.*)

Text-fig. 51.
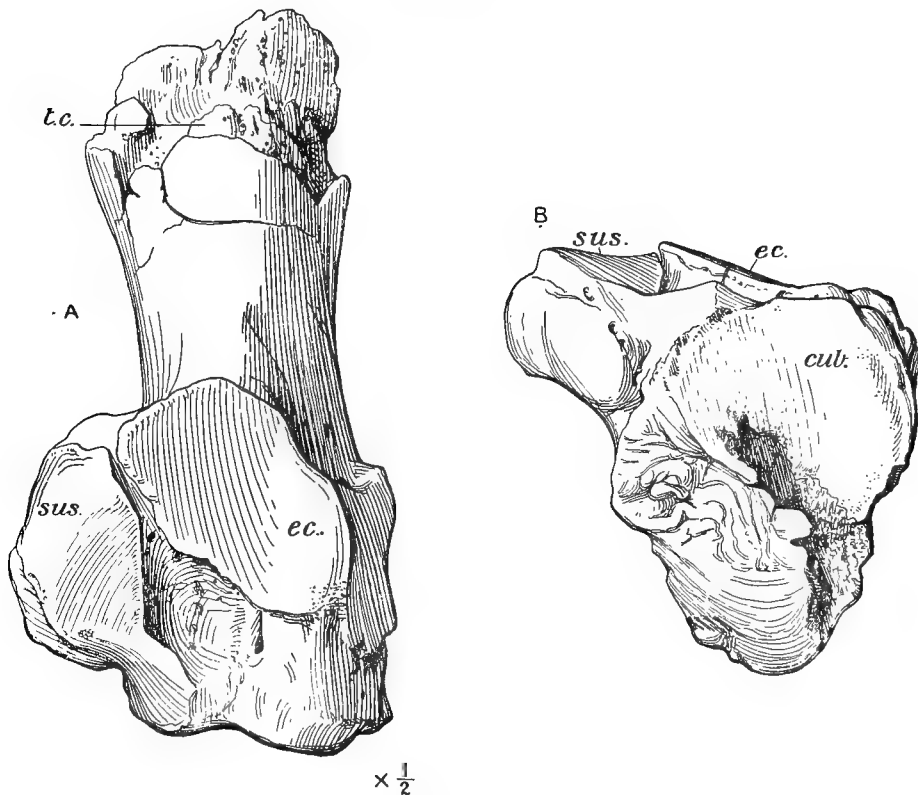
Left calcaneum of *Palæomastodon beadnelli*: A, from above; B, distal end.

cub., facet for cuboid; *ec.*, ectal facet; *sus.*, sustentacular facet; *t.c.*, tuber calcis.
The fibular facet lies immediately outside the ectal facet. ½ nat. size.

is much like that seen in *Elephas*, but is narrower and does not extend so far towards the inner side of the bone; it is gently concave. Beneath and to the inner side of it there is a roughened surface which ventrally passes into a prominent tuberosity. The outer face of the calcaneum is concave from above downwards, while the inner side of the *tuber calcis* is slightly convex, the whole tuber being much more compressed laterally than in *Elephas*, though perhaps not more so than in *Tetrabelodon angustidens*.

No *astragalus* large enough to have belonged to *P. beadnelli* has been found; but a

number of smaller ones, which appear to have belonged to Proboscideans, occur in the collections. The largest of these is shown in text-figure 52, and may be referred provisionally to *P. wintoni.* The tibial surface (*tib.*) is comparatively narrow from before backwards and is strongly and evenly convex in the same direction; at its outer edge it is continuous with the nearly vertical surface for the fibula (*fib.*), and on its inner side it is cut into by a deep rounded concavity (*i.m.*) looking upwards and inwards, evidently for the reception of a large internal malleolus such as has been described as occurring in the tibia of *Palæomastodon* (see above, p. 147). Behind this the postero-internal angle of the bone is produced into a strong tuberosity which in some of the smaller specimens forms a pedunculate knob. In front of the tibial surface the anterior face of the bone is concave and forms a short neck for the prominent rounded

Text-fig. 52.
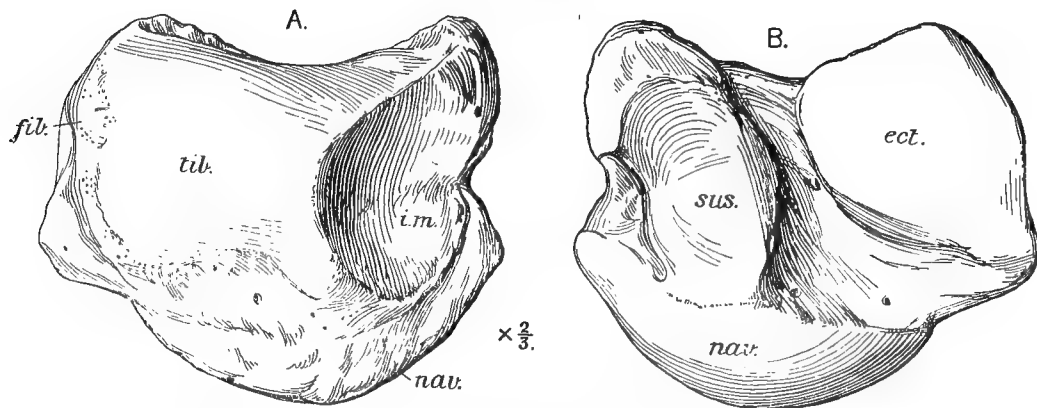
Right astragalus of *Palæomastodon*: A, from above; B, from below.

ect., ectal facet; *fib.*, fibular facet; *i.m.*, surface for internal malleolus of tibia; *nav.*, navicular facet; *sus.*, sustentacular facet; *tib.*, tibial facet. $\frac{2}{3}$ nat. size.

navicular facet (*nav.*), which is almost precisely as in the astragalus of *Tetrabelodon angustidens.* There are two calcaneal surfaces: of these the ectal (*ect.*) is flat and nearly triangular in outline, the apex being anterior, while the sustentacular (*sus.*) is an elongated oval facet with the long axis antero-posterior, in which direction it is deeply concave. The anterior edge of the sustentacular joins the lower edge of the navicular facet. The two surfaces are separated posteriorly by a deep groove, which widens out in front into a broad fossa, the anterior border of which is formed by the lower edge of the navicular surface. The chief differences between this astragalus and those of the later Proboscidea are: (1) the tibial surface is narrower and at the same time more strongly convex; (2) there is a large internal malleolus in the tibia involving the presence of a deep concavity in the astragalus for its reception; (3) the neck is somewhat better developed, at least in the smaller species; (4) the postero-internal angle of the bone is very prominent.

Palæomastodon beadnelli, Andrews.

[Plates XII.–XVI.; text-figs. 50 A, 51.]

1901. *Palæomastodon beadnelli*, C. W. Andrews, Tageblatt des V. Internationalen Zoologen-Congresses Berlin, No. 6, p. 4 (Verhandlungen, p. 528, 1902); Zoologist, [4] vol. v. p. 319; Geol. Mag. [4] vol. viii. pp. 401–403, fig. 1 (mandible).

1903.   „   „   C. W. Andrews, Phil. Trans. vol. 196 B, pp. 110–113, figs. 10–13 (skull and mandible).

1904.   „   „   C. W. Andrews, Geol. Mag. [5] vol. i. pp. 112–115, fig. 2 (skull).

Type Specimen.—Left ramus of mandible with *pm.* 4 (broken) and *m.* 1–3 (Pl. XV. figs. 1, 1 A); Geological Museum, Cairo.

The type species and the largest yet known. The length of the molar and premolar series in the lower jaw is 28 cm. The molars are distinguished by the comparatively small development of the accessory and intermediate cusps and the antero-posterior compression of the main cusps, the consequence of these peculiarities being that the teeth are more distinctly lophodont than in the other species, with the exception of the small *P. minor*. The last lower molar has no talon beyond a slight ridge of the cingulum, which is almost as strongly developed in *m.* 2. The molars also differ from those of *P. wintoni* and *P. minor* in being wider in proportion to their length; in this respect they resemble the molars of *P. parvus*. The elongation of the mandibular ramus between the anterior end of the cheek-teeth and the symphysis also distinguishes *P. beadnelli* from *P. wintoni* and *P. minor*, in which the posterior end of the symphysis is very little in front of the anterior premolar (*pm.* 3): in *P. beadnelli* the interval is about 12 cm. The degree to which the symphysis is prolonged in the present species is uncertain. The mental foramen opens almost immediately beneath the anterior end of *pm.* 3, and therefore some distance behind the symphysis.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 10014. Imperfect left ramus of mandible with *pm.* 4 and *m.* 1–3. The type specimen noticed in 'Tageblatt des V. Internationalen Zoologen-Congresses,' No. 6, p. 4 (Berlin, 1901); also described and figured in Geol. Mag. [4] vol. viii. (1901) p. 401; also Pl. XV. figs. 1, 1 A. The dimensions (in centimetres) of this specimen are :—

Total length of specimen	. . . .	61
Depth of ramus in middle of diastema	. . . .	9·6
„ „ immediately in front of *pm.* 3	. . . . .	10·5
„ „ „ beneath *pm.* 4	. . . . . .	12

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 3 (alveolus only)	4·1	..
pm. 4	4·8	3·3 app.
m. 1	4·8	3·7 app.
m. 2	6·5	5·1
m. 3	7·8	5·3

Approximate length of molar and premolar series 28·5.

M. 8059. Plaster cast of the above specimen.   *Made in the British Museum.*

The following specimens were collected in the immediate neighbourhood of the type specimen ; from this circumstance, together with their large size, they may be referred to the present species with reasonable certainty :—

C. 10014 a. Portion of left maxilla with greatly worn *m.* 2 and *m.* 3. This specimen is figured on Pl. XV. fig. 2. The approximate dimensions (in centimetres) of the teeth are :—

	Length.	Width.
m. 2	5·6	4·8
m. 3	6·5	5·2

M. 9234. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 10060. Atlas vertebra from same locality. Figured (partly restored from another specimen) Pl. XV. fig. 3. Width between outer edges of condylar cups 24·5 cm.; total height 14·7 cm.

M. 9120. Imperfect atlas vertebra from same locality.

Presented by the Egyptian Government, 1904.

C. 10061. Atlas vertebra from same locality. Figured on Pl. XVI. figs. 1, 1 A. Total length from end of odontoid to postero-inferior point of centrum (approx.) 17 cm.; width of anterior end of centrum (approx.) 20 cm.; height 20+.

M. 9121. Imperfect axis from same locality.   *Presented by the Egyptian Government,* 1904.

C. 10016. Left scapula from same locality. Suprascapular and much of postscapular region broken away. Length of glenoid surface (approx.) 13 cm., width (approx.) 8 cm.

M. 9235. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 10013. Right humerus, wanting the proximal portion, from the same locality. Figured on Pl. XVI. figs. 2, 2 A. The dimensions (in centimetres) of this specimen are :—

Length (so far as preserved)	61
Width of shaft at narrowest point	10
„ distal articular surface	19
„ distal end at condyles	21 app.
Length of supinator ridge	18·5 app.

M. 8060. Plaster cast of above specimen.   *Made in the British Museum.*

C. 10062. Portions of right os innominatum from same locality, including the acetabulum and the acetabular ends of the pelvic bones. Longest diameter of the acetabulum 13 cm.

C. 10017. Right femur from same locality.   Figured on Pl. XVI. figs. 3, 3 A.   The dimensions (in centimetres) of this specimen are :—

Length . . . . 87·5
Longest diameter of head . . . . 12·3
Width of proximal end 28
    „   middle of shaft above third trochanter 12
    „   distal articulation . . . . 17·2
    „   distal end at widest point . . . . 19·7

M. 8061. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 10015. Left tibia from same locality.` Figured on Pl. XVI. figs. 4, 4 A.   The dimensions (in centimetres) of this specimen are :—

Length . . . . 33·5
Width of proximal end 20
    „   distal end . . . . 13·5
    „   shaft at narrowest point 8

M. 9236. Plaster cast of above specimen.   *Made in the British Museum.*

M. 9231. Imperfect left tibia.   *Presented by the Egyptian Government,* 1904.

M. 8484. Left calcaneum, probably of the present species.   Text-fig. 51.   The dimensions (in centimetres) are :—

Extreme length 19
    „   depth of anterior end . . . . 9·8
Width of astragalar surface . . . . 9·5
    „   cuboid surface . . . . 6·3

                        Presented by W. E. de Winton, Esq., 1903.

The following specimens may be provisionally referred to *P. beadnelli*, for, in the absence of associated series of bones, especially of upper and lower jaws, it is impossible in many cases to be certain of the specific determination.   Since, however, many of these specimens have been found in the immediate neighbourhood of mandibles similar to that upon which *P. wintoni* has been founded (see below, p. 156), and since that species appears to have been the commonest in these beds, some at least will no doubt eventually be referred to it.

M. 8464. Skull, wanting part of the supraoccipital and most of the facial regions ; the cheek-teeth are preserved on the left side.   Figured Pl. XII. and text-fig. 49 A.   The description of the skull in this genus given above is founded so far as possible on this specimen.   The dimensions (in centimetres) of this specimen are :—

Greatest length (so far as preserved, see Pl. XII.) . . . . . 63·5
Width at zygomatic arch 42
    „   external auditory opening . . . . 32·2
Height from junction of basioccipital and basisphenoid to
    sagittal crest 22
Width of palate between *m.* 2 7
    „   foramen magnum . . . . 6·3
Height of foramen magnum . . . . 3·7
Width between outer angles of occipital condyles . . . . . 16·2
    „   of glenoid surface . . . . 9·2
    „   between inner ends of glenoid surfaces 14
Height of opening of internal nares . . . . 5·5

The dimensions (in centimetres) of the teeth are :—

		Length.	Width.
pm. 3	. . . .	3·1 app.	3
pm. 4	. . . .	3	3
m. 1.	. . . .	3·9	3·1
m. 2.	. . . .	5·5	3·9
m. 3.	. . . .	6·2	4·4

Length of molar series 15·5. Length of premolar series 10 (app.).

Presented by W. E. de Winton, Esq., 1903.

C. 8458. Base and palatal portion of skull. The left maxilla, part of right maxilla, and left zygomatic arch preserved. The figure of the skull given in Phil. Trans. vol. 196 B, 1903, p. 110, figs. 10, 11, was founded upon this skull. The dimensions (in centimetres) of this specimen are :—

Width of skull at zygomatic processes 38
    „   palate between *m.* 2 . . . . 5·6
    „   foramen magnum 7
Height of foramen magnum . . . . 4·5 app.
Width between outer angles of occipital condyles 17
    „ of glenoid surface . . . . 9·1
Length from ventral edge of foramen magnum to posterior
border of hard palate . . . . 23·1

The dimensions (in centimetres) of the teeth are :—

		Length.	Width.
pm. 2	. . . .	4	2·3
pm. 3	. . . .	3·8	2·9
pm. 4	. . . .	3·8	3·5
m. 1.	. . . .	4 5	3·4
m. 2.	. . . .	6·1	4·7
m. 3.	. . . .	6·1	5·1

Length of molar series 17.
Length of molar and premolar series 28·4.

C. 9225. Palatal portion of skull with *pm.* 3, 4 and *m.* 1–3 on left side : on right *pm.* 3 is wanting. Length of molar series 15·7 cm. The last molar just come into wear.

C. 9354. Lower portion of skull. The dimensions (in centimetres) of this specimen are :—

Length from condyles to tip of snout . . . . 60·5
    „   „   hinder border of palate 26

The lengths (in centimetres) of the teeth are :—

pm. 3	. . . .	3
pm. 4	. . . .	3·1
m. 1	. . . .	4·4
m. 2	. . . .	5·4
m. 3	. . . .	6·1

Length of molar series 15·6.

M. 8383. Palatal portion of skull with *m.* 1–3, *pm.* 3, 4, and broken base of *pm.* 2 on one side. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2 (base only)	3·7	..
pm. 3	3	2·8
pm. 4	3·4	3·2
m. 1	4·5	3·4
m. 2	6·3	4·3
m. 3	5·8	4·4

Length of molar series 15·5. Length of premolar series 10.

Presented by the Egyptian Government, 1902.

M. 8852. Palatal portion of skull with *m.* 1–3 and *pm.* 3–4 on left side, *m.* 2, 3 on right. Length of molar series 14·5 cm. *Presented by the Egyptian Government*, 1904.

C. 8111. Palatal region and basis of skull: the right zygomatic arch also present. The form of the palate is well shown in this specimen; it is slightly concave from side to side and is widest opposite *m.* 1, where its width is 7·5 cm. The maxillæ diverge slightly from one another in the middle line and end in a point anteriorly: at the upper and outer side of this anterior region there is a deep concavity running forwards and downwards and marking the position of the alveolus of the tusk, so that, as in *Mœritherium* and *Elephas*, the maxilla seems to have extended forwards beneath the premaxillæ and helped to support the tusks, and may even have formed part of the hinder border of their alveoli. Length from occipital condyle to ends of maxillæ 66 cm. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	3·8	2·1
pm. 3	3·1	2·5
pm. 4	3·2	3·1
m. 1	4·2	2·9
m. 2	5·6	4
m. 3	7	4·7

Length of molar series 17. Length of premolar series 10·2.

C. 9398. Palatal portion of skull of a young individual in which *m.* 3 is not yet cut and *pm.* 4 has just appeared. The posterior end of *m.* 2 is opposite the hinder border of the palate. This specimen also shows the orbit, portions of the premaxillæ, and the nasal opening. The lengths of the teeth (in centimetres) are :—*m.* 2, 5·9 ; *m.* 1, 4·5 ; *pm.* 4, 3·5 ; *pm.* 3, 3·2 ; *pm.* 2, 3·4.

C. 8116. Anterior portion of skull of a young individual with the milk-molars 2–4 (?) *in situ*. This specimen shows the form and position of the nasal opening. Figured on Pl. XIII. The dimensions (in centimetres) of this specimen are :—

Total length of specimen	24·5
Length from tip of nasals to end of snout	13·4
„ „ anterior rim of orbit to end of snout	13
Distance between the postorbital processes of the jugal and frontal	4·5
Width of skull-roof at postorbital processes	14
Greatest width of nasals	6·4

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
mm. 2	2·4	1·1
mm. 3	2·9	2
mm. 4	4	2·3

M. 8542. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 7890. Right maxilla with base of zygoma. Chiefly remarkable for the large size of *pm.* 3. The lengths of the teeth are :—*pm.* 3, 3·7 cm. ; *pm.* 4, 3·5 cm. ; *m.* 1, 4·8 cm. ; *m.* 2, 6·2 cm.

C. 9296. Right maxilla with the molars; *m.* 3 greatly worn. Lengths :—*m.* 1, 3·7 cm. ; *m.* 2, 4·7 cm. ; *m.* 3, 5·3 cm.

C. 7837. Portion of an upper incisor tusk of large size. At base the long diameter is 6 cm., the short 3·9 cm.

C. 8981. Upper incisor tusk with a slight spiral twist and a band of enamel on outer face. This specimen is nearly complete. Length in straight line 25·3 cm. ; length along curve 28 cm.

C. 8467. Upper incisor tusk : slight spiral twist, enamel lost. Imperfect, length preserved 18·3 cm. in straight line.

M. 8417. Upper incisor tusk with a slight spiral twist and a band of enamel on outer face. Length (so far as preserved) 16·5 cm. ; long diameter near base 4·7 cm., short diameter near base 2·6 cm.

M. 8417 a. Terminal portion of large upper tusk. Enamel band on outer side, wear-surface on lower side of tip. Length 15 cm. ; long diameter at widest part 5·2 cm., short diameter at widest part 3·5 cm.

M. 8483. Portion of base of lower incisor, cut to show internal structure.
           Presented by W. E. de Winton, Esq., 1903.

C. 9305, C. 9307. Two right upper premolars.

C. 8488. Left upper premolar.

M. 8845. Two right upper second premolars.   *Presented by the Egyptian Government,* 1904.

M. 8419. Left upper second premolar.

C. 8479. Right upper third premolar. Length 3·6 cm.

C. 8964. Right upper third premolar. Length 3·1 cm.

M. 8419 a. Left upper third premolar.

C. 8101, C. 8474, C. 8487. Three right upper fourth premolars.

M. 8419 b, M. 8845 a (two). Three left upper fourth premolars.

M. 8850. Fragment of left maxilla with *pm.* 3 and *pm.* 4. The lengths of the teeth are 3·3 cm. and 3·5 cm. respectively.   *Presented by the Egyptian Government,* 1904.

M. 8851. Fragment of right maxilla with *pm.* 4 and *m.* 1. Lengths 3·3 cm. and 4·4 cm. respectively.
           Presented by the Egyptian Government, 1904.

M. 8480. Fragment of right maxilla with *m.* 1 and *m.* 2. Lengths 4·1 cm. and 5·8 cm. respectively.
           Presented by W. E. de Winton, Esq., 1903.

C. 8954.　Left upper first molar, much worn.

C. 8101.　Two right upper second molars.

M. 8481.　Left upper second molar.　　　*Presented by W. E. de Winton, Esq., 1903.*

M. 8418 a.　Right and left upper second molars.

M. 8418.　Three upper third molars.

C. 8965.　Left upper third molar.

C. 8489, C. 9291.　Right upper third molars.

M. 8420.　? Upper third molars.

M. 8847.　Left upper third molar.　　　*Presented by the Egyptian Government, 1904.*

M. 8418 b.　Portion of maxilla with *m.* 3 and part of *m.* 2.

M. 9122.　Posterior portion of right ramus of mandible with *m.* 3.　The dimensions (in centimetres) are :—

> Height at coronoid process . . . . 21·5
> 　　　„　　condyle 25
> Width of ascending ramus . . . . 19·5
> Length of *m.* 3 . . . . 8·7
> Width of *m.* 3 . . . . 5·2

　　　　　　　　　　　　　Presented by W. E. de Winton, Esq., 1903.

M. 8494.　Atlas vertebra.

> Width of articulation for skull . . . . 17 cm., app.
> 　　　„　　　　„　　axis . . . . 14·4 cm.

　　　　　　　　　　　　　Presented by W. E. de Winton, Esq., 1903.

The following vertebræ may belong to *Palæomastodon* :—

M. 8840.　Cervical vertebra.　　　*Presented by the Egyptian Government, 1904.*

M. 8389.　Cervical vertebra.　　　*Presented by the Egyptian Government, 1902.*

M. 8390.　Lumbar vertebra.　　　*Presented by the Egyptian Government, 1902.*

M. 8842.　Lumbar vertebra.　　　*Presented by the Egyptian Government, 1904.*

C. 9115.　First thoracic vertebra.

C. 9235.　Anterior thoracic vertebra.

C. 8084.　Anterior thoracic vertebra.

C. 8275.　Centrum of lumbar vertebra.

Palæomastodon wintoni, Andrews.

[Text-figs. 50 B, 53, 54.]

1905. *Palæomastodon wintoni*, C. W. Andrews, Geol. Mag. [5] vol. ii. p. 563.

Type Specimen.—A mandible wanting the angular region and the anterior cheek-teeth (text-fig. 53) ; British Museum.　A fine mandible in Cairo, in which the

incisors are wanting but which is otherwise nearly complete (text-fig. 54), may be regarded as a co-type.

This species differs from *P. beadnelli* in (1) its somewhat smaller size; (2) the extension backwards of the symphysis so that its posterior border is only just in front of *pm.* 3; (3) the position of the mental foramen on the side of the symphysis instead of behind it; (4) the greater complication of the molars and their greater length in proportion to the width, the last lower molar (text-fig. 50 B) consisting of three transverse crests and a distinct talon. From *P. minor* and *P. parvus* this species is easily distinguished by its larger size and the difference of its last lower molar (see text-fig. 50).

P. wintoni seems to be by far the commonest species, and probably the greater number of specimens above referred provisionally to *P. beadnelli* belong here. This

Text-fig. 53.
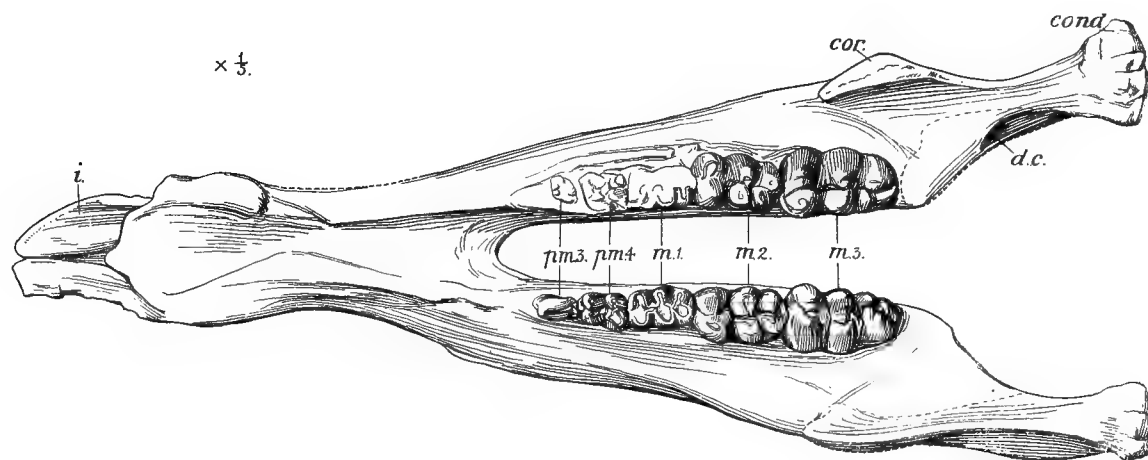
Mandible of *Palæomastodon wintoni*, type specimen, from above.

cond., condyle; *cor.*, coronoid process; *d.c.*, dental canal; *i.*, incisor. The premolars and first molar on the left side have been restored from another specimen. $\frac{1}{5}$ nat. size.

remark particularly applies to the skulls and upper teeth, which, in the absence of associated skulls and mandibles, cannot be determined with certainty; though the absence of any mandibles of the type of *P. beadnelli* from the pits in which most of these specimens were collected is strong presumptive evidence that they do not belong to that species, but to the present one, to which all or nearly all the mandibles and lower teeth are referable.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

M. 8414. Mandible wanting the angular region and the cheek-teeth in front of *m.* 2. Type specimen figured (text-figs. 50 B, 53). The incisors are preserved; they are procumbent and spatulate teeth terminating in a point; their width at the base is 5·2 cm., the length

along their median border is 8 cm.   The dimensions (in centimetres) of this specimen
are :—

Length from condyle to tip of symphysis   74
        „   posterior end of m. 3 to tip of symphysis . . .   54·5
Width of symphysis at narrowest . . . .   8 app.
Length of symphysis . . . .   21·5

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
m. 2	5·5	3·5
m. 3	7·4	4·4

C. 8456.   Nearly perfect mandible wanting the incisors.   Figured in text-fig. 54.   May be regarded
as a co-type.   The characters of the species, viz. the symphysis extending back nearly
to the level of the anterior premolar and the comparatively long and narrow trilophodont
molars, are well shown.   The dimensions (in centimetres) of this specimen are :—

Length from condyle to tip of symphysis . . . .   67·2
        „   angle to tip of symphysis . . . .   64·2
        „   posterior end of m. 3 to tip of symphysis . . .   49
Width of symphysis at narrowest   8
Length of symphysis . . . .   24·5
Height at coronoid process . . . .   18·5 app.
        „   condyle   23

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 3	2·7	1·7
pm. 4	3·7	2·4
m. 1	3·5	2·8
m. 2	5·7	3·5
m. 3	7	4·1

C. 8457.   Nearly perfect mandible of a somewhat smaller individual than either M. 8414 or C. 8456,
the whole jaw being rather more slender.   The dimensions (in centimetres) are :—

Length from condyle to tip of symphysis   64
        „   from angle to tip of symphysis   60
        „   of symphysis . . . .   22·6
        „   of posterior end of m. 3 to tip of symphysis . . . .   47·5
Width of symphysial region at narrowest . . . .   5·5

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 3	2·9	1·4
pm. 4	3·5	2
m. 1	3·8	2·5
m. 2	5·4	3·1
m. 3	6·6	3·5

M. 8384.   Mandible of small individual.   The angular region is imperfect, and the symphysis is
much broken.   The dimensions (in centimetres) are :—

Approximate length from condyle to tip of symphysis   . . .   64
        „   „   of symphysis   22

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 3	3	1·8
pm. 4	3·9	2·6
m. 1.	4·1	2·8
m. 2.	5·6	3·3
m. 3.	6·9	4

Presented by the Egyptian Government, 1902·

Text-fig. 54.
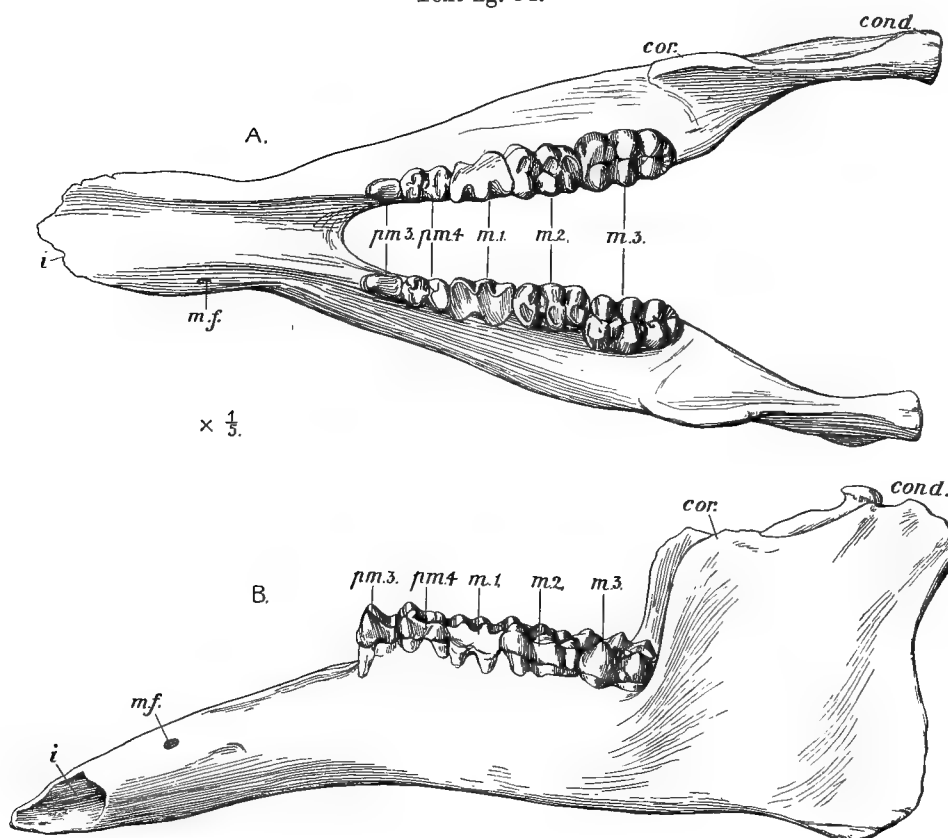
Mandible of *Palæomastodon wintoni*: A, from above ; B, from left side.
cond., condyle ; *cor.*, coronoid process ; *i.*, alveolus of incisor ; *m.f.*, mental foramen. $\frac{1}{5}$ nat. size.

M. 8415. Portions of right and left rami of mandible of a young individual in which *m.* 3 had not been cut.   The dimensions (in centimetres) of the teeth present are :—

	Length.	Width.
pm. 3	3·7	··
pm. 4	4·6	··
m. 1.	5	3
m. 2.	6·5	4·2

M. 8853. Portion of left ramus of mandible with the cheek-teeth in excellent preservation.

The posterior end of the symphysis is between 2 and 3 cm. in front of the anterior end of the tooth-series. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 3	3·1	1·7
pm. 4	3·4	2·4
m. 1	4·1	2·8
m. 2	5·5	3·5
m. 3	7·3	4·1

Presented by the Egyptian Government, 1904.

M. 8854. Portion of right ramus of mandible with *pm.* 3-4 and *m.* 1-2 in excellent preservation. The dimensions (in centimetres) of these teeth are :—

	Length.	Width.
pm. 3	3·3	1·7
pm. 4	3·7	2·5
m. 1	4·1	2·8
m. 2	5·5	3·4

Presented by the Egyptian Government, 1904.

M. 8464. Portion of right ramus of mandible with *pm.* 4 and *m.* 1. The lengths of these teeth are 3·8 cm. and 4·3 cm. respectively. *Presented by W. E. de Winton, Esq.,* 1903.

M. 8416. Left lower molars and premolars. Length of *m.* 3, 7·5 cm.

M. 8420. Right lower third molar. Length 6·9 cm.

M. 8481. Right lower third molar. Length 7·5 cm. *Presented by W. E. de Winton, Esq.,* 1903.

M. 8849 a. Left lower third molar. Length 6·5 cm. *Presented by the Egyptian Government,* 1904.

M. 8849 b. A large lower third molar of peculiar type. The whole tooth is broad ; the intermediate tubercles are well developed and each of the main cusps forming the two hinder crests is partly divided into two tubercles. This specimen may indicate the existence of another as yet undescribed species. Length 8·2 cm., width 4·8 cm.

Presented by the Egyptian Government, 1904.

The following may be referred to the present species, but possibly some may belong to *P. beadnelli* :—

C. 7841. Right ramus of mandible, complete posteriorly. The lengths of the teeth are : *pm.* 3, 3·3 cm.; *pm.* 4, 4·2 cm. ; *m.* 1, 4·0 cm. (?); *m.* 2, 6·1 cm. ; *m.* 3, 7·3 cm.

C. 7839. Left ramus of mandible. The lengths of the teeth are : *pm.* 3, 3·1 cm. ; *pm.* 4, 3·4 cm.; *m.* 1, 3·9 cm. ; *m.* 2, 5·3 cm. ; *m.* 3, 7·3 cm.

C. 9294. Left ramus of immature mandible. The lengths of the teeth are : *pm.* 3, 2·9 cm.; *pm.* 4, 3·3 cm.; *m.* 1, 3·7 cm. ; *m.* 2, 5·4 cm.

C. 7848. Left ramus of immature mandible with *pm.* 3-4 and *m.* 1-2.

C. 7835. Left ramus of immature mandible with *m.* 1-2, the latter just cut. *M.* 1, 5·0 cm. long.

C. 7833. Right ramus of an immature individual with *pm.* 3-4 and *m.* 1-2 *in situ*, *m.* 3 as germ at back of jaw. The lengths of the teeth are : *pm.* 3, 3·3 cm. ; *pm.* 4, 4·0 cm. ; *m.* 1, 5·1 cm.; *m.* 2, 4·6 cm.

C. 8914. Anterior portion of mandibular symphysis with incisors *in situ.*

Greatest width between the outer edges of the alveoli . . . 10 cm.

Width of each incisor . . . . 4·5 „

Length protruded from alveolus . . . . 6·2 „

M. 8478. Symphysial region of mandible with incisors of a large individual. Figured on Pl. XIV. fig. 3 as *P. beadnelli.*

Length of symphysis . . . . 27 cm.

Width of symphysis at narrowest . . . . 8·5 „ app.

„ the two incisors . . . . 11·5 „

Length of outer side of incisors . . . . 20 „

„ inner side of incisors . . . . 14 „

Presented by W. E. de Winton, Esq., 1903.

C. 8468. Right lower incisor. The wear-surface extends both on the upper and lower side of the tooth for about 5 cm. The ventral face is enamel-covered; the surface of the dentine is marked by straight longitudinal grooves. Width 4·3 cm.; length (so far as preserved) 17·0 cm.

C. 9214. Large left lower incisor. Ventral face covered with enamel; also a very thin covering on upper surface. The dentine core is marked by broad, shallow, longitudinal grooves. Width 7·5 cm.

M. 8385. Imperfect left incisor, showing wear-surface. Width 4·5 cm.

Presented by the Egyptian Government, 1902.

M. 8848 a. Left lower third premolar. *Presented by the Egyptian Government,* 1904.

C. 8470, C. 8963, C. 8971, C. 9304. Lower third premolars.

M. 8848 b. Left lower fourth premolar. *Presented by the Egyptian Government,* 1904.

C. 8472, C. 8492, C. 9279, C. 9303. Lower fourth premolars.

C. 9301–2. Right and left lower first molars. Length 4·2 cm.

C. 9269. Right lower first molar. Length 4 cm.

M. 8846. Left lower second molar. Length 5·8 cm. *Presented by the Egyptian Government,* 1904.

M. 8420, M. 8481. Lower second molars. *Presented by W. E. de Winton, Esq.,* 1903.

M. 8479 a. Portion of mandible with second molar. *Presented by W. E. de Winton, Esq.,* 1903.

C. 9292. Left lower second molar. Length 5·7 cm.

C. 9298. Right lower second molar. Length 6·0 cm.

C. 9299, C. 9300. Right and left lower third molars. Length 7·2 cm.

M. 8482. Last lower milk-molar. Length 4·2 cm.; width 1·9 cm.

Presented by W. E. de Winton, Esq., 1903.

The following vertebræ may be referred provisionally to *P. wintoni* :—

C. 9094. Atlas vertebra.

C. 9074. Atlas vertebra.

C. 8261, C. 8266, C. 8315. Atlas vertebræ.

M. 8856 a, b. Two atlas vertebræ. *Presented by the Egyptian Government,* 1904.

The dimensions (in centimetres) of some of the above specimens are :—

	C. 9094.	C. 9074.	C. 8261.	C. 8315.	M. 8856 a.	M. 8856 b.
Width between outer edges of articulation for skull	15·5	15·5	16	15·7	15·3	15
„ of surfaces for axis	13·5	12	13	12	12	12
„ to ends of transverse processes . .	25·7	..	..	25 app.	26·4	25·4

C. 8079. Nearly complete axis vertebra. This specimen shows the large peg-like, somewhat compressed odontoid with distinct ventral facet, the strong hypapophysial ridge, the very high neural arch with the neural spine deeply hollowed out posteriorly by a deep fossa for the attachment of ligaments.

M. 9123. Atlas vertebra similar to last, but less nearly complete.

M. 8857. Imperfect centrum of smaller axis. *Presented by the Egyptian Government, 1904.*

The dimensions (in centimetres) of the above axis vertebræ are :—

	C. 8079.	M. 9123.	M. 8857.
Length of centrum with odontoid . .	12·5	12 app.	9·5
Width of surface for atlas	11 app.	11 app.	10
„ posterior face of centrum . .	7·5 app.	8	..
Height to top of neural spine	14+	15·5	..
„ of neural canal	3	3·5 app.	..

M. 8513. Right astragalus. Figured in text-fig. 52. The dimensions (in centimetres) are :—

Width of tibial surface, including facet for internal malleolus 8
„ calcaneal surfaces 8
„ navicular surface . . . . 7·7

Presented by W. E. de Winton, Esq., 1903.

C. 8355. Portion of left astragalus.

C. 10063. Imperfect left calcaneum.

Palæomastodon parvus, Andrews.

[Text-figs. 50 C, 55–59.]

1905. *Palæomastodon parvus,* C. W. Andrews, Geol. Mag. [5] vol. ii. p. 562.

Type Specimen.—Imperfect right ramus of mandible, with *pm.* 3–4 and *m.* 1–3 *in situ* (text-fig. 55); British Museum.

This species is distinguished from *P. beadnelli* by its small size, but at the same time it approaches that species very nearly in the comparative simplicity of its teeth, particularly in the form of *m.* 3, and in having the posterior end of the mandibular symphysis some distance in advance of the anterior premolar, a character which at once distinguishes it from *P. wintoni.* The third molar (text-figs. 50 C, 55) consists of two transverse ridges, each composed of two tubercles, and a small third ridge consisting

of a larger outer and a smaller inner tubercle; there is a small intermediate tubercle in the anterior valley, but otherwise accessory tubercles are wanting; the enamel is very smooth and the cingulum practically absent. *M.* 2 is trilophodont, but the last ridge is much smaller than the others; it consists of an outer larger and a smaller inner cusp. So far as their molar pattern is concerned, both this species and *P. beadnelli* seem to be more primitive than *P. wintoni*; but, on the other hand, *P. beadnelli* by its larger size, and both it and the present species in the elongation of the mandibular rami, seem to be somewhat more specialized. This intermingling of primitive and more specialized characters is to be expected in a group represented by several

Text-fig. 55.
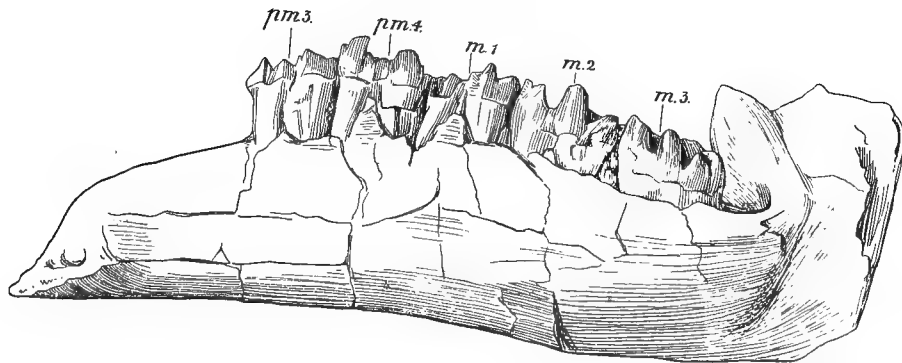
Right ramus of mandible of *Palæomastodon parvus.* Type specimen. About ⅓ nat. size.

contemporary species and undergoing rapid change in a given direction, the final product, in this instance *Tetrabelodon* or some closely similar form, being the resultant of the various modifications, and in this case combining increased length of the mandible with more complicated molar structure.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

M.8479a. Right mandibular ramus, imperfect at both ends: *pm.* 3 & 4 are greatly crushed and *m.* 1–3 much worn. Type specimen figured (text-figs. 50 C, 55). The mental foramen is beneath the anterior end of *pm.* 3, and the posterior end of the symphysis is about 5·5 cm. in front of that point. The dimensions of the teeth are given in the table on page 169. The depth of the mandibular ramus beneath *m.* 2 is 7·2 cm., in front of *pm.* 3 6·6 cm.

Presented by W. E. de Winton, Esq., 1903.

M.8847. Almost unworn third lower molar. *Presented by the Egyptian Government*, 1904.

M.8846. Right upper molar (? second) almost certainly belonging to this species.

Presented by the Egyptian Government, 1904.

Probably several of the smaller teeth and jaws in Cairo may belong to this species, but further examination of the material there would be necessary to determine this.

The humerus, ulna, and tibia enumerated below, together with some small astragali similar to that described above (p. 149) and figured in text-fig. 52, probably belong to this species or to *P. minor*.

C. 8881. Right humerus with its upper part much crushed (text-fig. 56). This specimen differs more from the humerus of the later Proboscideans than does the humerus of *P. beadnelli* described above. The large rounded head (*h.*) is abruptly truncated on the inner side by the flat inner face of the upper part of the shaft. Anteriorly it bears a small " lesser "

Text-fig. 56.
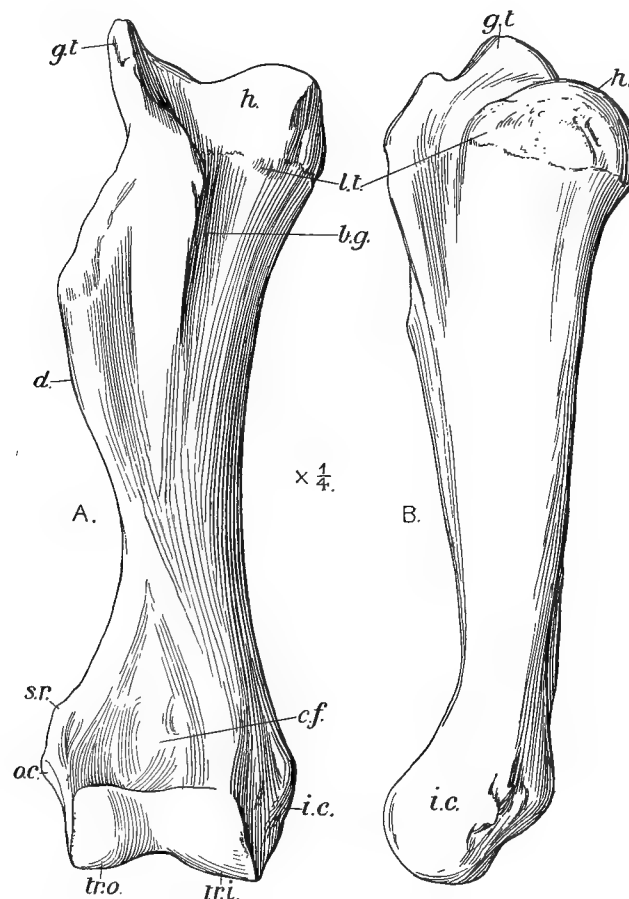
Right humerus of *Palæomastodon* (?) *parvus* : A, from front ; B, from inner side.

b.g., bicipital groove ; *c.f.*, coronoid fossa ; *d.*, deltoid crest ; *g.t.*, greater tuberosity ; *h.*, head ; *i.c.*, inner condyle ; *l.t.*, lesser tuberosity ; *o.c.*, outer condyle ; *s.r.*, supinator ridge ; *tr.i.*, inner part of trochlea ; *tr.o.*, outer part of trochlea. ¼ nat. size.

tuberosity (*l.t.*), which is separated by a deeply concave bicipital groove (*b.g.*) from the greater tuberosity (*g.t.*), which is very large and rises considerably above the head ; from it a ridge forming the outer edge of the bicipital groove runs down the anterior face of the upper third of the shaft. It is difficult to determine the exact form of the upper portion of the shaft owing to the crushing it has undergone, but it can be

seen that the deltoid ridge (*d.*) formed a prominent oblique crest continued up to the greater tuberosity. The coronoid fossa (*c.f.*) is wide and moderately deeply concave; the olecranon fossa is large and deep, particularly on the outer side. The outer and inner (*i.c.* and *o.c.*) condyles are both fairly prominent, the latter projecting considerably backwards. The supinator ridge (*s.r.*) is short, much shorter relatively than in the humerus of *P. beadnelli* described above. The articular surface is divided by a broad groove into an inner larger (*tr.i.*) and an outer smaller portion (*tr.o.*). The former bears a slight ridge which marks the separation of the surface for the radius from that for the inner portion of the ulna. The bone, as a whole, is very thin-walled and lightly built—a circumstance that may account for the extreme rarity of bones of *Palæomastodon*. The chief points by which this humerus differs from that of *Elephas* are : (1) the greater tuberosity is larger and rises more above the head ; (2) the supinator ridge is very much smaller, so that the distal portion of the bone is less expanded.

M. 8889. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 8063. A similar right humerus wanting the proximal end.

M. 8890. Plaster cast of the above specimen.   *Made in the British Museum.*

The dimensions (in centimetres) of the above humeri are :—

	C. 8881.	C. 8063.
Length	45·2	43·3+
Width of head	9	..
,, of shaft at narrowest	5·7	5·4
,, lower end at widest	13·8	13+
,, distal articulation	9·8	10

C. 8028. Nearly complete right ulna (text-fig. 57). The olecranon (*ol.*) is large, greatly expanded at the end, and projecting strongly towards the inner side ; it does not rise above the upper angle of the articulation. This latter is triradiate in form ; the upper lobe projects strongly forwards, while of the lower two, the outer has a straight anterior border, beneath which is the elongated facet (*r.s.*) for the upper end of the radius ; the inner is oval in outline and seems to have little or no contact with the radius. The whole shaft of the bone is curved backwards ; it is triangular in section, the anterior face being deeply concave from side to side near its upper end (*r.g.*) Distally it widens out somewhat, but the epiphysis having been lost, the distal articulation cannot be described. The whole ulna is practically that of a miniature elephant. The dimensions (in centimetres) of the specimen are :—

Length (without epiphysis) 38
Width of articulation for humerus . . . . 9·3
,, middle of shaft . . . . 4·8

M. 8891. Plaster cast of the above specimen.   *Made in the British Museum.*

M. 8858. Upper end of left ulna.   *Presented by the Egyptian Government,* 1904.

C. 8883. Right tibia (text-fig. 58). In form this bone is almost exactly similar to the tibia of *P. beadnelli* figured on Pl. XVI. fig. 4. In the proximal articulation the inner facet (*i.*)

is the larger and is widest from before backwards; at its antero-external angle it runs up on to the prominent intercondylar process (*ic.p.*), on the outer side of which there is a deep fossa for the attachment of ligament. The outer facet (*o.*) is widest from side to side, and beneath its outer edge there is a flattened surface, apparently for the upper end of the fibula. The upper part of the not very prominent cnemial crest (*cn.*) is divided into two by a deep depression, the outer portion being the largest. The middle portion of the shaft is flattened behind and convex in front; towards the distal articulation it widens out and bears on its postero-internal surface a prominence (*p.*) forming the outer side of a groove, precisely similar to that seen in the tibia of *P. beadnelli.* The distal articulation is also like that found in the large species: there is a prominent internal malleolus (*i.m.*) bearing an astragalar facet looking outwards and forwards ; external to

Text-fig. 57.
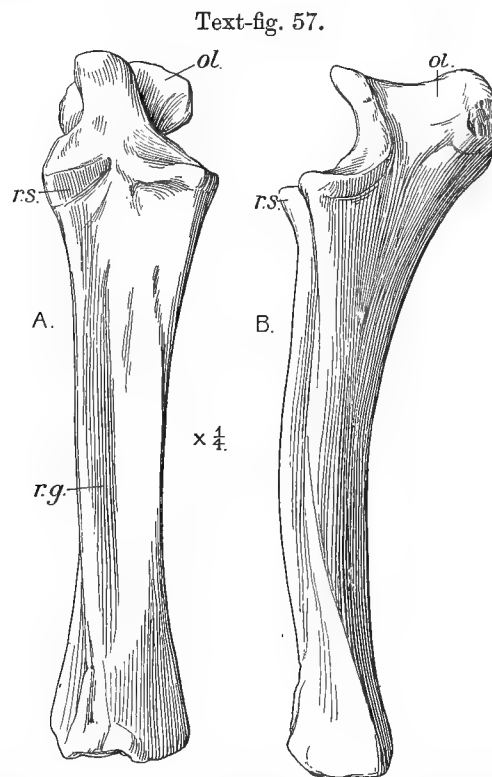
Right ulna of *Palæomastodon* (?) *parvus* : A, from front ; B, from inner side.

ol., olecranon process ; *r.g.*, radial groove ; *r.s.*, radial surface. ¼ nat. size.

this is the main surface for the astragalus (*as.*), strongly concave from before backwards, and is produced downwards into a blunt point both before and behind. External to this surface there is a roughened facet (*f.*) looking downwards and outwards, apparently for articulation with the fibula. The chief difference between this tibia and that of *Elephas* is in the form of the distal articulation. In the recent form, probably owing to the increasing size and weight, the astragalar surface is much broader and more gently concave, and this increase of width has led to the reduction of the internal malleolus to a mere blunt point. Otherwise the two tibias are very similar even in small points.

These remarks apply likewise to the tibia of *P. beadnelli*. The dimensions (in centimetres) of this bone are :—

Extreme length . . . . 38·8
Width of proximal articulation (for astragalus only) . . . . 11·5
 „   middle of shaft . . . . 5·3
 „   distal articulation 6

The length of the tibia of *P. beadnelli* is 63·5.

Text-fig. 58.
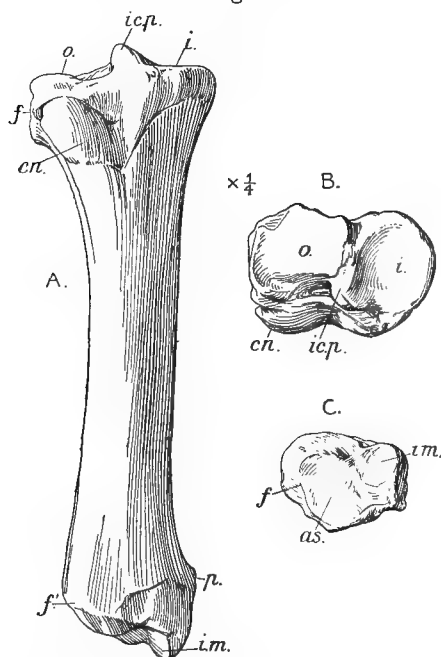
Right tibia of *Palæomastodon* (?) *parvus* : A, from front ; B, proximal end ; C, distal end.

as., surface for astragalus ; *cn.*, cnemial crest ; *f., f'.*, surfaces for fibula ; *i.*, surface for inner condyle of femur ; *ic.p.*, intercondylar process ; *i.m.*, internal malleolus ; *o.*, surface for outer condyle of femur ; *p.*, internal distal prominence. ¼ nat. size.

Text-fig. 59.
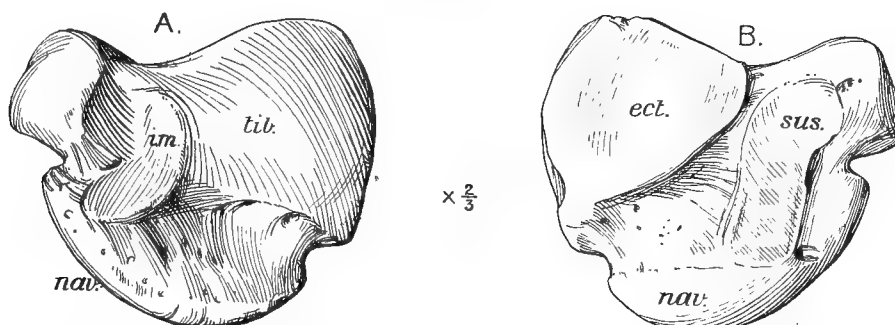
Left astragalus of *Palæomastodon* (?) *parvus* : A, from above ; B, from below.

ect., ectal facet ; *i.m.*, surface for internal malleolus of tibia ; *nav.*, navicular facet ; *sus.*, sustentacular facet ; *tib.*, tibial facet. ⅔ nat. size.

M. 8892. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 8016. Immature left tibia, imperfect at ends.

C. 9221. Immature right tibia, rather smaller than last, imperfect at ends.

C. 8334. Left astragalus, the proximal articulation of which agrees with the distal articulation of the tibia just described. This bone is figured (text-fig. 59) and is very similar to that described above (p. 149) and figured (text-fig. 52). It is chiefly remarkable for the prominence of the knob forming its postero-internal angle. The dimensions (in centimetres) are :—

Width of tibial surface, including facet for internal malleolus .   5·8
„   calcaneal surfaces . . . .   5·6
„   navicular surface   5

M. 9237. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 8636. Left astragalus, similar to last.

M. 8406. Left astragalus, similar to last.

Palæomastodon minor, Andrews.

[Plate XIV. figs. 1, 1 A; and text-fig. 50 D.]

1904. *Palæomastodon minor,* C. W. Andrews, Geol. Mag. [5] vol. i. p. 115.

Type Specimen.—Portion of the right ramus of the mandible of a young individual (Pl. XIV. figs. 1, 1 A) ; British Museum.

This species is not only much smaller than *P. beadnelli* and *P. wintoni,* but differs in the structure of its molars, particularly of *m.* 3. This tooth is long in proportion to its width ; it consists of three complete transverse main crests and a small talon-like fourth ridge consisting of several small cusps. The anterior crest is composed of two large cusps, the outer of which is connected with a small accessory tubercle partly filling the first valley. The second and third crests consist of two main cusps, each partly divided into two transversely arranged tubercles ; there is no tubercle in the posterior main valley ; the whole tooth is more clearly lophodont than in the other species. This tooth is easily distinguishable from the last molar of *P. parvus,* which consists of only two crests and a talon, which is composed of two large cusps (see text-fig. 50 C).

M. 1 and *m.* 2 are both trilophodont ; the antero-external cusp in each is. connected posteriorly with a small cusp in the anterior valley ; the second outer cusp is distinctly divided into two tubercles, especially in *m.* 2.

Pm. 4 is bilophodont, *pm.* 3 a simple compressed cone with small anterior and posterior cingular ridges. The length of the symphysis is unknown.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

M. 8479 b. Right ramus of mandible, imperfect at both ends. *Pm.* 3, *pm.* 4, *m.* 1–3 are present, *m.* 3 as an uncut germ; *pm.* 4–*m.* 2 are somewhat imperfect on the inner side. Type specimen described in Geol. Mag. [5] vol. i. (1904) p. 115. Figured on Pl. XIV. figs. 1, 1 A; also the second and third molars in text-fig. 50, D. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 3	2·8	1·6
pm. 4	2·6	2 app.
m. 1	3·2	2·1 app.
m. 2	4·5	2·9 app.
m. 3	4·8	2·9

The lengths (in centimetres) of the teeth compared with those of the other species are shown in the following table :—

	P. minor.	P. parvus.	P. wintoni.	P. beadnelli.
pm. 3	2·8	3·5 app.	3	4·1 app.
pm. 4	2·6	3·5 app.	3·5	4·8
m. 1	3·2	3·8	4·3	4·8
m. 2	4·5	4·5	5·7	6·5
m. 3	4·8	4·6	7·3	7·8
Length of molar series	12·6	13	17·2	19·4
„ premolar series	5·7	7 app.	6 3	9·2 app.
„ molar and premolar series	18	19·7	23	28·5

Presented by W. E. de Winton, Esq., 1903.

The following specimens may be referred provisionally to this species :—

C. 8110. Two trilophodont upper molars. These teeth are of the size and type that might be expected in the upper jaw of this species. Length 4·5 cm.; width 3·1 cm.

M. 8860. Atlas vertebra.

Width of articulation for skull . . . . 12·8 cm.

„ „ axis . . . . 10 „

Genus **PHIOMIA**, Andrews & Beadnell.

[A Preliminary Note on some new Mammals from the Upper Eocene of Egypt, pp. 1–5, figs. 1, 2 (Survey Department, Cairo, 1902).]

Known only from an imperfect mandibular ramus, in which the single spatulate incisor is serrated on its outer margin.

It was originally suggested that this mandible might represent a very aberrant type of Creodont, but this determination is certainly wrong. Schlosser * has suggested that the specimen in question is the anterior portion of the mandible of a very young *Palæomastodon*, a supposition which not impossibly may be correct, though since this is by no means certain it seems preferable to keep the genus *Phiomia* for the present and place it in its present position.

* Neues Jahrb. f. Min. Geol. u. Palæont. 1905, vol. i. pt. i. (Referate) p. 157.

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Phiomia serridens, Andrews & Beadnell.

[Plate XVIII. figs. 4, 4 A.]

1902. *Phiomia serridens*, Andrews & Beadnell, A Preliminary Note on some new Mammals from the Upper Eocene of Egypt, pp. 1–5, figs. 1, 2 (Survey Dept., Cairo).

1905. *Palæomastodon*, juv., Schlosser, Neues Jahrb. f. Mineralogie, etc. vol. i. pt. i. (Referate) p. 157.

Type Specimen.—Anterior portion of left ramus of mandible with incisor and two cheek-teeth, figured and described *loc. cit. supra*, also Pl. XVIII. figs. 4, 4 A; Geological Museum, Cairo.

The type and only known species, with mandibular symphysis 6·5 cm. in length.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

The mandibular ramus (Pl. XVIII. figs. 4, 4 A) upon which the species is founded is incomplete posteriorly. The symphysial region (*sym.*) is very long and deepens considerably from before backwards; the upper surface with its fellow of the opposite side must have formed a spout-like groove, while the ventral surface is strongly convex from side to side and to some extent also from before backwards. Behind the symphysis the ramus of the jaw arches outwards, its outer surface being convex from before backwards and also from above downwards; the inner surface is concave in the former direction and nearly flat in the latter. There are two foramina on the outer face: one, the larger of the two, is just behind the socket of the incisor; the other is beneath the anterior end of the second of the cheek-teeth *in situ*. The bone shows traces of the peculiar fibrous appearance characteristic of many young bones, a circumstance which tends to support Schlosser's view as to the nature of the specimen.

The incisor (*i.* 1) is of very peculiar form. Its inner border, where it is in contact with its fellow of the opposite side, is straight. The outer edge is convex in front and is marked by a series of crenulations (about five in number). The upper face of the tooth is concave from side to side, the ventral convex with two or three slight longitudinal ridges. The tooth thickens rapidly towards its base. The enamel covering is confined to the end of the crown; it is found on both the upper and lower surface; on the outer side it extends back as far as the last of the denticulations, and on the inner not quite so far. The incisors must have formed a spout-like continuation of the symphysis, much as in *Palæomastodon*. The great size and increase in thickness of these teeth towards their base make it difficult to regard them as belonging to the milk-series; on the other hand, if they are the permanent incisors, they could never have attained the size of those of *Palæomastodon beadnelli* or *wintoni*, so that if this animal was a *Palæomastodon* it must have been quite a small species.

Behind the incisors there is a long sharp-edged diastema about 5·5 cm. in length. The first cheek-tooth is small and laterally compressed, with a high anterior cusp, slightly bifid at the summit, and a smaller posterior one, which seems to belong to the cingulum ; there is also a slight cingular prominence on the front of the tooth. The next tooth is large and complex. The anterior half consists of three cusps: one anterior, with a small stylid closely united to it in front; the other two arranged transversely. There is a small accessory tubercle on the posterior slope of the outer of the two cusps. This anterior portion of the tooth is separated from the wider posterior part by a deep valley, behind which there are two large and closely united cusps arranged transversely and a small accessory posterior tubercle. The nature of these two cheek-teeth is open to some doubt; probably they are deciduous molars, though this is not absolutely certain, and although the jaw has been carefully cut away beneath the larger tooth no trace of any germ of the replacing tooth can be seen. On the whole, it seems that Schlosser is possibly right in his surmise as to the nature of this specimen, and it may be considered as having belonged to a young individual perhaps of one of the smaller species of *Palæomastodon*; but since it is very small and there is some doubt as to the nature of the teeth, the generic name *Phiomia* may be retained till further material is available.

C. 10007. Anterior portion of left mandibular ramus, with incisor and two cheek-teeth. Type specimen described and figured, *loc. cit.* ; also Pl. XVIII. figs. 4, 4 A. The dimensions (in centimetres) of this specimen are :—

Extreme length of specimen, so far as preserved	14·2
Length of protruded portion of incisor, measured along median border	3 app.
Width of incisor at alveolus	1·6
Length of symphysis	6·5
Greatest depth of symphysis	2
Length of diastema between incisor and first cheek-tooth . .	6 app.
Depth of ramus beneath second cheek-tooth	3·5
Length of first cheek-tooth	1·2
Width of first cheek-tooth	·5
Length of second cheek-tooth	2·7
Width of second cheek-tooth	1·3

M. 8193. Plaster cast of the above specimen.   *Made in the British Museum.*

INCERTÆ SEDIS.

Family BARYTHERIIDÆ.

This family is known only from a single genus, *Barytherium*, the characters of which are given below. Its systematic position is still very doubtful and it does not fall within the limits of any of the suborders as at present defined. In a former paper * it was suggested that possibly it may be found to constitute a subdivision of the Amblypoda, which would be of the same rank as the Dinocerata and might be called the Barytheria.

Genus **BARYTHERIUM**, Andrews.

[' Nature,' Oct. 10th, 1901, vol. lxiv. p. 577; also Geol. Mag. [4] vol. viii. (1901) p. 528.]

1901. *Bradytherium*, C. W. Andrews, Tageblatt des V. Internationalen Zoologen-Congresses Berlin, No. 6, p. 4 ; also Geol. Mag. [4] vol. viii. pp. 407–8, figs. 3–4 (September) ; also the ' Zoologist,' p. 319. [Name preoccupied in March 1901 by G. Grandidier for a genus of extinct Edentates from Madagascar (Bull. Mus. d'Hist. Nat. Paris, vol. vii. p. 55.]

1902. *Barytherium*, C. W. Andrews, Verhandlungen des V. Internationalen Zoologen-Congresses Berlin, p. 528.

The dental formula, so far as known, is : $i. \frac{?}{1(?2)}$, $c. \frac{?}{0}$, $pm. \frac{3}{3}$, $m. \frac{3}{3}$. The first lower incisor is a large procumbent tusk in contact with its fellow in the middle line, and separated from the anterior premolar by a long diastema ; the molars of both jaws are bilophodont, the last lower molar having a talon. The mandible is extraordinarily massive, the symphysis being very long and deep ; on its ventral border there is a pair of blunt tuberosities. The anterior border of the ascending ramus rises on the side of the jaw beneath *m.* 2. The humerus is very massive, with greatly expanded distal end, in which all the muscle-ridges are strongly developed.

Skull (Pl. XVII. fig. 4).—The only portions of the skull at present known are parts of the right and left maxillæ bearing the cheek-teeth. On the left side the zygomatic process (*zyg.*) is preserved: it is of great width, its base extending from above the anterior lobe of *m.* 1 to the middle of *pm.* 2, a distance of about 13 cm.; its ventral edge is nearly parallel to the alveolar border and very little above it; its upper surface is completely cut away by sand-drift, and, the anterior edge being somewhat imperfect, it may have been considerably wider even than is shown in the figure.

Upper Dentition (Pl. XVII. fig. 4).—Of the upper teeth *pm.* 2–4 and *m.* 1–3 are present on the left side ; the premolars, especially *pm.* 2, are imperfect on their inner side and the crowns of all the teeth are greatly worn. *Pm.* 2 seems to have been more

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* "Note on the Barypoda, a new Order of Ungulate Mammals," Geol. Mag. [5] vol. i. 1904, p. 482.

or less triangular in outline and was borne on three roots. *Pm.* 3 had a rectangular crown and was widest from side to side. *Pm.* 4 was also widest transversely; its crown seems to have consisted of a broad anterior ridge (now greatly abraded) connected posteriorly at its outer and inner ends with the hinder border of the tooth. *M.* 1 is greatly worn, but seems to have been bilophodont. *M.* 2 was bilophodont, the crests being widest at their inner ends. The inner half of the posterior crest was connected with the cingulum towards the middle of the posterior border. *M.* 3 is also bilophodont; the anterior crest is somewhat **S**-shaped, its inner end turning forwards on to the antero-internal angle of the crown. The posterior crest is curved with the concavity posterior. The dimensions of these teeth are given below.

Mandible (Pl. XVII. fig. 5).—The mandible, wanting much of the posterior region, was found associated with the above-described maxillæ. It is chiefly remarkable for its extraordinarily massive construction, shown in the length of the symphysis and the depth of the rami. The symphysis is very long, extending back to the level of the hinder end of *m.* 1; its upper surface is spout-like and in front it carried a pair of large procumbent tusk-like incisors, and there may also have been a pair of small second incisors above and behind these, but this is doubtful. The ventral surface of the symphysis is broad and convex, at least posteriorly; at about its middle and a little in front of the level of the anterior premolars the ventral border bears on either side a large blunt process (*pr.*), which projects forwards, outwards, and downwards. There is a large mental foramen (*m.f.*) on the middle of the outer face of the jaw above the base of this process, and a groove runs downwards and forwards from this opening; there is also a second smaller opening above that just referred to. Beneath the cheek-teeth the ramus is very deep and its outer face nearly flat, while behind the symphysis the ventral border is convex from before backwards. The ascending ramus arises on the outer face of the horizontal ramus about midway between the ventral and alveolar borders; it arches strongly outwards, and the anterior end of its base is beneath *m.* 2. From this point its anterior border, which is greatly thickened, slopes a little forwards, rising into the massive coronoid process (*cor.*), the horizontal upper edge of which is about 11 cm. above the level of the crowns of the teeth: the whole of the condyle and the angular region of the mandible are wanting.

Lower Dentition (Pl. XVII. figs. 5, 6).—Behind the incisors, to which reference has already been made, there is a long diastema (13 cm.), the next tooth being the second premolar. The portion of the alveolar border of the jaw bearing the cheek-teeth seems to be raised considerably above the anterior edentulous portion. The anterior premolar (*pm.* 2) has a triangular crown and appears to have been supported on three roots, of which one is anterior, the other two arranged transversely posteriorly. *Pm.* 3 and *pm.* 4 have each four roots and a nearly square crown, apparently bilophodont, at least in *pm.* 4. *M.* 1 is greatly broken, the crown being almost entirely wanting;

it has four roots. *M.*2 is bilophodont; it is somewhat longer than broad. *M.*3 (Pl. XVII. fig. 6) is also bilophodont, with a talon; the anterior crest is slightly concave forwards, the shorter posterior one nearly straight. There seems to have been a small accessory cusp in the valley between the main crests, and another on the anterior border of the tooth; in wear these become united with the inner ends of the posterior and anterior crests respectively. There are only four roots to this tooth, the postero-internal one being enlarged to support the talon.

Fore Limb.—The *scapula* (Pl. XVII. figs. 9, 9 A) is not completely known, the best specimen wanting the upper portion. The prescapular fossa is very small, the post-scapular large and regularly concave from side to side. The spine (*s.*) commences some distance above the glenoid surface and rises very rapidly; its greatest height, so far as preserved in the specimen here described and figured, is about 7·5 cm. The coracoid border (*c.b.*) is thin and sharp above, but thickens rapidly below, where it passes into the great tuberous coracoid process (*cor.*). This seems to be larger than in any other mammal, forming a massive hook-like process overhanging the glenoid cavity, the articular surface of which appears to have been continued for a short distance on its posterior face. On its inner side it is raised into a prominent ridge, separated from the border of the glenoid cavity by a groove. The glenoid border is marked off from the actual edge of the glenoid cavity by a slight notch, above which it is thickened and rounded, thinning, however, very rapidly upwards. The large glenoid cavity proper (*g.c.*) is nearly circular in outline, but, as already mentioned, the articular surface is continued forwards on the coracoid process; the articular surface (fig. 9 A) is nearly flat from side to side and concave from before backwards. The dimensions of this scapula are given below.

Two specimens of the *humerus* are known, one, though otherwise imperfect, exhibiting the whole length, while the other (Pl. XVII. figs. 7, 7 A) includes the distal three-quarters of the bone in almost perfect condition with exception of the articular surface. The chief peculiarity of this humerus is the enormously massive distal extremity, the condyles especially being greatly developed. The trochlear surface is divided into two nearly equal portions by a comparatively shallow groove which runs obliquely outwards and forwards, so that the articulation appears somewhat oblique. There is a very large and deep coronoid fossa (*c.f.*) and a deep though much smaller and more sharply defined olecranon fossa (*ol.f.*), but the two do not appear to have communicated with each other. The outer condyle (*o.c.*) is a great mass of bone, of which the posterior flattened surface forms the outer wall of the olecranon fossa. The outer face is also flattened and looks outwards and downwards. From its upper end the supinator ridge (*s.r.*), forming a prominent crest, runs upwards and backwards. The inner condyle (*i.c.*) is also very prominent; below it seems to be separated from the trochlea by a deep notch; anteriorly it is hollowed into a pocket-like fossa which is sharply defined by a prominent ridge below, but above passes gradually into the antero-internal face of the shaft. The deltoid crest (*d.*)

arises from the union of the two rounded ridges which form the outer and inner borders of the coronoid fossa; it runs outwards and upwards, forming a crest which projects strongly outwards and then a little backwards. There is also a ridge running up the front of the shaft from the lower end of the deltoid ridge. The head of the bone seems to have been large and rounded, but in no specimen is the upper end sufficiently well preserved for description.

The great expansion of the distal end of this humerus, arising from the large size of the condyles and the strong development of all the ridges and processes for the attachment of muscles, seems to indicate that the fore limb was employed for some other purpose than mere progression on land, possibly for digging or scraping up the ground. Apart from this great distal expansion the humerus is somewhat similar to that of *Uintatherium*, resembling it in the small and deep olecranon fossa, the presence of the ridge running up the shaft from the lower end of the deltoid crest. At least, it may be said that this humerus is much more similar to that of the Dinocerata than it is to that of any Proboscidean. The differences from the humerus of *Arsinoitherium* are very considerable (*cf.* text-fig. 16); in that genus the form of the deltoid crest is different, there is no anterior ridge running up the shaft, while the form of the outer condyle and supinator ridge is dissimilar and approaches rather the Proboscidean type.

A nearly complete specimen of the left *radius* (Pl. XVII. figs. 8, 8 a, 8 b) was found in association with the upper and lower jaws above described. In general form it greatly resembles the radius of *Uintatherium*. The upper articulation for the humerus is very wide and consists of two parts, a much larger outer portion (*o.*), oval in outline with its long axis transverse and nearly twice the length of the antero-posterior axis; this surface is slightly concave in all directions. The other portion (*i.*) is very small and bent down at an angle with that just described; it helped to form the articulation for the inner portion of the trochlear surface of the humerus. Beneath the expanded proximal portion, the shaft becomes trihedral, one angle being anterior while the flat posterior face appears to be roughened for union with the ulna. Towards the distal end the bone expands enormously: its posterior or postero-external face is deeply concave and must have fitted closely against the inner side of the ulna; the antero-internal surface is convex. The very large distal articulation is incomplete on the outer side, and consists of two facets separated by a prominent ridge. Of these facets the smaller (*sc.*) for the scaphoid on the inner side is triangular in outline and concave from before backwards. The larger facet (*lu.*) for the lunar is concave in front and slightly convex posteriorly. It will be seen that this form of distal articulation is quite different from that found in the radius of *Arsinoitherium* (see text-fig. 17) or in *Elephas*, and that the structure of the carpus must also have been different, the scaphoid forming a relatively large share in the carpal joint compared to what it does in the two genera referred to. In fact, both in its distal articulation and in its general form the radius here described resembles that of *Uintatherium* fairly closely.

The *ulna* is known only from an imperfect upper half. The olecranon process is large, but rises very little above the level of the sigmoid notch, which is deep; the shaft narrows considerably beneath the articulation, and its anterior face is crossed obliquely by a flat surface which united with the posterior face of the radius.

Hind Limb.—The upper portion of a *femur* shows that the head is rounded, somewhat pedunculate, and directed upwards. The greater trochanter is comparatively small and does not rise to the level of the head.

No bones of either the fore or the hind foot are known.

Barytherium grave, Andrews.

[Plate XVII. figs. 4–9.]

1901. *Bradytherium grave*, C. W. Andrews, Tageblatt des V. Internationalen Zoologen-Congresses Berlin, No. 6, p. 4 ; Geol. Mag. [4] vol. viii. pp. 407–8, figs. 3–4.

1901. *Barytherium grave*, C. W. Andrews, ' Nature,' Oct. 10th, vol. lxiv. p. 577.

1902. *Barytherium grave*, C. W. Andrews, Verhandl. d. V. Internationalen Zoologen-Congresses Berlin, p. 528.

Type Specimen.—Portions of a skeleton including upper and lower jaws with teeth, scapula, humerus, and radius (Pl. XVII. figs. 4–9); Geological Museum, Cairo.

This species is the only one at present known. It appears to have been fairly common, traces of several skeletons having been observed, but unfortunately in nearly all cases the bones are completely broken up and only recognisable with difficulty. They occur in the same beds as *Mœritherium lyonsi* and *Eosiren libyca*, with remains of reptiles and fishes. Probably this animal lived in swampy country and perhaps was semi-aquatic. In any case the form of the fore limb is such that it was almost certainly used for something besides mere progression on firm ground, possibly, as already suggested, for digging or scraping away the surface of the soil or for forcing the animal through soft swampy ground.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

C. 10012. Maxillæ and mandible with teeth, portions of scapulæ, imperfect left humerus, left radius, and upper portion of ulna. Type specimens found in association. Figured in Geol. Mag. [4] vol. viii. pp. 407–8, figs. 3–4 ; and on Pl. XVII. figs. 4–9. These specimens have been described above. Their dimensions (in centimetres) are :—

Upper teeth (Pl. XVII. fig. 4):	Length.	Width.
pm. 2	5·7	5·7
pm. 3	3·9	6·5
pm. 4	5	8
m. 1	5·9	8·4
m. 2	7·5	8·6
m. 3	8·3	8·7

Lower teeth (Pl. XVII. figs. 5, 6):

	Length.	Width.
pm. 2	5·1	3·5 app.
pm. 3	4·3	4·7
pm. 4	5·7	5·5
m. 1	5·7	..
m. 2	8·6	6·4
m. 3	10·5	7

Total length of upper molar and premolar series . . . . . 36·5

,, ,, lower molar and premolar series . . . . . 38 5 app.

Mandible (Pl. XVII. fig. 5):

Length of mandible so far as preserved 66

Depth of ramus beneath *pm.* 4 . . . . 25·5

Length of symphysis . . . . 38·4

Height to top of coronoid process 36

Scapula (Pl. XVII. figs. 9, 9 A):

Length so far as preserved 48

Width of glenoid cavity 13

Distance in straight line between posterior edge of glenoid cavity and end of coracoid process 18

Width of neck of bone 17

Humerus:

Length . . . . 60·4 app.

Width of distal articular surface . . . . 16·5

Radius (Pl. XVII. figs. 8, 8 A):

Length . . . . 42·5

Width of proximal articulation (side to side) . . . . . . 11·5

,, ,, ,, (before backwards) 6

,, shaft at narrowest point . . . . 5·5

,, distal end . . . . 11 app.

M. 8054. Plaster cast of left maxilla and teeth described above. *Made in the British Museum.*

M. 8055. Plaster cast of mandible and teeth described above. *Made in the British Museum.*

M. 8057-8. Plaster casts of the radius and scapula described above. *Made in the British Museum.*

C. 10012 a. Left humerus, wanting proximal end. This specimen is described above and figured on Pl. XVII. figs. 7, 7 A. The dimensions (in centimetres) are :—

Length so far as preserved 56

Extreme width at condyles 29

Width of distal articulation . . . . 14 app.

,, shaft at narrowest point . . . . 11·2

,, ,, deltoid crest . . . . 17·7

M. 8056. Plaster cast of the above. *Made in the British Museum.*

M. 9125. Proximal end of a right femur.

Diameter of head . . . . 10·2 cm. app.

Greatest width of upper end . . . . 22 cm.

Suborder *ARTIODACTYLA.*

Family ANTHRACOTHERIIDÆ.

Genus **ANCODON**, Pomel.

[Archiv. Sci. Phys. et Nat., Genève, [4] vol. v. p. 207 (June 1847) (as a subgenus
of *Palæotherium.*)]

1848*. *Bothriodon,* Aymard, Ann. Soc. Agric. Sci., Arts, et Comm. du Puy, vol. xii. pp. 239,
246–247, footnote (as a subgenus of *Anthracotherium*).
1848. *Hyopotamus*†, Owen, Quart. Journ. Geol. Soc. vol. iv. p. 103.
1848. *Ancodus,* Pomel, *op. cit. suprà*, [4] vol. viii. pp. 324–5 (raised to generic rank, and
unnecessarily emended from *Ancodon*).

At least two species referable to this genus occur in the Upper Eocene beds of the
Fayûm, and from the comparative abundance of their remains these animals seem to
have been very common in the later Eocene period.   As might be expected from their
somewhat earlier date, the species here described are rather more primitive in their
tooth-structure than are the forms from the Oligocene of Europe and America.   This
is especially noticeable in the more brachyodont and less selenodont character of the
molars, which resemble to some extent those of *Anthracotherium,* but are still more
like those of the much later (L. Miocene) genus *Brachyodus,* remains of which, it
is interesting to note, have been found at Moghara, to the north-west of the Fayûm.
It may eventually be necessary to separate the present species from *Ancodon,* but on
account of the great general resemblance of the lower jaw of *A. gorringei* to that of
some of the European forms such as *A. velaunus,* it seems desirable, until a more
distinctive character than the slight differences in the teeth above referred to has
been found, to retain the same generic name for both.

The skeleton in this genus has been described in detail by Kowalevsky ‡, Filhol §,
Scott ‖, and others, so that here it will only be necessary to give a short account of
the various specimens in the collection under their several numbers in the list below.

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* There is some doubt about this date, since while the titlepage of the volume is dated 1846, the cover
has 1848.   In spite of the fact that it has been authoritatively stated (see Bush, Amer. Journ. Sci. [4]
vol. xvi. (1903) pp. 97–98) that this volume was *printed* in 1847, it seems probable that the date on the
cover represents the date of *issue* (i. e. of publication), particularly as the author's separate copies are
known to have been dated 1848 also.   This being the case, it seems desirable to adopt Pomel's name *Ancodon*
of 1847 for the genus.

† Preoccupied in 1844 by Kaup for a genus of Hippopotamidæ.

‡ "On the Osteology of the Hyopotamidæ," Phil. Trans. 1873, p. 19.

§ "Études des Mammifères fossiles de Ronzon," Annales des Sciences Géologiques, vol. xii. (1882).

‖ "Structure and Relationships of *Ancodus,*" Journ. Acad. Nat. Sci. Philadelphia, [2] vol. ix. (1884–95)
p. 461.

Ancodon gorringei, Andrews & Beadnell.

[Plate XVIII. figs. 1, 2, 3; text-figs. 60, 61.]

1902. *Ancodus gorringei*, Andrews & Beadnell, A Preliminary Note on some new Mammals from the Upper Eocene of Egypt (Survey Dept., Cairo), p. 7.

Type Specimen. — A mandible wanting the ascending ramus of the left side (Pl. XVIII. figs. 1, 1 A); Geological Museum, Cairo.

This is the larger of the two species found in these beds. The extreme length of the jaw exceeded 34 cm.; the length of the symphysis 9 cm.; length of the molar series 7·2 cm. Remains are fairly common, and, in addition to the lower jaw and dentition, the upper molars and premolars, some vertebræ, limb-bones, and tarsals are known.

Form. & Loc.—Fluvio-marine beds (Upper Eocene); north of Birket-el-Qurun.

C. 8629. Mandible, wanting ascending ramus on left side. On the left side only the molars are preserved, but on the right there are also *i.* 1, *i.* 3, *pm.* 2, *pm.* 3, and *pm.* 4; *i.* 2 and *c.* are represented by their alveoli only, *pm.* 1 by its broken base. Type specimen described by Andrews and Beadnell, *loc. cit.* Figured on Pl. XVIII. figs. 1, 1 A.

This mandible is very long, owing mainly to the great elongation of the spout-like symphysis (*sym.*), the upper surface of which is gently concave from side to side, while the ventral surface is convex in the same direction with a slight median ridge, which forms a small projection posteriorly. This form of the ventral surface of the symphysis differs considerably from that seen in *A. velaunus,* in which not only is this region somewhat shorter, but the posterior portion of the ventral surface is flattened in front and concave behind. The horizontal ramus is slender; its ventral border, which is thickened and rounded from side to side, is nearly straight from before backwards beneath the premolars and slightly convex beneath the molars. Behind this the ventral edge thins and is slightly concave, and then passes down into the rounded angle of the jaw, which does not form a vertical process projecting considerably below the rest of the mandible as in some species, *e. g. A. bovinus* and *A. aymardi.* The outer face of the horizontal ramus beneath the premolars is concave from above downwards, beneath the molars it is flat or slightly convex; its greatest depth is beneath the last molar. Behind the last molar the rami diverge rapidly. The anterior border of the ascending ramus is convex and slopes back to the summit of the coronoid process (*cor.*), the posterior border of which is slightly concave; it rises considerably above the level of the condyle (*cond.*), which is transversely elongated and is convex from before backwards and nearly flat from side to side. The posterior region of this mandible is imperfectly preserved.

The incisors are procumbent: *i.* 1 is the smallest; *i.* 2, here wanting, was probably the largest; *i.* 3 has a small hastate crown, the lower face of which is strongly convex, the upper flat or gently concave; the root is relatively very large. The canine (represented by the alveolus only) is separated in front from *i.* 3 by a short diastema (·8 cm.) and behind from *pm.* 1 by a longer interval (2·2 cm.). *Pm.* 1 is represented

2 A 2

only by a single-rooted stump, and between it and *pm.* 2 is a space of 2·5 cm.   *Pm.* 2 is a two-rooted tooth with a compressed conical crown, the anterior and posterior borders of which form sharp edges. A ridge runs down from the summit on the postero-internal surface, dividing the inner face into a larger anterior fossa and a smaller posterior rugose fossa, which looks inwards and backwards. The cingulum is developed on the inner side of the tooth, particularly towards the posterior end, and it is also present for a short distance on the postero-external side. The third premolar is, on the whole, similar to *pm.* 2, from which it is separated by a short interval. The cingulum, however, is better developed, and forms a sort of small talon posteriorly. The postero-internal ridge is also more strongly developed. The fourth premolar is larger and is much wider posteriorly, where the cingulum forms a well-marked prominence; the postero-internal ridge is still more strongly developed, its lower end almost forming a tubercle, though it cannot be said that, even in this tooth, there is any distinct inner cusp. The molars consist of two pairs of cusps, the outer being crescentoid, the inner pyramidal; both are much lower than in the typical Oligocene species of the genus, and approximate closely to the type seen in *Brachyodus*, so that if it were not for the greatly elongated symphysis this animal might perhaps have been referred to that genus. In wear, the anterior limb of the postero-external crescent is seen to be divided into two ridges, one running forwards and inwards across the main transverse valley to the base of the antero-internal cusp, the other running inwards and joining a ridge running forwards from the postero-internal cusp, thus forming the anterior boundary of a fossa lying between the outer and inner posterior cusps. In *Brachyodus* and the later forms of *Ancodon* the same fossa is present, but its anterior border is formed by the main anterior arm of the postero-external crescent. The talon of *m.* 3 consists of a large crescent forming its outer side and a prominent ridge forming its inner edge, the two enclosing a well-defined fossa. The talon, as a whole, is broader and more massive than in the later forms of *Ancodon*, and is much like that found in *Brachyodus*.

The dimensions (in centimetres) of this, the type specimen, are :—

Approximate length of mandible	34
,, ,, symphysis	9
Depth of ramus behind *m.* 3	4·5
Height at coronoid	11 app.

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	1·5	·9
pm. 3	1·8	1·1
pm. 4	1·8	1·2
m. 1	1·7	1·2
m. 2	2	1·6
m. 3	3·3	1·8

Length of molar series 7·2. Length of premolar series (including *pm.* 1) 8·6.

The diastema between the canine and *pm.* 1 is 2·2, that between *pm.* 1 and *pm.* 2 is 2·5.

M. 8881. Plaster cast of the above specimen.   *Made in the British Museum.*

M. 8424. Palatal region of skull with teeth. On the right side *pm.* 4 and *m.* 1–3 are preserved, on the left *m.* 3 is wanting. Right side figured Pl. XVIII. fig. 3. In the figure *pm.* 3 is drawn in outline from another specimen (M. 8425).

The fourth premolar consists of an outer crescentic cusp and a large inner rounded tubercle ; the cingulum is well developed on the inner side. This tooth resembles the fourth premolar of the other species of *Ancodon* and differs from that of *Brachyodus* in the absence of a postero-internal cusp. The molars increase regularly in size from before backwards. They are quadrate in outline, and as in the other members of the family are composed of five main cusps, three anterior and two posterior. These cusps are lower and much less distinctly selenodont than in the other species of *Ancodon* except *A. porcinus*, Gerv., a species which Lydekker * has shown to be intermediate in molar structure between the typical species of *Ancodon* and *Anthracotherium*. The outer wall is strongly folded into a **W**-shaped ectoloph, the parastyle and mesostyle being very prominent in all the molars, while in *m.* 3 there is a large metastyle also. The cingulum is strongly developed and continuous round the anterior and inner sides of the teeth. This also seems to be the case in *A. porcinus* and in *Brachyodus*, while in the more hypsodont species of *Ancodon* the cingulum is almost wanting on the inner side of the teeth, and in *Anthracotherium* it is absent on the inner side of the inner main cusps. The dimensions (in centimetres) of the teeth are :—

	Length.	Breadth.
pm. 4	1·2	1·6
m. 1	1·6	1·8
m. 2	2·2	2·2
m. 3	2·5	2·5

Length of molar series 5·8.

M. 8425. Right maxilla with *pm.* 3–4 and *m.* 1–3. The first and second molars are incomplete on the outer side. *Pm.* 3 consists of a long trenchant outer cusp rising to a sharp point ; internally the cingulum is well developed and forms a sort of shelf-like projection on the postero-internal face of the tooth, which is therefore triangular in outline. This tooth is borne on three roots, one beneath the anterior angle, the others arranged transversely beneath the wider posterior portion. This tooth is shown in outline on Pl. XVIII. fig. 3. (*pm.* 3). The dimensions (in centimetres) of the teeth are :—

	Length.	Breadth.
pm. 3	1·6	1·4
pm. 4	1·4	1·7
m. 1	..	..
m. 2	2·2 app.	..
m. 3	2·6	..

Length of molar series approximately 6·1 cm.

M. 8423. Portion of palatal region of skull with *pm.* 3–4, *m.* 1–3 on the right side, and *m.* 3 on left. The length of the molar series is 6 cm.

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* " Note on the Anthracotheriidæ of the Isle of Wight," Geol. Mag. [3] vol. i. (1884) pp. 547–8.

C. 8814. Right upper molars and premolars. In this specimen *pm*. 3 has a small postero-internal cusp, apparently belonging to the cingulum. The dimensions (in centimetres) of the teeth are :—

	Length.	Breadth.
pm. 3	1·9	1·6
pm. 4	1·5	1·7
m. 1	1·7	1·7
m. 2	2·1	2·3
m. 3	2·9	2·7

Length of molar series 6·2 cm.

C. 8630. Portion of left maxilla with much broken *m*. 2 and *m*. 3 ; similar to C. 8814.

C. 8983. Nearly complete right ramus of mandible with *pm*. 2–4 and *m*. 1–3. Length of molar series 7·2 cm.

M. 8505a. Portion of right ramus of mandible with *pm*. 4 and *m*. 1–3. Length of molar series 7 cm.

M. 8505b. Portion of left ramus of mandible of a smaller individual with *pm*. 4 and *m*. 2–3. The enamel shows the peculiar sculpturing consisting of fine irregular ridges. Length of molar series 6·4 cm.

M. 8428. Portion of right ramus of mandible of a young individual with unworn *m*. 2–3. Figured on Plate XVIII. fig. 2. Length of *m*. 2, 1·8 cm. ; length of *m*. 3, 3·0 cm.

C. 9295. Portion of right ramus of mandible with the molars. Length of molar series 7·5 cm. (app.).

C. 8623. Portion of right ramus of mandible with *pm*. 2–4 and *m*. 1–3. Length of molar series 6·9 cm.

C. 8975. Portion of mandible of a much older individual. Much more massive than C. 8983. Length of molar series 7·6 cm.

C. 8825. Fragment of right ramus of young mandible with *m*. 2 and *m*. 3 ; the latter is just being cut ; its length is 3·2 cm.

M. 8427. Portion of left ramus of mandible with *pm*. 3–4 and *m*. 1–2.

M. 8506a. Posterior portion of right ramus of mandible. Length of *m*. 3, 3·4 cm.

M. 8506b. Fragment of left ramus of mandible. Length of *m*. 3, 3·1 cm.

C. 8827. Left ramus of mandible with *m*. 2 and *m*. 3. Length of *m*. 3, 3·2 cm.

C. 8615. Portion of left ramus of young individual with *m*. 2 and *m*. 3 ; the talon of *m*. 3 is smaller than usual. Length of *m*. 3, 2·8 cm.

The following specimens are provisionally referred to this species :—

C. 9232. Posterior cervical vertebra, wanting posterior epiphysis. The arch is very broad and massive, the zygapophyses being exceptionally large ; there is no neural spine ; a vertebrarterial canal is present, but the transverse process is broken away. Width of centrum 8 cm. (app.) ; height of ditto 6·5 cm. ; height to top of arch 10·5 cm.

C. 9233. Anterior dorsal vertebra, wanting the epiphysis. In this the centrum is slightly opisthocœlous; the neural spine is large, backwardly directed, and narrowing to a point; strong transverse processes directed upwards and outwards; posterior zygapophyses flat and looking nearly directly downwards. Large concave surfaces for the heads of ribs at upper angles of posterior face of centrum. Width of centrum 7·5 cm. (app.); height of ditto 6·5 cm.; height to top of neural spine 14 + cm.; width between ends of transverse processes 14·6 cm.

M. 8867. Posterior dorsal vertebra of a smaller animal. Centrum wanting epiphyses; deeper than wide and with a strong hypapophysial ridge: shallow facet for rib-head about the middle of the pedicle of the neural arch; neural spine sloping strongly backwards. Width of centrum 5 cm.; height of ditto 4·5 cm.; height to top of neural spine 13 + cm.

Presented by the Egyptian Government, 1904.

C. 7884. Nearly complete lumbar vertebra, wanting posterior epiphysis. The centrum is a little higher than wide, at least posteriorly; it has a strong hypapophysial ridge, and its neural surface is strongly concave from side to side. The neural arch is high and the neural spine is a broad thin plate of bone abruptly truncated at its upper end and sloping very little backwards. The posterior zygapophyses are large and overhang the hinder border of the centrum; the anterior zygapophysial surfaces are slightly concave from side to side; the transverse process is broken away.

M. 8867 a. Imperfect lumbar vertebra, similar to last, but of a larger individual.

Presented by the Egyptian Government, 1904.

C. 8637. Glenoid end of right scapula. The glenoid cavity is nearly circular in outline, and separated from it by a notch is the strongly recurved coracoid process, which does not quite reach the level of its margin. The glenoid border in the region of the neck is flattened and bears a small but well-defined pit. This bone differs from that of *Diplopus* in the relatively smaller size of the much more recurved coracoid process, in the absence of a deep fossa on the glenoid border of the neck, and in the more nearly circular outline of the glenoid cavity itself. Fragments of scapulæ from Hamstead Cliff, referred to *Ancodon*, differ in having no distinct coracoid notch, a larger coracoid process, and a more oval glenoid cavity.

Antero-posterior diameter of glenoid cavity	4·8 cm.
Total width with coracoid process	6·5 „
Width of neck	4·1 „

M. 8510. Glenoid end of right scapula, similar to last specimen.

Presented by W. E. de Winton, Esq., 1903.

C. 8655. Distal end of left humerus. This resembles very nearly the distal ends of some humeri from Hamstead, presumably belonging to *Ancodon*. The inner portion of the trochlea is larger than in *Diplopus*, and is not produced down into a thin flange-like edge. The intertrochlear ridge is much narrower and sharper than in that genus. There is a small supratrochlear perforation. The inner condyle forms a large blunt prominence on its inner side and is produced backwards into a posterior projection, the distal border of which is at right angles to the posterior border. The shaft was comparatively slender. The dimensions (in centimetres) of this specimen are:—Width of shaft 3; greatest width of distal end 5·2; width of distal articulation 3·8.

M. 8509. Distal ends of three humeri of similar form to C. 8655.

M. 8430. Distal ends of two right humeri.

C. 8652. Distal end of right humerus of a similar form, but considerably larger size, the width of its distal articular surface being 4·7 cm. against 3·8 cm. in C. 8655.

M. 8862. Distal part of right humerus. In this specimen there is a supratrochlear perforation. The dimensions (in centimetres) are :—Width of shaft 3 ; width of distal end 6 ; width of distal articulation 4·5.   *Presented by the Egyptian Government,* 1904.

C. 8124. Left radius. This bone is comparatively long and slender, but it widens out considerably towards the distal end. The anterior face of the shaft is convex, the posterior (ulnar) surface flattened. The proximal articular surface consists of a larger outer portion, deeply grooved towards its inner side for the intertrochlear ridge of the humerus, and a smaller inner portion only very slightly concave from before backwards and looking upwards and inwards : this, with the large inner portion of the sigmoid surface of the ulna, articulates with the inner portion of the distal articulation of the humerus. About the middle of the posterior face there is a prominent facet for articulation with the ulna, but in addition to this the whole posterior surface seems to have been ridged and roughened, showing that the union between the two bones was a very close one. The distal articulation is unknown. The dimensions (in centimetres) of this specimen are :—

Width of proximal articular surface . . . .   4·7
   „   middle of shaft   . . . .   2·4
   „   distal end   . . . .   5·3
Length (without distal epiphysis) . . . .   31·4

M. 9124. Incomplete left radius similar to last.

M. 8863. Upper portion of a left ulna. The olecranon process is large and rises high above the articulation, but projects very little backwards. The inner border of its upper end is produced upwards into a flange which forms the inner side of a large groove (? for a tendon). The sigmoid notch is shallow and except towards the upper end the surface for the humerus is on the inner side only. There is a small distal surface for the outer side of the humeral articulation, and immediately beneath it is the projecting facet by which the bone interlocks with the upper end of the radius, which must also have been closely united with the rugose anterior face of the shaft. This becomes considerably narrowed towards its middle and is strongly compressed from before backwards, though less so than in *Diplopus* ; towards the distal end the radial surface forms a sort of shelf on the inner side of the shaft and is bordered externally by a strong ridge. The distal extremity of the bone is unknown. The dimensions (in centimetres) of this specimen are :—

Greatest antero-posterior width of olecranon process . . . .   5·8
Height of olecranon above articulation   . . . .   6·7
Length of sigmoid notch . . . .   4·4
Width of surface for upper end of radius   . . . .   3·6

Presented by the Egyptian Government, 1904.

M. 8863a. Upper end of a similar right ulna.   *Presented by the Egyptian Government,* 1904.

C. 8836. Left ulna, wanting the distal end. This specimen shows that this bone is long and slender. The dimensions (in centimetres) are :—

Length of sigmoid notch	4·7
Height of olecranon process above articulation	5·5
Length of bone so far as preserved	38

C. 8805. Left os innominatum (text-fig. 60). The long axis of the ilium (*il.*) is nearly on the same straight line as that of the ischium (*isc.*). For a short distance in front of the

Text-fig. 60.
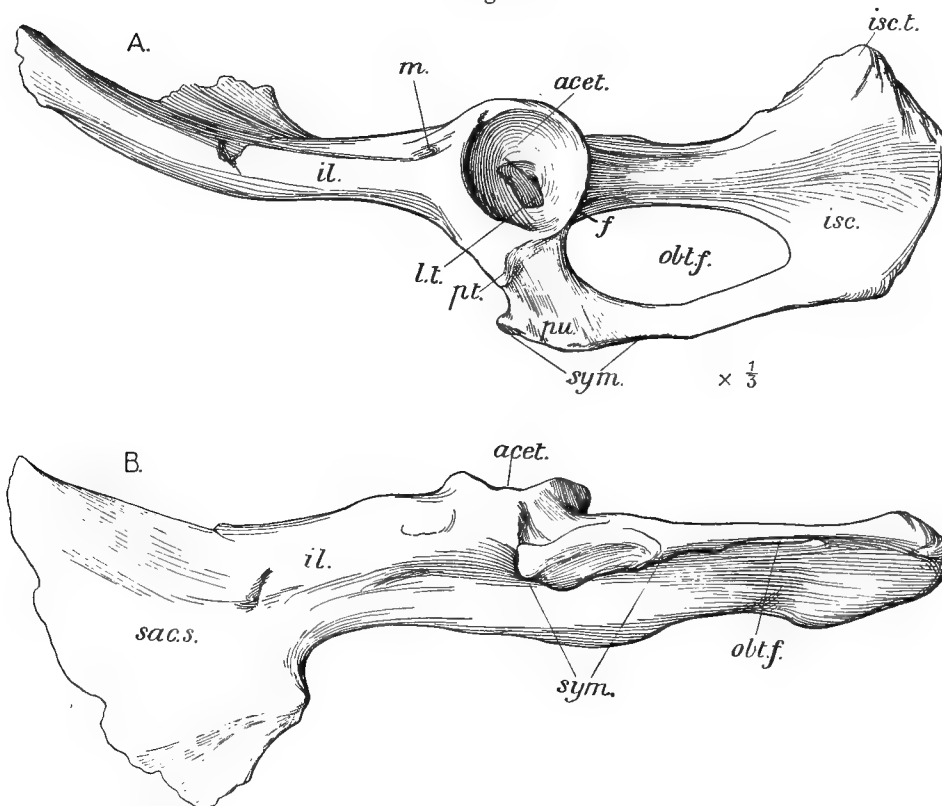
Left os innominatum of *Ancodon gorringei* : A, from side ; B, from below.

acet., acetabulum ; *f.*, foramen formed by closure of the cotylar notch (the passage into the acetabulum is marked by a line from *f.*); *il.*, ilium ; *isc.*, ischium ; *isc.t.*, ischial tuberosity ; *l.t.*, pit for *ligamentum teres*; *m.*, pit for attachment of a muscle, probably the *rectus femoris*; *obt.f.*, obturator foramen ; *pt.*, pectineal tubercle ; *pu.*, pubis ; *sac.s.*, surface for sacrum ; *sym.*, symphysial surface of pubis. $\frac{1}{3}$ nat. size.

acetabulum the upper and lower borders of the laterally compressed neck of the ilium are nearly parallel, then the bone expands greatly into a roughly triangular region, the inner (sacral) face of which bears a large and clearly defined surface for the sacrum (*sac.s.*); this surface is bounded ventrally and separated from the lower border of the bone by a rounded ridge. The upper edge of the ischium is thin and sharp, and there is a slightly developed superior ischiadic spine ; posteriorly the bone expands and bears a large

2 B

flattened ischial tuberosity (*isc.t.*). The outer surface of the ischium is in almost the same plane as the gluteal surface of the ilium. The pubis (*pu.*) is a stout bar of bone compressed from above downwards. On its anterior border beneath the acetabulum is a well-marked pectineal tuberosity (*pt.*); towards its inner end it widens out and terminates in a flat oval surface by which it unites in symphysis (*sym.*) with its fellow. Behind this surface there runs back to the ischium a thin bar of bone, closing the obturator foramen. This bar has a thin sharp edge, and neither it nor the ischium seems to have united with the corresponding portion of the opposite os innominatum. The obturator foramen (*obt.f.*) is an elongated oval. The acetabular cup (*acet.*) is nearly circular in outline; it is deep, its edges being prominent and thickened, particularly in front. Its border is complete, there being no cotylar notch, which is only represented by a passage (*f.*) running through the posterior wall of the acetabulum from just above the anterior end of the obturator foramen and opening into the posterior end of the pit for the *ligamentum teres* (*l.t.*), which is a deep elongated depression at the bottom of the acetabulum. This arrangement is also found in a very similar pelvis of *Brachyodus africanus* from Moghara and in *Hippopotamus* : this last genus, in fact, seems to be intimately related with these African Anthracotheres, and annectant forms similar to *Merycopotamus* will probably be discovered in the Miocene beds between Moghara and the Wadi Natrun, in the Lower Pliocene deposits of which remains of a primitive Hippopotamus have already been found. The dimensions (in centimetres) of this specimen are :—

Total length of os innominatum	.	37·2
„ ilium from centre of acetabulum . .	. .	20·4
„ ischium from centre of acetabulum .	.	17·5
Width of peduncle of ilium		6
„ crista ilii		16·4
Diameter of acetabulum		5·2
Length of obturator foramen		9·4
Width of pubic bar on inner side of obturator foramen . . .		1·5
Length of symphysial surface of pubis	.	5·5
Depth of symphysial surface of pubis		3

M. 9242. Plaster cast of the above specimen.   *Made in the British Museum.*

C. 9224. Portion of left os innominatum, wanting part of front of ilium and the pubis.

M. 8866. Portion of left os innominatum.   *Presented by the Egyptian Government,* 1904.

M. 8864 a. Complete left tibia. The most notable character of this bone is the slenderness of its distal portion compared with the heaviness of its upper end. The outer facet for the femur is concave from side to side and strongly convex from before backwards ; its inner edge forms a rounded ridge separated by a groove from the raised outer edge of the inner facet, the two together forming a bifid intercondylar prominence. The inner facet is concave from side to side and nearly flat from before backwards. In front of the articular surface the upper end of the large cnemial crest forms a broad flattened surface. The upper portion of the shaft is trihedral ; its antero-external side is deeply concave, the posterior slightly so ; this latter face is overhung by the posterior border of the proximal articulation. The cnemial crest disappears about halfway down the shaft,

which beneath this point becomes much more slender, expanding again a little towards the distal articulation. The distal articulation is quadrate in outline, and its outer border is occupied by a large facet for the fibula, looking outwards and downwards. The groove for the outer half of the astragalar articulation is both broader and shallower than the inner, which is very narrow and is deepened anteriorly by the presence of a strong internal malleolar process. The dimensions (in centimetres) of this specimen are :—

Extreme length . . . . 40·5
Width of proximal end 10
„ distal end . . . . 6·2
Antero-posterior length of distal articulation . . . . . . 4·2
Width of shaft at narrowest . . . . 3·8

Presented by the Egyptian Government, 1904.

C. 8899. A similar right tibia, of which the dimensions (in centimetres) are :—

Extreme length 39
Width of proximal end 10
„ distal end . . . . 5·4
„ shaft at narrowest . . . . 3·7

C. 9312. Right tibia of rather more slender form, probably of a different species. A very prominent thin internal malleolus. The dimensions (in centimetres) are :—

Extreme length 41
Width of proximal end 9
„ distal end . . . . 4·6
„ shaft at narrowest . . . . 3·4

M. 8864 b. Right tibia, similar to M. 8864 a, but wanting the proximal epiphysis.

Presented by the Egyptian Government, 1904.

M. 8507. Right astragalus (text-fig. 61). In this bone the relative heights of the outer (*o.c.*) and inner condyles (*i.c.*) of the proximal trochlea are about as in astragali of *Ancodon* (*Hyopotamus*) from the Isle of Wight, but the outer condyle is rather more massive. In the distal trochlea the cuboid surface (*cub.*) is relatively rather wider, and the keel between it and the navicular surface (*nav.*) less prominent than in the European species. The sustentacular articulation (*sus., sus.'*) seems to be closely similar to that described by Scott * in the American species—that is to say, it is divided into an outer facet (*sus.*), nearly flat from side to side, but convex from before backwards and looking towards the plantar surface, and an inner (*sus.'*), in this case much narrower, facet, which does not extend quite so high up proximally, but further distally, the distal portion being an almost distinct rounded surface; this internal portion of the sustentacular articulation looks towards the outer and plantar surface. Of the outer calcaneal facets the proximal one (*ect.*) is divided by a deep depression into proximal and distal portions, of which the latter is borne on a strong prominence and looks mainly towards the

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* " The Structure and Relationships of *Ancodus*," Journ. Acad. Nat. Sci. Philad. [2] vol. ix. pp. 482–83.

plantar surface. Beneath it the outer surface of the bone is deeply excavated. The distal calcaneal facet (*calc.*) is large and flat, looking outwards and a little downwards. The dimensions (in centimetres) of the specimen above described are :—

Greatest length . . . . 7·6
Width of proximal articulation . . . . 3·5
    ,,   distal articulation . . . . 3·8 app.
    ,,   sustentacular articulation . . . . 2·7

C. 8388, C. 9004, C. 9043–4, C. 9276. Right astragali.

C. 8431. Two right astragali, rather smaller than M. 8507.

C. 8412. Left astragalus.

M. 8431a, M. 8507. Left astragali.

C. 8810. Left astragalus, from highest beds.

Text-fig. 61.
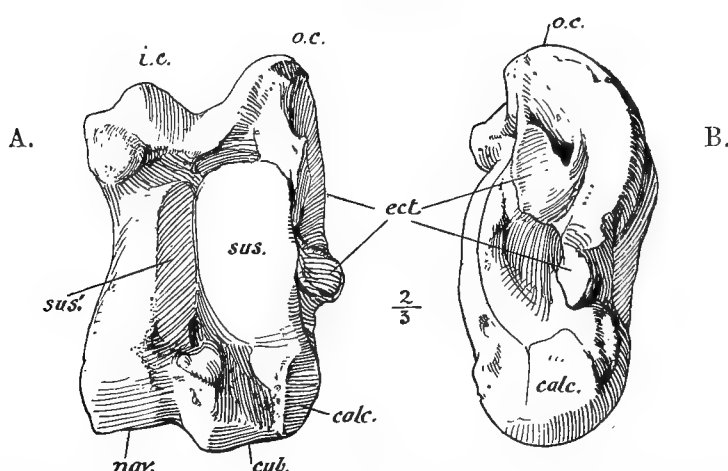
Right astragalus of *Ancodon gorringei* : A, from behind ; B, from outer side.

calc., distal calcaneal facet ; *cub.*, facet for cuboid ; *ect.*, ectal facet (divided into two) ; *i.c.*, proximal inner condyle ; *nav.*, facet for navicular ; *o.c.*, proximal outer condyle ; *sus.*, *sus.'*, outer and inner portions of sustentacular facet. ⅔ nat. size.

M. 8432. Right calcaneum, wanting the *tuber calcis*. The sustentaculum is large ; it bears two facets, a larger outer one, concave from before backwards, and looking upwards, and a smaller inner one looking upwards and inwards. The ectal facet is also divided into a larger posterior portion looking inwards, and a smaller anterior portion looking upwards and separated from the large fibular facet by a notch. On the outer side of the bone, beneath the fibular facet, there is a deep fossa, bounded below by a broad ridge, which runs forwards to the lower end of the bone, and at the same time forms the upper limit of a broad longitudinal groove which runs along the distal half of the outer face. The anterior astragular facet is flat and looks nearly inwards ; the cuboid facet obliquely truncates the distal end of the bone. On the whole, this bone much

resembles the calcaneum of *Diplopus* figured and described by Kowalevsky *. The dimensions (in centimetres) of this specimen are :—

Greatest width from above downwards . . . . 5·7
      ,,   ,,   ,,   side to side . . . . 4·5
Width of sustentacular surface . . . . 3·2

M. 8516 b. Portion of right calcaneum similar to last.   *Presented by W. E. de Winton, Esq.,* 1903.

M. 9224. Left cuboid.

C. 7993. Right calcaneum. Length 14·5 cm.

C. 8387. Portion of left calcaneum.

M. 8516 c. Proximal end of (?) the third left metatarsal. This bone seems to have interlocked with the second metatarsal, as in *Ancodon*, as figured by Kowalevsky. The shaft of the bone is much compressed from before backwards. The lateral (2nd) digit must have been of considerable size.   *Presented by W. E. de Winton, Esq.,* 1903.

C. 8894. A metapodial bone (? third metacarpal), 11·5 cm. long.

C. 7990. Portion of metapodial.

M. 9127. Distal ends of two metapodials.

Ancodon parvus, sp. nov.

[Text-fig. 62.]

Type Specimen.—A portion of the right ramus of a mandible with *m.* 1 and *m.* 2 *in situ*, together with the empty alveolus of *m.* 3 (text-fig. 62) ; Geological Museum, Cairo.

This species differs from *A. gorringei* in its considerably smaller size. The molars also differ in the following points :—(1) The cusps seem to be relatively higher ; (2) the cingulum is much more strongly developed on the posterior end of the tooth ; (3) the teeth are longer in proportion to their width ; (4) the enamel is nearly smooth. Possibly when more is known of this species it may be necessary to refer it to a distinct genus.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

C. 8821. Part of the right ramus of the mandible with *m.* 1 and *m.* 2 in perfect preservation. Type specimen (text-fig. 62). The depth of the jaw beneath *m.* 2 is 1·8 cm. The dimensions of the molars (in centimetres) are :—

	Length.	Width.
m. 1	1·2	·6
m. 2	1·5	·9

The length of *m.* 1 and *m.* 2 together is 2·7 cm.; in *A. gorringei* this measurement is 3·8 cm.

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* " On the Osteology of the Hyopotamidæ," Phil. Trans. vol. 163 (1873) p. 53, pl. xxxv. fig. 4.

To this species a number of more or less imperfect bones of an Artiodactyl smaller than *A. gorringei* may be provisionally referred. These are enumerated below.

M. 8429. Right scapula with large portion of the blade preserved. The articular end is like that already described. Above the neck the blade expands rapidly; the postscapular fossa is concave from side to side, and widens rapidly towards the suprascapular border; the prescapular fossa also widened rapidly, but the upper anterior portion of the blade being broken away, its exact form, as well as that of the coracoid border, cannot be made out. On the whole, this scapula seems to have resembled that of *Diplopus* figured by Kowalevsky (Phil. Trans. vol. 163, 1873, pl. xxxv. fig. 1) rather than that of *Ancodon brachyrhynchus* figured by Scott (Journ. Acad. Nat. Sci. Philad. [2] vol. ix. 1895, p. 474). The dimensions (in centimetres) of this specimen are :— Width of glenoid cavity 3·8; width of neck 4·2; width of blade at widest part preserved 12.

Text-fig. 62.
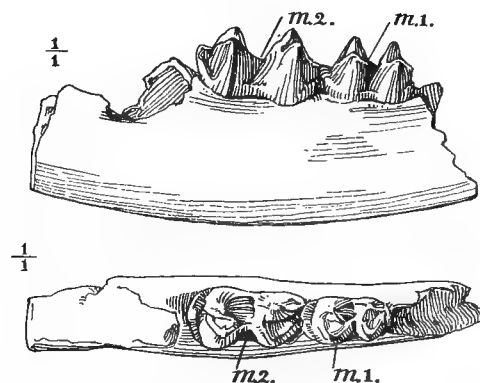
Portion of right ramus of mandible of *Ancodon parvus,* with *m.* 1 and *m.* 2 *in situ.* Nat. size.

C. 7832. Glenoid end of left scapula, probably of a smaller species. Width of glenoid cavity 3·5 cm. (app.); width of neck of scapula 2·7 cm.

C. 8640. Glenoid half of a left scapula, showing that the spine was high and terminated in a free acromion process. Width of glenoid surface 3·8 cm.; height of spine (app.) 3 cm.

C. 9289. Right humerus, wanting the proximal end. The deltoid crest is very slightly developed; the lower part of the shaft is nearly circular in section. There is a supratrochlear perforation; the trochlear ridge is more strongly developed than in *Diplopus.* The dimensions (in centimetres) of this specimen are :—

Length so far as preserved		19
Width of shaft at narrowest point		2·2
,, distal end		5
,, distal articulation		3·3

M. 8516. Proximal ends of two radii.   *Presented by W. E. de Winton, Esq., 1903.*

M. 8508. Upper part of a left ulna similar to that of *A. gorringei*. The dimensions (in centimetres) are :—

Antero-posterior width of the olecranon process . . . . . . 4 app.
Length of sigmoid notch . . . . 3·5
Width of surface for radius 2

Presented by W. E. de Winton, Esq., 1903.

M. 8508 a. Upper end of similar right ulna.　　*Presented by W. E. de Winton, Esq., 1903.*

M. 8508 b. Upper half of an abraded right ulna of rather smaller size.

Presented by W. E. de Winton, Esq., 1903.

C. 8641. Proximal end of right ulna.

M. 8516 a. Distal end of right tibia. Width of articulation 3·8 cm.

Presented by W. E. de Winton, Esq., 1903.

M. 8431. Right astragalus. Width of proximal articulation 2·6 cm. ; greatest length 6·2 cm.

M. 8507. Left astragalus. Width of proximal articulation 2·7 cm.; greatest length 6·2 cm.

Presented by W. E. de Winton, Esq., 1903.

C. 8636. Somewhat smaller left astragalus. Greatest length about 5·4 cm.

Ancodon sp.

Two associated right upper molars (*m.* 2, *m.* 3) of about the same size as those of *A. gorringei*, but differing from them in possessing higher, sharper, and more selenodont cusps, were collected by Mr. Beadnell. This specimen indicates the probable existence of another species of Anthracotheroid which approaches more nearly to the later typical species of *Ancodon* (e. g., *A. velaunus*) than does *A. gorringei*. At the same time the evidence does not seem sufficient to warrant the establishment of a new species.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 10500. Two associated right upper molars (*m.* 2, *m.* 3). The outer side of *m.* 2 is partly broken away. The dimensions (in centimetres) of these teeth are :—

	Length.	Width.
m. 2	1·6	1·6 app.
m. 3	1·9	2

M. 9242. Plaster cast of the above specimen.　　*Made in the British Museum.*

Genus RHAGATHERIUM, Pictet.

[Mémoire sur les Animaux Vertébrés trouvés dans le Terrain Sidérolithique du Canton de Vaud, p. 43 (1855).]

This genus was founded by Pictet (*loc. cit.*) for the reception of a small species of Anthracotheroid in which the incisors are small, while the canines have cutting-edges

and are separated both from the incisors and premolars by long diastemata. In the upper jaw there are four premolars, *pm.* 1 being separated from *pm.* 2 by a diastema. The molars have very brachyodont crowns, the cusps being only slightly selenodont but strongly convex on their outer face. The type species is *R. valdense*. Later, Kowalevsky * described and figured another species, *R. fronstettense*, in which the upper molars are still more bunodont, the cusps being shorter and thicker; the middle fold of the outer wall (*mesostyle*) is also more strongly developed, as, judging from the figures, is the cingulum generally. A single tooth from the Upper Eocene of the Fayûm resembles those figured by Kowalevsky so closely in its structure that it is here referred to the same genus, though, on account of its much greater size, to a distinct species.

Rhagatherium ægyptiacum, sp. nov.

[Plate XVIII. fig. 5.]

Type Specimen.—Left upper molar, probably the third (Pl. XVIII. fig. 5); British Museum.

The tooth upon which this species is founded is clearly that of a primitive Anthracotheroid, in which the selenodont condition of the molars of the later forms is still only indicated, and the cusps are low and strongly convex on the outer as well as on the inner face. There are three main cusps in front and two behind, as usual in the family; the intermediate anterior cusp is the smallest. The cingulum is well developed round the whole crown, with the exception of the outer face of the postero-external cusp. The fold on the outer face between the main cusps forms a well-developed mesostyle. In wear, the inner cusps would tend to give a **V**-shaped pattern, but this would not be the case with the outer ones. The tooth differs from those of *R. valdense*, Pictet, and *R. fronstettense*, Kowalevsky, by its much larger size, and from the former by its still more bunodont crown. Possibly, when the dentition is fully known, it may be necessary to establish a new genus for this species.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-et-Qurun.

M. 8449. Left upper molar, probably the third; the low cusps are just coming into wear. Type specimen, figured Pl. XVIII. fig. 5. The length of this tooth is 1·8 cm.; its greatest width 2 cm. In *R. valdense* the corresponding measurements are ·75 cm. and ·8 cm.; in *R. fronstettense* they are 1 cm. and 1 cm.

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* "Monographie der Gattung *Anthracotherium*, Cuv.," Palæontographica, vol. xxii. (1876) p. 228, pl. viii. figs. 57, 58.

Family SUIDÆ.

The peculiar genus *Geniohyus* may be referred provisionally to this family, of which it may be taken as representing a distinct subfamily, the *Geniohyinæ*. Further knowledge of this remarkable form may lead to the establishment of a new family for its reception, but at present the course here adopted seems best.

Genus **GENIOHYUS**, Andrews.

[Geol. Mag. [5] vol. i. (1904) p. 160.]

Known only from the mandible and lower teeth. The dental formula for the mandible seems to be *i.* 3, *c.* 1, *pm.* 4, *m.* 3, but possibly the canine may be wanting, as will be explained below. The anterior incisors are enlarged and procumbent; the premolars are all simpler than the molars, which are bunodont. The mandible bears on its lower border, immediately behind and beneath the symphysis, a pair of large backwardly-directed processes.

Three species of this genus are at present known.

Geniohyus mirus, Andrews.

[Plate XIX. figs. 1, 1 A.]

1904. *Geniohyus mirus,* C. W. Andrews, Geol. Mag. [5] vol. i. pp. 160–161, pl. vi. fig. 4.

Type Specimen.—Symphysis and part of the right ramus of a mandible with the premolars and molars well preserved (Pl. XIX. figs. 1, 1 A); Geological Museum, Cairo.

This is the smallest of the three species, and at the same time the premolars are the simplest. Length of the premolar series is 5 cm.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 8634. Symphysis and part of right ramus of mandible. Type specimen described and figured *loc. cit. supra*; also Pl. XIX. figs. 1, 1 A. The spout-like symphysial region is narrow both from side to side and from above downwards, and behind it, just where the rami begin to diverge, the ventral border of the jaw is produced downwards and backwards on either side into a long backwardly directed process (*pr.*), which is oval in section and probably ended in a point, but the tip is broken away. The hinder border of the base of this process is connected with the lower edge of the horizontal ramus by a thin plate of bone. The ramus is incomplete ventrally, but was evidently narrow from above downwards. The function of the peculiar paired ventral process is uncertain. In the Dinocerata a somewhat similarly situated prominence on the mandible helped to protect

2 c

the point of the upper canine tusk, while in *Elotherium*, a more nearly related form, there are sometimes two pairs of such processes, but they are directed downwards and more or less club-shaped: in the latter genus also their function is unknown.

On the side of the jaw there are several foramina. The most anterior of these is immediately behind the alveolus of $i.1$, the next two are beneath $i.3$ and $c.$, while the last is behind the posterior border of the symphysis at the level of $pm.2$.

The first incisors ($i.1$) are broken off short, but it can be seen that they were greatly enlarged and directed forwards. They were laterally compressed so as to give an elongated oval outline in section; the outer side, at least, was enamel-covered. The second incisor ($i.2$) was a small rounded tooth, represented in this specimen by its alveolus only. Behind this, at an interval of about 1·4 cm., is a small rounded root of a tooth and immediately behind this a second rather larger. The nature of these is doubtful: they look as if they might be roots of one tooth, but since from their position this is not probable, they are here regarded as the roots of the third incisor ($i.3$) and the canine ($c.$). The distance between the canine and first premolar is about 1 cm. This enlargement of the anterior incisors and the very small size of the canine distinguish *Geniohyus* from the other members of the family, and at least justify its separation in a distinct subfamily. The anterior premolar ($pm.1$) is a compressed tooth consisting of small anterior and posterior tubercles and a high main cusp. In the next ($pm.2$) there is a small cingular ridge in front of the tooth and the main cusp is much larger, showing a tendency towards division into an outer and an inner element. In wear it gives a triangular surface, from the outer angle of which a ridge runs down the outer face of the tooth, while from its front angle there is a small ridge connecting it with the anterior tubercle, and similarly posteriorly a small ridge unites it with the posterior tubercle. The next tooth ($pm.3$) is similar, except that the posterior lobe is larger and shows a tendency to give a V-shaped surface iu wear. In the last premolar ($pm.4$) the replacement of the main cusp by two elements is complete, the inner being small and rounded, the outer larger and V-shaped in wear. From the anterior arm of the V a small ridge runs to the small anterior tubercle, while from the posterior a low ridge runs back uniting it with the anterior limb of the V-shaped posterior lobe. On the inner side of this last there is a trace of a small inner tubercle corresponding to the postero-internal cusp of the molars.

The characters of the molars are those of a primitive member of the Suidæ, in which the outer cusps are distinctly selenodont. Each molar consists of two pairs of cusps, the outer V-shaped, the inner more rounded or pyramidal. In the first molar ($m.1$) the outer cusp is considerably worn; it consists of the main tubercle forming the apex of the V, of which the arms form slight ridges terminating in small accessory tubercles, of which the anterior is situated on the anterior border of the tooth, while the posterior is connected by a slight ridge with the postero-internal angle of the inner cusp. The postero-external cusp shows the selenodont character still more clearly: its small anterior accessory tubercle partially fills the main transverse valley; the posterior accessory tubercle is on the hinder border of the tooth. The internal cusps are trihedral, and in wear they also show some tendency to form a V-shaped surface, the opening of the V of the antero-internal cusp looking outwards and backwards, that of the postero-internal cusp outwards and forwards. There is a slightly developed cingulum on the outer side of the tooth, most marked opposite the opening of the transverse valley and

near the anterior end of the tooth. The second molar (*m.*2) is similar to the first, except that on the hinder border there is an additional minute tubercle lying internal to the posterior accessory tubercle of the postero-external cusp. In *m.*3 the structure is similar, so far as it is preserved, but the talon is almost entirely broken away.

The dimensions (in centimetres) of this specimen are :—

Extreme length so far as preserved	16·2
Length of symphysis	6·3
Distance between end of process and alveolar border . . .	7·2
Width of symphysial region at *i.* 3	2·5 app.

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 1	1·2	·7
pm. 2	1·2	·9
pm. 3	1·3	1
pm. 4	1·3	1·1
m. 1	1·5	1·1
m. 2	1·7	1·3
m. 3	?	1·5

M. 8541. Plaster cast of the above specimen.   *Made in the British Museum.*

Geniohyus fajumensis, Andrews.

[Plate XIX. figs. 2, 2 A.]

1904. *Geniohyus fajumensis*, C. W. Andrews, Geol. Mag. [5] vol. i. p. 162.

Type Specimen.—Portion of right ramus of mandible with the premolars well preserved (Pl. XIX. figs. 2, 2 A); British Museum.

This species is distinguished from *G. mirus* by (1) its larger size, the premolar series measuring 5·6 cm. in length; (2) the main cusp being distinctly divided into an inner and outer tubercle in *pm.* 2; (3) the posterior lobe of the premolars being much larger and more distinctly selenodont.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

M. 8435. Portion of right ramus of mandible with *pm.* 1–4. Type specimen described in Geol. Mag. [5] vol. i. (1904) p. 162. Figured Pl. XIX. figs. 2, 2 A.

The first premolar (*pm.* 1) is strongly compressed, with a very small anterior tubercle, a high main cusp from which three ridges diverge posteriorly, one running down the outer face of the tooth, a second back to the anterior arm of the V-shaped posterior cusp, the third inwards down the inner face of the tooth. The posterior lobe is distinctly selenodont. In *pm.* 2 the anterior tubercle is larger, and the ridge running inwards from the main cusp has a small tubercle on its inner end. The posterior lobe is larger than in *pm.* 1. *Pm.* 3 has a still larger anterior tubercle and the cusp on the inner side of the main cusp is nearly as large as that element and clearly separated from it; the posterior **V** is still larger. *Pm.* 4 is similar, except that the small anterior cusp is

doubled, the posterior lobe still larger, and there are traces of a small postero-internal tubercle.   The dimensions (in centimetres) of the premolars are :—

	Length.	Width.
pm. 1	1·3	·7
pm. 2	1·3	·8
pm. 3	1·5	1
pm. 4	1·6	1·2

Length of premolar series 5·6.

Geniohyus major, Andrews.

[Text-fig. 63.]

1904. *Geniohyus major*, C. W. Andrews, Geol. Mag. [5] vol. i. p. 212.

Type Specimen.—Portion of left ramus of mandible with *pm.* 1–3 (text-fig. 63); Geological Museum, Cairo.

Text-fig. 63.
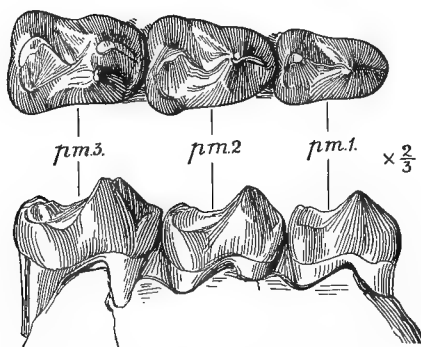
Left lower premolars (*pm.* 1–*pm.* 3) of *Geniohyus major*.   ⅔ nat. size.

This species is considerably larger than either of the others, the length of the three premolars being 5·5 cm., while in *G. mirus* the same teeth measure 3·6 cm. and in *G. fajumensis* 4·1 cm.   The posterior lobes of the premolars are still larger and more selenodont than in *G. fajumensis.*

Form. & Loc.—Fluvio-marine beds (Upper Eocene): Birket-el-Qurun.

C. **8980.** Portion of left ramus of mandible with *pm.* 1–3 in good preservation.   The teeth (text-fig. 63) are very similar to those of *G. fajumensis,* but the hinder lobe is wider and more massive, and in wear gives an even more distinct **V**-shaped surface.   The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 1	1·8	1
pm. 2	1·9	1·4
pm. 3	2	1·5

M. 8876. Plaster cast of the above specimen.   *Made in the British Museum.*

Order SIRENIA.

Family HALICORIDÆ.

The occurrence of Sirenians in the Eocene beds of Egypt was first made known by Owen, who described a natural cast of the brain-case of one of these animals under the name *Eotherium ægyptiacum* *.   This specimen was from the white Mokattam Limestone of Cairo, and therefore from a rather lower horizon than the Qasr-el-Sagha beds. A few years afterwards Filhol described † some teeth from the same limestone under the name *Manatus coulombi*, which may be synonymous with *Eotherium ægyptiacum*. Lately much more information concerning *Eotherium* has been given by Dr. O. Abel, who, in his important memoir entitled "Die Sirenen der mediterranen Tertiärbildungen Österreichs " ‡, gives an account of some recently collected remains of this animal. This writer also proposes to publish shortly an exhaustive account of the remains of Sirenians both from the neighbourhood of Cairo and from the Fayûm, so that in the present Catalogue it will only be necessary to give a short description of such remains as are preserved in the British Museum and in Cairo.   All the specimens from the Fayûm appear to belong to the genus *Eosiren*.

Genus EOSIREN, Andrews.
[Geol. Mag. [4] vol. ix. (1902) p. 293.]

Sirenia in which the three incisors and the canine are present at least in the upper jaw.   The first pair of incisors are enlarged downwardly-directed tusks ; the second and third are small and probably lost early ; their alveoli are situated somewhat on the outer side of the rostrum close to the maxillo-premaxillary suture.

Eotherium is distinguished from the present genus in several important particulars, some of the chief of which are :—(1) the anterior incisors are not greatly enlarged and tusk-like, and the two other incisors, though situated far back in the premaxilla, are still large and placed on the edge of the jaw ; (2) the natural cranial cast on which this genus is based differs so considerably from a cast of the brain-cavity in *Eosiren*

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* Owen, Quart. Journ. Geol. Soc. vol. xxxi. (1875) p. 100. The generic name *Eotherium* had been previously employed by Leidy in 1853 for a genus of Perissodactyls, and therefore strictly the name *Eotheroides* suggested by Palmer ('Science,' n. s. vol. x. 1899, p. 494) should be employed for this genus.

† Bull. Soc. Philomathique de Paris, ser. vii. vol. ii. (1878) pp. 124–5.

‡ Abhandl. k.-k. geol. Reichsanstalt, vol. xix. pt. 2 (Vienna, 1904).

that Dr. Elliot Smith is of opinion that their generic separation would be justified by this difference alone; (3) the *os innominatum* is much less reduced and has a completely closed obturator foramen and a well-defined acetabulum with which a functional femur probably articulated, whereas in *Eosiren* the reduction of the pelvis has proceeded almost as far as in *Halitherium*. These particulars are taken partly from Abel's paper above referred to, and partly from a skull and mandible of *Eotherium* recently acquired by the Geological Museum, Cairo: to this specimen further reference, with figures, is made below.

Prorastomus *, another primitive Sirenian from the Lower Tertiary beds of Jamaica, differs from the present form both in the general shape of the skull, the slight deflection of the snout, the absence of enlarged anterior incisors, and in the form of the mandibular symphysis.

Halitherium (Prototherium) veronense, Zigno†, approaches this genus very nearly, but in it the dentition seems to have already undergone considerable reduction.

Eosiren libyca, Andrews.

[Plate XX. figs. 1–7; text-figs. 64, 65, 68 B.]

1902. *Eosiren libyca,* C. W. Andrews, Geol. Mag. [4] vol. ix. pp. 293–4, figs. 1–3.
1904. „ „ O. Abel, Abhandl. k.-k. geol. Reichsanst. vol. xix. pt. 2, *passim*.

Type Specimen.—A nearly complete skull described and figured, *loc. cit.*; Geological Museum, Cairo.

This is the type and only species of the genus at present known.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

Skull (Pl. XX. figs. 1, 1 A, 1 B; text-fig. 64).—The type skull is not quite complete, the zygomatic arches and a portion of the basal region of the cranium being lost. The occipital surface is high and broadens out from above downwards. The occipital condyles (*cond.*) are larger and more prominent than in any other Sirenian skull with which comparison has been made, except *Eotherium*; they are almost pedunculate and their articular surface is strongly convex from above downwards and extends considerably on their ventral face. In the mid-ventral line they are separated by a deep rounded notch; but it cannot be determined what share, if any, the basioccipital took in their formation, the sutures being obliterated.

Above the foramen magnum the *exoccipitals* (*exo.*) meet in a suture about 2·3 cm. in length, thus completely excluding the supraoccipital from the opening: their upper

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* Quart. Journ. Geol. Soc. vol. xi. (1855) p. 541.

† Zigno, "Sirenii fossili trovati nel Veneto," Mem. Ist. Veneto d. Sci. vol. xviii. (1875) p. 445; also by the same author, "Quelques Observations sur les Siréniens fossiles," Bull. Soc. géol. France, [3] vol. xv. (1887) p. 728.

edges make an angle of about 160° with one another. The foramen magnum (*f.m.*) itself is wider than high; its upper margin is deeply notched in the middle line, on either side of which the exoccipitals are produced into low tuberosities which overhang the opening. Laterally the exoccipitals are produced downwards into paroccipital processes, which resemble those found in the Dugong rather than those of the Manatee. The lower ends of these processes are about on a level with the lower border of the condyles; their anterior face bears a vertical groove. Superiorly the anterior face of the exoccipital has a broad surface for union with the supraoccipital, and laterally a second for junction with the squamosals. The *supraoccipital* is roughly hexagonal in outline, the two lower sides uniting with the exoccipitals, between which the lower angle is thrust; the lateral borders join the squamosals, at least in part, while the upper borders form the middle part of the lambdoidal ridge, being separated in the middle line by a prominence, from which a ridge runs down in the middle line, dividing the surface into two halves, each of which is slightly concave.

In front of the lambdoidal crest the roof of the cranium formed by the *parietals* (*pa.*) is slightly concave both from side to side and from before backwards. In front of this the roof becomes concave from side to side, at least in the middle line, the borders being the somewhat prominent temporal ridges which form the angles between the roof and the nearly vertical sides of the temporal fossæ. The narrowest part of the skull-roof is about 6 cm. in front of the lambdoidal crest; at this point the width is 4·2 cm., but behind this the roof widens slightly to its posterior border, where it measures about 5·5 cm. across. Anteriorly it widens out much more considerably, and at the post-orbital processes of the frontals it is 8·8 cm. wide. The sides of the cranium immediately in front of the occipital surface are somewhat rounded, but further forwards are nearly flat and, as already remarked, almost vertical: in this region the bone is thin, while in the middle of the skull-roof the parietals may attain a thickness of 1·8 cm.

The anterior part of the roof is formed by the *frontals* (*fr.*), and the shape of the suture between these bones and the parietals is shown in text-figure 64. Anteriorly they widen out to the large postorbital processes. Their anterior borders are notched by the comparatively large *nasals* (*na.*), between which they send a narrow process, which seems to have extended to the nasal opening, thus completely separating the nasals in the middle line. Outside the nasals (see text-fig. 64) the frontals are in contact with the upper ends of the facial processes of the premaxillæ, which form the whole of the side and front border of the narial opening. The anterior angles of the nasals seem to be produced downwards along the inner side of the premaxillæ till they meet the upper edges of the underlying maxillæ. (See also Lepsius, *Halitherium schinzi*, pp. 64–66 *.)

The *maxilla* (*mx.*) is a very large bone with a great antero-posterior extension.

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* Abhandl. d. Mittelrheinischen geol. Vereins, vol. i. pt. 1 (Darmstadt, 1881).

Rather in advance of its middle point, and about beneath the anterior border of the orbit, its front portion is bent down, making an angle of about 140° with the posterior part. The alveolar border forms a double curve; posteriorly it is convex outwards, so that the palate is much wider opposite the middle molars than at any other point. In the premolar region the border is concave outwards, so that the palatal surface is greatly narrowed, the narrowest point being about opposite the tooth here called the second premolar. In front of this the border thickens and turns outwards to the canine alveolus (c.), immediately in front of which is the maxillo-premaxillary suture. On the palate the maxilla extends rather further forwards, terminating as the posterior edge of

Text-fig. 64.
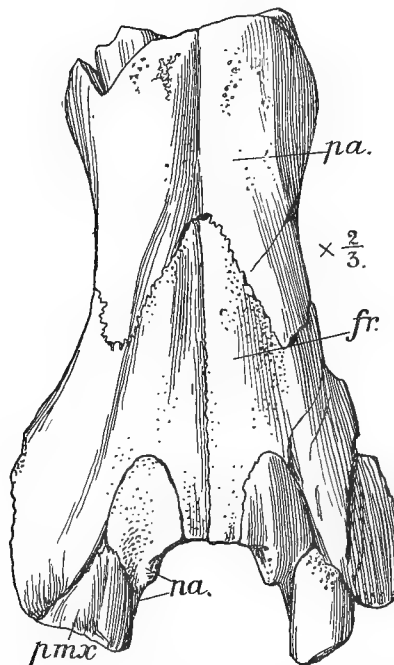
Middle portion of roof of skull of *Eosiren libyca*.

fr., frontals; *na.*, nasals; *pa.*, parietals; *pmx.*, premaxillæ. ⅔ nat. size.

the large median anterior palatine foramen (*a.p.f.*). The facial surface of the anterior part of the maxilla is nearly flat and vertical. Posteriorly it bears a broad shelf-like zygomatic prominence, which forms the floor of the orbit and is perforated in front by a large antorbital foramen.

The *premaxillæ* (*pmx.*) form the greater part of the downwardly turned rostrum; the suture between these bones and the maxillæ, after crossing the alveolar border, runs first upwards and backwards, then nearly directly backwards, terminating about the level of the hinder border of the narial opening (*nar.*). Here they join the anterior end of the frontals, thus, as above mentioned, excluding the maxillæ from any share in the

border of the narial opening. This aperture is an elongated oval in outline, its long diameter being about twice its width. In front of it the upper surface of the rostrum is broad and rounded from side to side, but towards its extremity it becomes compressed and its upper border forms a sharp angle. At the end of the premaxillæ there is a pair of large though comparatively shallow sockets for the enlarged incisors (*i.* 1), separated by a thin wall of bone. Behind and beneath these the alveolar border forms a sharp edge continuous with that of the maxillæ. The palatal surface of the premaxillæ is strongly arched and posteriorly forms the roof of the large anterior palatine foramen (Pl. XX. fig. 1 A, *a.p.f.*), the lower border of which, as already mentioned, is formed by the anterior edge of the maxillæ. Posteriorly the palatine foramen opens into the narial cavity; its form and relations differ somewhat from those of the same opening in *Manatus*, *Halicore*, and *Rhytina*. In *Manatus* the palatal portions of the premaxillæ are scarcely at all developed; in *Halicore* they are in the same plane as, and unite with, the palatine plates of the maxillæ, the lateral borders of the elongated anterior palatine foramen being formed equally by the two bones. In *Rhytina* the elongated foramen is almost entirely enclosed by the premaxillæ; in the present genus it approximates much more nearly to the condition seen in *Halitherium*, in which, however, the palatine region of the premaxillæ is rather less developed.

The *vomer* seems to be much like that of *Halitherium*, as figured by Lepsius; it is deeply grooved and the nasal opening must have been divided, at least posteriorly, by a vertical cartilaginous septum.

In all the specimens the zygomatic arch is broken and incomplete. Judging, however, from an imperfect specimen, it appears that the structure was much as in *Halitherium*, the zygomatic process of the squamosal forming a broad blade, the lower edge of which is underlain by the backward process of the *jugal*. This latter widens out in its middle region and bears a downwardly-directed blunt process, as in *Halitherium*. The body of the *squamosal* forms a considerable portion of the side wall of the cranium. Posteriorly it unites with the supraoccipital above and perhaps for a short distance below this with the exoccipital; but for the most part it is separated from the latter bone by the mastoid portion of the periotic, which is exposed on the occipital surface as an elongated convex mass. In front of its union with the mastoid the squamosal bears a strong rounded ridge, forming the outer portion of the lambdoidal crest. In front of this there is a concave surface bounded in front by the ridge marking the origin of the zygomatic process.

The base of the skull is for the most part wanting; in the type specimen, however, it can be seen that the basisphenoid and presphenoid were both much thickened and that the former is embraced by the upper ends of the massive pterygoids.

The cast of the brain-cavity (text-fig. 65) is of considerable interest. The olfactory lobes (*ol.*) are small and situated low down. The hemispheres are divided from one another by a very deep groove in front, and each is divided into a swollen anterior

(frontal) portion (*f.l.*) and a lateral (temporal) prominence (*t.l.*) by a well-marked depression, which seems to be homologous with the " pseudosylvian " * depression (*p.*) in the brains of recent Sirenians and Proboscidea. The cerebellum (*cb.*) is small, but its limits are not well shown in the cast. The base of the brain also is not well preserved, only the roots of one pair of nerves, probably the fifth, being shown.

Text-fig. 65.
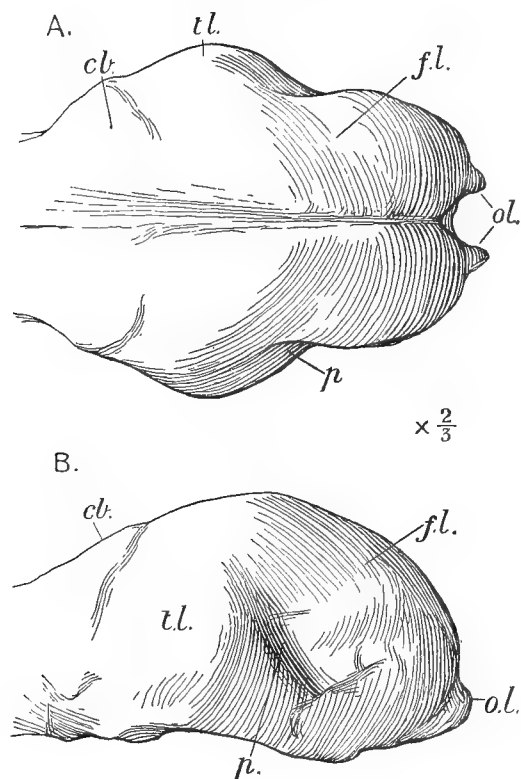
Cast of the cranial cavity of *Eosiren libyca* : A, from above ; B, from right side.
cb., cerebellum ; *f.l.*, frontal lobes ; *ol.*, olfactory lobes ; *p.*, pseudosylvian depression ; *t.l.*, temporal lobes.
⅔ nat. size.

In *Eotherium* the general form of the brain is not unlike that figured, but the pseudosylvian depression is very slightly marked, so that the separation of the hemispheres into anterior and lateral lobes is obscure. The chief interest of the brain of *Eosiren* lies in its remarkable similarity with that of *Mœritherium* (*cf.* text-fig. 41, p. 106). In both animals the hemispheres are divided in a quite similar way by the pseudosylvian depression, and the cerebellum is relatively small. In *Mœritherium*, as

* Elliot Smith, ' Catalogue of the Physiological Series, Museum, Coll. Surgeons,' vol. ii. ed. 2 (1902) p. 344.

might be expected in a land-animal, the olfactory lobes are more developed than in *Eosiren*, but this does not affect the general similarity, which is the more striking when taken in conjunction with the many other points of likeness existing between the Sirenia and the Proboscidea. It is interesting to note further that in the Middle Eocene forms of both these orders the brain is relatively large for mammals of that early date. In the terrestrial Proboscidea living exposed to many enemies, and in a complex and changing environment, this large development of the brain persists even in the modern types, and, indeed, their survival may be due to this very character. On the other hand, in the Sirenia, which early adopted a sheltered and sluggish mode of life, the conditions of which must have remained nearly constant, although there is some tendency towards increase in the size of the brain, there is no need for increased complexity, the result being the peculiar type of structure which Dr. Elliot Smith states can only be parallelled by the structure " occasionally presented by the brains of idiots in which the process of elaboration has ceased in the earlier months of intra-uterine life, and the organ has simply grown in size without becoming perfected in structure."

Upper Dentition.—The dental formula of the upper jaw appears to be *i.* 2 or **3**, *c.* 1, *m.*+*pm.* 8. At the anterior end of the downwardly turned rostrum there are the alveoli for a pair of enlarged incisors (*i.* 1), which were oval in section and directed downwards and forwards; the sockets are comparatively shallow, these teeth being apparently rooted.

The only trace of the second incisors (*i.* 2) seems to be a small alveolar pit situated a little below and just in front of the third incisors (*i.* 3), which also are represented in this specimen by their alveoli only, these being placed immediately in front of the maxillo-premaxillary suture and on the side of the rostrum about 5 mm. above the sharp edge of the premaxillæ. Both the second and third incisors are clearly on the way to disappearance, and seem to have been thrust outwards to the side of the jaw by the development of a horny plate covering the palatal and sharp lateral edges of the premaxillary region and replacing the teeth functionally. The canine alveolus (*c.*) is also small and on the side of the rostrum; it is placed immediately behind the maxillo-premaxillary suture, and is almost in contact with the alveolus of *i.* 3.

Behind the canine, and separated both from it and from one another by nearly equal intervals (about 1·3 cm.), are the sockets for four single-rooted teeth. In the type specimen only the last of these is *in situ*; it consists of a comparatively small single cone with a very strongly developed internal shelf or cingulum. Immediately behind this come the relatively small quadrate two-rooted molars. There are four of these teeth, of approximately equal size. Each molar crown consists of two transverse ridges, each composed of two pointed cusps without any secondary tubercles; there is also a small anterior ridge or cingulum with a median cusp, which in wear becomes connected with the antero-internal main cusp. All the specimens

available are in bad preservation and further material is necessary before any detailed comparison with teeth of other genera is possible.

Skull of Eotherium.—The skull and mandible of a primitive Sirenian from the limestones of the Mokattam Hills has recently been acquired by the Geological Museum in Cairo and is important for comparison with *Eosiren*. The horizon from which these specimens come is lower than that from which the Fayûm remains were obtained, and is probably the same as that in which was found the cast of the cranial cavity which Owen made the type of *Eotherium ægyptiacum*. This skull and mandible may in fact be referred to Owen's species, though in some respects it differs from the brief description of some new material of that Sirenian lately published by O. Abel *. When this author has published his complete account of the Egyptian Eocene Sirenia it will no doubt be possible definitely to determine these specimens ; meanwhile the fact that they represent a more generalized form than *Eosiren*, and are from a lower horizon in the same region, is sufficient to justify the comparison of the two types.

The skull in question (text-fig. 66) is nearly complete, but the anterior portion has been compressed in such a way that the rostrum has been straightened, instead of bending down as, judging from the mandible, it must have done in the living animal ; the anterior ends of the premaxillæ have been separated by a fracture, the result of which is that this region has the appearance of having been more elongated than was actually the case.

The occipital condyles are very large and are more sessile than in *Eosiren* ; in the mid-ventral line they are separated by a sharply defined notch. Laterally the *exoccipitals* (*exo.*) are produced downwards into strong paroccipital processes (*pp.*) which extend below the level of the condyles ; there is a large condylar foramen opening at the bottom of the groove between the base of the paroccipital process and the occipital condyle. The sutures between the exoccipitals and *basioccipital* (*boc.*) are not clear, but that between the basioccipital and the *basisphenoid* (*bsp.*) is marked by a transverse ridge, which crosses the *basis cranii* just behind the level of the posterior edge of the vertical plates of the *pterygoids* (*pt.*), which are closely united above with the basisphenoid. Above the foramen magnum (*f.m.*) the occipital surface is broad, much broader than in *Eosiren*, and somewhat like the same region in *Mœritherium* (see Pl. VIII. fig. 1 B). The *supraoccipital* (*soc.*) is gently concave from side to side ; its upper border is greatly thickened and forms a great part of the massive lambdoidal ridge. In the middle line in front it thrusts a blunt triangular process between the posterior ends of the parietals ; laterally its upper angles form prominent backwardly directed bosses of bone, to the anterior face of which the parietals are closely united. The upper

* " Die Sirenen der mediterranen Tertiärbildungen Oesterreichs," Abh. k.-k. geol. Reichsanst. vol. xix. pt. 2 (Vienna, 1904).

posterior angle of the *squamosal* (*sq.*) is shut off from contact with the supraoccipital by a narrow posterior prolongation of the parietal which is wedged in between the two bones, somewhat as in *Mœritherium*. Beneath this point there is a large fossa lying between the exoccipital behind and the squamosal in front; this is occupied

Text-fig. 66.
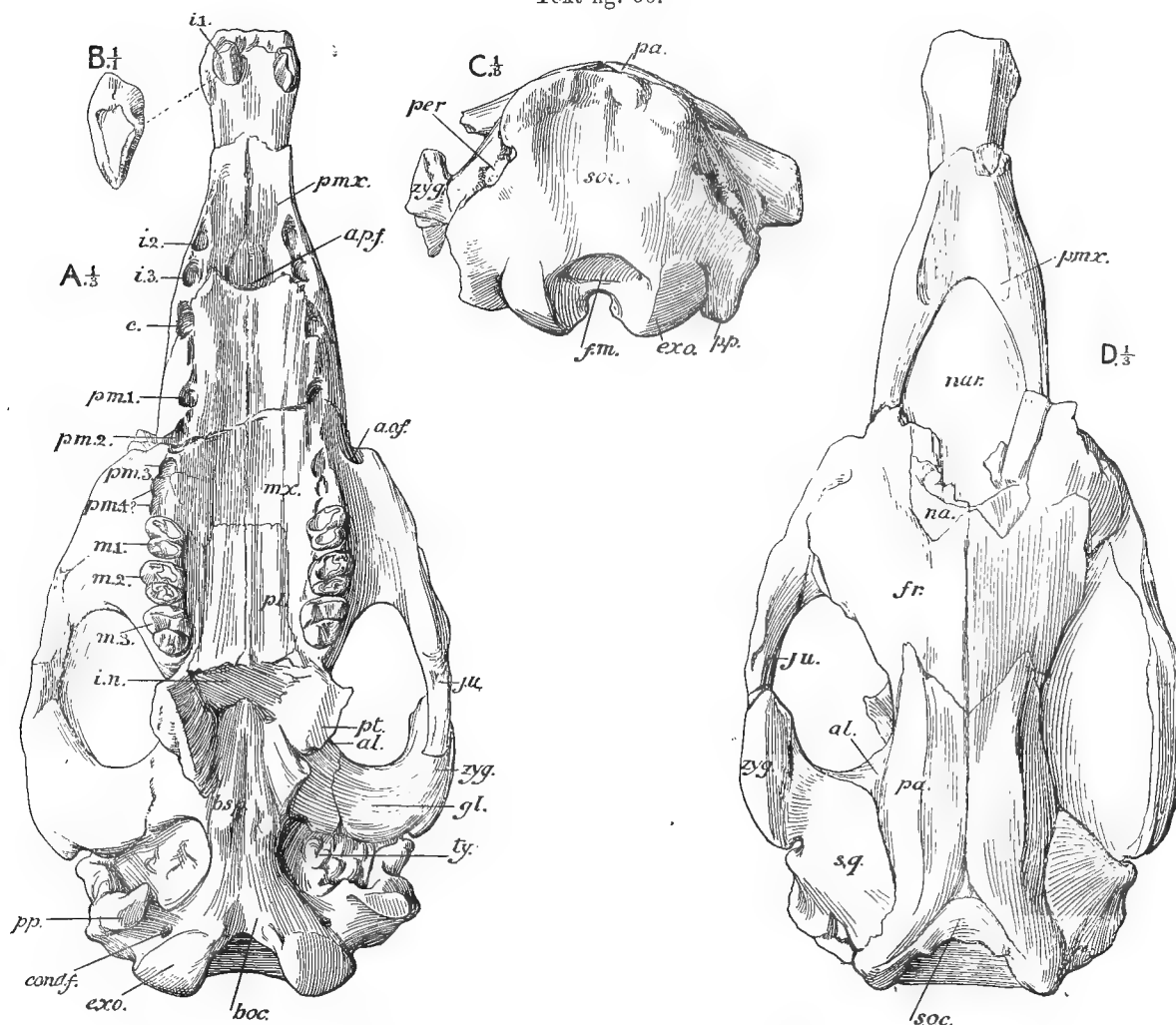
Skull of *Eotherium ægyptiacum* (?): A, from below; B, worn surface of crown of first incisor; C, from behind; D, from above.

al., alisphenoid; *a.o.f.*, antorbital foramen; *a.p.f.*, anterior palatine foramen; *boc.*, basioccipital; *bsp.*, basisphenoid; *c.*, canine; *cond.f.*, condylar foramen; *exo.*, exoccipital; *f.m.*, foramen magnum; *fr.*, frontals; *gl.*, glenoid articulation; *i.* 1–3, incisors; *i.n.*, internal nares; *ju.*, jugal; *m.* 1–3, molars; *mx.*, maxilla; *na.*, nasals; *nar.*, external nares; *pa.*, parietals; *per.*, periotic; *pl.*, palatine; *pm.* 1–4, premolars; *pmx.*, premaxillæ; *p.p.*, paroccipital process; *pt.*, pterygoid; *soc.*, supraoccipital; *sq.*, squamosal; *ty.*, tympanic; *zyg.*, zygomatic process of squamosal. About ⅓ nat. size (except B, which is natural size).

by the apparently loosely united *periotic* (*per.*).   The relations of the bones in this
region seem to be very similar to those found in *Manatus*, except that in the latter
genus the squamosal is not entirely cut off from contact with the supraoccipital.

Beneath the periotic opening the post-tympanic portion of the squamosal unites
closely with the anterior face of the paroccipital region of the exoccipital, and in front
forms the posterior border of the external auditory meatus, the anterior boundary
of which is constituted by the slightly developed postglenoid process.   The articular
surface (*gl.*) for the mandible is very broad ; it is slightly concave from side to side
and gently convex from before backwards, except where it runs on to the slight post-
glenoid ridge.   The zygomatic process (*zyg.*) is very stout and is triangular in section ;
it is underlain anteriorly by a slender prolongation of the jugal.   The *parietals* (*pa.*)
are large bones forming most of the cranial roof; posteriorly, as already mentioned,
they are separated in the middle line by a process of the supraoccipital, and laterally
they send back processes which thrust themselves between the squamosal and
supraoccipital, and help to form the large prominences of the lambdoidal ridge.   From
the posterior angles of the bones a pair of not very well-defined supratemporal ridges
run forwards, first converging slightly, then running parallel to about the level of
the anterior border of the glenoid surface; in front of this they diverge considerably,
and finally become continuous with the hinder edges of the postorbital processes
of the frontals.

Owing to the comparatively small development of the supratemporal ridges and
also to the slight inflation of the cranial portion of the skull, the roof is not nearly
so sharply marked off from the temporal fossæ as in the later forms, even in *Eosiren.*
The ventral borders of the parietals unite with the squamosals posteriorly, then for
a short distance with the upper end of the *alisphenoid* (*al.*), and in front of this again
with the frontals, which they overlap in a squamous suture, running forwards in
a sharp angle on the supratemporal ridges.   The *frontals* (*fr.*) are very wide, forming
the broad gently convex skull-roof in the region of the orbits, which they overhang
as large supraorbital plates.   Posteriorly they join the alisphenoid and in front
of this their ventral edges seem to form the outer border of the groove for the optic
nerve.   Their anterior border is notched for the reception of the hinder ends of the
nasals, between which they send a short triangular process.   The *nasals* (*na.*) seem to
have been of considerable size, and overhung the narial opening (*nar.*) to some extent.
The opening itself is an elongated oval in outline, and its borders are formed by the
nasals behind and by the premaxillæ in front and at the sides.   The premaxillary
rostrum must have been bent down to a considerable extent, but in this specimen it
has been straightened out by the pressure to which it has been subjected, and the end
has been broken across the alveoli of the anterior incisors.   The upper surface of the
rostrum in front of the narial opening is gently concave from side to side.

The *maxilla* (*mx.*) is a greatly elongated bone ; the anterior edge of its palatine region

forms the posterior border of the large anterior palatine foramen (*a.p.f.*). Behind this the palate is deeply concave from side to side, but on either side is raised into a prominent ridge lying just within the alveolar border and extending back to the level of the alveolus of the tooth here regarded as *pm.* 2. Behind this, the palate widens out, its greatest width being about opposite the front of *m.* 2. The transverse suture with the palatines is about opposite the front of *m.* 1; the posterior palatine foramina are either very small or absent. On the outer side of the maxilla the broad zygomatic process rises by a very long base, and its ventral surface is very little above the alveolar border; the antorbital foramen (*a.o.f.*) is smaller than in *Eosiren*. The suture between the *jugal* (*ju.*) and maxilla is not very distinct, at least posteriorly; probably the relations of the two elements were almost as in *Manatus*; at any rate, it is clear that the jugal made a broad squamous overlap on the upper surface of the zygomatic process of the maxilla, so that it forms the actual floor of the orbit. Behind this, it widens out suddenly, being produced downwards into a blunt point and upwards into a slight postorbital process. Posteriorly it becomes a mere rounded rod of bone underlying the zygomatic process of the squamosal.

The *palatines* (*pl.*) form the greater part of the palate as far as the front of the molar series. The posterior border of the palate seems to have been a little behind the last molar, but in this specimen it is somewhat incomplete. The descending plates bounding the mesopterygoid fossa no doubt are formed by the palatines in front and the pterygoids behind, but the sutures are indistinct; the same is the case with the junction of the lower part of the alisphenoid with the pterygoid. The body of the *alisphenoid* (*al.*) joins the parietals above, the squamosals behind, and the frontals in front; its lower border forms the outer lip of a deep groove, at the bottom of which the optic and other foramina opened; this groove is continued forwards to the orbit by the lower edge of the frontal. The *orbitosphenoid* is not distinct. The *tympanic* (*ty.*) is incomplete on both sides.

The dentition in this specimen is of great interest. The dental formula seems to have been: *i.* 3, *c.* 1, *pm.* 4, *m.* 3. The anterior incisors are very remarkable teeth, and as in the later forms they are situated at the end of the snout, while they are already somewhat enlarged. They have very long roots, and their enamel-covered crowns are a little compressed from side to side; the anterior border is rounded, the posterior sharp. The outer face is flat or slightly convex, while the inner is raised into vertical ridges, so that the worn surface of the tooth has the appearance shown in text-fig. 66, B, looking almost as if it were a complex tooth composed of several elements. The thick enamel has a peculiar appearance, owing to the development of numerous obscure wrinkles. Behind these teeth there is a diastema of considerable length separating them from the second incisors, which were large teeth situated on the edge of the premaxilla and not displaced outwards as in *Eosiren*. Immediately behind these were the third incisors, the posterior borders of the alveoli of which are in contact with the

anterior edge of the maxilla. The canine, which was about the same size as the incisors, is separated from *i.* 3 by an interval of about ·7 cm. ; behind it again there is a diastema of about 2 cm. separating it from a single-rooted tooth, behind which again, and separated from it by a short interval, are four closely crowded alveoli. From the examination of this specimen alone, in which the teeth themselves are wanting or represented by their roots only, one would come to the conclusion that these four posterior alveoli belonged to the single-rooted *pm.* 2, *pm.* 3, and a double-rooted *pm.* 4, as they have been marked in the figure ; but Dr. Abel, who has better specimens in which the teeth are preserved, states that in *Eotherium* the posterior premolars are single-rooted, and that there are in all six premolars, of which the second is lost very early. If this be so, then the alveoli marked *pm.* 4 in the figure belong to *pm.* 5 and *pm.* 6 ; those marked *pm.* 2 and *pm.* 3 to *pm.* 3 and *pm.* 4, while between the *pm.* 2 and *pm.* 1 of the figure a tooth has been lost and its alveolus disappeared ; it may, however, be remarked that there is only a very short diastema behind *pm.* 1, while the interval between it and the canine is considerable, so that if a premolar has been lost at all it seems more likely to have been the first of the series. It is possible that the skull here figured may have come from a rather higher horizon than that at which *Eotherium* proper is found, and that some modification of the teeth in the direction of the later forms may already differentiate it from the animal described by Abel ; possibly it may belong to Abel's new genus *Protosiren* *, at present undefined. Until that writer's work on these Middle Eocene Sirenians is published, these questions must remain undecided. The molars are three in number ; they are bilophodont teeth, the anterior crest being formed by a large blunt inner cusp and an outer sharper portion composed of two obscurely separated elements. The posterior crest also consists of a blunt inner tubercle and a sharper outer one. From the antero-external side of the antero-internal cusp a ridge runs down to the cingulum, which forms a small shelf-like projection on the anterior face of the tooth : from the postero-external face of the postero-internal cusp a similar ridge runs down to the cingulum of the posterior end of the tooth ; this ridge is best developed in *m.* 3, where, with the main inner cusp, it gives a **V**-shaped surface in wear. This type of tooth agrees with the description given by Dr. Abel † of the primitive Sirenian molar, except that the intermediate cusp of the hinder row is very obscurely developed, if at all.

The dimensions (in centimetres) of this skull are :—

Extreme length (exaggerated by fractures)	36·5
Width between outer angles of occipital condyles	8·2
Greatest width of occipital surface	13
Width of *foramen magnum*	4
Height of occipital surface above *foramen magnum*	7·2

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* Abel, *op. cit.* p. 146.   † Abel, *op. cit.* pp. 145–46.

Width of skull-roof at lambdoidal ridge . . . . 6·8 app.
  „   skull at middle of temporal fossæ . . . . 3·6
  „   skull between ends of supraorbital processes . . . 15 app.
  „   snout in front of narial opening . . . . 6·2
  „   narial opening . . . . 4·8
Length of dental series from canine to last molar . . . . 14·2

The dimensions (in centimetres) of the molars are :—

	Length.	Width.
m. 1	1·6	1·7
m. 2	1·8	1·9
m. 3	1·9	1·8

The chief differences between this skull and that of *Eosiren* are :—(1) the occipital surface is wider and the lambdoidal crest more strongly developed ; (2) the supra-temporal ridges are less developed, so that the skull-roof is less clearly marked off from the temporal fossæ ; (3) the cranial region is somewhat rounded ; (4) the nasals are large, and must have overhung the nasal opening to a considerable extent ; (5) the anterior incisors are not very much enlarged and have rather complexly folded crowns ; (6) the second and third incisors, though shifted back close to the premaxillary suture, are large and not displaced outwards ; (7) the canine is a large tooth on the alveolar border ; (8) the palate is less narrowed between the anterior premolars. The arrangement of the nasals and the condition of the incisors and canines are the chief primitive characters noticeable.

Mandible (Pl. XX. figs. 2, 2 A).—In the mandible of *Eosiren* the downwardly turned symphysial region is greatly thickened, the anterior end of each ramus swelling out into a rounded bulbous mass, which, uniting with that of the opposite side, forms the massive symphysis. The line of union is marked ventrally by a deep groove (*sym.*). The large mental foramen (*m.f.*) opens on the outer side of the symphysis, and is continued forwards by a deep groove to the extremity of the jaw. The rami are comparatively narrow from above downwards ; their alveolar border is convex and their ventral edge concave, forming a regular arch from the symphysis to the lowest point of the enlarged and rounded angular region. The coronoid process arises from the outside of the ramus opposite the last molar which is in position, but in front of a posterior alveolus-like depression, which seems to point to the existence of a posterior successional tooth (see below). The upper portion of the coronoid process, the articulation, and the posterior portion of the angular region are broken, so that it cannot be seen whether any of the peculiarities described by Zigno in *Halitherium (Prototherium) veronense* existed in the present species. The large posterior aperture of the dental canal is situated on the inner surface of the expanded posterior region a little behind the posterior end of the molar series. Just within the

2 E

opening, and beneath the alveolus-like depression noticed above, there is a rounded mass, which seems to be homologous with the bony capsule in which the successional teeth develop in the Manatee. Probably, therefore, in the mandible at least of the present species, the beginning of a molar succession similar to that seen in the Manatee had already been established.

Lower Dentition.—In no specimen are the lower teeth well preserved, and in the most nearly complete example there are only three greatly worn and broken molars *in situ.* The following account of the lower teeth is therefore deduced merely from the alveoli in the jaw figured on Pl. XX. figs. 2, 2 A, and, when more satisfactory specimens are found, may have to be revised. In the downwardly turned alveolar surface of the symphysial region there are four pairs of alveoli, probably indicating the existence of three pairs of incisors and a canine. The most anterior pair of sockets are shallow and not very well defined, so that not improbably the anterior tooth was deciduous, and its place covered with a horny sheath as in *Manatus* and probably *Halitherium.* On the other hand, the remaining three pairs of alveoli are so deep and sharply defined that most likely their teeth were functional. Behind these symphysial alveoli come thirteen others, increasing in size from before backwards. The posterior six sockets undoubtedly bore three double-rooted molars (as can be seen in another specimen), and the remaining seven probably belonged to three anterior single-rooted teeth (? premolars) and two posterior double-rooted teeth. If this interpretation be correct, the dental formula of this mandible is *i.* 3, *c.* 1, *pm.* 3, *m.* 5, regarding the double-rooted teeth as molars. As mentioned above, it seems not impossible that the number of molars would subsequently be added to from behind.

The only lower molars available for examination are greatly worn, but seem to have consisted of a pair of transverse crests and a small posterior talon.

Mandible of Eotherium.—A mandible (text-fig. 67) from the white limestones of the Mokattam Hills probably belongs to the same species and perhaps to the same individual as the skull above referred to *Eotherium ægyptiacum.* It differs very little in form from the mandible of *Eosiren,* having the same strongly deflected anterior region; the symphysis (*sym.*) is greatly thickened, though much less so than in *Eosiren.* The chief difference between the two is that the alveoli of the anterior teeth are better marked. Unfortunately, only the three molars are present, and the interpretation of the dentition from the alveoli is open to much uncertainty. The three pairs of incisors were large teeth, the anterior ones (*i.* 1) being in contact with one another in the middle line, and directed almost forwards. On the upper surface of the symphysis between the alveoli of the second and third pairs of incisors (*i.* 2, *i.* 3) and of the canines (*c.*) is a rough surface which was probably covered with the horny substance which eventually displaced and replaced the teeth. A little

behind the canine alveolus are two more alveoli about the same size, and immediately behind these again two small pits, the posterior of which is much the smaller; at this point the alveolar border of the jaw is thin and sharp. Separated from the last-mentioned small pit by a very short interval are two rather small alveoli in close contact. The anterior molar is separated from these alveoli by an interval of about ·7 cm. In the absence of teeth from the front of the jaw it is not possible to determine the dental formula with certainty, but it seems that between the canine and the molars there may have been two one-rooted premolars and two with two roots each; it is very probable, however, from Abel's account of the upper premolars, that one (or perhaps both) of the pairs of alveoli assigned to the two-rooted premolars may have been occupied by two (or four) single-rooted teeth.

Text-fig. 67.
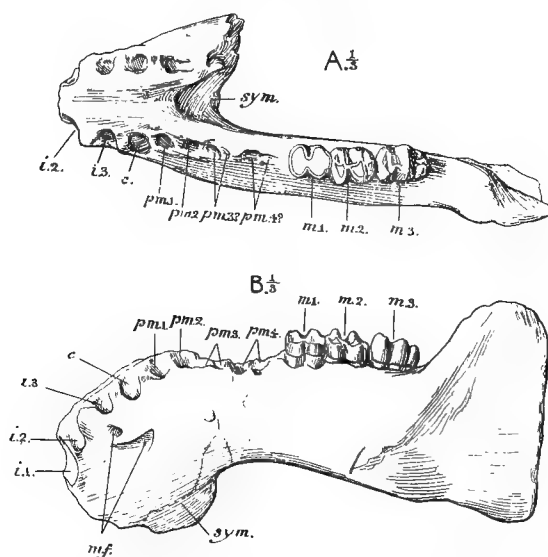
Mandible of *Eotherium ægyptiacum* (?): A, from above; B, from left side.

c., canine; *i.* 1–3, incisors; *m.* 1–3, molars; *m.f.*, mental foramina; *pm.* 1–4, premolars; *sym.*, symphysis. About ⅓ nat. size.

The molars may be described as bilophodont, each having a well-developed talon. Each transverse crest consists of a low, blunt, outer cusp and a higher, sharper, inner one. From the inner anterior angle of the antero-external cusp a ridge runs inwards on to the front of the tooth; from the inner anterior side of the postero-external cusp a ridge runs across the main valley to the cusp in front. In the first and second molars the talon seems to consist of a simple transverse ridge connected with the inner end of the postero-external main cusp; in the third molar the talon is more complex, and consists of three small elements, the middle one of which joins the

2 E 2

postero-external main cusp. The inner side of these comparatively small molars is considerably higher than the outer.

The dimensions (in centimetres) of the mandible and teeth just described are :—

Length from anterior end of symphysis to end of molar series .   15·5
Greatest width of symphysis . . . .   5·5
Length of symphysis . . . .   6·5
Depth of mandibular ramus beneath *m*. 3 . . . .   4·7

The dimensions of the teeth are :—

	Length.	Width.
m. 1	1·6	1·3
m. 2	1·9	1·5
m. 3	2·2	1·4

Vertebral Column.—On account of their massive character the ribs and vertebræ of *Eosiren* are among the commonest fossils in the Qasr-el-Sagha beds. For the most part, they only occur scattered in small groups or as single specimens, but occasionally a considerable number are found in association. The best of these sets is here noticed ; it includes fifteen more or less nearly perfect vertebræ associated with part of a skull and an *os innominatum.*

The *atlas* is wanting. The *axis* is greatly abraded and broken, but in the form of its odontoid process and articular surfaces for the atlas it was evidently closely similar to that of *Halitherium.* In the third (?) cervical vertebra the centrum is rectangular in outline and much wider than high ; it is much less shortened antero-posteriorly than in later forms ; its ends are smooth and flat. The transverse processes are broad and long, and are perforated at their base by the vertebrarterial canal. Another cervical vertebra of the same series is very similar. The number of the cervicals is unknown.

The thoracic and lumbar vertebræ are like those of *Halitherium*, but the hæmal ridge is very slightly developed, and in the thoracic region the zygapophyses are better developed and the interlocking of the vertebræ is closer.

One of the vertebræ (Pl. XX. fig. 4) in the series referred to presents some peculiar characters. It appears to be a first lumbar ; the anterior face of the centrum narrows somewhat towards its neural border, the neural arch is much higher than in the other vertebræ, and the anterior zygapophyses are also considerably elevated. The transverse processes rise from the ventro-lateral borders of the centrum and curve backwards and downwards. The whole vertebra differs so far from the others that perhaps its association with them may be a matter of accident, and it may actually belong to some other animal.

A sacral vertebra (Pl. XX. fig. 6) is preserved in which the arch is comparatively low with a short neural spine ; the centrum is transversely oval, with a slight median

hæmal ridge; the transverse processes or sacral ribs (*s.r.*) are very large, expanding considerably towards their outer ends, which are truncated by a flat surface looking downwards and outwards, probably for connection with the ilium.

Several caudal vertebræ (Pl. XX. fig. 5) are present. In these the anterior face of the centrum is nearly as high as wide, while in the case of the posterior face the width is the greatest. The neural arch and spine are low, and both anterior (*a.z.*) and posterior zygapophyses well developed. The transverse processes are broad, short, and somewhat downwardly directed. The posterior border of the ventral side of the centrum bears a pair of facets for a chevron-bone.

Fore Limb.—The *scapula* (Pl. XX. fig. 3) is of a very primitive Sirenian type, and very nearly resembles that of *Halitherium* (*Prototherium*) *veronense* figured by Zigno (Mem. Ist. Veneto d. Sci. vol. xxi. (1880) pl. iv. fig. 1). The blade is strongly curved backwards, the upper border being drawn out into a tongue-shaped prolongation. In the middle the width is much greater than towards the ends, owing to the strong convexity of the coracoid border (*c.b.*). The postscapular fossa is narrow and of nearly uniform width throughout, the prescapular fossa is very wide, the subscapular surface is quite flat. The spine (*sp.*) is low and dies away above some distance from the suprascapular border. Towards the lower end its base terminates about 2·5 cm. above the glenoid cavity, while its upper border is produced into a short acromion process directed downwards and backwards, but not reaching nearly to the level of the glenoid cavity. The coracoid process (*cor.*) is fairly prominent, more so than in *Halitherium veronense*, and its extremity is sharply truncated by a somewhat concave surface for the attachment of a muscle. The glenoid cavity (*gl.*) is comparatively large; it is oval in outline and is produced somewhat forwards and downwards on to the base of the coracoid prominence; its direction is more oblique to the axis of the scapula than in *H. veronense*.

Comparison with the scapulæ described and figured by Abel (*op. cit. suprà*, pp. 164–68, pl. ii.) shows that in its small size, in the narrowness and curvature of the blade, in the small size of the coracoid process (larger, however, than in *H. veronense*), in the approximation of the lower end of the spine to the glenoid cavity, and in the form of the latter, this bone is primitive, as might be expected from the age of the deposits in which it is found.

The *humerus* is known only from a young specimen wanting the proximal epiphyses, and from the very imperfect proximal and distal ends of adult bones. In the most nearly complete specimen figured on Pl. XX. fig. 7, both the greater (*g.t.*) and lesser (*l.t.*) tuberosities are well developed, and there is a well-marked bicipital groove (*b.g.*). The deltoid crest (*d.*) is prominent and is continuous in the middle of the shaft with a strong ridge which runs up to the inner angle of the greater tuberosity. The trochlea (*tr.*) is somewhat oblique, and both the coronoid and olecranon fossæ are deep, though there is no supratrochlear perforation. The inner

Text-fig. 68.
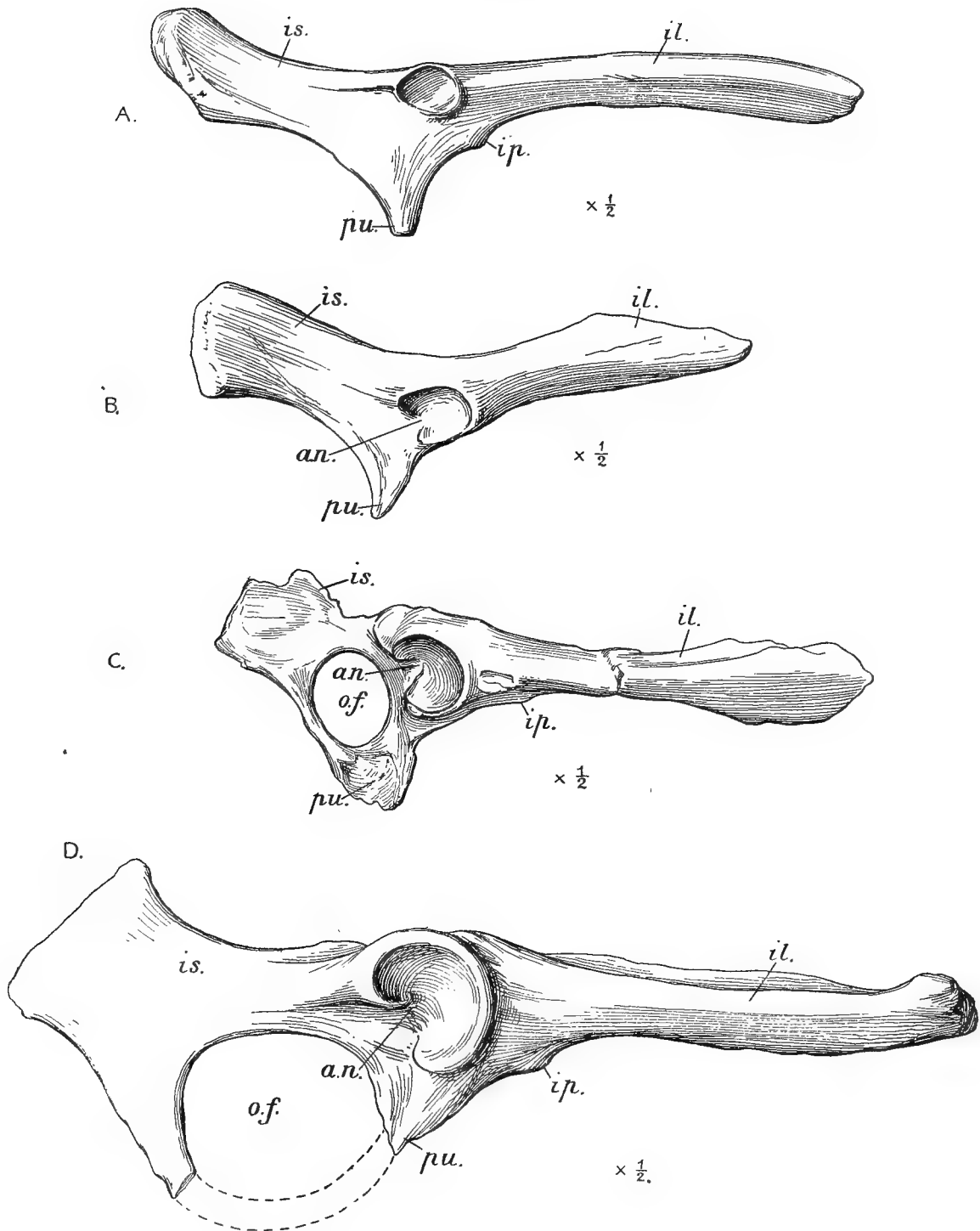
Right ossa innominata of : A, *Halitherium* ; B, *Eosiren* ; C, *Eotherium* (after Abel) ;
D, *Mœritherium.*

a.n., acetabular notch ; *il.,* ilium ; *ip.,* ilio-pectineal tubercle ; *is.,* ischium ; *o.f.,* obturator foramen ;
pu., pubis.　½ nat. size.

condyle (*i.c.*) is greatly developed and is directed backwards; its lower end is about on a level with the lowest point of the trochlea, a condition not seen in other Sirenia.

The proximal end of a large humerus perhaps belongs to this species. In this specimen the head is strongly convex in all directions and somewhat oval in outline; its edge forms a projecting rim. The tuberosities are worn, but it can be seen that the outer was the largest, and that there was a small bicipital groove.

In many respects the humerus of *Eosiren* resembles that of *Mœritherium*, the chief points of similarity being the form of the distal trochlea and of the inner condyle, and the arrangement of the deltoid crest; on the other hand, in *Mœritherium* the humerus is relatively longer and more slender, and the supinator crest is strongly developed.

Hind Limb.—A right *os innominatum* (text-fig. 68, B) was found associated with the anterior portion of a skull and the vertebræ described above. This specimen is of great interest, as showing in some respects a degree of reduction intermediate between that seen in the pelvis of *Eotherium* (text-fig. 68, C) lately described by Abel [*] and that found in *Halitherium schinzi* (text-fig. 68, A), though approaching much more nearly the form of the latter. The bone, as a whole, is considerably abraded, so that many details of structure have been obliterated. The *ilium* (*il.*) is roughly trihedral in section for some distance in front of the acetabulum, and further forwards still it expands somewhat, becoming a little flattened from within outwards. The outer convex face is traversed by a slightly marked ridge running from the anterior point to the anterior angle of the rim of the acetabulum. The inner face of the anterior end is somewhat flattened and probably was in contact with the end of the sacral rib. Immediately in front of and above the acetabulum there is a roughened prominence, apparently the point of origin of the *rectus femoris* muscle. No trace of an ilio-pectineal tubercle is preserved. The *ischium* (*is.*) is a broad bar of bone, expanding a little towards its somewhat thickened distal end, which is sharply truncated by a surface looking inwards and backwards; its upper and lower borders are both concave, the latter most deeply so; the outer face is divided by a slight ridge running from the posterior angle of the acetabulum to the ischial tuberosity into a narrower dorsal portion and a much wider ventral region. The *pubis* (*pu.*) is represented by a large triangular process, the anterior border of which rises just opposite the lower angle of the acetabulum. The posterior border forms a continuous curve with the lower edge of the ischium. There is no descending process of the pubis or ascending process of the ischium, so that there is no complete obturator foramen, the whole of the lower and posterior borders found in the ordinary mammalian pelvis and still persisting in *Eotherium* (Abel, *op. cit.* p. 191) being wanting. At the same time the remnants of the pubis and ischium so far as they go approach rather more nearly the normal form than is the case in the later *Halitherium* (see also *suprà*, p. 119). The oval acetabulum is well developed, with a prominent border; the acetabular notch (*a.n.*) is situated as in *Eotherium*.

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[*] Abel, *op. cit.* pp. 187–195, pl. vii. fig. 1.

C. **10054.** Imperfect skull, wanting the zygomatic arches and much of the base and left side of the cranium. The teeth are badly preserved or represented by the alveoli only ; the dental formula is *i.* 2 or 3, *c.* 1, *pm.* 4, *m.* 4. Type specimen described and figured in Geol. Mag. *loc. cit. suprà*, also figured on Pl. XX. figs. 1, 1 A, 1 B. This specimen forms the basis for the description of the skull given above. Its principal dimensions (in centimetres) are :—

Extreme length	30
Width between outer angles of occipital condyles	7·5
Greatest width of occipital surface	13 app.
Width of *foramen magnum*	3·4
Height of occipital surface above *foramen magnum*	6·5
Width of skull-roof at lambdoidal ridge	5 9 app.
„ „ narrowest point, opposite the middle of the temporal fossæ	4·4
Width between ends of supraorbital processes	8·8
„ of snout in front of external nares	4·7
Length of narial opening	6·7
Width of narial opening	3·3
Length of dental series from canine to last molar	11·4
„ four molars	5·5

Owing to the somewhat crushed condition of the specimen, some of the above measurements are only approximate.

M. **8581.** Plaster cast of the above specimen.   *Made in the British Museum.*

M. **8581a.** Plaster cast of the brain-case of the above specimen (text-fig. 65).

                                                  Made in the British Museum.

C. **10190.** Anterior portion of skull of a larger individual than C. 10054. This specimen is associated with the cervical, dorsal, and caudal vertebræ described above (Pl. XX. figs. 4–6), and with the right os innominatum (text-fig. 68, B). The dimensions (in centimetres) of the vertebræ are :—

	Anterior cervical.	(?) Anterior lumbar (fig. 4).	Sacral (fig. 6).	Anterior caudal (fig. 5).	Caudal.
Width of centrum	3·8	5·1	5·6	6·2	5·8
Height of centrum	2·3	4·5	4	5·3	4·2
Length of centrum	1·8	4·2	4	3·7	4·1
Width between ends of transverse processes .	12	13+	19	13·4	13·8
Height to top of neural spine	..	8·5+	8·7	8·5	8·2

The dimensions (in centimetres) of the os innominatum (text-fig. 68, B) are :—

Total length	17·7
Length of ilium from centre of acetabulum	9·7
„ pubis from centre of acetabulum	4·2
„ ischium from centre of acetabulum	8·6
Greatest width of ilium	2·6
„ „ ischium	4·1

M. 8152. Upper portion of middle region of skull, showing the nasals and their relations to the premaxillæ and frontals (text-fig. 64). The anterior ends of the frontals are thrust between the nasals, and probably completely separated them, but this cannot be definitely ascertained on account of the breaking away of the bone at this point. The posterior portion of this specimen also shows the anterior upper portion of the brain-case, of which a natural cast is preserved. The width of the skull-roof between temporal fossæ 3·9 cm. ; width of nasal opening 3·2 cm.

Presented by W. E. de Winton, Esq., 1903.

C. 10040. Mandible incomplete posteriorly. All the teeth wanting and represented only by the empty alveoli. Figured in Geol. Mag. [4] vol. ix. (1902) p. 294, fig. 3 ; also on Pl. XX. figs. 2, 2 A. This specimen shows the presence of possibly functional incisor and canine alveoli in the downwardly turned symphysial region ; this latter is enormously thickened ventrally. There is some evidence that the replacement of the molars from behind had already begun, at least in the mandible. The dimensions (in centimetres) of this specimen so far as preserved are :—

Total length	20·5
Depth of ramus beneath posterior molars	4·6
Width of symphysis	6·4
Length of symphysis	6·3

M. 8926. Imperfect mandible, wanting the vertical portions of the rami and symphysis. The greatly worn posterior molars are present, the other teeth are represented by the alveoli only. The length of this specimen is 20 cm., the length of the symphysis 5 + cm.

C. 10048. Numerous ribs and vertebræ. This specimen shows that in *Eosiren* the ribs had attained the great thickness and generally massive structure characteristic of some of the later Sirenians. In the case of one rib the length is about 24 cm., the greatest diameter 5·4 cm.

C. 10191. Complete left scapula, showing the peculiar backward curvature and prolongation of the upper end. Figured on Pl. XX. fig. 3. The dimensions (in centimetres) of this specimen are :—

Extreme length	20·8
Width of upper prolongation	6·2
Greatest width of blade	8·5
Width of neck	4·2
„ at coracoid process	5·4
Antero-posterior diameter of glenoid cavity	4
Lateral diameter of glenoid cavity	2·5

M. 9232. Plaster cast of the above specimen. *Made in the British Museum.*

M. 9238. Left humerus, wanting the proximal epiphyses. Described above ; figured on Pl. XX. fig. 7. The dimensions (in centimetres) of this specimen are :—

Length (so far as preserved)	13·2
Width of proximal end	4·7
„ middle of shaft	1·8
„ distal end	4·8
„ distal articular surface	2·9

C. 10041. Imperfect right humerus, very short and stout, but shape altered by adherent matrix. Length 13·4 cm.

M. 9239. Proximal end of a large humerus described above.   Long diameter of head 5·1 cm., short diameter of head 4·5 cm.   *Presented by W. E. de Winton, Esq.,* 1903.

M. 9240. Distal end of a large humerus, much abraded.   Total width 7 cm., width of articular surface 4·3 cm.   *Presented by W. E. de Winton, Esq.,* 1903.

Order CARNIVORA.

The Carnivora are only represented in these deposits by members of the primitive group—the Creodonts, but traces of several genera of these, all referable to the family Hyænodontidæ, have been found.   One interesting point is, that certain of the limb-bones indicate that some of these animals lived an aquatic or semi-aquatic life. One humerus (C. 9445) is practically identical in form with that of *Lutra*, or still more with that of the probably more aquatic *Potamotherium*.   The occurrence of such aquatic Creodonts is of considerable interest in view of the possible origin from them of the Pinnipedia.   The conditions under which the Sirenia originated from primitive semi-aquatic Ungulates, probably Proboscidean, would be precisely those under which semi-aquatic Carnivores might be expected to become modified in the direction of the Pinnipedia, a group which some writers regard as having arisen directly from the Creodonta.

Family HYÆNODONTIDÆ.

This family, as defined by Wortman[*], is here represented by three genera—*Pterodon, Apterodon,* and *Sinopa* (or a very closely allied form), which are all known from other regions.   The first lower molar is relatively small and weak, and the most specialized lower carnassial tooth is the third molar.   The isolated limb-bones that have been found can only be referred provisionally to any particular species.

Genus **HYÆNODON**, Laizer & Parieu.
[Comptes Rendus, vol. vii. (1838) p. 442 ; also Ann. des Sc. Nat. [2] vol. xi. p. 27.]

Third upper molar wanting; first and second without antero-internal cusps ; posterior lobe (metastyle) forming a cutting-blade larger than the anterior lobe.   Lower molars with neither postero-internal cusp nor talon.

[*] " Studies of Eocene Mammalia in the Marsh Collection, Peabody Museum," Amer. Journ. Sci. [4] vol. xiii. (1902) p. 433.

This genus is represented by a single specimen only, consisting of the anterior part of a right ramus of a mandible with the alveoli of the large canine and the anterior premolars, the roots of the latter being *in situ*.   Associated with this, and no doubt belonging to the same jaw, is a third right lower molar.   The crown of this tooth consists of two high secant cusps, which together form a cutting-blade : the posterior cusp is the larger and considerably the higher of the two.   On the antero-external face of the anterior cusp near its base there is a small adherent tubercle ; there is no talon, though the cingulum is slightly developed on the posterior angle of the tooth.   The outer face of the tooth is considerably worn, the direction of wear being such that the cutting-edge remains sharp.   This tooth is similar in general form to the last lower molar of the European species of *Hyænodon*, especially in the presence of the small antero-external tubercle and the absence of the talon ; the posterior cusp, however, is shorter and higher than in the other species.   This specimen seems to be sufficient to show that remains of a Carnivore referable to the genus *Hyænodon* or some closely allied type exist in these beds, though insufficient to justify the establishment of a new species. '

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 8812–3. Fragment of anterior part of right ramus of mandible and a last lower molar.   The dimensions (in centimetres) of the tooth are :—Length 1·3, width ·7, height of posterior lobe 1·1.

Genus **PTERODON**, de Blainville.

[Ann. Franç. et Étrang. d'Anat. et Phys. vol. iii. (1839) p. 23.]

1885. *Hemipsalodon* *, Cope, Amer. Naturalist, vol. xix. p. 163.
1887. *Pseudopterodon* *, Schlosser, Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. vi. p. 201 ; also vol. viii. (1890) p. 71.

This genus has hitherto been recorded only from the Eocene of Europe.   In the upper jaw the third molar is small and transversely elongated.   The first and second molars have an antero-external cusp, wanting in *Hyænodon*, and the posterior lobe of the cutting-blade is smaller.   In the lower molars there is no postero-internal cusp, but there is a small cutting-talon.   *M.* 3 is much the largest.   The jaw is relatively short and heavy.

Only one species at present known from Egypt.

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* *Fide* Matthew, Bull. Amer. Mus. Nat. Hist. vol. xiv. (1901) p. 20.

Pterodon africanus, Andrews.

[Plate XIX. fig. 3; text-figs. 69–71.]

1903. *Pterodon africanus*, C. W. Andrews, Geol. Mag. [4] vol. x. p. 342, fig. 3.

Type Specimen.—Right ramus of mandible, incomplete posteriorly, with *pm.* 2–4 and *m.* 1–3 well preserved (Pl. XIX. fig. 3); British Museum.

This species is distinguished from all the others by its much larger size.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

M. 8503. Right ramus of mandible, wanting the posterior portion : *pm.* 2–4 and *m.* 1–3 *in situ.* Type specimen figured *loc. cit. suprà.*

The symphysis, which seems to have remained unanchylosed through life, is very deep and long, extending back to the level of the middle of *pm.* 3 ; its depth is largely due to the enlargement of the front of the jaw resulting from the great size of the canine tooth. Behind the symphysis the ramus increases very little in depth from before backwards, in which direction its lower border is gently convex.

On the outer face of the jaw, in addition to two small apertures in the thickened wall of the canine alveolus (*c.*), there are three foramina: the smallest is in front beneath the posterior half of *pm.* 2 ; the other two (*m.f.*) are larger and are beneath the anterior lobes of *pm.* 3 and *pm.* 4 respectively.

The last molar (*m.* 3) is much the largest of the cheek-teeth ; it consists of a pair of high compressed cusps which form a cutting-blade, the posterior lobe of which is considerably the higher and has a sharp keel-like ridge on its postero-internal face ; the small talon apparently consists of a single cusp with a sharp median ridge. There is a small projection on the antero-external angle of the tooth near its base ; this seems to belong to the cingulum, which is wanting elsewhere. The second molar (*m.* 2) is similar to the first, except that the talon is relatively larger and forms a more distinct blunt edge, and the small antero-external prominence is also larger. The first molar (*m.* 1) is much the smallest of the series ; the two main cusps, which are considerably worn, are less compressed and form a less trenchant blade than in the other molars. The talon is similar to that of *m.* 2 and the antero-external projection is almost obsolete. The fourth premolar (*pm.* 4) is much larger than the first molar : it consists of a large, conical, somewhat laterally compressed and backwardly directed cusp with a cutting-edge; behind this there is a small talon also with a cutting-edge in the same line with that of the main cusp, and internal to it a sloping shelf-like surface. At the antero-internal and postero-external angles of the tooth there are small tubercles belonging to the cingulum, which is also slightly developed along the whole inner face of the tooth. *Pm.* 3 is similar to *pm.* 4, except that the main cusp is not so high, the talon rather smaller, and the antero-internal tubercle almost absent. *Pm.* 2 consists of a single cusp, of which the anterior slope is shorter than the posterior ; just a trace of the talon is still to be seen. *Pm.* 1 is represented only by its single nearly circular alveolus; all the other premolars and molars are implanted by two roots. The alveolus of the canine (*c.*) shows that that tooth was very large and oval in section, the long axis being

antero-posterior. There were three small incisors crowded together so as to form nearly a vertical row ; the smallest alveolus is on the actual edge of the alveolus of the canine.

The dimensions (in centimetres) of this specimen are :—

Total length of the specimen, so far as preserved	23·8
Length of the symphysis	8·6
Depth of the ramus opposite the hinder end of the symphysis .	5·5
,, ,, beneath m. 2	5·8
,, ,, ,, m. 3	5·7
Transverse diameter of the canine alveolus	2 app.
Antero-posterior diameter of the canine alveolus	2·7 app.

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
pm. 2	2·3	11
pm. 3	2·6	13
pm. 4	2·6	13
m. 1	2·1	10
m. 2	2·8	14
m. 3	3·4	17

C. 10192. Anterior part of a much-crushed skull in which pm. 2–4 and m. 1 are preserved on the right side and pm. 3–4 and m. 2 on the left (text-fig. 69). On the left side the upper portion of the muzzle is preserved about as far back as the anterior border of the orbit, from beneath which a strong ridge, probably continued from the zygomatic process, runs forwards on the side of the face, terminating just behind the large antorbital foramen (ao.f.), which is situated above pm. 3. The snout seems to have been broad and massive, and contracts a little in width just behind pm. 2, but the whole is greatly fractured, so that it is not possible to be sure of its original form. The anterior part of the palate is concave from side to side and there is a pair of large anterior palatine (incisive) foramina (a.p.f.), elongate-oval in form and apparently situated between the canine alveoli. All the incisors and the canine are wanting, and their alveoli so crushed and imperfect that nothing can be said about them. Pm. 1 seems to have been a small, perhaps one-rooted tooth. Of pm. 2 the hinder half is preserved on the right side ; it had a high laterally compressed conical crown, probably somewhat curved backwards, and there were two roots. Pm. 3 consists mainly of a high laterally compressed cusp ; it is narrower anteriorly than posteriorly, there being a slight prominence at the postero-internal angle. There is a small tubercle on the hinder slope of the main cusp near its base, and this tooth has two roots. Pm. 4 is much larger : it consists of a high conical backwardly-sloping cusp, connected with the hinder edge of which is a short cutting-talon ; on its inner anterior side there is a small keel-like prominence borne on a separate root ; there are three roots in all, two anterior and one posterior. M. 1 is a large triangular tooth ; it consists of a large pointed main cusp, obscurely divided into two by a shallow vertical groove, and connected antero-internally with a small but distinct cusp borne on a separate root. On the antero-external face a small cusp apparently represents the parastyle, and posteriorly there is a large trenchant talon, the cutting-edge of which is on its inner side. M. 2 is similar to m. 1 in structure, but larger. M. 3 cannot be made out, but it must have been a small tooth. The antero-internal angles of the first and second molars project

somewhat in advance of the hinder border of the tooth next in front ; there is a deep fossa for the reception of the lower molar behind and to the inner side of $m. 2$. The whole dentition, so far as preserved, is closely similar to that of *Pterodon dasyuroides*, from which, however, this species is distinguished by its greater size.

The dimensions (in centimetres) of this specimen are :—

Width of snout at level of canines   7
   ,,   ,,   behind $pm. 2$ . . . .   5·5

Text-fig. 69.
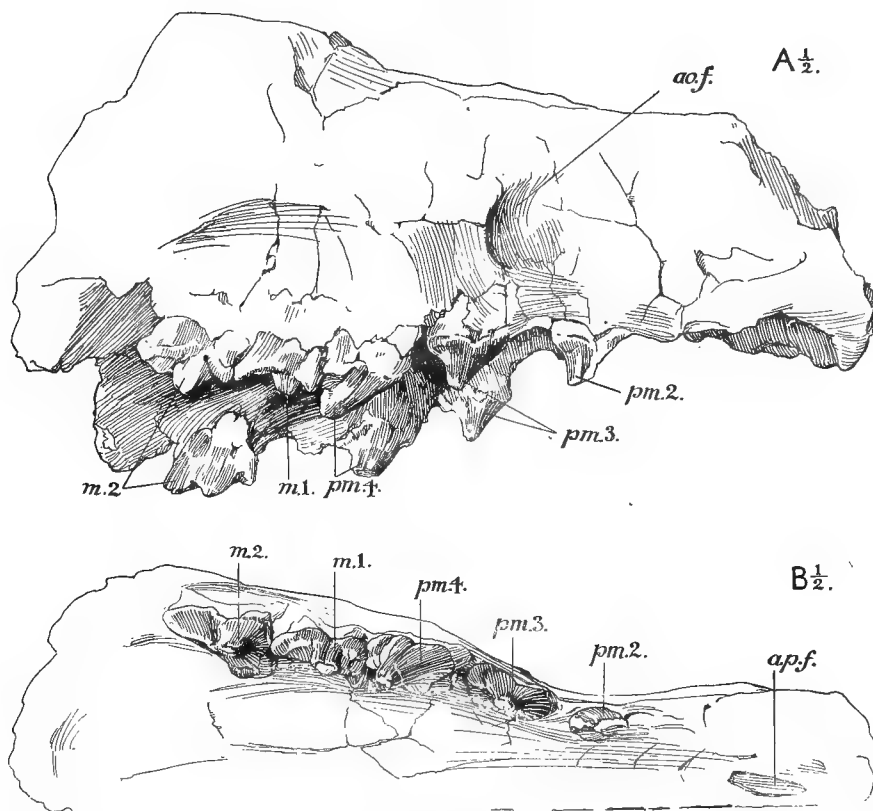
Anterior part of skull of (?) *Pterodon africanus* : A, from right side ; B, from below.

a.p.f., anterior palatine foramen ; *ao.f.*, antorbital foramen ; $m. 1$–2, first and second molars ; $pm. 2$–4, second, third, and fourth premolars.   On the right side the second molar has been restored from that preserved on the left.   ½ nat. size.

The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
$pm. 2$	2·4 app.	1·2
$pm. 3$	2·4	1·3
$pm. 4$	2·5	2
$m. 1$	2·9	2
$m. 2$	3·6	2·3

Length from anterior end of $pm. 2$ to posterior end of $m. 2$, 13·5 app.

The following specimens are referred provisionally to this species :—

C. **8898**. Left humerus, somewhat imperfect at proximal end (text-fig. 70). The head (*h.*) is very strongly convex from before backwards, and less so transversely ; its surface looks nearly as much backwards as upwards. The outer tuberosity (*o.t.*) is massive and roughened, but it is broken away above, so that its height cannot be observed. The shaft is to some extent laterally compressed till just above the distal expansion. The

Text-fig. 70.
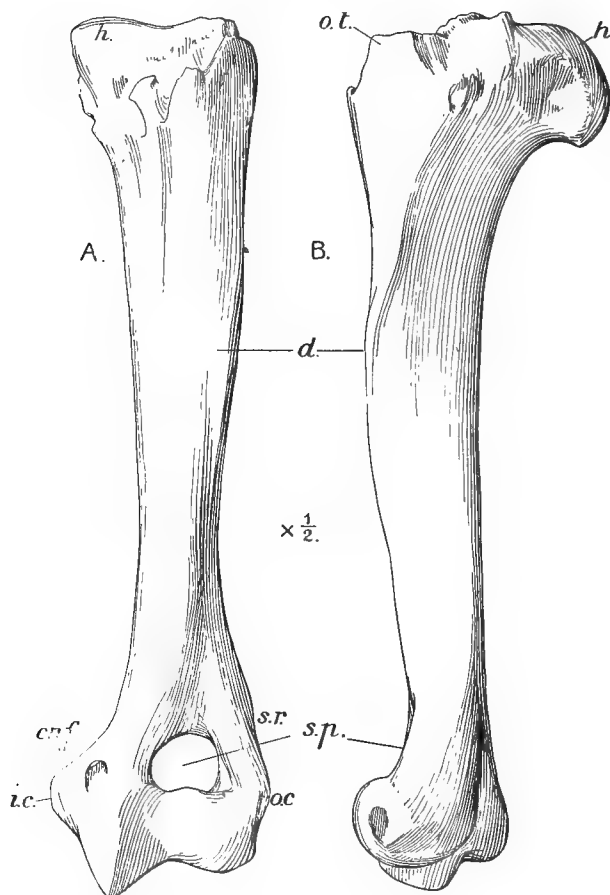
Left humerus of (?) *Pterodon africanus*: A, from front ; B, from outer side.

d., deltoid crest ; *en.f.*, entepicondylar foramen ; *h.*, head ; *i.c.*, inner condyle ; *o.c.*, outer condyle ; *o.t.*, outer (greater) tuberosity ; *s.p.*, supratrochlear perforation ; *s.r.*, supinator ridge. $\frac{1}{2}$ nat. size.

deltoid crest (*d.*) is only moderately prominent, and extends down about two-thirds of the shaft. The supinator ridge (*s.r.*) is very slightly marked. The inner condyle (*i.c.*) is moderately prominent, and there is a large entepicondylar foramen (*en.f.*). Both the coronoid and olecranon fossæ are large and communicate by a very large supratrochlear foramen (*s.p.*). The trochlear surface consists of an inner portion produced considerably downwards, a broadly rounded intercondylar ridge, and a narrower outer portion. The whole bone seems to resemble the humerus of the American species of

Hyænodon as described by Scott *. The dimensions (in centimetres) of this specimen are :—

Length from top of head . . . . 23·5
Width of proximal end . . . . 7·3
    „   middle of shaft (from side to side) 2
    „   „   (from before backwards) 3
    „   distal end . . . . 6 app.
    „   „ articulation . . . . 4·3

M. 8886. Plaster cast of the above specimen.   *Made in the British Museum.*

Text-fig. 71.
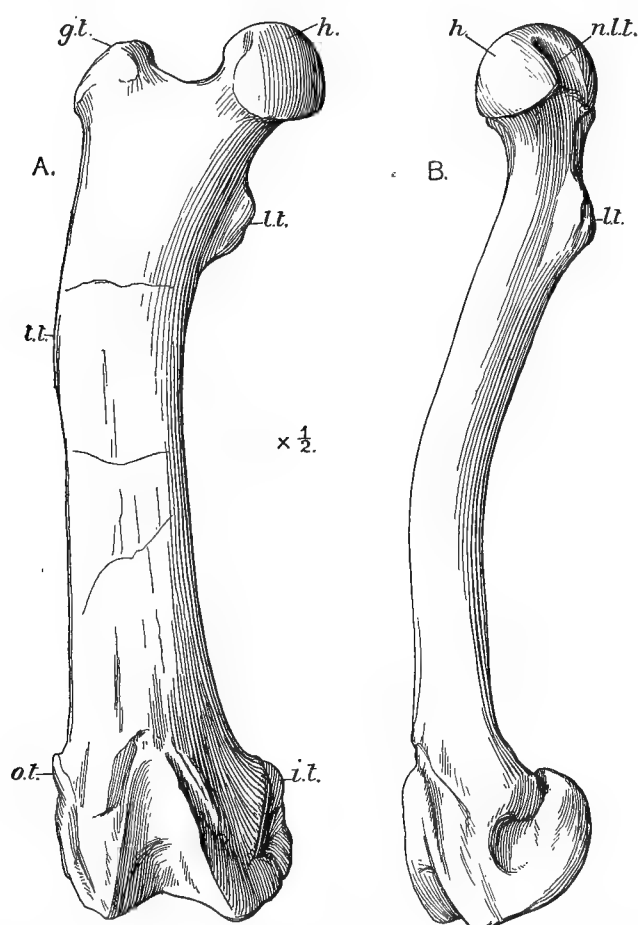
Right femur of (?) *Pterodon africanus*: A, from front; B, from inner side.

g.t., greater trochanter; *h.*, head; *i.t.*, inner tuberosity; *l.t.*, lesser trochanter; *n.l.t.*, notch for *ligamentum teres*; *o.t.*, outer tuberosity; *t.t.*, third trochanter. ½ nat. size.

C. 8897. Right femur, somewhat crushed at the distal end (text-fig. 71). The head (*h.*) is large, rounded, and pedunculate; on its posterior surface there is a deep notch or groove for the round ligament (*n.l.t.*). The great trochanter (*g.t.*) is not very large, and does not rise

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* Scott, "The Osteology of *Hyænodon*," Journ. Acad. Nat. Sci. Philadelphia, vol. ix. (1895) p. 513.

quite as high as the top of the head. The lesser trochanter (*l.t.*) is a large prominence united with the great trochanter by a strong ridge, which forms the outer border of the deep digital fossa. The shaft is strongly compressed from before backwards, and broad from side to side; on its outer side, about a third of its length from the proximal end, there is a rugose ridge representing a third trochanter (*t.t.*). The whole shaft is curved, the convexity being forwards. The distal articulation is very large. The rotular trochlea is narrow and extends far up the front of the bone, as in the femur of *Hyænodon* figured by Scott (Journ. Acad. Nat. Sci. Philad. vol. ix. p. 523). The tuberosities are large and project strongly backwards, the inner (*i.t.*) rather the furthest; they are separated by a broad and deep intercondylar groove. In its general form, particularly in the broad flattened shaft, the bone suggests that the animal may have been to some extent aquatic. It is possible that this femur may have belonged to *Apterodon*, or at least to the same animal as the humerus provisionally referred to *Apterodon*, since that bone also suggests possibly aquatic habits on the part of its possessor. The dimensions (in centimetres) of this specimen are:—

Extreme length	23·2
Diameter of head	3·1
Width of proximal end	7
,, mid-shaft	3·2
,, distal end	6

M. 8887. Plaster cast of the above specimen.   *Made in the British Museum.*

Genus **APTERODON**, Fischer.

[Bull. Soc. Géol. France, [3] vol. viii. (1880) p. 288.]

1887. *Dasyurodon*, A. Andreae, Bericht Senckenberg. naturforsch. Gesellschaft, Frankfurt-a.-M. p. 125, pl. iv.

The specimens described below agree closely with the figures of the teeth of *Dasyurodon* given by Andreae. Unfortunately, Fischer gives no figures of his *Apterodon*, which, from his description, differs a little from *Dasyurodon*; but, since most authors regard the two names as synonymous, *Apterodon* is here adopted on the ground of priority.

This genus is distinguished from *Pterodon* by the much slighter development of the cutting-blade of the lower carnassials, due to the smaller degree of compression of the cusps, and also to the much smaller size of the antero-internal cusp; the talon also is relatively much larger. In these points *Apterodon*, in fact, seems to be intermediate between forms like *Sinopa* and *Pterodon*, just as the latter is intermediate between *Apterodon* and *Hyænodon*, in the latter of which the talon is almost obsolete and the two anterior cusps form a sharp secant blade.

2 G

Apterodon macrognathus, Andrews.

[Plate XIX. figs. 4, 5; text-figs. 72–76.]

1904. *Pterodon macrognathus*, C. W. Andrews, Geol. Mag. [5] vol. i. p. 211.

Type Specimen.—Left ramus of mandible with *m.* 1–2, *pm.* 2–4, and the base of the canine (text-fig. 72); Geological Museum, Cairo.

This species, as its name implies, is especially remarkable for the elongation of the jaw, particularly of the post-alveolar portion. This character furnishes a further distinction from *Pterodon*, in which the mandible is comparatively short and stout. The dental formula is *i.* 3, *c.* 1, *pm.* 4, *m.* 3. The length of the molar-premolar series is 9·7 cm., the total length of the jaw being 22 cm. Judging from Fischer's description, *A. gaudryi* differs from the present species in being smaller, in the smaller size of the antero-internal cusp of the molars and of the posterior tubercle

Text-fig. 72.
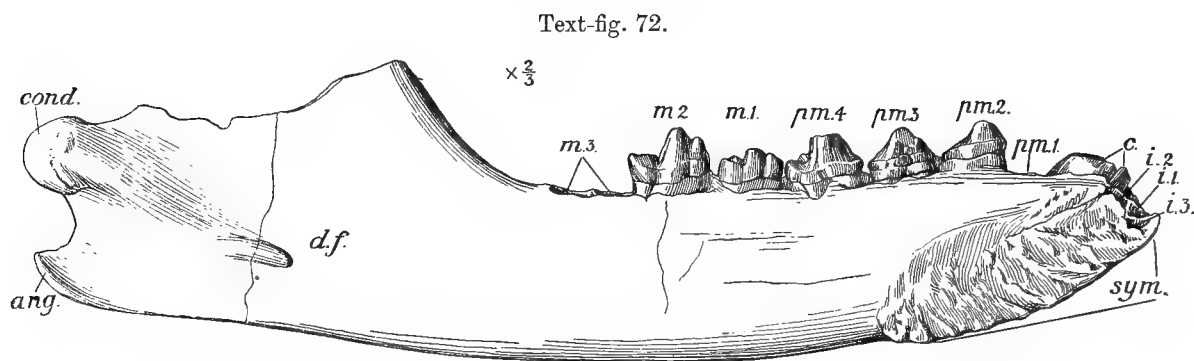
Left ramus of mandible of *Apterodon macrognathus*, type specimen, from inner side.

ang., angle of mandible; *c.*, canine; *cond.*, condyle; *d.f.*, opening of dental canal; *i.* 1–3, incisors; *m.* 1–3, molars; *pm.* 1–4, premolars; *sym.*, symphysis. $\frac{2}{3}$ nat. size.

of the last premolar. *Apterodon (Dasyurodon) flonheimensis*, Andreae, sp., is strikingly similar to the present species, but the main cusps of the molars are rather lower and blunter, and the talon is shorter.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 8982. Left ramus of mandible with *m.* 1–2, *pm.* 2–4, and base of canine *in situ*. Type specimen, described in Geol. Mag. *loc. cit. suprà*; figured in text-fig. 72. The symphysis (*sym.*) is deep and extended back to beneath the third premolar. The mandibular ramus is narrow from above downwards and proportionately very long; the ventral border is nearly straight. The length of the jaw behind the alveolus of the last molar is very great. The condyle (*cond.*) is cylindrical and elongated from side to side; it is on the same level as the alveolar border. The angular region (*ang.*) is separated from the

condyle by a deep notch and is slightly inflected. The coronoid process is incomplete. The dental canal (*d.f.*) opens low down near the ventral border. On the outer face of the mandible there are four or five foramina, of which the most anterior is beneath the alveolus of *pm.* 1, the next beneath the middle of *pm.* 2, the third and fourth beneath the front and hinder roots respectively of *pm.* 3. The third molar is represented by its alveolus only. The second consists of a high anterior portion and a large talon with a blunt cutting-edge. The anterior portion consists of a large posterior cusp with a much smaller one closely united to its antero-internal side, the two together forming a very blunt and imperfect blade ; in *Pterodon* and *Hyænodon* the antero-internal cusp is enlarged and secant, and with the posterior cusp forms the powerful cutting-blade of the carnassials. There is no trace of a postero-internal cusp. The first molar is much smaller than *m.* 2 ; it is greatly worn, particularly on its antero-external face. The anterior half of the tooth is composed of a small antero-internal cusp (paracone) and a larger main posterior cusp (protocone). The talon consists of an outer cusp and a lower inner ridge apparently continuous with the cingulum.

The fourth premolar is much larger than *m.* 1 ; it is composed of a large stout main cusp and a small talon. The second and third premolars are simple compressed cones, each borne on a pair of relatively large roots. In both premolars and molars the cingulum is well marked. *Pm.* 1 is represented by its alveolus only ; it seems to have been a one-rooted tooth squeezed outwards between the hinder edge of the canine in front and *pm.* 2 behind. The canine is relatively large, and there are three incisors so crowded together that one, probably *i.* 2, is displaced so as to lie above and behind the other two.

The dimensions (in centimetres) of this specimen are :—

Total length of the jaw	22
Depth of ramus at hinder end of symphysis . . .	3·2
„ „ beneath *m.* 3	3·2
Length of symphysis	5·8
Width of condyle	2·3
Distance between hinder border of the alveolus of *m.* 3 and the posterior angle of the condyle	10·2
Antero-posterior diameter of canine	2

The dimensions (in centimetres) of the cheek-teeth are :—

		Length.	Width.
m. 3	(alveolus)	1·6	..
m. 2		1·6	·9
m. 1 .		1·2	·7
pm. 4		1·7	1
pm. 3		1·4	·9
pm. 2		1·2	·7

M. 8880. Plaster cast of above specimen. *Made in the British Museum.*

C. 8815. Posterior portion of right ramus of mandible with *m.* 1–3 in perfect preservation (text-fig. 73). The description given above of the second molar in specimen C. 8982 applies equally to *m.* 2 and *m.* 3 in this mandible. It can, however, be seen that the cingulum

is strongly developed on the inner side of the cutting-talon, which is slightly notched in the middle. The talon of $m.1$ is composed of an outer cusp, a very small posterior and a rather larger inner tubercle belonging to the cingulum, the three surrounding a shallow depression. The dimensions (in centimetres) of the teeth are :—

	Length.	Width.
$m.3$	1·9	1
$m.2$	1·8	·9
$m.1$	1·3	·6

M. 8873. Plaster cast of the above specimen.   *Made in the British Museum.*

M. 8437 a. Portion of right ramus of mandible with greatly worn and broken cheek-teeth.

M. 8437 b. Portion of right ramus of mandible with $pm.2$ and 3 complete, the other cheek-teeth broken and worn. Figured on Pl. XIX. fig. 4.

M. 8436. Posterior portion of right ramus of mandible with $m.2$ and $m.3$. Figured on Pl. XIX. fig. 5.

Text-fig. 73.
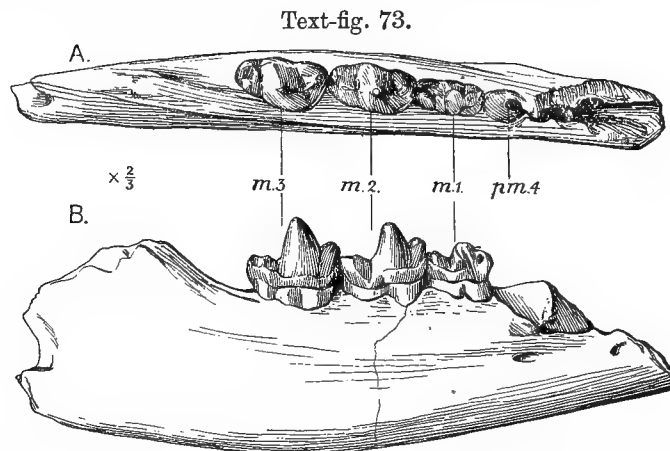
Portion of right ramus of mandible of *Apterodon macrognathus* : A, from above ; B, from outer side. *pm.* 4, fourth premolar ; *m.* 1–3, the molars. $\frac{2}{3}$ nat. size.

The following specimens are referred provisionally to this species :—

M. 8439. Nearly complete axis vertebra. In this vertebra the centrum is very much depressed ; anteriorly its ventral surface is concave from side to side, but posteriorly there is a median keel terminating behind in a hypapophysis. The odontoid is much flattened dorso-ventrally ; its ventral surface for the atlas is limited posteriorly by a sharp ridge. The lateral surfaces are about as deep as wide, their ventral borders being produced downwards considerably below the ventral surface of the rest of the centrum. The backwardly directed transverse processes are large and long, extending considerably behind the posterior end of the centrum ; the vertebrarterial canal is small. The neural canal is both wide and high. The neural spine is a very high hatchet-shaped plate projecting considerably backwards behind the rest of the vertebra ; its postero-ventral border is much thickened. The posterior zygapophyses are massive projections, their

articular surfaces being oval in outline. The dimensions (in centimetres) of this vertebra are :—

Length from top of odontoid to posterior face of centrum . . 6·6
Width of anterior articular surface of centrum 5
　　　　,,　　　posterior articular surface of centrum　.　. . . 2·9
Height to top of arch . . . . 6·7 app.
Width between outer ends of zygapophyses . . . . 4·7

Text-fig. 74.
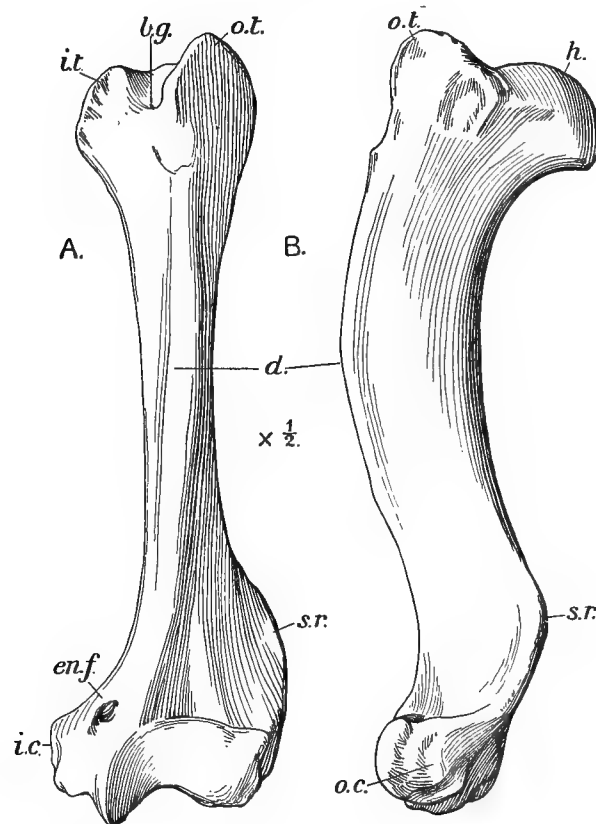
Left humerus of (?) *Apterodon macrognathus* : A, from front ; B, from outer side.

b.g., bicipital groove ; *d.*, deltoid crest ; *en.f.*, entepicondylar foramen ; *h.*, head ; *i.c.*, inner condyle ; *i.t.*, inner tuberosity ; *o.c.*, outer condyle ; *o.t.*, outer (greater) tuberosity ; *s.r.*, supinator ridge. ½ nat. size.

C. 9445. Left humerus (text-fig. 74). The head (*h.*) is strongly convex and greatly elongated from before backwards ; it looks as much backwards as upwards, while from side to side it is narrow and not very strongly convex. The outer tuberosity (*o.t.*) is high and somewhat compressed, its outer face is flattened, the inner concave. The inner tuberosity (*i.t.*) is a massive prominence with a flattened end ; between it and the outer tuberosity is a deep bicipital groove (*b.g.*). The shaft is very strongly compressed laterally and the

deltoid crest (*d.*) is enormously developed, forming the strongly convex sharp anterior edge of three-fourths of the length of the shaft. The supinator ridge (*s.r.*) is greatly developed as a sort of scroll-like flange which projects very strongly backwards as well as outwards. The inner condyle (*i.c.*) is very prominent, and there is an entepicondylar foramen (*en.f.*). The coronoid fossa is small and shallow; the olecranon fossa is also small, but sharply defined; there is no supratrochlear perforation. The distal articulation consists of a prominent inner portion, projecting below the rest of the surface, a gently rounded intercondylar ridge, and a narrow outer surface deeply notched distally as in *Lutra*. On the whole, this humerus is very like that of *Lutra* and

Text-fig. 75.
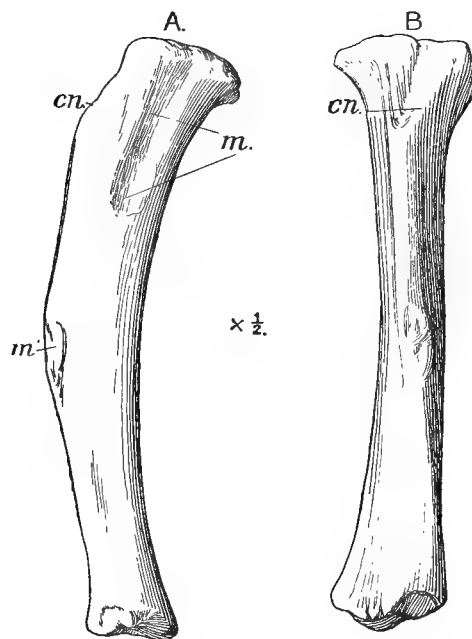
Right tibia of (?) *Apterodon macrognathus*, lacking epiphyses: A, from inner side; B, from front.

cn., cnemial crest; *m.*, *m.'*, deep impressions for muscle-attachments. $\frac{1}{2}$ nat. size.

still more like that of *Potamotherium*, so that it is possible that the animal to which it belonged may have lived a semi-aquatic life. The dimensions (in centimetres) of this specimen are:—

Length (from top of great trochanter)		21
Width of proximal end		5·8
,, middle of shaft (from side to side)		1·6
,, ,, ,, (from before backwards) . . .		3·8
,, distal end		6·3
,, ,, articulation		4·2

M. 9257. Plaster cast of the above specimen.   *Made in the British Museum.*

M. 8504. Distal end of right humerus. Figured on Pl. XIX. figs. 7, 7 A. Closely similar to C. 9445.

M. 8440. Distal ends of two similar humeri.

C. 8845. Right tibia, wanting the epiphyses (text-fig. 75). The bone, as a whole, is strongly curved, the convexity being anterior. The cnemial crest (cn.) slopes away and probably its upper end was overlapped by the patella. It extends about halfway down the bone, and terminates in a rugose prominence for the attachment of a powerful muscle. The upper half of the shaft is trihedral. On the inner face just below the upper end there is a long roughened depression for muscle-attachment (m.). The posterior face at the upper end of the bone is concave from side to side. Towards the distal end the shaft widens out a little, but in this specimen the articular region is wanting. On the whole, this bone seems to lend some support to the idea that this Creodont may have

Text-fig. 76.
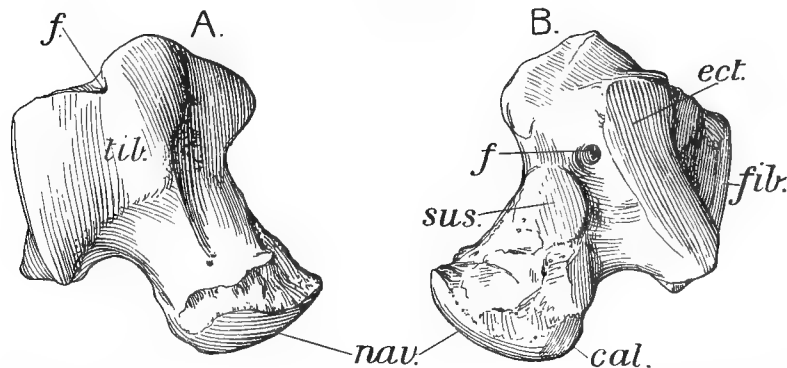
Right astragalus of (?) *Apterodon macrognathus* : A, from above ; B, from below.

cal., facet for calcaneum ; *ect.*, ectal facet ; *f.*, astragalar perforation ; *fib.*, surface for fibula ; *nav.*, facet for navicular ; *sus.*, sustentacular facet ; *tib.*, surface for tibia. Nat. size.

been more or less aquatic in its habits. The well-marked rugose surface for the attachment of muscles at the inner side of the proximal end of the shaft (m.) seems to occur also in some Seals and in *Lutra*, while that marked m′ in the figure may correspond with a somewhat similarly situated rugosity in some Seals. The dimensions (in centimetres) of this bone are :—

Length	15·4
Width of proximal articulation	3·7
Antero-posterior width of shaft at muscular prominence . .	2·5

M. 9258. Plaster cast of the above specimen. *Made in the British Museum.*

C. 8116. Right astragalus (text-fig. 76). The trochlear surface (tib.) is very slightly grooved ; on its inner side it is produced backwards in a sort of tongue to the extreme hinder border. At the angle between the outer edge of this backward extension and the posterior border of the outer half of the trochlea is the large upper opening (f.) of the astragalar canal.

The fibular facet (*fib.*) is nearly flat above, but curved a little outwards towards its antero-inferior border, where it joins the ectal facet for the calcaneum is a sharp angle. On the inner side of the trochlea the body of the bone is slightly concave and is produced backwards and inwards into a considerable prominence.

The neck is long and is directed more inwards than usual in the true Carnivora ; the head bears two facets, a large terminal gently convex surface for the navicular (*nav.*) and a small surface looking outwards and making an obtuse angle with the last; this (*cal.*) is probably for contact with the distal end of the calcaneum or perhaps with the cuboid. The elongated ectal facet (*ect.*) is placed very obliquely to the dorso-plantar axis; it is slightly concave posteriorly and flat in front. It is sharply bounded on both sides by deep fossæ, that in front separating it from the sustentacular facet and having at its posterior end the ventral opening of the astragalar canal. The sustentacular facet (*sus.*) is oval and gently convex ; it appears to be connected with the distal calcaneal facet above noticed by a narrow band.

The most notable characters of this astragalus seem to be (1) the great extension backwards of the inner half of the tibial surface ; (2) the large size of the astragalar foramen ; (3) the presence of a considerable prominence of the postero-internal angle of the bone. The dimensions (in centimetres) of this bone are :—

Greatest length . . . . 4·4
      ,,   width . . . . 3·7
Width of tibial surface . . . . 2·4

M. 9259.   Plaster cast of the above specimen.   *Made in the British Museum.*

M. 8441.   Left astragalus, imperfect proximally.

M. 8512.   Imperfect left calcaneum. The tuber is almost entirely wanting. The ectal facet is oblique and elongated ; it is convex posteriorly and flat in front, its outer border being continuous with the small convex fibular facet. The sustentaculum is not very prominent ; it bears an oval concave facet. The cuboid facet is oblique to the long axis of the bone and looks inwards and forwards ; it is very slightly concave. The whole bone seems to have been short and stout.   *Presented by W. E. de Winton, Esq., 1903.*

M. 8441a. Imperfect right calcaneum.

Genus SINOPA, Leidy.

[Proc. Acad. Nat. Sci. Philad. 1871, p. 116.]

1872. *Stypolophus*, Cope, Proc. Amer. Phil. Soc. vol. xii. p. 466.
1872. *Limnocyon* (part.), Marsh, Amer. Journ. Sci. [3] vol. iv. p. 126.
1874. *Prototomus*, Cope, Report on Vertebrate Fossils obtained by the Wheeler Expedition in New Mexico, p. 13.

This genus includes small or medium-sized Creodonts, in the mandible of which the first molar is the smallest of the series. The lower molars consist of a high anterior

blade and a small talon. The high anterior portion consists of an antero-internal and a postero-external cusp, which tend to form a cutting-blade, and a small postero-internal cusp. The talon in the typical species is more or less basin-shaped.

It is with considerable hesitation that the fragment of a mandible described below has been referred to a member of this genus, which has hitherto been almost, if not quite, confined to North America. The European genera *Cynohyœnodon* and *Proviverra* are very closely allied to *Sinopa*, but the present specimen differs from the mandibles of species referred to them both in being considerably larger and in possessing more massive molars, the cusps of which are neither so high nor so pointed. Rütimeyer [*] has already referred a small Creodont from the Eocene of Egerkingen to *Stypolophus* (*Sinopa*), distinguishing it from *Proviverra* and *Cynohyœnodon* on these same grounds, and his specimen must be very similar to that now described and made the type of a new species.

Sinopa ethiopica, sp. nov.
[Plate XIX. figs. 6, 6 A.]

Type Specimen.—Portion of left ramus of mandible with *pm.* 4 and *m.* 1–3 *in situ* (Pl. XIX. figs. 6, 6 A); Geological Museum, Cairo.

This species is about the same size as *Sinopa agilis* (Marsh), but differs from it, and apparently from the other American species also, in the relatively smaller size of the last premolar and first molar compared with the last molar. It also differs from the typical members of the genus in having a trenchant talon, the cutting-edge of which is situated rather towards the outer side of the tooth ; in the other species the talon is basin-shaped. This difference suggests that when more is known of its structure, this species may require to be placed in a new genus.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 10193. Portion of the left ramus of the mandible with the somewhat broken molars and fourth premolar. Type specimen figured on Pl. XIX. figs. 6, 6 A.

    The ramus, so far as preserved, is of nearly the same depth throughout ; posteriorly it is broken away about 1·5 cm. behind the last molar ; there seems to have been a well-marked masseteric fossa. The last premolar (*pm.* 4) consists of a large, somewhat compressed, main cone, with small anterior and posterior basal cusps, the posterior one being the smaller and forming a short cutting-talon ; the basal length of this tooth is a little greater than that of *m.* 1. The molars increase in size from before backwards. Each consists of a high tricuspid anterior portion and a talon. In all the teeth the ends of the main cusps have been broken away, but it can be seen that the postero-external cusp was the largest and with the antero-internal formed an imperfect cutting-blade ; the postero-internal cusp is small and intimately connected with the inner face of the

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[*] Abhandl. Schweiz. Pal. Ges. vol. xviii. (1891) p. 104, pl. vii. figs. 10, 11.

large postero-external cusp. The talon is of moderate size, and its outer border is high and forms a cutting-edge; it is separated from the much lower inner border by a slightly concave surface, which is homologous with the basin-shaped depression of the talon in the other species. On the antero-external angle of the tooth there is a well-marked tubercle (stylid) belonging to the cingulum, which is wanting round the rest of the crown.

The dimensions of this specimen are :—Length, so far as preserved, 4·6 cm. ; depth of ramus beneath *m.* 3, 1·6 cm. The lengths of the teeth are :—*pm.* 4, 8 mm. ; *m.* 1, 6·5 mm.; *m.* 2, 8·5 mm. ; *m.* 3, 11 mm.

M. 9260. Plaster cast of the above specimen.   *Made in the British Museum.*

Order C E T A C E A.

Suborder *A R C H Æ O C E T I.*

Family ZEUGLODONTIDÆ.

Facial region of skull greatly elongated ; external nares opening comparatively far forwards ; nasal canal prolonged backwards by the union of the maxillæ, palatines, and pterygoids, so that the internal nares are far back ; nasal bones elongated ; frontals forming broad supraorbital processes. Parietal region of the skull very narrow, and temporal fossæ very large. In the earliest forms (*Protocetus*) the normal eutherian dentition seems to have been present, and the teeth behind the second premolar have three roots. In the later forms (*Zeuglodon*) the dentition is reduced, probably by loss at the hinder end of the series ; the anterior premolars may have one or two roots, but the other teeth of the molar-premolar series are two-rooted, and have compressed crowns with sharp serrated edges. The new genus *Prozeuglodon* described below is intermediate between these two types.

The Zeuglodonts of the Fayûm are especially interesting, because the first mammalian bones described from this region were parts of the skeleton of a member of this family. In 1879 Schweinfurth collected some vertebræ, including an axis, from the island Geziret-el-Qorn in the lake Birket-el-Qurun : the beds in which these remains were found belong to the Birket-el-Qurun series of Beadnell, forming the upper part of the Lower Mokattam beds. The specimens were described by Dames *, by whom they were referred to three forms :—(1) a large species with

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* Sitzungsb. k. preuss. Akad. Wiss. vol. i. (1883) p. 129.

elongated dorsal vertebræ, referred to as "species major" and said to be similar to the *Zeuglodon macrospondylus* of J. Müller; (2) a smaller form with short vertebræ, resembling the *Z. brachyspondylus* of Müller and referred to by Dames as "species minor"; (3) a still smaller species represented only by a few vertebræ, which are said to resemble some vertebræ regarded by Müller as belonging to a young individual of *Z. brachyspondylus*, but in the light of recent discoveries may more probably be referred to *Z. osiris* or a closely allied species.

Somewhat later Schweinfurth collected on the mainland near Qasr-el-Sagha (see map in Introduction) some further remains, including portions of the premaxillæ and a nearly complete ramus of the mandible. These specimens were described in detail by Dames *, who founded upon them, especially upon the mandible, the species *Z. osiris*.

Further material, including a fine skull and mandible of *Z. osiris*, was collected in 1902 in the neighbourhood of Qasr-el-Sagha by Drs. Stromer and Blanckenhorn, the former of whom has since published an exhaustive memoir † on these remains, referring most of them to *Z. osiris*, but some to a smaller form to which the name *Z. zitteli* is given. This writer also compares the Egyptian Zeuglodonts with those of other localities and discusses the relationship of the group. Dr. Elliot Smith ‡ has given an account of natural and artificial brain-casts from the same region, and concludes that probably two genera were present; he also discusses the probability of the relationship of the Archæoceti to the true Whales, and considers that on the whole the brain-structure is in favour of the usual classification. Recently Dr. E. Fraas § has described a skull of extraordinary interest from the bottom of the Lower Mokattam series of Cairo (corresponding with the Wadi Rayan series of Beadnell). This specimen has been made the type of a new genus and species, *Protocetus atavus*, and is remarkable as combining a skull which is typically Zeuglodont in general form with a dentition which is practically that of a Creodont. The dental formula is: *i.* 3, *c.* 1, *pm.* 4, *m.* 3. The premolars and molars have not the peculiar serrated form characteristic of *Zeuglodon*; *pm.* 3, 4 and *m.* 1–3 have three roots and indications of an inner cusp. There can be no doubt that Fraas is correct in regarding this type as an annectant form between the Zeuglodonts and the Creodonta, but, although the origin of the Zeuglodonts is thus made clear, it still seems to be by no means so certain as that author believes, that they may not themselves be the ancestral forms of the Odontoceti.

Of the material now to be described the most important is the skull of a Zeuglodont discovered by Mr. H. J. L. Beadnell in beds of the Birket-el-Qurun series, and

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* Palæont. Abhandl., n. s., vol. i. (1894) p. 189.

† Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xv. (1903) p. 64. See also Sitzungsb. math.-phys. Cl. k. bay. Akad. Wiss. vol. xxxii. (1902) p. 341, and Zeitschr. deutsch. geol. Gesell. vol. 55 (1903), Protokolle, p. 36.

‡ Proc. Roy. Soc. vol. 71, 1903, p. 322.

§ Palæont. Abhandl., n. s., vol. vi. (1904) p. 199, pls. x.–xii.

therefore intermediate between the horizons of *Protocetus atavus* and *Zeuglodon osiris*: as might be expected, it exhibits some interesting transitional characters in the teeth. Another specimen from the same horizon is a large mandible here described as the type of *Zeuglodon isis*. From the remains of *Z. osiris* collected by Mr. Beadnell and myself in the Qasr-el-Sagha series it is not possible to add anything of importance to Stromer's detailed descriptions.

Genus ZEUGLODON, Owen.

[Lond. & Edinb. Phil. Mag. (3) vol. xiv. (1839) p. 302.]

Dental formula :—$i. \frac{3}{3}$; $c. \frac{1}{1}$; $pm. \frac{4}{4}$; $m. \frac{2}{2 \text{ or } 3}$. Teeth with not more than two roots. Cheek-teeth with a laterally compressed crown—that of the premolars always strongly serrated on both edges, that of the molars serrated on both or only on the posterior edge.

Zeuglodon osiris, Dames.

[Plate XX. figs. 8, 8 A ; text-fig. 77.]

1894. *Zeuglodon osiris*, W. Dames, Palæont. Abhandl., n. s., vol. i. p. 204, pls. xxx., xxxi., xxxiv.–
      xxxvi.
1901.   ,,   ,,   C. W. Andrews, Geol. Mag. [4] vol. viii. p. 437.
1902.   ,,   ,,   E. Stromer, Sitzungsb. math.-phys. Cl. k. bay. Akad. Wiss. vol. xxxii.
      p. 345.
1903.   ,,   ,,   E. Stromer, Zeitschr. deutsch. geol. Gesell., Protokolle, vol. 55, p. 37.
1903.   ,,   ,,   G. Elliot Smith, Proc. Roy. Soc. vol. 71, p. 322.
1903.   ,,   ,,   E. Stromer, Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xv.
      p. 65, pls. viii.–xi.
1904.   ,,   ,,   E. Fraas, Palæont. Abhandl., n. s., vol. vi. p. 199.

Type Specimen.—Portions of premaxillæ, left ramus of mandible, and some vertebræ, described and figured by Dames, *tom. cit.* 1894, pp. 191–204, pls. xxx., xxxi., xxxiv.–xxxvi.; Royal Museum of Natural History, Berlin.

In this species the dental formula is: $i. \frac{3}{3}$; $c. \frac{1}{1}$; $pm. \frac{4}{4}$; $m. \frac{2}{3}$. The first premolar is one-rooted. Molars crowded together. The supraoccipital surface is narrow and very deeply concave from side to side, owing to the turning backwards of the sides of the prominent lambdoidal crest (see Pl. XX. fig. 8). For detailed description of the skull and mandible, see Stromer's memoirs referred to above.

Form. & Loc.—Qasr-el Sagha beds (Middle Eocene) : north of Birket-el-Qurun.

C. 10018. Portions of a somewhat distorted skull, including the occipital region and most of the roof as far forwards as the posterior portion of the nasals. Figured on Pl. XX. figs. 8, 8 A. The cast of the cranial cavity is described and figured by Elliot Smith in Proc. Roy. Soc. vol. 71, 1903, pp. 322–331, fig. 2.

This specimen, so far as it goes, seems to resemble closely that figured by Stromer, but is slightly larger. The occipital condyles (*cond.*), which project considerably, are relatively small; they are widest at their upper end, and are strongly convex from above downwards, but much less so from side to side. The exoccipitals (*exo.*) appear to meet in the middle line above the foramen magnum, making a suture with one another about 2·5 cm. long. The supraoccipital (*soc.*) is deeply concave from side to side, owing to the great size of the backwardly directed lateral portions of the lambdoidal crest (*l.c.*), of which it forms the posterior face, the anterior being constituted by the expanded posterior portion of the parietals (*pa.*), which unite with the supraoccipital in a very deep suture, the outer line running along the edge of the crest. In front of the lambdoidal crest, the upper part of the parietals forms a very high, sharp, sagittal crest (*s.c.*) extending as far as their junction with the frontals, which is about 5 cm. behind the great supraorbital expansions of those bones. Laterally, the posterior portions of the parietals form part of the very slightly convex cranial walls, and unite with the squamosals in a suture running downwards and forwards. The squamosals (*sq.*) are very large, and their upper surface is convex from before backwards; they form a considerable part of the cranial wall. The zygomatic process (*zyg.*) is large, and from its upper edge a ridge runs upwards and becomes continuous above with the lambdoidal crest, forming with it the posterior boundary of the enormous temporal fossa. The glenoid surface is wide and concave from before backwards; there is a fairly well-developed postglenoid process. The frontals are incomplete, but it can be seen that they formed the great supraorbital expansion usual in the genus. In front they are separated by the nasals (*na.*), which are thrust between or over them, and terminate behind in a sharp median angle. Of the nasals only the posterior portion is preserved: together they are convex from side to side and project a little above the rest of the surface of the snout. The whole of the front and base of this skull is wanting. The approximate dimensions (in centimetres) are:—

Width at zygomatic processes	32
„ of occipital surface	22
„ „ condyles	6·7
„ of foramen magnum	3
Height of occipital surface above foramen magnum	13·5
Length of sagittal crest of parietals	13
Greatest width of nasals	4·8

M. 8150. Plaster cast of the above specimen. *Made in the British Museum.*

M. 8150 a. Plaster cast of the cranial cavity of the above specimen. Figured Proc. Roy. Soc. vol. 71 (1903) p. 325, fig. 2. *Made in the British Museum.*

C. 10207. Left ramus of mandible wanting the angular and articular regions (text-fig. 77). This specimen is almost exactly like that described and figured by Dames (Palæont. Abhandl., n. s., vol. i. p. 191, pl. xxx.) in his original description of this species. In addition

to the loss of the posterior portion, the inner wall of the dental canal has been crushed in, and the anterior alveolus is incomplete. The symphysial surface (*sym.*) extends back as far as the hinder border of *pm.* 2. The single alveoli of the incisors, the canine, and the first premolar are empty; they are separated from one another and from *pm.* 2 by almost equal intervals of about 2·4 cm. *Pm.* 2 is a two-rooted tooth, compressed and sharp-edged, with two accessory denticles on its posterior border; *pm.* 3 is represented by its two alveoli only; *pm.* 4 is a large two-rooted tooth apparently having three accessory denticles on both its anterior and posterior borders. The molars are smaller teeth closely crowded together. In all, the anterior border is nearly vertical and without denticulations, while the posterior border has two or perhaps three accessory denticles in *m.* 1 and *m.* 2, and at least three in *m.* 3. The crowns of all the

Text-fig. 77.
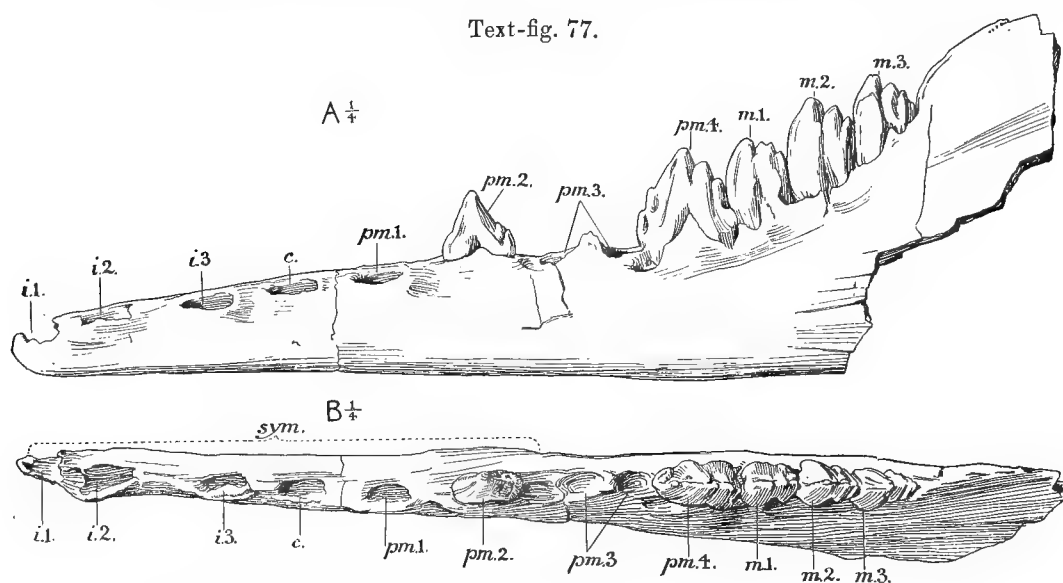
Left ramus of mandible of *Zeuglodon osiris*: A, from outer side; B, from above.

c., alveolus of canine; *i.* 1–3, alveoli of the incisors; *m.* 1–3, molars; *pm.* 1–4, premolars or their alveoli; *sym.*, symphysis. ¼ nat. size.

teeth are somewhat obscured by a coating of gypsum. There are depressions for the reception of the points of the upper teeth behind and rather to the outer side of the alveoli of *i.* 3, *c.*, *pm.* 1, and almost immediately behind the alveoli of *pm.* 2 and *pm.* 3.

The dimensions (in centimetres) of this specimen are given below; those of the specimens described by Dames and Stromer are placed in the second and third columns for comparison :—

		Dames's type specimen.	Stromer's specimen.
Length from anterior end of jaw to anterior border of *pm.* 2 . .	24	22 app.	25
„ „ border of *pm.* 2 to hinder border of *m.* 3 .	24·5	21	23·5
Height of jaw beneath *i.* 2	3·5	3	3·8
„ „ *pm.* 2	6·7	4·5	5·8
„ „ *m.* 3	11 app.	?9	11·5
Length of the symphysial surface	28	..	..

The dimensions (in centimetres) of the teeth (or their alveoli) are :—

	Length.	Width.	Height.
i. 1 (alveolus only)	2·2	..	..
i. 2 ,, ...	2·5	1·6	..
i. 3 ,, ...	2·5	1·5	..
c. 1 ,, ...	2·9	1·5	..
pm. 1 ,, ...	2·9	1·4	..
pm. 2	3·8	1·9	3·6
pm. 3 (alveoli only)	5	..	..
pm. 4	5·2	2·5	5
m. 1	3	2·5	..
m. 2	2·8	2·5	3·9
m. 3	3·2	2·5	3·5

Some of the above measurements of the teeth are probably somewhat in excess of the truth, owing to the presence of a coating of gypsum.

M. 9264. Plaster cast of the above specimen. *Made in the British Museum.*

The following specimens are referred provisionally to this species :—

C. 10055. Five caudal vertebræ. In these the epiphyses are fused to the centrum, which measures in length 7·5 cm., in width 7·7 cm., in height 7 cm. The neural arch, enclosing a very small neural canal, is situated on the anterior half of the centrum. There are broad transverse processes, the bases of which are perforated by a foramen. There seem to have been no vascular foramina on the ventral face of the centrum, which bears at its hinder end a pair of facets for the chevrons.

C. 10051. Six associated vertebræ, similar in general form to the last, but belonging to a much smaller animal, the length of the centrum in the largest of these specimens being only about 5 cm.

C. 10209. Four posterior lumbar and anterior caudal vertebræ, closely similar to the specimens figured by Dames (*loc. cit.* 1894, pls. xxxv., xxxvi.) and referred by him to *Z. osiris.* The ends of the centrum are slightly concave, the epiphyses being fused. The neural arch has a pedicle extending over three-fourths of the length of the centrum. The transverse processes are large and directed downwards and backwards ; in the caudal the base of the process is perforated. In the lumbars the ventral face of the centrum is concave or only very slightly convex from side to side ; in the middle are two large vascular foramina separated by a narrow bar of bone ; there is also a foramen (or a pair) in the floor of the neural canal. In the caudal vertebra there seem to have been large facets for the chevrons. These specimens are from the Birket-el-Qurun beds. The dimensions (in centimetres) of the centra of these vertebræ are :—

	Lumbar.		Caudal.
	a.	*b.*	*c.*
Length	6·7	6·8 app.	6·7
Width	8·5	8·2	8
Height	7·5	7·4	7 app.

Zeuglodon isis, Beadnell, MS.
[Text-fig. 78.]

1904. *Zeuglodon isis*, C. W. Andrews, Geol. Mag. [5] vol. i. pp. 214–5.
1905.   „   „   H. J. L. Beadnell, The Topography and Geology of the Fayûm Province, p. 44
                     (Survey Department, Cairo).

Type Specimen.—Right ramus of mandible, complete as far as the hinder end of the molar series (text-fig. 78); Geological Museum, Cairo.

This is a very large species, the distance from the anterior end of the mandible to the posterior border of the last molar being about 77 cm. against 48 cm. in *Z. osiris*. It is distinguished from the contemporary *Eocetus schweinfurthi* in having the molars and premolars serrated. The full dentition is present in the mandible, and the first premolar is one-rooted.

Form. & Loc.—Birket-el-Qurun beds (Middle Eocene): west of Birket-el-Qurun.

The occurrence of large Zeuglodonts in beds beneath the Qasr-el-Sagha series, in which the types of *Z. osiris* were found, was noticed by Dames * in his account of Schweinfurth's first collection, which came from the island Geziret-el-Qorn in the lake Birket-el-Qurun : the beds in which this collection was made are placed by Beadnell in the Birket-el-Qurun series. The existence of this large species was afterwards referred to by myself † and by Stromer ‡. Recently, Dr. E. Fraas has described a large Zeuglodont from beds of the same age, and has made it the type of a new genus and species *Eocetus schweinfurthi* §, stating that in several respects it is more primitive than *Zeuglodon* and in some respects intermediate between it and *Protocetus*. The teeth are described as secodont with a reduced inner tubercle, the edges of the crowns not being serrated as in *Zeuglodon*; the full dentition is present in the upper jaw. Dr. Fraas also refers to this species the large vertebræ from the same horizon. These, however, he admits are closely similar to those of the larger American Zeuglodonts. A number of these large vertebræ were collected near Dimé in 1900 by Mr. Beadnell and myself, and subsequently he obtained near the western end of Birket-el-Qurun a fine mandibular ramus of very large size with the teeth of typically Zeuglodont form. The dental formula is: *i.* 3, *c.* 1, *pm.* 4, *m.* 3. This animal, from its tooth-structure, cannot be the same as *Eocetus schweinfurthi*, although of similar size and from about the same horizon. In his notes, Mr. Beadnell referred to this species as

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* Sitzungsb. k. preuss. Akad. Wiss. vol. i. (1883) pp. 130–135.

† Geol. Mag. [5] vol. i. pp. 214–5.

‡ Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xv. (1903) p. 82.

§ Originally *Mesocetus schweinfurthi* (Palæont. Abhandl., n. s , vol. vi. (1904) p. 217), but *Mesocetus* having been previously employed, the author changed it to *Eocetus* (Geol. Centralblatt, vol. v. (1904) no. 1048).

Zeuglodon isis, a name also employed in his report on the Fayûm and adopted here. The large vertebræ, in the absence of proof to the contrary, will be regarded as belonging to this species.

C. 10208. Right ramus of mandible, imperfect posteriorly; the premolars and molars are present, though somewhat broken. Type specimen (text-fig. 78). The total length preserved is about 83 cm. Anteriorly it terminates in a rounded extremity bearing the alveolus of the first incisor; externally it is convex in front, becoming flatter posteriorly; internally there is a flat symphysial surface extending back to about the middle of *pm.* 2. The ramus deepens gradually from before backwards; opposite *i.* 2 it is about 6·4 cm. deep, while beneath *m.* 3 the depth is about 22 cm. In the anterior 26 cm. there are the alveoli for four single-rooted teeth: *i.* 1 is situated at the extreme end; *i.* 2 is

Text-fig. 78.
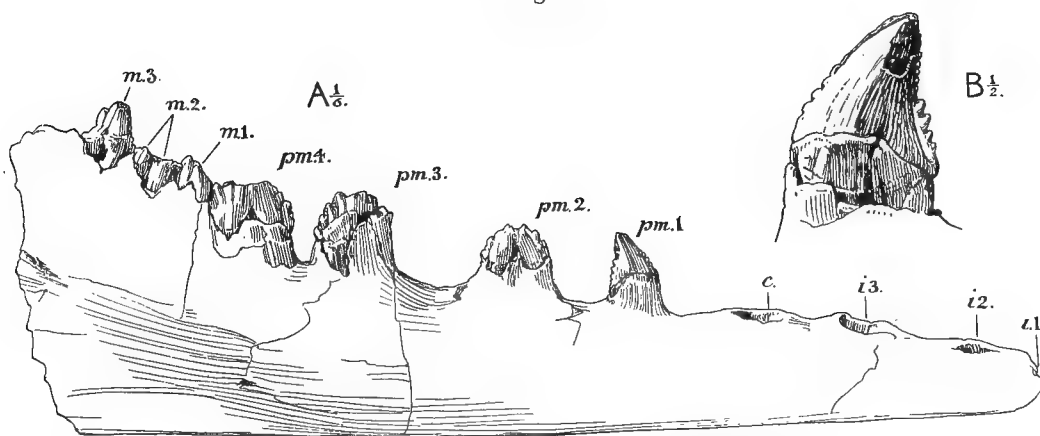
Right ramus of mandible and premolar tooth of *Zeuglodon isis*:
A, outer side of mandible, ⅙ nat. size; B, inner side of the first premolar, ½ nat. size.
i. 1–3, alveoli of incisors; *c.*, alveolus of canine; *m.* 1–3, molars; *pm.* 1–4, premolars.

situated about 2 to 3 centimetres behind it, and has an antero-posterior diameter of about 4 cm.; *i.* 3 is about 5·5 cm. behind *i.* 2, and its antero-posterior diameter is about 5 cm.; the canine is about 4·5 cm. behind the last, and its alveolus is about 5 cm. in diameter. The edges of the alveoli of these anterior teeth are very prominent. The first premolar (*pm.* 1, text-fig. 78, A) is *in situ*; it is a single-rooted tooth with a high compressed crown curving rather backwards; both its sharp anterior and posterior edges are serrated, the posterior serrations being the coarser (see text-fig. 78, B). The surface of the enamel, especially on the inner side of the crown, is sculptured by a series of fine more or less vertical ridges, which anastomose at intervals and do not run on to the serrations of the posterior border, the surface of which is quite smooth. The height of this tooth is about 6·5 cm., its antero-posterior diameter about 5 cm. *Pm.* 2 is separated from *pm.* 1 by a space of 5 cm.; it is a large double-rooted tooth with serrated anterior and posterior edges; the number of the serrations cannot be made out; the enamel both on this and the succeeding teeth is sculptured like that of *pm.* 1. The

next tooth (*pm.* 3) is separated by an interval of about 6 cm. : it is likewise two-rooted, and is much larger than *pm.* 2 ; it can be seen that the posterior border of the crown had at least three accessory denticles, of which the uppermost is the largest ; the summit of the crown is broken away ; the antero-posterior width is 6·2 cm. The next tooth (*pm.* 4) is almost in contact with *pm.* 3, to which it is closely similar in form ; its antero-posterior diameter is 6·2 cm. Immediately behind *pm.* 4 come three closely crowded molars, which differ from the premolars in having no accessory denticles on the anterior border and only one or two on the posterior. These teeth increase in size from before backwards, the last having an antero-posterior width of 4·5 cm. ; they are so closely crowded that the hinder border of the penultimate fits into a groove on the front of the last. Beneath the molars the depth of the mandible increases very rapidly, so that they are arranged in a steeply sloping line.

Mr. Beadnell records the discovery in beds of Birket-el-Qurun age, and associated with remains of *Prozeuglodon*, of a large nearly complete skull measuring 116 cm. in length. This may belong to either Fraas's species *Eocetus schweinfurthi* or to the present form ; but, judging only from a rough photograph by Mr. Beadnell of the occipital surface of this skull, it seems that the former alternative is the more likely, since the breadth of the supraoccipital region appears to be greater than in *Zeuglodon* proper.

The following specimens are provisionally referred to this species :—

C. 10019. A number of posterior lumbar and anterior caudal vertebræ of large size. Of these, two are from the lumbar region (see text-fig. 79) and are closely similar to those of *Z. macrospondylus*, figured by J. Müller * on his pl. xv. The ends of the centrum are oval in outline, and in each case the epiphysis has been lost. The ventral surface is convex from side to side, particularly near the posterior end ; in the middle is a depression into which a pair of vascular foramina open. The transverse processes are fairly large and project forwards and downwards ; they are strongly flattened from above downwards ; on their upper surface is a ridge which gives them the appearance of consisting of outer and inner elements, though in section this is found not to be the case. Above the base of the transverse processes the side of the centrum is concave. The neural arch, which occupies about half the total length of the centrum, is situated towards its anterior end ; it is very low, and the floor of the neural canal is concave both from side to side and from before backwards ; at the bottom of the concavity there is a large vascular foramen. Anteriorly the arch bears a pair of large quadrate metapophysial processes, but neither the anterior nor the posterior zygapophyses are developed ; the posterior part of the arch bears a low neural spine and is produced back in the middle line into a blunt point overhanging the posterior opening of the neural canal. In another specimen, apparently a little further back in the series, there is a deep notch for the passage of a vessel on the anterior border of the transverse process. Further back still in the caudal region this notch is converted into a foramen perforating the base of the process. In the caudal region the metapophyses become very large and massive

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* ' Ueber die fossilen Reste der Zeuglodonten von Nordamerica ' (Berlin, 1849).

processes projecting upwards, outwards, and forwards; the neural canal is very small, and there is a pair of prominences for the articulation of the chevron on the posterior lower border of the centrum.

Text-fig. 79.
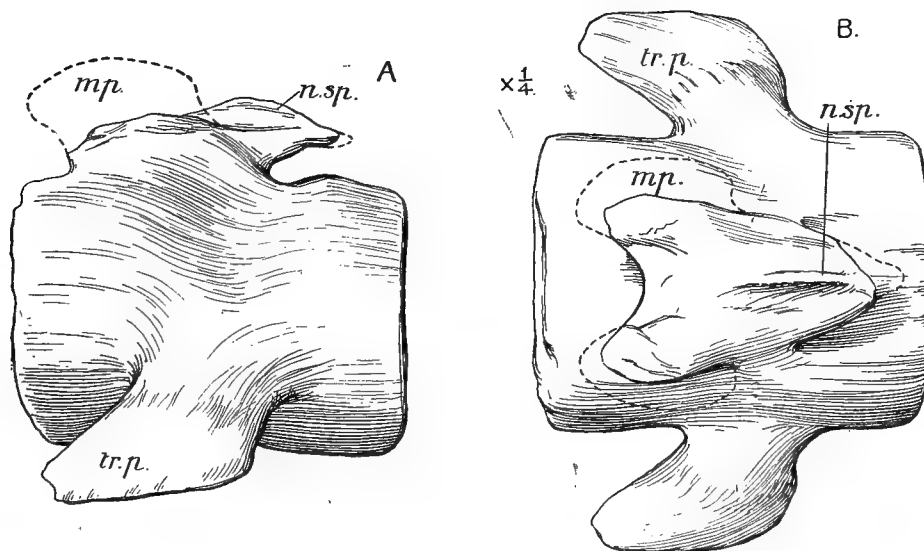
Vertebra of (?) *Zeuglodon isis*: A, from left side; B, from above.

mp., metapophysis; *n.sp.*, neural spine; *tr.p.*, transverse process. $\frac{1}{4}$ nat. size.

These vertebræ may have belonged to the large form, *Eocetus schweinfurthi*, Fraas, but their similarity to the vertebræ of the American Zeuglodonts makes it more probable that they belong to a member of the type genus, and therefore in the absence of associated skull or mandible they are placed here.

The dimensions (in centimetres) of some of these vertebræ are :—

	Lumbars.		Caudals.		
	a.	*b.*	*c.*	*d.*	*e.*
Length of centrum (without epiphysis)	20·3	21	18·5 app.	20·3	19·5
Width of anterior face of centrum.	17·5	16·5	15·5 app.	14	13 app.
Height of anterior face of centrum	14 app.	13·5	12 app.	10	. .
Width between outer ends of transverse processes .	29	32·4	27+	. .	. .
Length of neural arch	. .	9·5	8·3	. .	8·2

Genus PROZEUGLODON, gen. nov.

Includes Zeuglodonts intermediate between *Protocetus* and *Zeuglodon* proper. The dental formula is: $i. \frac{3}{3}, c. \frac{1}{1}, pm. \frac{4}{4}, m. \frac{?2}{?3},$ as in *Z. osiris*. The crowns of the molars and the three posterior premolars have accessory denticles on their sharp

cutting-edges as in *Zeuglodon*, but the two posterior premolars and the first molar of the upper jaw have a postero-internal buttress, enamel-covered, and evidently the remnant of a postero-internal cusp : in the premolars at least this buttress is supported by a large distinct third root.

Text-fig. 80.
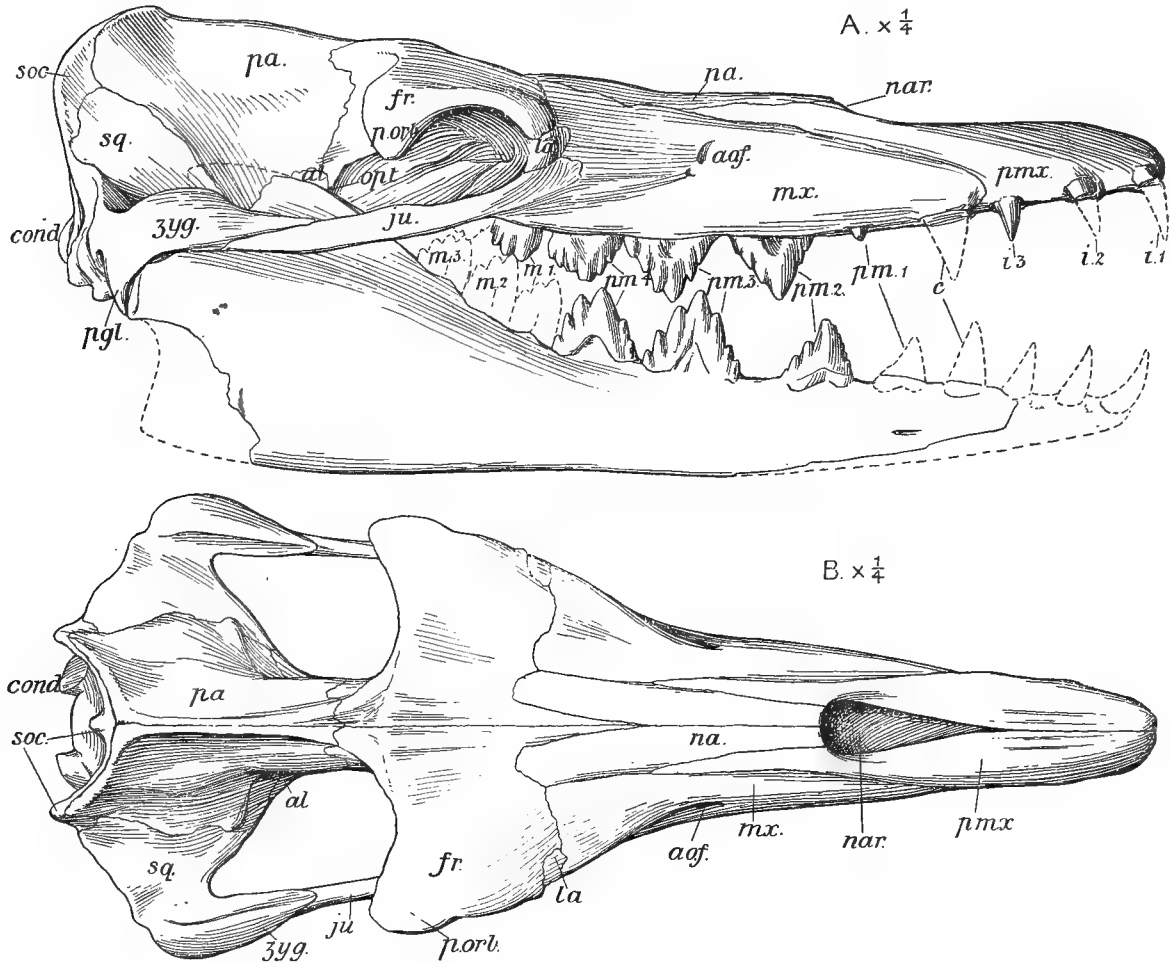
Restored figures of skull and mandible of *Prozeuglodon atrox* : A, from right side ; B, from above.

al., alisphenoid ; *ao.f.*, antorbital foramen ; *c.*, canine ; *cond.*, occipital condyles ; *fr.*, frontal ; *i.* 1–3, incisors ; *ju.*, jugal ; *la.*, lachrymal ; *m.* 1–3, molars ; *mx.*, maxilla ; *na.*, nasals ; *nar.*, external nares ; *opt.*, optic foramen ; *pa.*, parietal ; *pgl.*, postglenoid process ; *pm.* 1–4, premolars ; *pmx.*, premaxilla ; *p.orb.*, postorbital process of frontal ; *soc.*, supraoccipital ; *sq.*, squamosal ; *zyg.*, zygomatic process of squamosal.　¼ nat. size.

The genus is at present known only from one species, remains of which were found in abundance by Mr. Beadnell * in a valley about 12 kilometres W.S.W. of Gar-el-Gehannem, in beds of the Birket-el-Qurun series, a horizon beneath that in which

* ' The Topography and Geology of the Fayûm Province of Egypt' (Survey Department, Cairo, 1905), p. 47.

Z. osiris occurs, and above that of *Protocetus*. *Eocetus* of Fraas also belongs to this horizon, and the large skulls and other remains mentioned by Beadnell as occurring in the same locality may belong to that genus or to *Z. isis*.

The material available for description consists of a skull with the right ramus of the mandible, the base of the skull, the posterior end, and right side of the palate being imperfect; also portions of another skull and the three anterior cervical vertebræ in a beautiful state of preservation.

Skull (Pl. XXI.; text-figs. 80–82).—The occipital surface is broad (Pl. XXI. fig. 1 *c*; text-fig. 81), and its upper portion is comparatively flat, the lateral portions of the supraoccipital (*soc.*) which form the posterior face of the great lambdoidal crest not being reflected backwards at the sides as in *Z. osiris*; the supraoccipital, in fact, is apparently flatter even than in the earlier *Protocetus atavus*, according to Fraas.

Text-fig. 81.
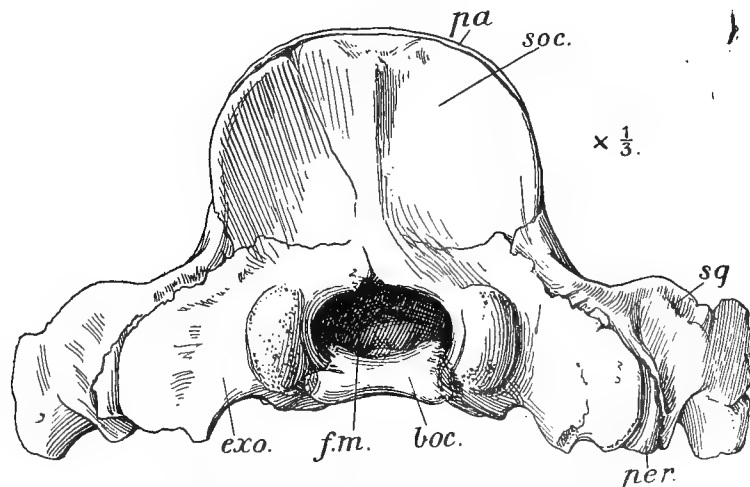
Posterior surface of skull of *Prozeuglodon atrox*.

boc., basioccipital; *exo.*, exoccipital; *f.m.*, foramen magnum; *pa.*, parietal; *per.*, periotic; *soc.*, supraoccipital; *sq.*, squamosal. $\frac{1}{3}$ nat. size.

The condyles (*cond.*) are relatively larger than in *Z. osiris*; they are strongly convex from above downwards, and appear to have run down so that their narrow ventral portions are separated from one another in the middle line by a short interval only, and must have been formed in part by the basioccipital. Above the foramen magnum (*f.m.*) the *exoccipitals* (*exo.*) meet in a median suture, excluding the supraoccipital from the opening; laterally they run out into a broad wing-like expansion, the upper edge of which unites with the posterior border of the squamosal (*sq.*), but laterally is separated from that bone by the intercalation of a strip of the mastoid portion of the periotic (*per.*), very narrow above, but widening out below. This lateral expansion

of the exoccipital is separated from the ventral portion which joins the basioccipital
by a rounded notch, which seems to have formed the hinder border of the *foramen
lacerum posterius*.   Close to the inner angle of this notch the body of the bone is
perforated by the condylar foramen, the inner opening of which is on the inner face
of the base of the condyle.

The *supraoccipital (soc.)* forms the whole of the upper part of the occipital surface :
it is gently concave from side to side, and in the middle line bears a vertical ridge
which increases in height towards the upper border, but stops short before reaching it.
This bone, together with the parietal, forms the upper part of the extraordinarily
developed lambdoidal crest, the two bones sometimes uniting in a suture as much
as 5 cm. deep.   The lateral portion of the crest for a short distance is formed by the
supraoccipital alone, which here extends on the side of the skull, forming part of
the posterior end of the temporal fossæ.   Beneath this the bone joins the squamosals
and by its ventral border the exoccipitals.

The *basioccipital (boc.)* is a very broad bone, probably forming the ventral angles
of the occipital condyles.   Its dorsal (cranial) surface is convex from side to side, the
ventral concave.   In front near its point of union with the basisphenoid the bone
widens out and bears on its outer angles a pair of large roughened tuberosities
which project outwards and downwards.

The *basisphenoid* is a very broad flat bone, uniting with the basioccipital behind
in a long straight transverse suture.   Laterally the boundaries of the bone are obscure ;
probably it united with the lower end of the alisphenoid, but if so the suture is
completely obliterated : behind this it unites in a complicated suture with the
squamosal just internal to the inner end of the articular surface for the mandible.
In front the bone is overlapped on either side by the posterior ends of the pterygoid,
which runs back to about the level of the glenoid surface.

The *parietals (pa.)* form the roof of the strongly compressed cranial portion of the
skull.   Posteriorly they unite with the supraoccipital in a very deep suture, forming
the upper part of the lambdoidal crest : in the middle line they join one another also
in a very deep suture to form the high sagittal crest.   The cranial region, though
very narrow, is somewhat more inflated than in *Z. osiris*, and beneath the sagittal
crest is gently convex from above downwards.   Ventrally these bones unite with the
portion of the supraoccipital which appears on the hinder wall of the temporal fossa,
and in front of this with the squamosal in a suture running downwards and forwards ;
the antero-ventral angle of the parietals forms a blunt projection apparently for muscle-
attachment.   The union with the frontals occurs about 3 cm. behind the great
supraorbital expansions of those bones ; the suture is a complex one, but, speaking
generally, it runs first downwards, then downwards and backwards.   In this region both
the parietals and frontals are enormously thickened.

The *frontals (fr.)*, as just mentioned, unite in a complex suture with the parietals,

forming the anterior portion of the narrow skull-roof between the temporal fossæ, though the sagittal crest is not actually continued on to them. In front of this they widen out suddenly to form the very broad and massive supraorbital processes, which completely overhang the orbits, the skull-roof at this point being very wide and gently convex from side to side. The posterior border of each supraorbital process is concave and its outer end (*p.orb.*, text-fig. 80) is greatly thickened and turned sharply down at right angles to the roof. In front of the orbit also the frontals are thickened and there join a pair of small bones, the lachrymals (*la.*), which are wedged in between them and the anterior end of the jugal (*ju.*). In the middle line in front the combined frontals send forwards a wedge-shaped process between the hinder ends of the nasals; to the side of this they are overlapped, first by the hinder end of the nasals, and external to these by the maxillæ, the line of junction running outwards and forwards. The *nasals* (*na.*) are of moderate length; posteriorly, as just mentioned, they are separated for a short distance by the frontals; in front they meet one another in a median suture. They seem to have been about the same width throughout, but anteriorly they are overlapped to some extent by the facial processes of the premaxillæ. Their anterior border in the skull described is incomplete, but it can be seen that they formed the posterior border of the narial opening (*nar.*), which they overhung to some extent. The rest of the border of the external nares is formed by the large *premaxillæ* (*pmx.*). These are greatly enlarged anteriorly, and are strongly convex on their outer face; the alveolar border bears the three alveoli of the large incisors, the first being at the extreme end of the snout, while the others are separated from it and from one another by intervals of about 1·5 cm.: on the outer surface behind and above the second and third alveoli are slight depressions for the reception of the points of the lower teeth. Within the alveolar border is a rounded ridge, which is continued back on the maxilla; there was a short palatine process. The posterior part of the upper surface of the combined premaxillæ is gently concave from side to side, and forms the floor of the narial opening, which is not sharply defined in front. Posteriorly the bones send back long facial processes, which are lodged in a groove on the upper anterior borders of the maxillæ and form the lateral borders of the narial opening, deepening considerably posteriorly where they join the nasals; the facial processes extend back to the level of the interval between the second and third premolars.

The *maxillæ* (*mx.*) are very large bones: by their upper border they unite with the premaxillæ in front, receiving the facial processes of those bones in a deep groove along their upper edge; behind this they join the nasals. Their posterior edge overlaps the anterior border of the frontals, to the outer side of which they join first the small lachrymals, then the anterior end of the jugals, beneath which, moreover, they send back a short process which bears the alveoli of the posterior molars. There is a large antorbital foramen (*ao.f.*) opening on to the side of the face at the level of the

anterior root of *pm.* 3, and beneath it a smaller aperture. The alveolar border is broad : in front are the large single alveoli for the canine, which is much larger than the incisors, and for the first premolar, behind and to the outer side of which are shallow pits for the points of the lower teeth. Then come the alveoli for the large double-rooted *pm.* 2; behind and to the inner side of the posterior root of this and the remaining premolars are deep fossæ for the reception of the points of the lower teeth. The third and fourth premolars are large three-rooted teeth which will be described below. The first molar is beneath the orbit; it had two or three roots, there being doubt as to whether the wide posterior root is merely grooved or actually divided into two. Whether any other molars were present is uncertain, but probably there was at least one more. The palatine surface of the maxilla is raised into a broad ridge as far back as the hinder end of the second premolar; then it flattens out to form the palate and unites behind with the palatines in an oblique suture : there is a pair of small posterior palatine foramina. The inner face of the bone forming the wall of the nasal passage is strongly concave from above downwards : on this face towards the anterior end of the bone is a strong longitudinal ridge increasing in height backwards, perhaps representing the maxillo-turbinal. The *lachrymal* (*la.*) is a small element forming a slight projection at the anterior border of the orbit and wedged in between the frontal, the jugal, and the maxilla. The *jugal* (*ju.*) is a comparatively stout bar of bone, the anterior end of which is thrust between the lachrymal and the backward prolongation of the maxilla; it forms the ventral border of the orbit. Its free portion is slightly flattened from above downwards in front and from side to side posteriorly; its pointed posterior end underlies the strong zygomatic process of the *squamosal* (*sq.*). This bone is very large and forms the whole of the great lateral expansion of the hinder part of the skull. Posteriorly it unites with the supraoccipital above, then with the exoccipital, and below this again with the mastoid portion of the periotic. External to this it forms a broad concave surface, looking backwards and forming the lateral region of the posterior face of the skull. The lambdoidal crest is continued on the squamosal, running downwards in an **S**-shaped curve, then becoming continuous with the sharp upper border of the zygomatic process. The upper edge of the bone unites with the supraoccipital and in front of this with the parietal, the line of union with which runs downwards and forwards and is raised into a moderately prominent ridge. Its anterior border is produced forwards as a sharp-edged shelf, the lower face of which is occupied by the glenoid articulation for the mandible. The large zygomatic prominence (*zyg.*) projects considerably beyond the rest of the bone; posteriorly it is produced downwards into a large flange-like postglenoid process. The anterior free portion of the zygomatic process is convex externally, its upper edge being continuous posteriorly with the lambdoidal crest, as already mentioned; the jugal runs back beneath it as far as the anterior boundary of the glenoid surface.

Internal to the articular surface, the squamosal unites in suture with the alisphenoid, and appears to send down a flange of bone which helped to support the great swollen *tympanic*. This element is badly preserved in the available specimens, but it can be seen that it formed a great egg-like expansion with very thick walls and seems to be obscurely divided into a small postero-internal lobe and a very much larger outer one; it is wedged in between the squamosal on the outer side, the basioccipital and (?) the basisphenoid on the inner, and the alisphenoid in front. The *periotic* (*per.*), as already described, appears on the posterior surface of the skull between the exoccipital and the squamosal; on the inner face of the skull it extends some distance upwards. The external auditory meatus opened immediately behind the postglenoid process of the squamosal.

The *alisphenoid* (*al.*) must have united at its lower end with the basisphenoid, but the suture is obliterated. Immediately in front of the tympanic bulla it is perforated by a large foramen, apparently the *foramen ovale*. Above this it joins and is overlapped by the inner end of the portion of the squamosal bearing the articular surface. Above this again it runs obliquely upwards and forwards on the side of the cranium as a wing of bone, which unites behind with the parietal and above with the frontal for a short distance. The upper part of its anterior border forms the outer lip of the posterior end of the deep groove for the optic nerve (*opt.*), which runs forwards and upwards, the upper edge of the groove being apparently formed by the lower border of the frontal and its floor by the *orbitosphenoid* (*os.*). The lower part of the anterior edge of the alisphenoid seems to unite with the posterior edge of the orbital plate of the palatine, which takes a large share in the formation of the side wall of the skull, and along its upper edge overlaps the orbitosphenoid. To the inner side of and slightly below the level of the orbit there is a large orbito-nasal (spheno-palatine) opening (Pl. XXI. fig. 1 D, *o.n.f.*), which appears to perforate the orbital plate of the palatine and communicates with the nasal passage.

The foramina of the skull are not well seen. There is a distinct condylar foramen in the exoccipital. The *foramen lacerum posterius* probably occupied the interval between the basioccipital and exoccipital and the tympanic. The lower end of the alisphenoid is perforated by a foramen which may be equivalent to the *foramen ovale*. The *foramen lacerum anterius* and the optic foramen must have opened behind the edge of the alisphenoid at the bottom of the deep groove which runs forwards to the orbit as above mentioned. The relations of the lower part of the palatines and the pterygoids cannot be made out.

From the above description it will be seen that the skull in *Prozeuglodon* differs in no important particulars from the skulls of *Protocetus atavus* and *Zeuglodon osiris*, so well described by Drs. E. Fraas and Stromer respectively. It is, in fact, in some ways intermediate between the two, as, for instance, in the position of the nares. Thus, if the total length of the skull be taken as 100, then in *Protocetus* (assuming

that Fraas's restoration of the snout is correct) the distance of the posterior border of the nares from the occipital crest would be represented by 70, in *Prozeuglodon* by 63, and in *Zeuglodon osiris* by 51. Other points in which this skull differs from that of *Protocetus* are: (1) the rostrum is much broader and more massive, and does not narrow suddenly in front of *pm.* 3; (2) the nasals are rather shorter and are separated posteriorly by a process of the frontals; (3) the supraoccipital surface is perhaps a little less concave from side to side. From the skull of *Zeuglodon osiris* this form is also distinguished by: (1) a relatively rather stouter rostrum and generally more heavily built skull; (2) the possession of much longer nasals, separated posteriorly by a process of the frontals—this nasal process of the frontals does, however, exist in some species of the genus (see J. Müller, pl. vii. fig. 2); (3) having a very much less concave supraoccipital surface; (4) the greater inflation of the cranial region of the skull.

A plaster cast of the brain-case, taken from an imperfect skull, agrees fairly well,

Text-fig. 82.
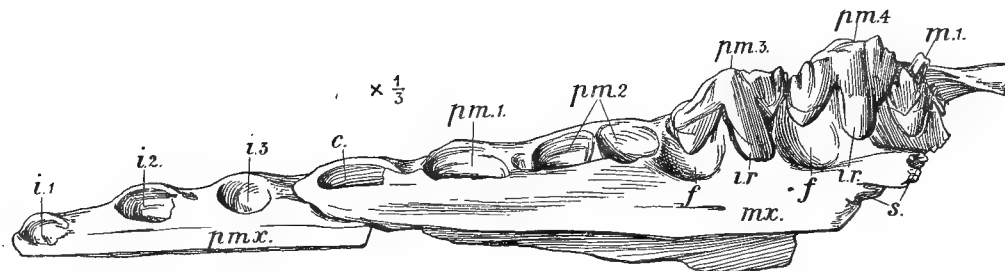
Palatal view of left premaxilla and maxilla, with *pm.* 3 and *pm.* 4, of *Prozeuglodon atrox*.

c., alveolus of canine; *f.*, fossæ for the reception of the points of the lower teeth; *i.* 1–3, alveoli of the incisors; *i.r.*, inner roots of *pm.* 3 and 4; *m.* 1, first molar; *mx.*, maxilla; *pm.* 1–4, premolars or their alveoli; *pmx.*, premaxilla; *s.*, suture for union with palatine. ⅓ nat. size.

so far as it goes, with a natural brain-cast described by Dr. Elliot Smith in his paper on the "Brain of the Archæoceti" *. In this he states that the natural cast differs so far from the artificial cast taken from a skull of *Zeuglodon osiris* that it must have belonged to an animal differing generically from that form.

Upper Dentition (Pl. XXI. figs. 1 A, 1 B; text-fig. 82).—There are three incisors, which, judging from one of which the crown is well preserved, were conical sharp-pointed teeth directed somewhat forwards. The crown is somewhat compressed laterally, and there is a slight keel on the anterior and posterior borders; the enamel at the base of the crown is raised into fine ridges. The first incisor is situated at the extreme anterior end of the premaxilla, the others follow at intervals of about 1·5 cm.;

* Proc. Roy. Soc. vol. 71 (1903) p. 322.

behind and external to the sockets of *i*. 2 and *i*. 3 there are slight pits for the reception of the tips of the lower incisors. The canine, represented by its alveolus only, was a very large tooth, much larger than the incisors : this seems to be a primitive character inherited from the Creodont ancestor. The first premolar is a single-rooted tooth, separated from the canine by an interval of about 1·5 cm., in which, to the outer side, is a pit for the lower tooth. In the skull described, *pm.* 1 is just being cut, its point appearing in the middle of the alveolus of the deciduous tooth it is replacing ; this seems to be the first instance in which any indication of a succession of teeth has been observed in the Zeuglodonts. The second premolar is separated from the first by an interval of 1·5 cm., occupied by a deep pit ; it is a double-rooted tooth with a strongly compressed high cutting-crown ; the anterior edge bears four or five small serrations, while on the hinder edge are two larger accessory denticles and a third smaller one belonging to the cingulum. Behind, and to the inner side of the posterior root of this tooth there is a deep fossa for the lower tooth. The third premolar is also a large high cutting-tooth, the crown of which is similar to that of *pm.* 2, except that on its inner side a little behind the middle point there is a prominent enamel-covered buttress, projecting inwards and backwards and supported by a large distinct root ; the presence of a third root in this and the following tooth distinguishes this genus from *Zeuglodon*. In one specimen there is also a small accessory root on the outer side of the tooth between the two main outer roots. The last premolar differs from *pm.* 3 in having a more molariform crown, the posterior border sloping much less steeply away and the three posterior denticles rising nearly to the same height ; on the anterior border the two accessory denticles are larger than on the anterior teeth. This tooth also has a large inner buttress and root. The first molar is considerably smaller than *pm.* 4 ; there seems to have been only one accessory denticle on its anterior border, while behind the main cusp there are two rising to nearly the same height, so that the edge of the posterior part of the crown is nearly horizontal. This tooth also had a postero-internal buttress, but it is relatively smaller than in the posterior premolars, and it is not clear whether it had a distinct root or is borne on the inner part of the transversely elongated posterior root, imperfectly divided by a vertical groove.

If these teeth be compared with those of *Protocetus*, they are found to be widely dissimilar. In that genus the dentition, so far as the premolars and molars are concerned, is practically that of a Creodont, the serration of the cutting-edges of these teeth, so characteristic of the later Zeuglodonts, not having been acquired in that early type. At the same time the posterior cheek-teeth (*pm.* 3–*m.* 3) possess an inner (third) root and distinct indications of an inner tubercle, both completely wanting in *Zeuglodon*. In *Prozeuglodon* the structure of the posterior premolars (*pm.* 3, *pm.* 4), and probably also of *m.* 1, is exactly intermediate, the characteristic serration having been attained while the inner (third) root is not yet lost. The posterior molars seem to be lost, or at least to be undergoing reduction. The large size of the canine compared with the

2 K 2

incisors is probably, as already remarked, a primitive character derived from a Creodont ancestry; in *Prozeuglodon* the canine seems to have been relatively larger even than in *Protocetus*. Another Creodont-like character in the upper jaw is the presence within the posterior upper premolars of large fossæ for the reception of the corresponding lower teeth. The pit for the reception of the point of the lower *pm.* 2 is on the alveolar border immediately behind *pm.* 1. In front of this the pits are on the outer side of the upper teeth, the upper and lower tooth-series crossing as in *Zeuglodon osiris* (see Stromer, *op. cit.* p. 67).

Mandible (Pl. XXI. fig. 1 E; text-fig. 80).—The imperfect right ramus of the mandible is preserved, articulated with the type skull. The posterior portions of the coronoid process and of the angular region are broken away, while the horizontal ramus is imperfect anteriorly and has lost most of its ventral border. The condyle is strongly convex from before backwards, the articular surface forming rather more than a quarter of a circle. From the condyle on the outer face of the jaw a strong shelf-like ridge runs forwards for a short distance, dying away in the strongly convex outer surface of the ventral part of the jaw; when the jaws are closed, the jugal lies in the groove above this projection. The coronoid process is thin and high; it is imperfect posteriorly, but its anterior convex border is well preserved and in front slopes steeply down to the alveolar border, which, so far as the region occupied by the molars is concerned, is also strongly inclined downwards. The horizontal ramus was comparatively slender, its outer face convex from above downwards, the inner nearly flat; the symphysis extended back to about the hinder border of *pm.* 2.

Lower Dentition (Pl. XXI. fig. 1 E; text-fig. 80).—The anterior part of the jaw is incomplete, and its upper border obscured by strongly adherent matrix, so that the alveoli of the incisors, canine, and first premolar are absent or covered up. The first tooth present seems to be *pm.* 2. This is a double-rooted tooth with a strongly compressed conical crown with sharp cutting-edges, the anterior of which is steeper than the posterior. On the anterior edge there are three or four small serrations, while on the posterior there are two accessory denticles of considerable size and a small cusp belonging to the cingulum. The next tooth, presumably *pm.* 3, is also two-rooted: it is much larger than *pm.* 2, but the crown is imperfectly preserved; both its anterior and posterior borders were serrated, the posterior serrations being few and large. The next tooth also is badly preserved; it is smaller than *pm.* 3, but the posterior serrations must have been larger. Behind these premolars are the sockets of two or three molars, the anterior molar being apparently nearly as large the last premolar. The second molar is just being cut, and there are indications of a third molar behind it.

Vertebral Column (text-fig. 83).—Three anterior cervical vertebræ probably associated with portions of a skull were collected by Mr. Beadnell. These specimens are in a remarkably perfect state of preservation, and have almost the appearance of recent bones. In the *atlas* (text-fig. 83, A, D) the surfaces for the occipital condyles (*cond.*) are

greatly elongated from above downwards, their upper ends running out on projecting plates of bone, the summits of which are nearly on a level with the upper border of the neural arch, with the anterior edge of which they are united by narrow bars of bone,

Text-fig. 83.
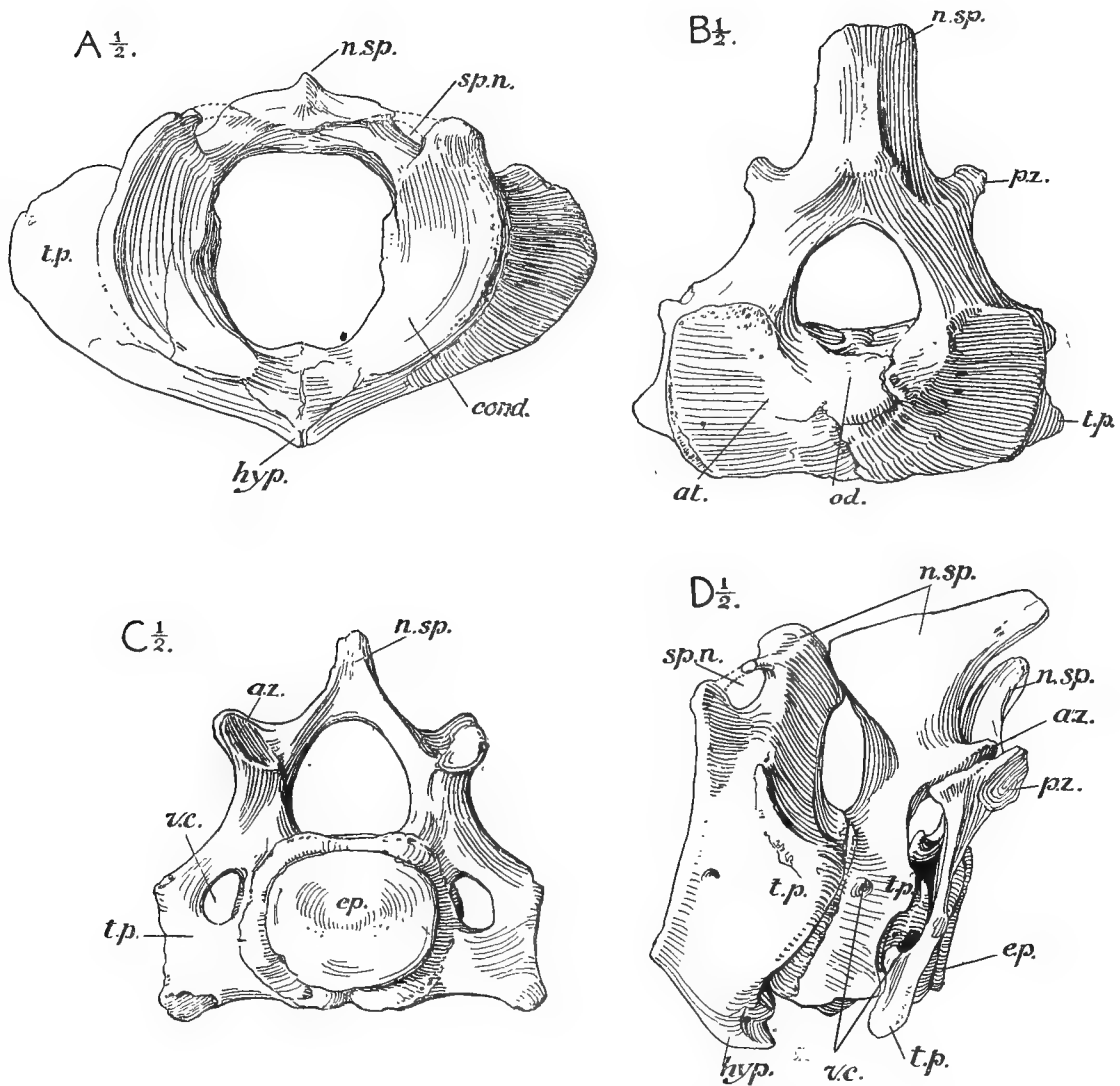
Anterior cervical vertebræ of *Prozeuglodon atrox*: A, atlas from front; B, axis from front; C, third cervical from front; D, the three anterior cervicals articulated with one another, from left side.

at., lateral surface for atlas; *a.z.*, anterior zygapophyses; *cond.*, condylar cups of atlas; *ep.*, epiphysis of centrum; *hyp.*, hypapophysis; *n.sp.*, neural spine; *od.*, odontoid process; *p.z.*, posterior zygapophyses; *sp.n.*, passage for first spinal nerve; *t.p.*, transverse process; *v.c.*, vertebrarterial canal. ½ nat. size.

enclosing a pair of large foramina for the first spinal nerve (*sp.n.*). The articular surfaces are strongly concave from above downwards and slightly so from side to side. They

are separated ventrally by an interval of about 2 cm.   The neural arch is a comparatively
narrow bar of bone connected antero-externally with the upper border of the condylar
prominences by a thin bar of bone as described above ; on the front of the bar there is
a low median ridge (*n.sp.*), but on the hinder face there is a flat facet, against which
the antero-ventral surface of the arch of the axis fits (see text-fig. 83, D).   The
transverse process (*t.p.*) is short and massive and directed a little backwards ; on the
posterior face, immediately outside the edge of the surface for the axis, there is a small
foramen, which, however, does not seem to perforate the transverse process, but merely
leads into the bone.   The surfaces for the axis are wide above, narrowing ventrally,
and passing into the surface for the odontoid without interruption ; they are slightly
convex from side to side.   The ventral bar bearing the odontoid facet is stout and
is produced downwards into a sharp-hooked hypapophysis (*hyp.*) ; from Lucas's
description * it seems that a similar process is present in the atlas of *Zeuglodon cetoides*.

In the *axis* (text-fig. 83, B, D) the odontoid process (*od.*) is short, blunt, and
rounded, passing at least ventrally into the lateral surfaces (*at.*) for the atlas.   These
are quadrate in outline, and nearly flat or even very slightly concave from side to side.
The neural arch is high, and the neural spine (*n.sp.*) high and massive ; it is triangular
in section, the posterior surface being flat, while the two anterior faces meet in an
acute angle, the lower end of which overhangs the odontoid process ; or the ventral
face of this projecting portion of the arch is a flat facet which articulates with the corre-
sponding surface on the posterior side of the neural arch of the atlas (text-fig. 83, D).
The posterior zygapophyses (*p.z.*) are well developed.   The transverse process (*t.p.*) is
a flange of bone directed a little backwards, and extending from the base of the neural
arch to the ventral border of the centrum ; externally it is divided into an upper and
lower process, and its base is perforated obliquely by a vertebrarterial canal (*v.c.*).
The posterior face of the centrum is much broader than high ; it is slightly concave,
and in this specimen the epiphysis is not completely fused with the rest of the centrum.
The ventral face of the centrum is imperfect.   The third cervical (text-fig. 83, C, D)
is remarkable for the extreme shortness of the centrum, which in the middle is only
about 1·5 cm. through, while its width is at least 5 cm.   The centrum is oval in
outline, and is completed by anterior and posterior epiphyses (*ep.*), here still separated ;
the anterior and posterior faces are slightly concave.   The neural arch is high, and
rises into a short stout neural spine (*n.sp.*) directed a little backwards.   Both the
anterior (*a.z.*) and posterior zygapophyses (*p.z.*) are well developed and nearly circular
in outline.   The transverse process (*t.p.*) is wide, and consists of a narrower upper bar
arising from the base of the arch and a much broader ventral bar from the lower half
of the centrum ; these unite externally, enclosing a large vertebrarterial canal (*v.c.*),
and forming a broad plate, the outer angle of which is produced a little downwards.

* Amer. Naturalist, vol. xxix. (1895) p. 746.

The ventral surface of the centrum bears two blunt ridges, separated by a narrow groove.

Comparison of these vertebræ with those of *Protocetus atavus* shows that a considerable alteration has taken place, and that there is much less similarity to the vertebræ of a carnivore. The atlas of *Protocetus* is unknown, but in the axis the peg-like odontoid and the relatively long centrum are characters approaching those found in the Carnivora; on the other hand, in *Prozeuglodon* the odontoid has already become short and blunt, and the centrum is much shortened, as also are the transverse processes; at the same time, the high massive neural spine is retained. In the third cervical, the great shortening up of the centrum in *Prozeuglodon* compared with the same vertebra in *Protocetus* is most striking; in this case also the transverse processes are reduced, while the neural spine is moderately developed. Comparison with the corresponding vertebræ of *Zeuglodon* shows that the present species approaches much more nearly to that genus than to *Protocetus*. The atlas is similar to the imperfect specimen figured by Müller (pl. xiii. figs. 1, 2), except that the ventral bar is not so thick; in both there is a hypapophysis. The odontoid process is more rounded than in *Zeuglodon*, its upper surface showing very little trace of flattening, and therefore differing widely from that of *Z. zitteli* as described by Stromer; the neural spine overlies the atlas, as described by Lucas. The third vertebra is shortened to about the same degree as in *Z. osiris*, and possesses a fairly developed neural spine, said to be absent in the corresponding vertebra in *Z. cetoides*.

This genus in the structure of the skeleton, so far as known, does not throw any new light upon the relationships of the Zeuglodonts to the Creodonts on the one hand or to the Odontoceti on the other; and its chief interest consists in its almost exactly intermediate position between *Protocetus* and *Zeuglodon*, both in structure and in time.

Prozeuglodon atrox, sp. nov.

[Plate XXI.; text-figs. 80–83.]

Type Specimen.—A nearly complete skull with right ramus of mandible (described above, and figured on Pl. XXI.); Geological Museum, Cairo.

This is the only species at present known. The length of the skull is 60 cm.; the length of the upper premolar series 18·2 cm.

Form. & Loc.—Birket-el-Qurun beds (Middle Eocene): a valley about 12 kilometres W.S.W. of the hill called Gar-el-Gehannem (see map in Introduction).

C. 9319. Skull with right ramus of mandible. The palatal region and base of the skull are imperfect. In the upper jaw the incisors and canine are represented by their alveoli only; the first premolar is just appearing, while the second, third, and fourth have high secant crowns, the two latter possessing three roots. Only one molar is *in situ*, and it is

uncertain whether this had two or three roots. In the mandible the only teeth preserved are the three posterior premolars. Figured Pl. XXI. In the following table the dimensions (in centimetres) of this skull are placed in the first column, the corresponding measurements in *Protocetus atavus* according to E. Fraas, and in *Zeuglodon osiris* according to Stromer, being given in the second and third columns respectively :—

	Prozeuglodon atrox.	*Protocetus atavus.*	*Zeuglodon osiris.*
Length from the end of the snout to the occipital crest	60	60	70 app.
,, ,, ,, ,, foramen magnum	61 app.	58	68
,, from hinder border of the narial opening to the occipital crest	36	42	36
,, of the narial opening	7 app.	7	..
Breadth of the narial opening	3·8	2·5	..
Length from the posterior border of the frontals to the occipital crest	16·5 app.	20·5	..
Width of the skull at the narial opening	9·4	4·3	..
,, ,, at the supraorbital expansion	24·5	16·7	24 (?)
,, ,, between the temporal fossæ	4·5	3·3	..
,, ,, at the zygomatic process	34 app.	24	28 (?)
Height of occipital surface above the upper edge of the foramen magnum	11·8	8	13 (?)
Width between outer ends of condyles	11 app.	..	..
,, of foramen magnum	5 app.	2·6	..
Length of premaxilla	29	30	34·5
,, nasals	16·2	18·5	16
Greatest breadth of nasals taken together	4·5	2·5	4·4
Distance between jugal and postorbital process of frontal	2·5	..	..

The dimensions (in centimetres) of the upper teeth (or, where absent, of their alveoli) :—

	Length.	Width.
i. 1 (at alveolus)	1·8	1·2
i. 2 ,,	2·3	1·4
i. 3 ,,	1·9	1·3
c. ,,	2·7	1·8 app.
pm. 1	?	?
pm. 2	4·7	1·3
pm. 3	4·5	1·8
pm. 4	3·7	1·7
m. 1	3·1	1·8

Length of incisor series 9 cm. Length of premolar series 18·2 cm.

M. 9266. Portions of a much broken skull, including the posterior (cranial) region, the frontal expansion, the maxilla, and the premaxilla ; the last contains no teeth, but in the maxilla *pm.* 3, *pm.* 4, and part of *m.* 1 are still *in situ*, and show the three roots of the premolars (text-fig. 82). The cranial region is interesting, because nearly all the sutures remain open, and the structure of the occipital region is well shown (text-fig. 81). From this specimen a brain-cast similar to the natural brain-cast described by Dr. Elliot Smith * has been made (M. 9265). The dimensions (in centimetres) of this specimen are :—

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* Proc. Roy. Soc. vol. 71 (1903) p. 322.

Width of supraoccipital surface	13·2	
Height of supraoccipital surface above foramen	11·7	
Width of skull at zygomatic process	34 app.	
„ between outer ends of exoccipitals	22	
„ of foramen magnum	6 app.	
„ between ends of supraorbital processes	13	
„ at temporal fossæ	4·5	
Length of alveolar border of premaxilla	11·5	

The dimensions (in centimetres) of the teeth (or their alveoli) are :—

	Length.	Width.
i. 1 (alveolus only)	2·5	1·8
i. 2 „	2·7	1·7
i. 3 „	2·4	1·6
c. „	3·1	2·4
pm. 1 „	3·5	2·2
pm. 2	5·2	1·8 (anterior root).
pm. 3	4·5	3·1
pm. 4	4·3	2·5

Presented by the Egyptian Government, 1905.

C. 9329, C. 9230, C. 9332. Atlas, axis, and (?) third cervical vertebræ, presumably associated and perhaps belonging to the same animal as the portions of a skull just noticed. Described and figured above (text-fig. 83). These vertebræ are in a nearly perfect state of preservation. The epiphyses are not fused with the centrum, though still *in situ*. The dimensions (in centimetres) of these vertebræ are given below :—

Atlas (text-figs. 83 A, 83 D) :

Greatest width at surface for condyles	11·2
„ „ „ axis	10·6
„ „ transverse processes	15·7
„ height	10
Width of neural canal	4·9

Axis (text-figs. 83 B, 83 D) :

Length of centrum including odontoid process	5·5
Height to top of neural spine	12
Width of posterior face of centrum	5·2 app.
„ at transverse process	11·2
„ of neural canal	3·2
Height of neural canal	3

Third cervical (text-figs. 83 C, 83 D) :

Width of centrum	4·8
Height of centrum	4·2
Thickness of centrum (in middle)	1·5
„ „ (lower border)	1·8
Height to top of neural spine	9·6
Width at transverse processes	10·5
Height of neural arch	3·2
Width of neural arch	3

Class AVES.

Order RATITÆ.

Genus EREMOPEZUS, Andrews.
[Proc. Zool. Soc. 1904, vol. i. p. 168.]

The distal end of the tibio-tarsus is compressed from before backwards; there is a well-marked intercondylar groove; no bony bridge over the groove for the extensor tendons is present.

Eremopezus eocænus, Andrews.
[Text-fig. 84.]

1904. *Eremopezus eocænus,* C. W. Andrews, *loc. cit.* p. 168, text-fig. 15.

Type Specimen.—The distal end of left tibio-tarsus (text-fig. 84); British Museum. Type and only known species; about as large as the Rhea.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

The only avian remains hitherto collected in the Fayûm are the distal end of a left tibio-tarsus and a doubtful phalange of the pes of a large Ratite bird. The fragment of the tibio-tarsus consists of the articular end and 4 or 5 centimetres of the shaft, and so far as it goes is in good preservation, only the inner condyle being slightly abraded. The outer condyle, the upper angle of which extends some distance up the antero-external border of the bone, seems to be larger in proportion to the inner than in the other Ratites, with the possible exception of *Struthio.* The condyles are separated by a well-marked intercondylar groove, thus resembling the tibiæ of *Casuarius* and *Rhea* rather than those of *Æpyornis* and *Struthio,* in which the groove is very shallow. The postcondylar prominences are small, being much less prominent than in *Struthio,* but are developed to about the same degree as in *Dromæus.* The outer postcondylar process does not extend so far upwards as does the condyle in front, and is separated from this last by a sharp angle of about 90° (see text-fig. 84 B, *a.*), which forms the distal end of the bone posteriorly; the consequence of this arrangement is that the articulation looks more forwards than is usually the case, though some

approximation to this condition is seen in *Struthio,* and still more in *Rhea.* The surface between the postcondylar processes is slightly concave, and above passes into the posterior surface of the shaft, which, like the articular end, is strongly compressed from before backwards. The lateral faces of the condyles bear deep pits for the attachment of ligaments (text-fig. 84 B).

The posterior face of the shaft passes by a gentle slope into the sharp antero-internal border of the bone, which is continuous with the upper angle of the inner condyle, as in *Casuarius* and *Dromæus.* The anterior face of the shaft near its inner border is deeply channelled by the groove for the extensor tendons (text-fig. 84 A, *e.g.*); this groove is closed at its lower end by a strong ridge running upwards and outwards towards the lower border and forming a prominent rugose surface above the outer

Text-fig. 84.
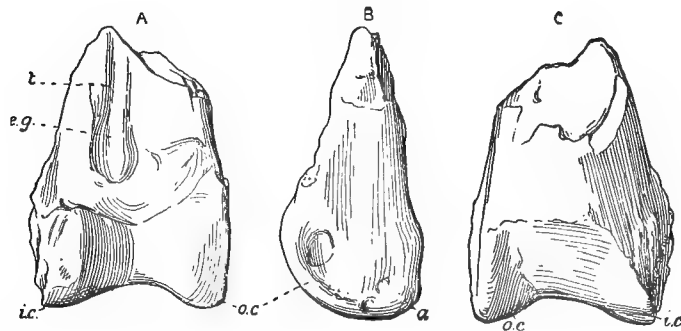
Distal end of left tibio-tarsus of *Eremopezus eocænus* (type specimen): A, from front; B, from outer side; C, from behind. (From Proc. Zool. Soc.)

a., angle between outer condyle and postcondylar surface; *e.g.*, extensor groove; *i.c.*, inner condyle; *o.c.*, outer condyle; *t.*, tubercle marking base of tendinous bridge. $\frac{2}{3}$ nat. size.

condyle. There is no extensor bridge, but a slight ridge along the inner side of the groove marks the insertion of a strong tendinous sling (*t.*).

Compared with the tibio-tarsi of other Ratites this specimen appears to combine the characters of several of them. In the depth of the extensor groove it approximates to *Rhea* and *Æpyornis.* The oblique ridge which blocks the lower end of the groove occurs also in *Struthio,* though in this case the groove itself is much narrower. In *Æpyornis,* on the other hand, the ridge is wanting, and the groove runs nearly down to the condyles. The form of the outer condyle and its relations to the postcondylar process are similar to what is seen in *Rhea,* and to some extent also in *Struthio.*

There seems to be no doubt that this fragment indicates the existence of a large Ratite bird in the Upper Eocene beds of Egypt, but much more material is necessary before its relationships can be determined satisfactorily.

A. 843.   Distal end of left tibio-tarsus.   Type specimen, described and figured in Proc. Zool. Soc. 1904, vol. i. pp. 168–170, text-fig. 15, which is reproduced in text-fig. 84.   The dimensions (in centimetres) of this specimen are :—

Width of distal articular end . . . .   4·8
   ,,   of lowest end of shaft (at highest point preserved) . .   3·5
   ,,   from front to back of the outer condyle . . . . . .   3·5

A. 843 a.   Phalange of toe, from the same pit as last specimen.   This bone is remarkable for the breadth and depth of its proximal end compared with the distal.   The dimensions (in centimetres) of this specimen are :—

Length . . . .   3·1
Width of proximal end   2
   ,,   distal end . . . .   1·2

Class R E P T I L I A.

Order C R O C O D I L I A.

Suborder *E U S U C H I A.*

Remains of Reptiles belonging to this group are fairly common both in the Qasr-el-Sagha beds (Middle Eocene) and in the Fluvio-marine beds of the Upper Eocene. From the former horizon remains of *Tomistoma africanum* and of a short-snouted species of *Crocodilus* have been obtained, while from the latter a *Tomistoma* (*T. gavialoides*), a long-snouted Crocodile (*C. articeps*) and a short-snouted form (*C. megarhinus*) have been collected. Scattered scutes, vertebræ, and other bones, sometimes in groups probably belonging to a single individual, are of common occurrence; but since none of these have been found in association with the skull or mandible, their satisfactory determination is difficult and may be deferred till better material is forthcoming.

Family CROCODILIDÆ.

Genus **CROCODILUS**, Laurenti.
[Synop. Rept. 1768, p. 53.]

Crocodilus articeps, Andrews.
[Plate XXII.]

1905. *Crocodilus articeps*, C. W. Andrews, Geol. Mag. [5] vol. ii. p. 481.

Type Specimen.—Anterior portion of a well-preserved skull (Pl. XXII. figs. 1, 1 A, 1 B); Geological Museum, Cairo.

This is a long- and narrow-snouted species, the length from the level of the front border of the orbits being about two and a half times the width at the same point. There are five premaxillary and sixteen maxillary teeth. The premaxillary region is scarcely at all expanded.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

The incomplete skull which is taken as the type of this species is the best preserved of the crocodilian skulls collected by Mr. Beadnell from the Upper Eocene beds.

The posterior portion behind the middle of the orbits is wanting, but the remainder is complete and undistorted, though nearly all the teeth are missing. In the general form of its head this Crocodile must have been very similar to the recent species *C. cataphractus* and *C. intermedius*, the snout being long and slender, its length being about $2\frac{1}{2}$ times as great as its width at the level of the front of the orbits, as in the species mentioned. The upper surface of the preorbital region is somewhat flattened and is bent sharply downwards at the sides to the alveolar border, at least posteriorly : as a whole, the snout is bent somewhat upwards, so that in profile it is slightly concave above ; it narrows gradually towards its anterior extremity, there being scarcely any expansion of the premaxillary region, the posterior boundary of which is, however, marked by a slight notch behind the fifth tooth, where the maxillo-premaxillary suture passes on to the palate. The facial processes of the premaxillæ extend back to the level of the alveolus of the third maxillary tooth, while the palatine processes reach only to the level of the interval between the first and second teeth ; there is a small triangular anterior palatine vacuity. The nasal opening is large and an elongate oval in outline ; the nasals extend into the opening, but the premaxillæ seem to have just met one another in its posterior border. The anterior angle of the palatine bones is opposite the eighth maxillary tooth, and the anterior angle of the posterior palatine vacuities is opposite the ninth. The sculpture of the facial surface of the bones is much more strongly marked in the neighbourhood of the orbits than it is further forwards.

The alveolar border of the jaw is sinuous, the concavities being at the junction of the maxilla and premaxilla and between the seventh and eighth maxillary teeth. The alveoli of the anterior premaxillary teeth are comparatively small and are almost in contact in the middle line. They are separated from the alveoli of the second pair by deep pits for the reception of the anterior mandibular teeth, which perforated the upper surface of the snout. The second pair are small, and they are in close contact with the much larger third pair, behind which there is a notch. The fourth pair are large and are separated by a pit from the smaller fifth and last pair of premaxillary teeth. Between the premaxillary and maxillary series there is a notch for the reception of the large mandibular tooth. The first three maxillary teeth are comparatively small and nearly equal in size, and are separated by shallow pits. The fourth and fifth are much larger, and the sixth is also large and is separated by a pit from the much smaller seventh. Behind this there is a deep notch in the side of the jaw. The eighth tooth is small, the ninth and tenth much larger ; then come six other teeth gradually diminishing in size from before backwards. The teeth themselves are nearly all wanting in the present specimen, but in one which is well preserved it can be seen that they had sharp anterior and posterior carinæ and that the inner face is flatter than the outer ; the enamel is marked with fine parallel grooves.

As already mentioned, the general form of this skull resembles that of the skulls

of *C. cataphractus* and *C. intermedius* and to a less degree of *C. americanus*; from the two former it is distinguished by the much longer nasals and the very slight expansion of the premaxillary region. In *C. americanus* also the premaxillary expansion is greater and the snout is rather less elongated.

Of the long-snouted Eocene Crocodilia previously described, the present species seems to approach most nearly to *C. arduini*, Zigno *, from the Nummulitic beds of Monte Zuello, near Verona; but it differs from the latter in the smaller expansion of the premaxillary region, the comparative narrowness of the interorbital bar, and the less rounded orbits. *Crocodilus spenceri*, Buckland †, which Lydekker ‡ regards as identical with *C. arduini*, differs in much the same way, but the premaxillary region seems to be still more expanded than in the Italian form, and, so far as can be seen, it differs also in having the premaxillo-maxillary suture on the palate almost transverse. *Crocodilus bolcensis*, Sacco §, from the nearly contemporary Monte Bolca beds, is distinguished from the present species by the fact that the nasals do not extend nearly to the nasal opening and, judging from the figure, by the much wider interorbital bar: this latter character may be partly dependent on the age of the individual. *Crocodilus vicentinus*, Lioy ‖, from the same beds, is a wide-snouted form.

Although no mandible has been found in actual association with the skull of this species, specimens showing a form and dentition such as might be expected to belong to it have been collected. The most nearly perfect of these (C. 10065) is figured on Pl. XXII. figs. 2, 2 A; it is almost complete, wanting only the posterior extremity of the left ramus: the teeth are for the most part in an excellent state of preservation. The symphysial region is comparatively long and narrow, though less so than in *C. cataphractus*, *C. intermedius*, *C. arduini*, and probably also than in *C. bolcensis*; it reaches back to the level of the sixth tooth, and the splenial does not extend into it. The alveolar border is sinuous, the convex portions bearing the larger teeth, which are the fourth and the tenth and eleventh. The horizontal ramus presents no special peculiarities (see Pl. XXII. figs. 2, 2 A). There are fifteen teeth in all; of these the first is rather large and projects forwards. As already remarked, the fourth and tenth teeth are the largest, the eleventh being a little smaller; the rest of the teeth are small. As far back as the eleventh all the teeth are sharp with strongly carinated anterior and posterior edges, but behind the eleventh they are blunt and rounded. There are well-marked notches for the reception of the upper teeth behind the second, sixth, and seventh teeth, and shallow pits behind the eleventh and twelfth teeth.

* Atti R. Accad. Lincei, Memorie, [3A] vol. v. (1880) p. 65, pls. i., ii.
† Geol. and Mineral. ed. 1 (1836) vol. i. p. 251, vol. ii. p. 36, pl. xxv'. fig. 1.
‡ Catal. Foss. Rept. Brit. Mus. vol. i. 1888, p. 60.
§ Mem. R. Accad. Sci., Torino, [2] vol. xlv. (1896) p. 77, pl. i. figs. 5 *a*, 5 *b*.
‖ Atti Soc. Ital. Sci. Nat. vol. viii. (Milan, 1865) p. 393.

C. 10036. Anterior portion of skull.   Type specimen, figured on Pl. XXII. figs. 1, 1 A, 1 B.
The dimensions (in centimetres) of this specimen are :—

Extreme length of specimen so far as preserved   43
Distance from anterior angle of orbit to tip of snout   . . .   37
Width of skull at the level of the anterior angle of the orbits.   14
    ,,   snout at narrowest   . . . .   4·8
    ,,   premaxillary expansion . . . .   5·5
    ,,   nasal opening . . . .   2·7
Length of nasal opening . . . .   3·3
Distance from anterior end of palatine fossa to tip of snout .   28·2

R. 3322. Plaster cast of the above specimen.   *Made in the British Museum.*

R. 3106. Anterior portion of snout of a larger individual.
                                         Presented by W. E. de Winton, Esq., 1903.

C. 10065. Nearly complete mandible. Figured on Pl. XXII. figs. 2, 2 A. The dimensions (in centi-
metres) of this specimen are :—

Extreme length . . . .   55·8
Length of symphysis . . . .   10·8
Width of symphysis at widest . . . .   8 app.
Greatest depth of ramus   8
Width of articular surface for quadrate   5

R. 3323. Plaster cast of the above specimen.   *Made in the British Museum.*

R. 3324. Symphysial portion of mandible of a rather large individual. Length of the symphysis
13·4 cm.   *Presented by the Egyptian Government,* 1904.

R. 3105. Symphysial region of left ramus of mandible of a large individual.
                                         Presented by W. E. de Winton, Esq., 1903.

Crocodilus megarhinus, Andrews.

[Text-fig. 85.]

1905. *Crocodilus megarhinus,* C. W. Andrews, Geol. Mag. [5] vol. ii. p. 482.

Type Specimen.—The anterior portion of a large skull (figured in text-fig. 85);
British Museum.

In this species the premaxillary region is considerably expanded, though longer in
proportion to its width than in *C. porosus*; the facial process of the premaxilla extends
back to behind the fourth maxillary tooth.   Five premaxillary teeth, behind the last a
deep notch for the lower tooth.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

Remains of a broad-snouted Crocodile, which attained very large dimensions, are
found in the Upper Eocene beds.   The most satisfactory specimen (text-fig. 85), which
has been taken as the type of the species, is the anterior portion of a snout.   In this
the premaxillary region is considerably expanded, but is longer in proportion to its

width than in *C. porosus* and is also less broadly rounded in front. There are five premaxillary teeth, here represented by their bases or by the alveoli only. The first tooth is small and close to the middle line ; it is separated by a deep fossa from the second, which is also small, and is situated immediately in front of the third, which is very large ; the fourth is still larger, the fifth much smaller. Behind this last is a deep and narrow notch for the fourth lower tooth, and behind this again are three sockets set close together and increasing rapidly in size from before backwards. The jaw behind this

Text-fig. 85.
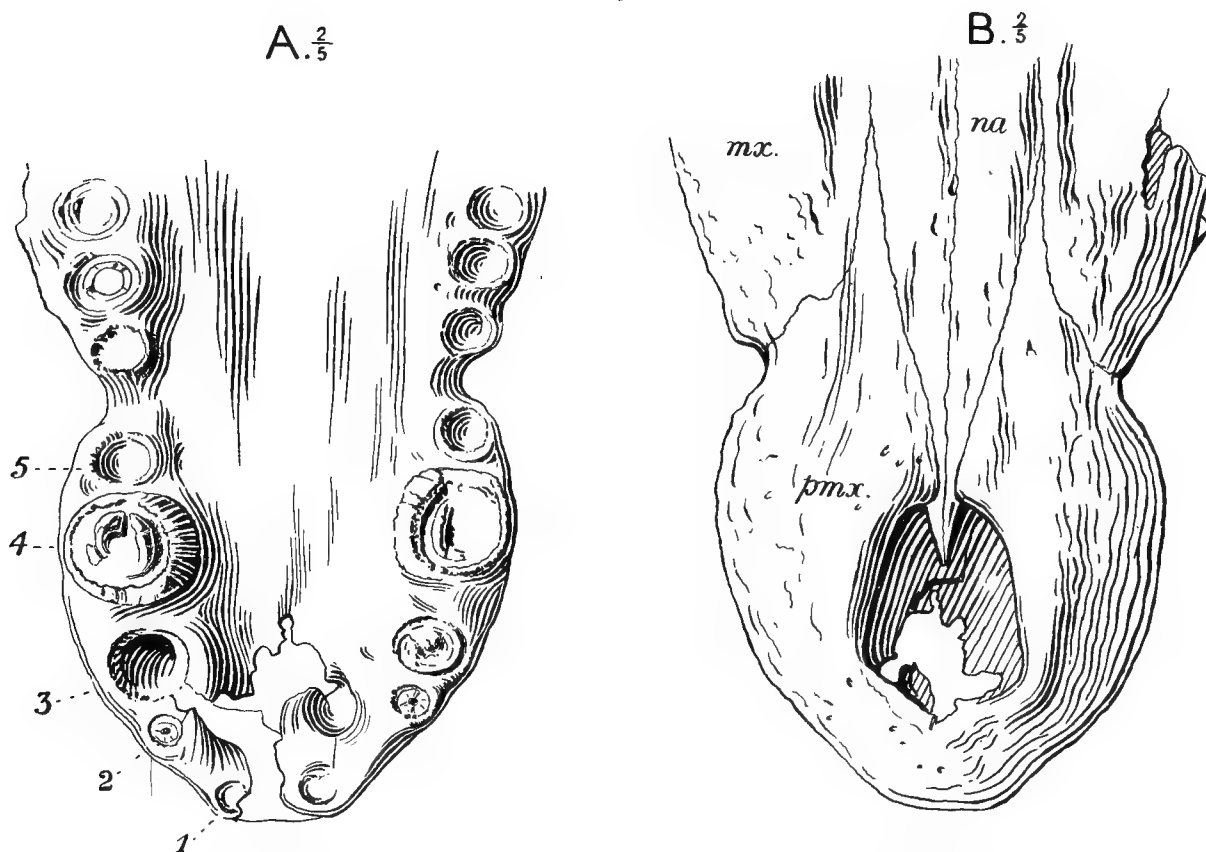
Anterior portion of skull of *Crocodilus megarhinus*, type specimen : A, from below ; B, from above.

mx., maxilla ; *na.*, nasal ; *pmx.*, premaxilla ; 1–5, premaxillary teeth. $\frac{2}{5}$ nat. size.

point is imperfect. In the premaxillary region the palate is gently concave from side to side ; the maxillo-premaxillary suture is obscure. Seen from above the comparatively considerable elongation of the premaxillary region is very noticeable and distinguishes this species from *C. porosus, C. paludosus*, and from *C. niloticus* of similar size. The nasal opening is large and oval in form ; the pointed ends of the nasals (*na.*) project into it posteriorly. The facial processes of the premaxillæ (*pmx.*) extend backwards

2 M

as far as behind the fourth maxillary tooth, or further than in the recent forms with which it has been compared.

The anterior portion of a large mandible, probably belonging to this species, has been found. As might have been expected from the longer premaxillary region, the symphysis is more elongated than in *C. porosus*, *C. paludosus*, and *C. niloticus*, and extends backwards to the level of the hinder border of the alveolus of the sixth tooth; the splenial takes no share in its composition. The upper surface of the symphysis is marked by a ridge along the line of junction of the two rami, while its ventral surface is somewhat flattened. The anterior tooth is large; it is followed by three smaller ones, then comes the greatly enlarged fourth tooth, followed by five smaller sockets. The two following teeth (10 and 11) are again very large.

R. 3327. Anterior portion of the snout. Type specimen described Geol. Mag. [5] vol. ii. p. 482. Figured in text-fig. 85. The dimensions (in centimetres) of the specimen are :—

Total length so far as preserved	50
Width of premaxillary expansion	15·6
Width at notch for fourth lower tooth	12·2
Distance from posterior border of nasal opening to tip of snout	11
Distance from posterior end of facial processes of premaxillæ to tip of snout	24·5

Presented by W. E. de Winton, Esq., 1903.

R. 3328. Anterior portion of mandible. The length of the symphysis is 17 cm.

Presented by W. E. de Winton, Esq., 1903.

R. 3104. Imperfect left ramus of mandible, probably of this species.

Presented by W. E. de Winton, Esq., 1903.

Crocodilus sp.

From the Qasr-el-Sagha beds (Middle Eocene) some very fragmentary remains of a broad-snouted Crocodile have been obtained, but the material is insufficient to determine whether or not this is a new species. Possibly some of the vertebræ and other bones enumerated under *Tomistoma africanum* should be placed here.

The best-preserved fragment is the anterior portion of the left ramus of a mandible. The symphysis extends to the level of the hinder border of the fourth tooth. The first tooth is rather large, the second and third are small, while the fourth is greatly enlarged and raised on a prominence of the alveolar border. Behind it are four small teeth, then two large ones; beyond this point the bone is broken away.

Another fragment shows that not only the ninth and tenth, but also the eleventh tooth was enlarged.

R. 3344. Anterior portion of left ramus of mandible. The total length of the specimen is 17 cm., the length of the symphysis about 6·5 cm.

R. 3197. Fragment of right ramus of mandible with the remains of three teeth.

<div align="center">

Genus **TOMISTOMA**, S. Müller.

[Arch. f. Nat. (1846) p. 122.]

Tomistoma gavialoides, Andrews.

[Plate XXIII. figs. 3, 3 A.]

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1905. *Tomistoma gavialoides*, C. W. Andrews, Geol. Mag. [5] vol. ii. p. 483.

Type Specimen.—A nearly complete skull, wanting only the posterior portion of the palate and the end of the rostrum (Pl. XXIII. figs. 3, 3 A) ; Geological Museum, Cairo.

This species is in many respects intermediate between *Gharialis* and *Tomistoma*. The roof of the skull is wide, the supratemporal openings large. The nasals extend forwards between the facial processes of the premaxillæ ; the premaxillary expansion is less than in *Gharialis*. There are 22–23 teeth on each side. The length of the type skull from occipital condyle to tip of snout is 64 cm.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

Remains of this species are fairly abundant, though for the most part fragmentary. The best specimen found by Mr. Beadnell is the nearly complete skull, which is figured and is to be regarded as the type. In its general form, as well as in many of the details of its structure, this skull is intermediate between those of *Tomistoma schlegeli* and *Gharialis gangeticus* *, resembling the latter in so many points that, were it not for the facts that the nasals are in contact with the premaxillæ and that the number of teeth is small, this species might almost as well be referred to *Gharialis* as to *Tomistoma*.

The upper part of the occipital surface is almost exactly as in *Gharialis*, a small wedge-shaped process of the supraoccipital appearing on the skull-roof, interposed between the posterior ends of the parietals and forming a backwardly projecting

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* For a comparison of the skulls in these two species, see Koken, " *Thoracosaurus macrorhynchus*, Bl., aus der Tuffkreide von Maastricht," Zeitschr. deutsch. geol. Gesell. vol. 40 (1888) p. 754.

prominence. The portion of the basioccipital beneath the occipital condyle is comparatively short and much more nearly resembles the basioccipital of *Gharialis* than the vertically elongated bone of *Tomistoma schlegeli*, but at the same time the basal tuberosities for muscle-attachment are only slightly developed. The *foramen magnum* is wider than high, as in *Tomistoma*. The skull-roof differs widely from that of the recent *Tomistoma*, particularly in its much greater breadth, which depends mainly on the large size of the supratemporal openings. One result of this increased width of the skull-roof is that the lateral temporal fossæ look more directly outwards and less upwards than in *Tomistoma*, thus more nearly approaching the condition found in the Gavial. The orbits, unlike those of *Tomistoma schlegeli*, are rounded more as in *Gharialis*, but at the same time have not the prominent borders found in that genus. In the width of the interorbital bar this skull is exactly intermediate between the two genera.

In front of the orbits the snout narrows less gradually than in *Tomistoma*, but at the same time not nearly so suddenly as in *Gharialis*; in the degree of its dorsiventral compression also it is intermediate between the two. The long slender nasals extend forwards to a point about opposite the first maxillary tooth, thrusting themselves between the slender facial processes of the premaxillæ, which extend back to the level of the space between the fourth and fifth maxillary teeth, so that the overlap of the two bones is considerable. It is mainly on account of this character that this species is referred to *Tomistoma*, since in *Gharialis* the nasals are separated from the premaxillæ by a long interval in which the maxillæ meet in a median suture. On the palate the palatines extend forwards in a wedge between the posterior ends of the palatine plates of the maxillæ, reaching the level of the twelfth maxillary tooth. The form of the maxillo-palatine suture is the same as in *Gharialis*, while in *Tomistoma schlegeli* it is only slightly convex forwards. The premaxillary expansion is much less than in *Gharialis*, but at the same time rather more marked than in *Tomistoma schlegeli*; on the palate the premaxillæ extend backwards between the maxillæ to just behind the level of the third maxillary tooth. The nasal opening is comparatively large.

In the specimen described all the teeth have fallen from their sockets, but from these it can be seen that there were 22 or 23 on each side, or rather more than in *Tomistoma* (20–21), but considerably fewer than in *Gharialis* (27–29). In each premaxilla there are five teeth arranged as in the Gavial. In the recent *Tomistoma* only four are present, though in some of the fossil forms referred by Lydekker to that genus five are present (*T. champsoides*, *T. eggenburgense*); the third and fourth are the largest, and behind the fifth is a broad notch for the reception of the mandibular tooth. In the maxillæ the alveoli are almost equal in size throughout, and they open outwards and forwards, both Gavial-like characters. There are no pits for the reception of the lower teeth, except perhaps between the alveoli 12–13 and 13–14.

In some respects the present species approaches the Lower Miocene form described

in detail by Toula and Kail * under the name *Gavialosuchus eggenburgensis*, and placed by Lydekker † in the genus *Tomistoma*. This species also is intermediate in many respects between *Gharialis* and *Tomistoma*. Some of the more important points in which its skull differs from that here described are: (1) the roof of the skull is relatively narrower; (2) the borders of the orbits are raised; (3) the temporal fossæ are smaller. On the other hand, the resemblances are so considerable that if the genus *Gavialosuchus* were maintained the present species might be referred to it.

Koken ‡ has described, under the name *Thoracosaurus macrorhynchus*, the skull of a long-snouted Crocodile from the uppermost Cretaceous beds of Mount Aimé, near Epernay, a form originally figured by de Blainville § as *Crocodilus macrorhynchus*. He shows that it is intermediate in form between the skulls of *Gharialis* and *Tomistoma*, and it seems to resemble closely the species now under discussion. It is doubtful, however, whether Blainville's *Crocodilus macrorhynchus* can properly be referred to *Thoracosaurus*, a genus originally founded by Leidy ‖ for the reception of the species *T. neocesariensis*, de Kay, sp. ¶, from the Upper Cretaceous of New Jersey, the skull of which differs in possessing antorbital vacuities (which, however, according to Koken, may be merely accidental breaks in the bone), a more massive skull, and relatively larger teeth. In any case it appears that the present species, *Gavialosuchus eggenburgensis*, and *Thoracosaurus macrorhynchus* are all intermediate between *Gharialis* and *Tomistoma*, as now existing, and for the present the contact of the nasals with the premaxillæ seems to incline the balance in favour of placing them in *Tomistoma*.

C. 8948. Skull, wanting the posterior part of the palate and the tip of the snout. The type specimen described above and figured on Pl. XXIII. figs. 3, 3 A. All the teeth are wanting. The dimensions (in centimetres) of this specimen are:—

Length from quadrate articulation to snout	68 app.
„ occipital condyle to snout	64
„ anterior border of orbit to end of snout	46·5 app.
Width between outer angles of quadrates	27
„ of foramen magnum	2·5
Greatest width of skull-roof	18
„ „ superior temporal fossa	5·9
Antero-posterior diameter of orbit	4·8
Width of interorbital bar	3·4
„ middle of rostrum	6·4
Extreme length of premaxillæ	19·5

R. 3329. Plaster cast of the above specimen. *Made in the British Museum.*

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* Toula and Kail, "Ueber einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg," Denkschr. d. k. Akad. Wiss. math.-naturw. Cl. vol. l. (1885) p. 299, pls. i.–iii.

† Lydekker, "On the Occurrence of the Crocodilian Genus *Tomistoma* in the Miocene of the Maltese Islands," Quart. Journ. Geol. Soc. vol. xlii. (1886) p. 20.

‡ *Op. cit. suprà.* § Ostéographie, Atlas, vol. viii. pl. vi.

‖ Proc. Acad. Nat. Sci. Philad. vol. vi. (1852) p. 35. ¶ Zool. New York, pt. iii. (1842) p. 28.

R. 3325. Posterior portion of skull.   The dimensions (in centimetres) of this specimen are :—

        Width between outer angles of quadrates . . . .   28·5

          „   of foramen magnum   3

          „   of skull-roof   18

          „   of supratemporal fossa . . . .   6·1

          „   of interorbital bar . . . .   3·9

                    Presented by the Egyptian Government, 1904.

R. 3108. Portion of hinder part of skull of a rather larger individual.

                    Presented by W. E. de Winton, Esq., 1903.

R. 3109. Portion of rostrum.   *Presented by W. E. de Winton, Esq.,* 1903.

The following specimens from the Fluvio-marine beds may also belong to this species :—

R. 3342. Anterior dorsal vertebra.

R. 3343. Scute.   Differs from the scutes from the Qasr-el-Sagha series referred to *T. africanum* in
        having a slight median carina.

R. 3341. Proximal half of a left scapula, closely similar to that of *T. schlegeli.*

R. 3107. Portion of right ischium.   *Presented by W. E. de Winton, Esq.,* 1903.

Tomistoma africanum, Andrews.

[Plate XXIII. figs. 1, 2 ; text-fig. 86.]

1901. *Tomistoma africanum*, C. W. Andrews, Geol. Mag. [4] vol. viii. p. 443.

Type Specimen.—A nearly complete mandible, from which the teeth are missing
(Pl. XXIII. fig. 1) ; Geological Museum, Cairo.

The mandible upon which this species is founded is that of a very long- and
slender-snouted Crocodile, the total length of the specimen being just over a metre
(106 cm.).   The symphysial region is long and narrow, and extends back to the
fourteenth alveolus; the splenial enters into its formation, extending forwards to
about the tenth alveolus.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

Anteriorly the jaw is very slender, but behind the last alveolus it deepens con-
siderably and the lateral opening (Pl. XXIII. figs. 1 A, 1 B) is as large as in the recent
Tomistoma, and considerably larger than in *Gharialis*.   The sutures between the bones
enclosing the opening are not to be made out.   The ridge forming the shelf-like border
of the inner side of the angular bone seems to be continued up to the posterior angle of
the lateral opening.   The articular bone (*art.*) is produced upwards and backwards into
a very long and narrow process, considerably longer than in the recent species of *Tomi-
stoma* or in the Gavial.   The articular surface for the quadrate is simply concave from
before backwards, and not divided by a ridge into a smaller inner and a larger outer

portion, showing that the quadrate articulation was almost simply cylindrical as in *Gharialis*, and not saddle-shaped as in *Tomistoma schlegeli*.

The teeth are twenty in number on either side, and the first and fourth are somewhat larger than the others. Behind the fourth there are two smaller sockets, then the alveoli are larger and remain about the same size till close to the hinder end of the series, where the last two or three decrease in size. With the exception of larger gaps between the second and third and the third and fourth teeth, they are all about equidistant from one another. The alveoli have prominent borders and open

Text-fig. 86.
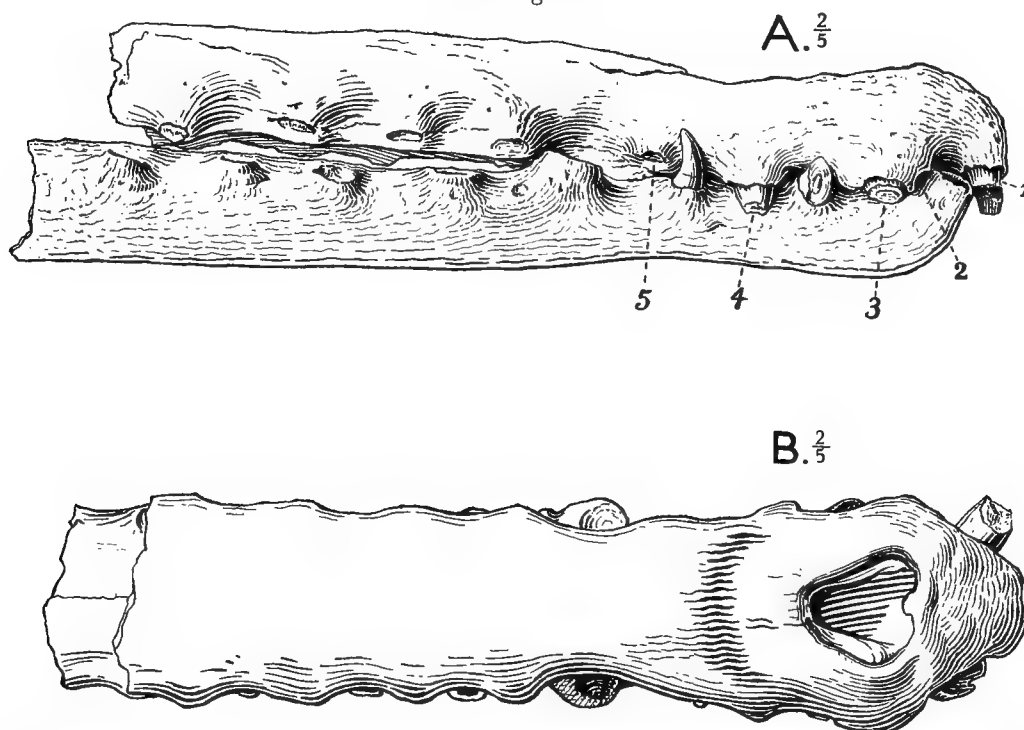
Anterior portion of snout of *Tomistoma africanum*, with the upper and lower jaws in their natural relation to one another : A, from right side ; B, from above.

1–5, premaxillary teeth. $\frac{2}{5}$ nat. size.

rather more outwards and forwards than in *Tomistoma schlegeli*. There seem to be no pits for the reception of the points of the upper teeth.

This mandible is referred to a species of *Tomistoma* on account of the comparatively small number of teeth in the jaw as a whole, 20 on each side, and the number (14) in the symphysial region. In *T. schlegeli* there are 20–21 teeth in all, 14 or 15 being in the symphysial portion of the jaw : in *Gharialis*, on the other hand, there are 25–26 teeth, of which 23–24 are symphysial. The dimensions of the type specimen are given below.

A specimen (text-fig. 86), consisting of the anterior portion of the upper and lower jaws in their natural position with regard to one another, was also obtained from the same horizon, and may be referred to this species with some confidence. There are five premaxillary teeth, the second * being very small and situated close in front of the third. The first, third, and fourth teeth are large; the fifth is small, and behind it there is a considerable diastema where the sides of the snout are hollowed out for the reception of the large fourth mandibular tooth. The alveoli, with the bases of four subequal maxillary teeth, are preserved. As in the mandible, the borders of the alveoli are very prominent, and the teeth seem to have been directed somewhat forwards. The premaxillary region is slightly expanded, and the nasal opening is large and heart-shaped, with the point directed backwards. Unfortunately, none of the sutures can be seen, so that the relations of the nasals and premaxillæ cannot be determined. The mandible, so far as preserved, agrees with that described above; the large size of the fourth tooth is well shown.

With the exception of the presence of a fifth premaxillary tooth, this specimen agrees in all essentials with the corresponding parts of the skull and mandible of *Tomistoma schlegeli.*

C. 10006. Mandible.   Type specimen described in Geol. Mag. [4] vol. viii. 1901, pp. 443–444. Figured on Pl. XXIII. figs. 1, 1 A, 1 B. The dimensions (in centimetres) of this specimen are :—

Total length   106
Length of symphysis . . . .   49·5
Width at narrowest part of symphysis . . . .   4·3
      „   posterior end of symphysis   11
Depth of ramus at posterior end of symphysis . . . . .   4·5
Greatest depth of ramus   12
Width of articular surface for quadrate . . .   . . .   4·2

R. 3330. Plaster cast of the above specimen.   *Made in the British Museum.*

R. 3201. Anterior portion of rostrum and mandible in their natural position with regard to one another. Figured in text-fig. 86. The dimensions (in centimetres) of this specimen are :—

Length of the portion of the rostrum preserved . . . . .   31·5
      „   „   mandible preserved . . . . . .   32·5
Width of premaxillary region . . . .   7·5 app.
      „   rostrum at narrowest point   5
Length of nasal opening . . . .   4·2
Width of nasal opening . . . .   4·2

Presented by the Egyptian Government, 1904.

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* In the description of this specimen given in Geol. Mag. [4] vol. viii. 1901, p. 444, the socket of this small additional tooth was overlooked.

R. 3340. Portions of mandible and cranial rostrum.

R. 3197. Portions of the back of two skulls. *Presented by W. E. de Winton, Esq.*, 1903.

R.3197 a. Portion of the left premaxilla of a large individual.

Presented by W. E. de Winton, Esq., 1903.

The specimens catalogued below probably in most cases belong to this species, which, from the numerous fragments of the skull that have been found, must have been more common than the broad-nosed form. Furthermore, some of the bones, *e. g.* the ilium, are much more similar to those of *Tomistoma schlegeli* than to those of any other species with which they have been compared. All are from the Qasr-el-Sagha beds.

R. 3332. Cervical vertebra. Figured on Pl. XXIII. figs. 2, 2 A. The greatest length of the centrum is 7·8 cm., its width 5·8 cm.; height of vertebra from hypapophysis to tip of neural spine 15 cm. (app.). *Presented by W. E. de Winton, Esq.*, 1903.

R. 3195, 3196, 3331. Numerous odd vertebræ. *Presented by W. E. de Winton, Esq.*, 1903.

C. 10050. Numerous odd vertebræ.

R. 3333. Mass of dorsal and cervical vertebræ and scutes cemented together by matrix.

Presented by W. E. de Winton, Esq., 1903.

R. 3334. Five posterior lumbar and sacral vertebræ. *Presented by W. E. de Winton, Esq.*, 1903.

R. 3335. Three scutes, with a sculpture of deep pits; the articular facet for junction with the scute in front is narrow, but very well defined; there is no trace of any keel in any of these Middle Eocene scutes. *Presented by W. E. de Winton, Esq.*, 1903.

C. 10037. Three scutes similar to last.

R. 3336. Proximal half of left scapula. This bone very closely resembles the scapula of *T. schlegeli.*

Presented by W. E. de Winton, Esq., 1903.

R. 3199. Right coracoid, similar to the coracoid of *T. schlegeli*, except that the single foramen is nearer the articulation. *Presented by W. E. de Winton, Esq.*, 1903.

C. 10032. Left coracoid.

C. 10044. A pair of complete ilia. Compared with the ilia of other Crocodilia, these bones are found to resemble those of *T. schlegeli* in many points, *e. g.* in their thin backward prolongation, the small acetabular notch, and the shallowness of the acetabular concavity. Of the other crocodilian ilia compared, that of the Gavial is also similar though to a less degree. The greatest length of these bones is 16·8 cm., the greatest depth 10 cm.

R.3199 a. Right ilium of similar form to last. *Presented by W. E. de Winton, Esq.*, 1903.

R. 3337. Portions of two right ischia. *Presented by W. E. de Winton, Esq.*, 1903.

C. 10033. Left ischium.

R. 3338. Portion of a pubis. *Presented by W. E. de Winton, Esq.*, 1903.

C. 10021. Right femur of a very large individual, somewhat imperfect distally. The trochanter is very strongly developed. The length of this bone is 32·3 cm.

C. 10056. Left femur of a somewhat smaller individual, much weathered on one side.

R. 3339. Second left metatarsal. *Presented by W. E. de Winton, Esq.*, 1903.

Tomistoma kerunense, Andrews.

1905. *Tomistoma kerunense,* C. W. Andrews, Geol. Mag. [5] vol. ii. p. 484.

Type Specimen.—An imperfect rostrum, the premaxillary region being lost; Geological Museum, Cairo.

This species differs from *T. gavialoides* in having a more gradually tapering snout and less rounded orbits. The teeth are more nearly equal in size, larger, and set at wider intervals than in other species of the genus.

Form. & Loc.—Birket-el-Qurun beds (Middle Eocene): 12 kilometres W.S.W. of Gar-el-Gehannem.

It is unfortunate that this species is very imperfectly known, since its remains occur in the beds below those at Qasr-el-Sagha in which *T. africanum* is found, and better specimens might have thrown some light on the succession of forms from this horizon to the Upper Eocene species *Tomistoma gavialoides.* The snout, which is the best specimen available for description, is much like that of *T. gavialoides* in general form. Immediately in front of the orbits its surface is curved regularly from side to side, much as in *T. schlegeli,* but it is somewhat more depressed, a condition which is continued throughout the length of the rostrum. The tapering of the preorbital region is quite gradual, more so than in *T. gavialoides* (see Pl. XXIII. fig. 3 A); the orbits are less rounded than in that species, though less elongated than in *T. schlegeli.* The specimen shows that the nasals meet the premaxillæ in the manner characteristic of the genus, thus excluding the maxillæ from union in the middle line on the upper surface of the snout. The interorbital bar is broader than in *T. gavialoides.*

The teeth, judging from the alveoli, were large and were directed more forwards and outwards than in *T. schlegeli,* from which this form is also distinguished by the absence of pits for the reception of the tips of mandibular teeth. The teeth seem to have been more nearly equal throughout the series than in *T. schlegeli* or *T. africanum,* and are separated by wider intervals, so that between the level of the posterior end of the palatine processes of the premaxillæ and the anterior angle of the posterior palatine fossa there are only nine teeth, while in *T. schlegeli,* in the same space, there are ten, and in *T. gavialoides* twelve.

A portion of the back of a skull, including the occipital surface and the roof as far as just in front of the supratemporal fossæ, was also collected by Mr. Beadnell in the same locality. So far as it is preserved, this part of the skull is almost identical with that of *T. gavialoides.*

C. 9350. Rostral portion of skull, incomplete anteriorly. The type specimen described in the Geol. Mag. [5] vol. ii. p. 484. The dimensions (in centimetres) of this specimen are :—

Total length so far as preserved   49

Distance from front of posterior palatine fossæ to posterior
  end of palatine processes of premaxillæ . . . .   29·2

Distance from orbit to posterior end of facial processes of
  premaxillæ   35

Width immediately in front of orbits . . . .   13 app.

    „   at hinder end of premaxillæ   5

C. 9351. Posterior portion of a skull from the same locality. The dimensions (in centimetres) of this specimen are :—

Width of posterior end of skull-roof   17

    „   supratemporal fossa . . . .   5·8

    „   bar between supratemporal fossæ . . . .   1·6

Order CHELONIA.

Suborder *ATHECÆ*.

Family SPHARGIDÆ.

Genus **PSEPHOPHORUS**, v. Meyer.

Psephophorus eocænus, Andrews.

[Text-fig. 87.]

1901. *Psephophorus eocænus*, C. W. Andrews, Geol. Mag. [4] vol. viii. pp. 440–441, fig. 3.
1903.   „   „   von Reinach, Abhandl. Senckenberg. naturf. Gesell. vol. xxix. pt. i.
              pp. 58–59.

Type Specimen.—A nearly complete left humerus, described and figured in Geol. Mag. [4] vol. viii. p. 441, fig. 3 ; Geological Museum, Cairo.

A species known only from the humerus, which has the ulnar crest more prominent than in *Psephophorus scaldii* and the radial crest more oblique.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene) : north of Birket-el-Qurun.

This species, which is the only representative of the suborder Athecæ found in these beds, is known only from the humerus (text-fig. 87), which differs widely in form from the humeri of all land and freshwater Chelonians, and from those of all the marine

Turtles except *Sphargis*, the only living representative of the Athecæ.   The bone, in fact, belongs to the most highly specialised type of swimming humerus, to which Wieland * has given the name parathalassic.   The whole bone is strongly compressed dorsi-ventrally.   The head (*b.*), so far as preserved, is strongly convex and somewhat triangular in outline.   The ulnar crest (*a.*) projects further beyond the head than in *Psephophorus scaldii* or in *Sphargis*.   Between the anterior thickening, which terminates on the head, and the posterior border the surface of the shaft is concave

Text-fig. 87.
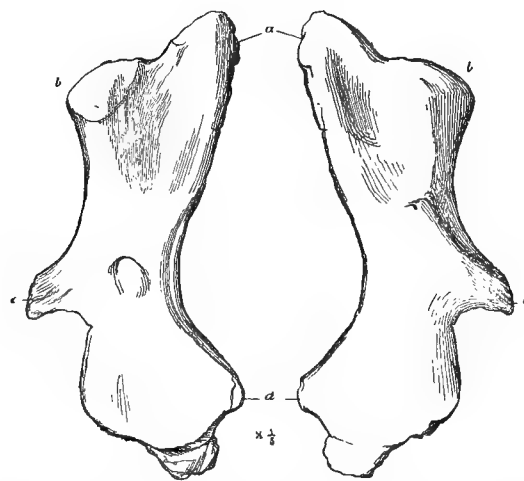
Left humerus of *Psephophorus eocœnus*, type specimen : dorsal and ventral views.

a., ulnar crest ; *b.*, head ; *c.*, radial crest ; *d.*, entocondyle. $\frac{1}{5}$ nat. size.

on the upper and lower faces of the bone, but the ventral concavity is deepest.   The part of the bone above the radial process is considerably more elongated in proportion to its width than in *Psephophorus scaldii* and still more than in *Sphargis*.   The radial prominence is very strongly developed, but it cannot be seen exactly what is the form of its ventral surface, which, however, is not divided into two or more separate knobs, as in *Psephophorus*, and is continued on the ventral face of the bone obliquely backwards, so that if the line of its direction were continued it would pass through the end of the ulnar process ; in both *Sphargis* and *Psephophorus* the ridge is placed more transversely.   The dorsal surface of the shaft opposite the base of the radial process bears a deep oval pit for the attachment of muscle ; in *Sphargis* this seems to be represented by several smaller depressions.   The distal end of the bone is incomplete, but, like the upper end, it seems to have been less expanded than in *Sphargis*.   There is no trace of any ectepicondylar groove or foramen.

On the whole, the bone resembles the humerus of *Psephophorus* rather than that of

* Amer. Journ. Sci. [4] vol. ix. 1900, p. 420.

Sphargis, and is referred to a member of that genus, at least provisionally, until further remains are found.

C. 10028. Left humerus. Type specimen described and figured in Geol. Mag. [4] vol. viii. (1901) pp. 440–441, fig. 3. The distal end is imperfect, and the whole bone is somewhat abraded at the angles. The dimensions (in centimetres) are :—

Length, so far as preserved	19
Width of head	4
„ at upper end	7·3
Least width of shaft above radial process	4·4
„ „ below radial process	4·2

R. 3017. Plaster cast of the above specimen. *Made in the British Museum.*

R. 3352. Proximal half of a humerus, much sand-worn.

Suborder *THECOPHORA.*

Division A. CRYPTODIRA.

Family TESTUDINIDÆ.

Genus **TESTUDO**, Linnæus.

[Syst. Nat. vol. i. (1766) p. 350.]

Neural bones usually alternately tetragonal and octagonal, but sometimes hexagonal. Costal bones alternately wider and narrower. Suture between the marginal and costal bones and shields usually coinciding; supracaudal shield usually single. Plastron extensively united to the carapace by suture, with short axillary and inguinal buttresses which do not reach, or only just touch, the costal bones; entoplastron usually in front of the humero-pectoral suture.

One of the most remarkable features of the fauna of the Fluvio-marine beds of the Fayûm is the number of giant Land-Tortoises, probably of several species, that must have existed during the period at which they were deposited. A considerable number of shells, some in a perfect condition of preservation, have been collected, mostly by Mr. Beadnell. The greater number of these specimens belong to the species *Testudo ammon*, already described in brief; other species, less satisfactorily known, will be noticed below.

Testudo ammon, Andrews.

[Plate XXIV.; text-figs. 88–90.]

1903. *Testudo ammon*, C. W. Andrews, A Preliminary Notice of a Land-Tortoise from the Upper Eocene of the Fayûm, Egypt (description) : Survey Dept., Cairo (with a Note on the Method employed in Excavation, Strengthening, and Transport, by H. J. L. Beadnell).

1904.   ,,   ,,   C. W. Andrews, Geol. Mag. [5] vol. i. pp. 527–530, pl. xvii.

Type Specimen.—A nearly complete, slightly distorted shell, probably of a male (described and figured, *loc. cit.*; also text-figs. 88, 89); Geological Museum, Cairo.

In this species the carapace is highly arched, the areas covered by the costal shields being strongly convex. The antero-lateral and posterior marginals are strongly everted; there is a small nuchal shield. In the plastron the epiplastra are prolonged forwards in the middle line into an abruptly truncated projection (at least in the males). The posterior end of the plastron is notched in the middle line, and the areas covered by the anal plates are sharply defined by deep grooves and notches.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

A considerable number of more or less nearly perfect shells of this species have been collected, but at present little is known about the rest of the skeleton. Some humeri, a part of the femur, and some other scattered remains of a large Chelonian may be referred to it, and a nearly complete pelvis has been found in actual association with the shell : of the skull nothing is known.

The carapace is strongly arched in all directions, and, looked at from above (text-fig. 88, A), it is somewhat quadrate in outline, owing to the eversion of the marginals at the postero- and antero-lateral regions. The areas covered by the three middle vertebral shields (*v.* 2–4) form prominent convex bosses, separated from one another and from the costals by deep grooves. The anterior border of the shell is notched in the middle line and somewhat upturned; there is a small nuchal shield (*nu.*). The area covered by the last vertebral shield is strongly convex, as also is that covered by the single pygal shield (*py.*). In this latter region the shell forms a strong arched covering for the tail, projecting below the level of the rest of the margin. The form of the bones of the carapace will be best understood from the figures (Pl. XXIV. fig. 1 A ; text-fig. 88, A). The neural bones (*N.* 1–7) vary considerably in form ; thus in the specimen figured in text-fig. 88 the first is quadrate, the second octagonal, the third quadrate, the fourth and fifth hexagonal, with the shorter of the lateral faces in front, the sixth octagonal, and the seventh quadrate. It appears, however, that in the form of the neural bones a considerable range of variation in different individuals occurs (see Pl. XXIV. fig. 1 A). There are three pygals (*Py.* 1–3), which, as already mentioned, form a strongly convex protection for the tail. Anteriorly

Text-fig. 88.
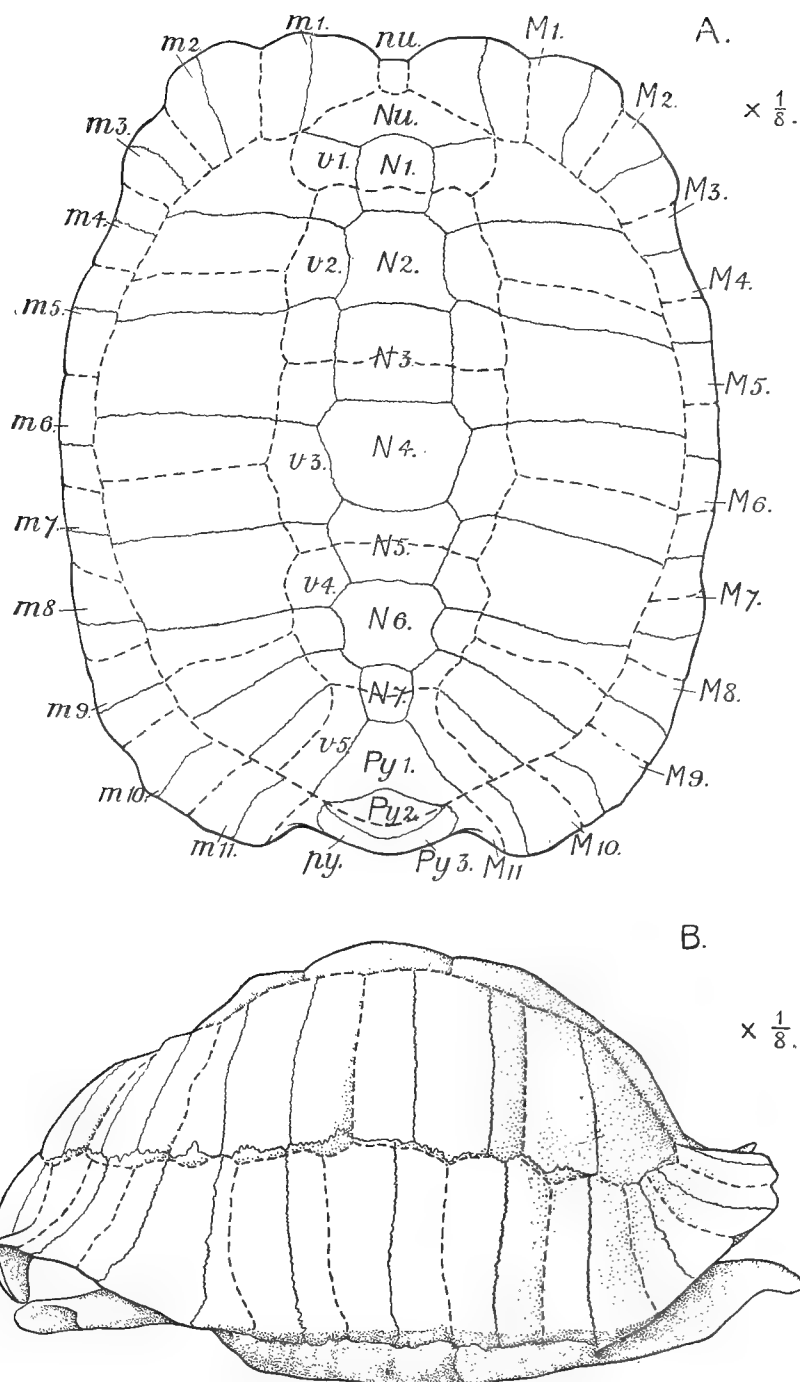
Restored shell of *Testudo ammon*: A, from above; B, from right side.

M. 1–11, marginal bones; m. 1–11, marginal shields; N. 1–7, neural bones; Nu., nuchal bone; nu., nuchal shield; Py. 1–3, pygal bones; py., pygal shield; v. 1–5, vertebral shields. About ⅛ nat. size.

and posteriorly the marginals (*M.* 1–11) are somewhat everted, but in the region of the junction with the plastron they are vertical. The angles of the bridge between the plastron and the carapace are greatly thickened and form a prominent border, upon which the shell rests.

The plastron (Pl. XXIV. fig. 1 B; text-fig. 89) is larger and the openings of the shell

Text-fig. 89.
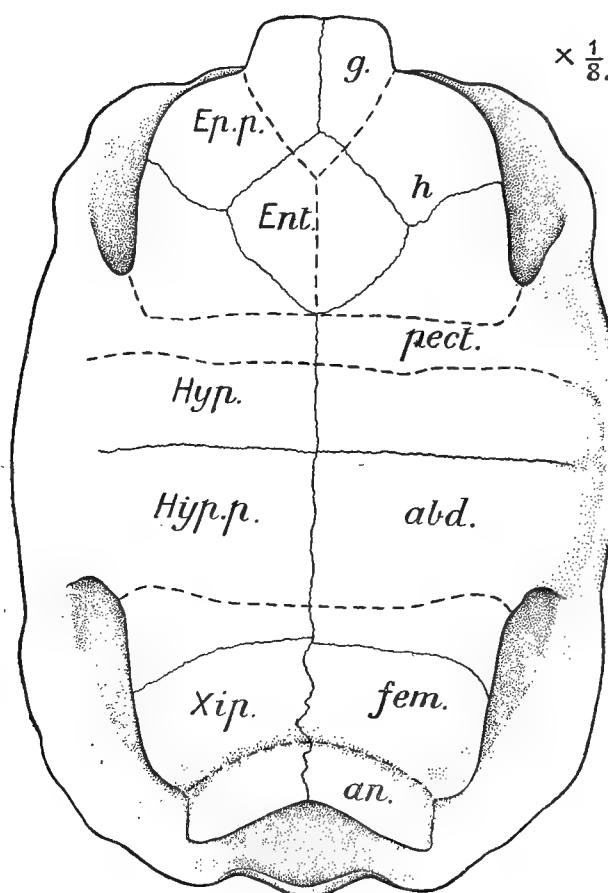
Plastron of *Testudo ammon*.

abd., abdominal shield; *an.,* anal shield; *Ent.,* entoplastral bone; *Ep.p.,* epiplastral bone; *fem.,* femoral shield; *g.,* gular shield; *h.,* humeral shield; *Hyp.,* hyoplastral bone; *Hyp.p.,* hypoplastral bone; *pect.,* pectoral shield; *Xip.,* xiphiplastral bone. About ⅛ nat. size.

are smaller than in most of the recent giant Land-Tortoises. In some individuals, including the type, the epiplastral region (*Ep.p.*) is prolonged forwards to a greater or less extent: as these have a deeply concave plastron, they are probably males. In the specimen figured on Pl. XXIV. fig. 1 B, however, this projection is very slight: as the concavity of the plastron in this shell is very slight, it may be regarded as belonging to

a female. Anteriorly the epiplastral projection is truncated at right angles to the long axis of the shell, and is slightly notched in the middle line. The posterior angle of the rather large entoplastral (*Ent.*) is on or a little behind the groove between the humeral (*h.*) and pectoral (*pect.*) shields. The posterior border of the xiphiplastral region (*Xip.*) forms a wide, open, **V**-shaped notch. The gular shields (*g.*) are paired, and the pectorals (*pect.*) are very narrow; the region covered by the short anals (*an.*) is considerably narrower than the part immediately in front of it, from which it is marked off by a deep groove.

In addition to the absence of the prolongation of the epiplastrals and the flatness of the plastron as a whole, the shell figured on Pl. XXIV. differs from the type specimen in the following points :—(1) it is much smaller; (2) the areas covered by the vertebral shields are less convex; (3) the caudal region is less convex inferiorly; (4) the shell, as a whole, is relatively rather longer and narrower; (5) the groove between the costal and marginal shields is deeper; (6) the anterior portion of the plastron, in front of a transverse line passing through the hinder angle of the gular shields, is turned upwards and greatly thickened above so as to form a sort of lip, behind which it thins again abruptly; (7) the anal region and the posterior notch are narrower.

These differences do not seem to be of great importance, and may be partly due to age, partly to sex; at the same time, although for the present this specimen is referred to *T. ammon*, the possibility that it may belong to another species must not be lost sight of. It is, perhaps, the most nearly perfect shell of a Lower Tertiary tortoise ever found, being undistorted and unbroken, and looking like a recent specimen; it, like the type specimen, was collected by Mr. H. J. L. Beadnell.

Of the recent gigantic Land-Tortoises *T. ammon* seems to approach most nearly to the Aldabra and Madagascar forms, having like them a nuchal shield and paired gulars. In the general form of the carapace, especially the convexity of the vertebral shields, it is similar to *T. gigantea*, Schweigger (*T. elephantina*, Günther), of North Aldabra *, but in that species the anterior and posterior marginals are smaller and less everted, and the shell is wider behind than in front. In the plastron also some points of similarity exist: in both it is large, the epiplastral region is prolonged forwards and truncated, and the xiphiplastral border forms an open notch; on the other hand, in the fossil the plastron is relatively larger, the anterior and posterior lobes narrowing very little towards their extremities.

Numerous Land-Tortoises of large size are known from various horizons in the Tertiary beds of Europe and India. *T. gigas*, Bravard †, from the Upper Oligocene

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* Günther, The Gigantic Land-Tortoises (Living and Extinct) in the Collection of the British Museum, pls. iii. & iv. fig. A ; also Proc. Linn. Soc. 1898, p. 14.

† Bravard, Considérations sur la distribution des Mammifères terrestres fossiles dans le Département du Puy-de-Dôme, p. 15 (Clermont-Ferrand, 1844); also Gervais, Zoologie et Paléontologie françaises, ed. 2 (1859) p. 436, pl. liv.

of Bournoncle-St.-Pierre (Allier), differs from the present species in the form of the plastron, the anterior lobe of which narrows gradually forwards to a point; it also differs in the great convexity of the carapace, the other characters of which unfortunately have not been described.

Another Tertiary giant Tortoise, with which *T. ammon* may be compared, is *T. perpiniana*, described by Depéret and Donnezan * from the Lower Pliocene of Roussillon. This species also attained a very large size, one shell measuring 120 cm. in length. The chief points in which it differs from *T. ammon* are:— (1) the carapace is much less convex and is smooth; (2) there is no nuchal; (3) the plastron, though somewhat similar posteriorly, differs anteriorly in narrowing more rapidly and in not having the epiplastral prolongation (which, however, may be a sexual character).

T. leberonis, Depéret †, from the Miocene of Mt. Lebéron, is very similar to *T. perpiniana*, but still larger, the shell attaining a length of 150 cm. It has also more slender epiplastra and xiphiplastra, and therefore approaches the present species in these points rather more nearly than does *T. perpiniana*. The gigantic extinct Tortoises of India, such as *T. atlas*, seem to be closely similar in many ways to these European Tertiary forms, particularly in the absence in most of them of the nuchal shield—a character which distinguishes them from the present species.

When the original description of this species was written the presence of a nuchal shield had not been recognised, and consequently it was considered that it was more nearly related to the European and Indian Tertiary forms than now appears to be the case. So far as the evidence goes now, it seems that the nearest relationship is with the Aldabra and Mascarene types and perhaps with some of the Indian forms, in which a nuchal is also present.

Several more or less nearly complete humeri of Land-Tortoises have been found in the same beds as the shells, and though none of them are large enough to have belonged to an animal of the size of the type specimens of *T. ammon* or *T. beadnelli*, nevertheless they may be regarded as probably referable to small specimens of one of these species or of *T. isis*. The shaft forms a strong sigmoid curve. The ulnar and radial crests are both strongly developed and make a very acute angle with one another; they are separated by a deep fossa : the ulnar crest rises considerably above the head, which is an elongated oval in form. The dorsal surface of the upper part of the shaft is marked by a strong ridge with a deep groove on its inner side for the insertion of muscles. The middle of the shaft is comparatively slender and is triangular in section. The distal expansion is not so great as in most of the large Land-Tortoises, e. g. *T. gigantea*. The ectepicondyle is rather small; there is a long and deep ectepicondylar groove which perforates the bone at its lower end.

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* Comptes Rendus, vol. cv. (1887) p. 1275 ; also Mém. Soc. Géol. France, Mém. 3 (1890) p. 140.

† Comptes Rendus, vol. cx. (1890) p. 915.

The coronoid fossa is deep. From side to side the articulation is slightly convex on its radial side, slightly concave on the ulnar.

This bone differs from that of the other giant Land-Tortoises in its comparative slenderness of shaft and the relatively slight expansion of its extremities. It is very like the humerus of *T. pardalis*, from which, however, it is distinguished by the greater prominence of the ulnar and radial crests, by the more dorsal position of the deep muscle-impression above referred to, and the presence of a deep ectepicondylar canal perforating the bone.

A pelvis (text-fig. 90) was found in association with a nearly complete shell (R. 3097) and, though not perfect, shows the following points:—the ilia (*il.*) are

Text-fig. 90.
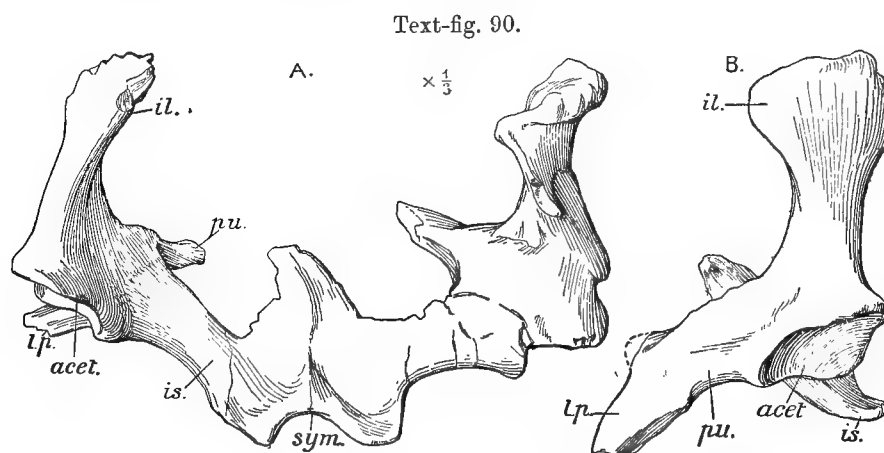
Pelvis of *Testudo ammon*: A, from above; B, from right side.

acet., acetabulum; *il.*, ilium; *is.*, ischium; *l.p.*, lateral process of pubis; *pu.*, pubis; *sym.*, ischial symphysis. ⅓ nat. size.

short and broad, somewhat compressed from within outwards and thickening greatly at their upper ends. The pubes (*pu.*), are incomplete at their symphysial end; they bear strong lateral processes (*l.p.*) projecting downwards, outwards, and forwards. The ischia (*is.*) are complete; they form a strong median symphysis (*sym.*), and are greatly thickened ventrally both posteriorly and on the middle line, where the bone seems to have been strengthened by cross-buttresses. In the middle line the posterior border of the combined ischia is deeply notched; the ischial tuberosities bordering the notch turn slightly upwards. The acetabulum (*acet.*) is large, shallow, and roughly triangular in outline. This pelvis, as a whole, particularly in the form of the ischia, is very like that of *T. pardalis*; the chief difference is that in the latter species the ilia are relatively longer and more slender.

C. 8130. Nearly complete, but somewhat distorted, carapace and plastron, probably of a male. Type specimen described and figured in 'A Preliminary Notice of a Land-Tortoise from the Upper Eocene of Egypt' (Cairo, 1903), p. 5, plate, and in Geol. Mag. [5] vol. i.

1904, pp. 527–530, pl. xvii.   Also text-figs. 88, 89.   The dimensions of this specimen are given below.

C. 8772.   Complete and undistorted carapace and plastron.   The dimensions of this specimen are given below.

R. 3274.   Plaster cast of the last specimen.

R. 3097.   Somewhat distorted carapace and plastron, incomplete posteriorly, associated with the pelvis (text-fig. 90).   The dimensions of this specimen are given below.

Presented by W. E. de Winton, Esq., 1903.

R. 3273.   Nearly complete and slightly distorted carapace and plastron.   The dimensions of this specimen are given below.   *Presented by the Egyptian Government*, 1904.

C. 9240.   Complete and undistorted carapace and plastron of a smaller individual, probably a female.   Figured on Pl. XXIV.   The dimensions of this specimen are given below.

The dimensions (in centimetres) of the above shells are :—

	C. 8130. (Type.)	C. 8772.	R. 3097.	R. 3273.	C. 9240.
Length of carapace in middle line	87	88	..	86	49·7
Greatest width of carapace	76	65·7 (?)	53	63	34·5
,, height of shell	44·7	45·5	47·5	40 +	29·2
Length of plastron in middle line	77·8	80·7	76	75·5	45·2
,, ,, to end of xiphiplastra	85	85·5	78·5	80	48·4
Width of anterior lobe of plastron	32	43·7	33·5	36·5	21
,, posterior lobe of plastron	34	42	36	37	22·5
Length of bridge	38·8	35·5	40 (?)	32 app.	22

R. 3099.   Portion of left xiphiplastral bone, showing form of anal shield.

Presented by W. E. de Winton, Esq., 1903.

The following humeri may belong to this or one of the other species of the genus described below.

R. 3351.   Nearly complete left humerus, described above.   The dimensions (in centimetres) of this bone are :—

Length	18·6
Width of upper end	5 app.
,, middle of shaft	2
,, distal expansion	5·3
,, ,, articulation	4·2

C. 9008.   Distal half of a much larger right humerus, differing from last in being relatively much wider and at the same time more compressed from above downwards.   The dimensions (in centimetres) are :—

Width of middle of shaft	2·7
,, distal expansion	7·8
,, ,, articulation	6·3

R. 3098.   Proximal end of a right humerus, similar to R. 3351, but rather larger.

Presented by W. E. de Winton, Esq., 1903.

R. 3098 a.   Right humerus, wanting radial side of distal end.   Length 18 cm.; width of middle of shaft 2 cm.

Testudo beadnelli, sp. nov.

[Text-fig. 91.]

Type Specimen.—A shell of which the carapace is somewhat incomplete, but the plastron is in excellent preservation (text-fig. 91); Geological Museum, Cairo.

The shell upon which this species is founded is the only one of this form that has been found. It differs so considerably from all the shells of *T. ammon* that its separation from that species seems fully justified. The chief of these differences

Text-fig. 91.
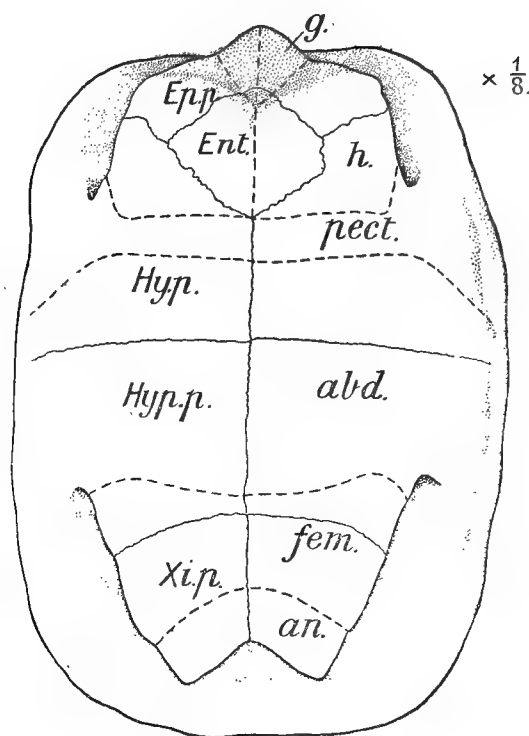
Plastron of *Testudo beadnelli.*

abd., abdominal shield; *an.*, anal shield; *Ent.*, entoplastral bone; *Ep.p.*, epiplastral bone; *fem.*, femoral shield; *g.*, gular shield; *h.*, humeral shield; *Hy.p.*, hyoplastral bone; *Hyp.p.*, hypoplastral bone; *pect.*, pectoral shield; *Xi.p.*, xiphiplastral bone. About ⅛ nat. size.

are:—(1 The areas covered by the vertebral shields are very slightly swollen and are scarcely at all marked off by any depression from the costals; (2) the carapace, as a whole, is less widened out and turned up in front, and it is considerably lower in proportion to its width; (3) the pygal region is less convex and does not extend so much below the rest of the margin. Otherwise in the arrangement of the bones and shields the two species are similar; the nuchal shield is well marked.

In the plastron the differences between the two species are considerable. Thus in the present species the length of the bridge is about half the length of the plastron in the middle line, in *T. ammon* it is usually less. In consequence of this the anterior and posterior lobes of the plastron, particularly the former, are relatively shorter. The median portions of the epiplastrals (*Ep.p.*) are produced forwards into a pointed anterior projection; in *T. ammon*, when this projection is present at all, it is truncated. The posterior lobe of the plastron narrows more towards its distal end, and the anal region is scarcely at all marked off by the notch or groove which is so strongly defined in *T. ammon*. Lastly, the groove between the femoral (*fem.*) and anal (*an.*) shields slopes more backwards. It may be added that the whole shell appears to have been less solidly built than in *T. ammon*. This species is named after Mr. H. J. L. Beadnell, by whom the type specimen was found.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 8773. Shell of which the carapace is somewhat imperfect. Type specimen described and figured above. The dimensions (in centimetres) of this specimen are:—

Length of carapace in middle line	75·1
„ plastron in middle line	66·4
„ „ to end of xiphiplastra	71·6
Width of anterior lobe	33 app.
Length of anterior lobe	18 app.
Width of posterior lobe	32·5
Length of posterior lobe	21 app.
„ bridge	33
Height of shell	35 app.

Testudo isis, sp. nov.

Type Specimen.—An imperfect shell, wanting the posterior marginals; Geological Museum, Cairo.

This species is founded on a comparatively small rounded shell in which the growth-lines of the bones are strongly marked, forming in places (*e. g.* on the costals) prominent ridges. The areas covered by the vertebral shields are not inflated and pass smoothly into the costal region. The neural bones are all hexagonal, with the antero-lateral sides the shortest. There is a very narrow nuchal shield.

The anterior end of the plastron is rounded and upturned, but is not greatly thickened as is the case in the carapace of the female of *T. ammon* (see Plate XXIV.). The posterior end of the plastron forms a wide open notch; the areas covered by the anals are sharply separated from the region in front.

The presence of the strongly marked growth-lines probably indicates that this is a young animal, but the fact that all the neurals are hexagonal seems to exclude

the possibility of this being the young of *T. ammon*, and even makes it somewhat doubtful whether it should be referred to the genus *Testudo* at all. For the present, until further material is available, this species may be called *T. isis*.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

C. 8774. Shell, wanting posterior marginals, but otherwise nearly complete and undistorted. The dimensions (in centimetres) are :—

Length in middle line of carapace	38 app.
Extreme width of shell	27
Length of plastron in middle line	35
„ „ to end of xiphiplastra	37·4
Length of bridge	18
Height of shell	21·4

Family CHELONIDÆ.

Genus **THALASSOCHELYS**, Fitzinger.

[Ann. Wien. Mus. i. (1835) p. 121.]

Represented only by imperfect skulls, probably of a single species.

Thalassochelys libyca, Andrews.

[Plate XXV. fig. 4.]

1901. *Thalassochelys libyca*, C. W. Andrews, Geol. Mag. [4] vol. viii. p. 441.

Type Specimen.—The posterior portion of an uncrushed skull (described *loc. cit.*; figured Pl. XXV. fig. 4); Geological Museum, Cairo.

Known only from imperfect skulls, the characters of which are described below.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

The specimens of nearly complete skulls of this Chelonian are so much crushed and distorted that they give a very erroneous idea of the general form, and, moreover, they are so much coated with gypsum that the sutures are invisible. For these reasons an imperfect but uncrushed skull has been taken as the type specimen. In this the whole of the anterior portion in front of the epipterygoid (*columella cranii*) is broken away, but the posterior part is undistorted and in a fair state of preservation.

In this skull the temporal fossæ are completely roofed in, the squamosal apparently meeting the parietal as in the Chelonidæ and Sphargidæ; but from the latter group

it is at once distinguished by the circumstance that the opisthotic and the squamosal join as usual, and there is a distinct epipterygoid, indicating that this Turtle is a member of the Chelonidæ. The occipital condyle is trilobate and the basioccipital portion thrusts itself between the exoccipital lobes, reaching the foramen magnum. In front of the occipital condyle the ventral face of the basioccipital is comparatively flat, and there is no deep depression at its union with the basisphenoid as in *Chelone*; laterally, together with the exoccipitals, the basioccipital forms a flat vertical surface, which is larger than is found in either *Chelone* or *Thalassochelys*. The opisthotics (*o.o.*) are arranged as in the recent types and are firmly united at their outer ends with the squamosals (*sq.*); they form the upper border of a large fossa into which several foramina opened. The form of the tympanic cavity (*t.o.*) is almost as in *Chelone*; it seems, however, to be a little more sharply defined in front and a little more elongated in a vertical direction. The pedicle of the quadrate (*q.*) is longer than in the recent forms, so that the articular surface for the mandible is further below the level of the palate.

The basisphenoid bears a pair of ridges, which converge forwards meeting in the middle line; on its upper (cranial) surface there is a strong median ridge. The epipterygoids arise by a narrow base and are less flattened from within outwards than in *Chelone* or *Thalassochelys caretta*.

There is no doubt that the skull here described is that of a member of the Chelonidæ, and since in the form of its basioccipital and basisphenoid it resembles the skull of *Thalassochelys* rather than that of *Chelone*, it is referred to that genus; but further material in better preservation is required before its precise position can be made out.

C. 10029. Posterior portion of skull, uncrushed but much covered with a reddish matrix and apparently impregnated with salt. The type described in Geol. Mag. [4] vol. viii. p. 441. Figured Pl. XXV. fig. 4. The dimensions (in centimetres) of this specimen are :—

Height of skull (from basisphenoid to roof)	7·5
Greatest width at squamosals	15·4
Width between outer angles of the quadrates	12·3
„ of occipital condyle	2·4

C. 10030. Much crushed and weathered skull, incomplete in front, showing the roofed-in temporal fossæ.

R. 3192. A similar but rather more imperfect specimen.

Presented by the Egyptian Government, 1904.

Division B. **PLEURODIRA.**

Family PELOMEDUSIDÆ.

Genus **PODOCNEMIS**, Wagler.

[Syst. Amph. (1830) p. 135.]

This genus, including Pleurodiran tortoises in which the temporal fossæ are roofed in and the mesoplastra are small and laterally situated, is represented in the Eocene of the Fayûm by several species. Of these *Podocnemis antiqua*, Andrews, and *Podocnemis stromeri*, Reinach, with its variety *major*, are from the Qasr-es-Sagha beds, while *Podocnemis fajumensis*, Andrews, and *P. blanckenhorni*, Reinach, with its variety *ovata*, are from the Fluvio-marine beds of the Upper Eocene. Judging from the great variation in the plastra, of which a considerable number have been examined, it seems very probable that *P. blanckenhorni* is identical with *P. fajumensis*; indeed, according to Reinach's figures, there seems to be more difference between the two forms of *P. blanckenhorni* than there is between the typical form and *P. fajumensis*.

Podocnemis antiqua, Andrews.

[Text-fig. 92.]

1903. *Podocnemis antiqua,* C. W. Andrews, Ann. & Mag. Nat. Hist. [7] vol. xi. p. 120, pl. viii. figs. 2 A, B.

1903.　　　 ,,　　　　 ,,　　A. von Reinach, Abhandl. Senckenberg. naturf. Gesell. vol. xxix. pt. 1, p. 19.

Type Specimen.—A crushed shell, much coated with gypsum and with all the furrows marking the outlines of the epidermal shields entirely lost (text-fig. 92); Geological Museum, Cairo.

Shell broad and short, somewhat pointed posteriorly. Nuchal bone broad and short, with a straight anterior border. In the plastron the xiphiplastrals form the longest suture in the middle line.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

The carapace in this species is flatter posteriorly than in front, where it seems to have been highly arched. The nuchal border is straight, without a trace of any emargination; the nuchal bone (*Nu.*) is much broader than long. There are six neurals. The first is in contact with the nuchal in front; at the point of junction of the nuchal, first neural, and first costal there is a small opening through the shell. The second to fifth neurals, like the first, are much longer than wide, their anterior borders are slightly concave, while laterally they are bounded by a very

2 P

short anterior and a long posterior side. The sixth is pentagonal and is wedged in between the front of the sixth costal plates, which behind it meet in the middle line, as also do the seventh and eighth costals. Of the eight pairs of costal bones the first is much the largest. The marginals are badly preserved, but there seem to have been ten or eleven pairs: the last marginals and the pygals are somewhat enlarged, giving the carapace its peculiar caudate appearance; though it is possible that this may be partly due to crushing, which has bent the posterior end of the shell a little upwards. The suprapygal is roughly triangular in outline, the sides being convex. The surfaces for the attachment of the ilia and scapulæ are exactly as in *P. madagascariensis*; and the buttresses are similar in position and quite as strongly developed as in that species, thus differing from the comparatively slightly developed buttresses of *Stereogenys*.

Text-fig. 92.
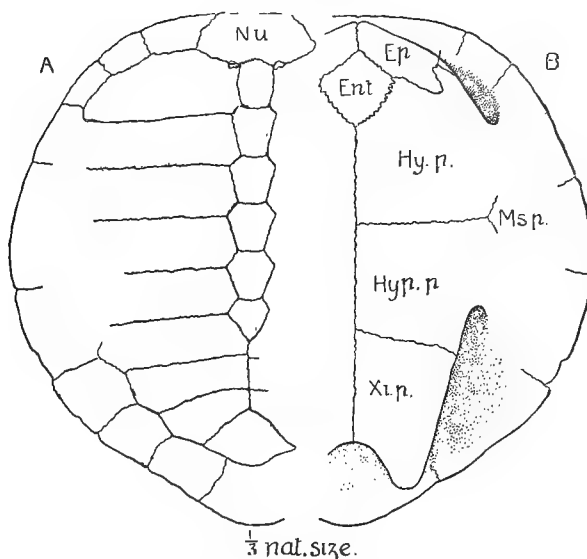
Carapace and plastron of *Podocnemis antiqua* : A, carapace ; B, plastron.

Ent., entoplastral bone ; *Ep.*, epiplastral bone ; *Hy.p.*, hyoplastral bone ; *Hyp.p.*, hypoplastral bone ; *Ms.p.*, mesoplastral bone ; *Nu.*, nuchal bone ; *Xi.p.*, xiphiplastral bone. About ⅓ nat. size.

(From the Ann. & Mag. Nat. Hist. [7] vol. xi.)

In the plastron (text-fig. 92, B) the entoplastral bone (*Ent.*) is rhomboidal in form: from its outer angles the sutures between the epi- (*Ep.*) and hyoplastrals (*Hy.p.*) run outwards and backwards for a short distance and then turn forwards, at least on the inner surface; on the outer face the sutures are obscure and, owing to the varying degrees of overlapping of the adjacent bones, may have been rather different from those on the inner face. The straight suture between the hyo- and hypoplastral (*Hyp.p.*) crosses about the middle of the bridge and terminates in the outer angle of a small lateral mesoplastral (*Ms.p.*). The xiphiplastra (*Xi.p.*) terminate in points, the whole posterior border being deeply notched. The bases of the fused pubes and ischium

are almost exactly as in *P. madagascariensis.* None of the boundaries between the epidermal shields are visible.

From *Podocnemis stromeri* described from the same horizon by Reinach, the present species is differentiated, according to that writer, in the following points :—

(1) Shortness and relatively much greater breadth of the shell.

(2) Different form of the surface of the carapace.

(3) Broader and shorter nuchal and the presence of a pair of foramina behind it and on each side of the first neural, which is not longer than the second.

(4) The sutures between the epi- and hyoplastrals are different in form. (In this connection it should be noticed that the sutures in the type specimen are not clearly visible on the *outer* face of the plastron.)

(5) The xiphiplastrals form the longest suture in the middle line.

(6) The suprapygal is of a different shape.

From this it will be seen that the two species are certainly distinct, though some of the differences may perhaps be due to the distortion through crushing, and others to the immaturity of the type specimen of *P. antiqua.*

C. 10038. Carapace and plastron of a probably young individual, much crushed and coated with gypsum. Type specimen described and figured in Ann. & Mag. Nat. Hist. [7] vol. xi. (1903) p. 120, pl. viii. figs. 2 A, B (reproduced in text-fig. 92). The dimensions of this specimen are :—

Length of carapace	20·2
Approximate width of carapace	19
Width of nuchal bone	5
Length of nuchal bone	3·2
„ neural series in straight line	12
„ plastron	18·5
Width of anterior lobe	10
Length of anterior lobe	4 app.
„ bridge	8 app.
Width of posterior lobe	8·5
Length of posterior lobe	7·8

Podocnemis fajumensis, Andrews.

[Text-figs. 93, 94.]

1903. *Podocnemis fajumensis*, C. W. Andrews, Ann. & Mag. Nat. Hist. [7] vol. xi. p. 121, pl. viii. fig. 2 c.

1903. (?) *Podocnemis blanckenhorni*, A. von Reinach, Abhandl. Senckenberg. naturf. Gesell. vol. xxix. pt. 1, p. 27, pl. ix.

Type Specimen.—Anterior portion of a plastron, with the sutures and grooves well defined (text-fig. 93) ; Geological Museum, Cairo.

In this species the anterior lobe of the plastron is longer compared with the posterior lobe than in *P. antiqua*, and the outline of the shell is more regularly oval than in that species. Its probable identity with *P. blanckenhorni*, Reinach, is referred to below. In *P. ægyptiaca* from the Lower Miocene of Mogara, the lobes of the plastron are longer in proportion to their width and the form of the vertebral shields is different.

Form. & Loc.—Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

Remains of small Podocnemid tortoises are fairly numerous in the Upper Eocene beds, the anterior part of the plastron, for some reason or other, being most commonly found. One of these was made the type of the present species *Podocnemis fajumensis*, while others have been described by Reinach under the names *P. blanckenhorni* and *P. blanckenhorni* var. *ovata*, the chief differences between the two species lying in the form of the suture between the epiplastrals and hyoplastrals and of the groove

Text-fig. 93.
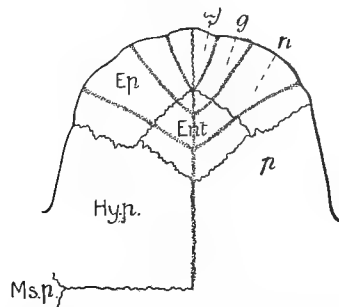
Anterior portion of plastron of *Podocnemis fajumensis* (type specimen).

Ent., entoplastral bone; *Ep.*, epiplastral bone; *g.*, gular shield; *Hy.p.*, hyoplastral bone; *i.g.*, intergular shield; *Ms.p.*, mesoplastral bone; *n.*, humeral shield; *p.*, pectoral shield. ⅓ nat. size.

(From the Ann. & Mag. Nat. Hist. [7] vol. xi.)

between the humeral and pectoral shields. Several other specimens have been examined, and it is found that a considerable degree of individual variation exists in this respect, so that it is not impossible that the different forms described may be merely variants of one species, although further more satisfactory material will be necessary to settle this point.

In the type specimen (text-fig. 93) the anterior border is rounded, with slight notches marking the boundaries of the areas covered by the epidermal shields. The anterior lobe widens gently towards the bridge. The entoplastral is diamond-shaped, all the sides being nearly straight. The suture between the epi- and hyoplastrals runs a little backwards from the outer angle of the entoplastral, then forwards and outwards parallel with the humero-pectoral groove, which is about 1·5 cm. in front of it. The intergular is small, the gulars longer, meeting in the middle line for about 1 cm. The humerals extend back to about the middle of the entoplastral bone (text-fig. 93).

In the type of *P. blanckenhorni* * the entoplastral is more elongated and its postero-lateral borders are convex; the groove between the humeral and pectoral shields curves backwards and crosses the suture between the epiplastra and hyoplastra, so that this form differs from the type of the present species both in the shape of the entoplastral and in the relations of the grooves and sutures. In the type of *P. blanckenhorni* var. *ovata* † the entoplastral is similar to that of *P. fajumensis*, while the grooves and sutures are nearly like those of the typical *P. blanckenhorni*. Other specimens of plastra still further bridge the gap between the two species: thus one

Text-fig. 94.
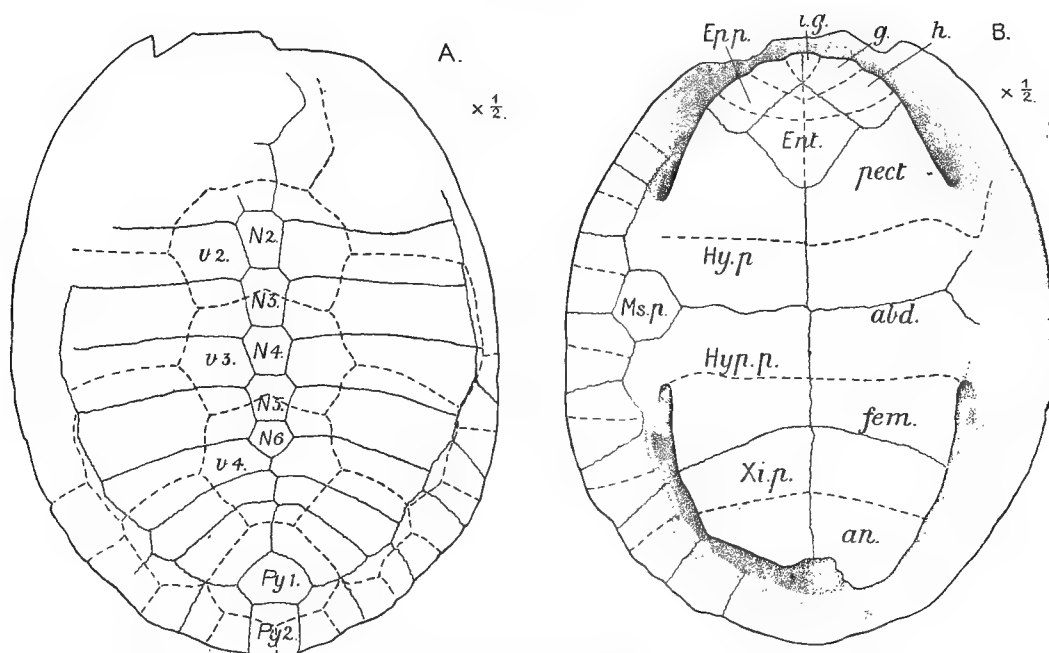
Carapace and plastron of (?) *Podocnemis fajumensis* : A, carapace ; B, plastron.

abd., abdominal shield; *an.*, anal shield; *Ent.*, entoplastral bone; *Ep.p.*, epiplastral bone; *fem.*, femoral shield; *g.*, gular shield; *h.*, humeral shield; *Hy.p.*, hyoplastral bone; *Hyp.p.*, hypoplastral bone; *i.g.*, intergular shield; *Ms.p.*, mesoplastral bone; *N.* 2–6, second to sixth neural bones; *pect.*, pectoral shield; *Py.* 1–2, pygal bones; *v.* 2–4, second to fourth vertebral shields; *Xi.p.*, xiphiplastral bone. ½ nat. size.

specimen has an entoplastral very similar to that of *P. blanckenhorni*, while the humero-pectoral grooves, although they curve backwards, do not cross the sutures between the epiplastrals and hyoplastrals. From the above observations it appears that it may be fairly assumed that all the specimens referred to are individual variations of a single species, and that Reinach's specific name is synonymous with *P. fajumensis*.

The best specimen of this species is a nearly complete shell preserved in the Geological Museum at Cairo (C. 8790) and figured in text-fig. 94. The carapace is

* A. von Reinach, *op. cit.* p. 27, pl. ix. figs. 3, 4. † A. von Reinach, *op. cit.* pl. ix. figs. 1, 2.

oval in outline and slightly wider posteriorly than anteriorly; its convexity is not very great, though the crushing, which has resulted in the breaking away of a part of the anterior border and the dislocation of some of the bones, may be to some extent responsible for the flattened form of the shell. There are six neurals (*N.*), of which the anterior five are hexagonal, with the antero-lateral borders much the shortest; the sixth (*N.* 6) is pentagonal, its posterior angle being thrust between the anterior part of the sixth costals, which behind it meet one another in the middle line, as also do the seventh and eighth costals. The nuchal bone seems to have been wide, but is badly preserved. The suprapygal (*Py.* 1) is triangular, with the postero-lateral angles truncated for union with the last pair of marginals; the pygal (*Py.* 2) is nearly as wide as long. The vertebral shields (*v.*) are hexagonal, with the anterior and posterior borders convex forwards. Both in its general form and in its structure the carapace is very similar to that of *P. madagascariensis.*

In outline the anterior part of the plastron (text-fig. 94, B) is like that of the type specimen, but the entoplastron is rather longer, the postero-lateral borders being longer than the antero-lateral ones. The sutures between the epiplastrals (*Ep.p.*) and hyoplastrals (*Hy.p.*) are strongly concave forwards. The posterior ends of the humeral shields (*h.*) do not reach so far back as the middle of the entoplastral, and the grooves between them and the pectoral shield (*pect.*) do not curve backwards, and so do not cross the suture between the epiplastrals and hyoplastrals. The small mesoplastra (*Ms.p.*) are roughly hexagonal in form; the xiphiplastrals (*Xi.p.*) are incomplete posteriorly, but the hinder border of the plastron was clearly deeply notched. The median sutures between the hyoplastra, the hypoplastra, and the xiphiplastra with one another are almost equal in length. The dimensions of this shell are given below.

C. 10202. Anterior portion of plastron. Type specimen figured and described in Ann. & Mag. Nat. Hist. [7] vol. xi. (1903) p. 121, pl. viii. fig. 2 c, the figure being reproduced as text-fig. 93. The dimensions (in centimetres) of this specimen are approximately :—

      Width of anterior lobe immediately in front of bridge . . .   11·5
      Length of anterior lobe . . . .   7·5
         ,,   entoplastron . . . .   3·7

C. 8509. Anterior portion of plastron. In this the humero-pectoral groove does not cross the suture between the epi- and hyoplastral bones, but terminates with it on the lateral border. The entoplastral is long; its postero-lateral sides are convex. The approximate width in front of the bridge is 12·5 cm., the length of the anterior lobe 7·5 cm., the length of the entoplastron 4·7 cm.

R. 3103. Anterior part of plastron similar to the type specimen, except that the suture between the epi- and hyoplastral bones is more concave forwards and just touches the humero-pectoral groove on the border of the plastron; the entoplastral is larger and its postero-lateral borders are convex.

C. 8790. Nearly complete shell, described above and figured text-fig. 94. The dimensions (in centimetres) of this specimen are :—

Length of carapace in middle line	16·7
Approximate width of carapace	13·4
Greatest length of plastron	14·4
Width of anterior lobe of plastron	7·4
Length of anterior lobe of plastron	3·7 app.
Width of posterior lobe of plastron	7·5
Length of posterior lobe of plastron	5·7 app.
„ bridge	5·9

R. 3346. Anterior portion of a mandible, probably of this species. This mandible differs from that of *P. madagascariensis* in having a broader symphysis; the biting surface is also much broader, and is partially divided into two by a median ridge.

Genus STEREOGENYS, Andrews.

[Geol. Mag. [4] vol. viii. (1901) p. 442.]

This genus is nearly allied to *Podocnemis,* but is distinguished from it by: (1) the great length and massiveness of the mandibular symphysis; (2) the posterior position of the internal nares resulting from the approximation of the palatines in the middle line to form a floor to the narial passage; (3) the large size of the intergular shield, which separates the gular and humerals; (4) the slight development of the axillary and inguinal buttresses. The fact that the anterior vertebral shield is narrower than the nuchal bone (in *S. libyca*) was originally regarded as a generic character, but, as Reinach * has pointed out, it is doubtful whether this character occurs in all the species; the same is the case with the separation of the neural bones from the nuchal in front and the suprapygal behind. Reinach has lately described a species of this genus, *S. podocnemioides,* from the Middle Eocene of the Fayûm, which in several respects, *e. g.* the relations of the intergular shield to the humerals, is intermediate in structure between the typical members of the genera *Podocnemis* and *Stereogenys.*

Stereogenys cromeri, Andrews.

[Plate XXV. figs. 1–3 ; text-figs. 95, 96.]

1901. *Stereogenys cromeri,* C. W. Andrews, Geol. Mag. [4] vol. viii. p. 442, fig. 4.
1903.   „   „   C. W. Andrews, Ann. & Mag. Nat. Hist. [7] vol. xi. p. 119, pl. viii. fig. 1.
1903.   „   „   A. von Reinach, Abhandl. Senckenberg. naturf. Gesell. vol. xxix. pt. 1, p. 41.

Type Specimen.—A skull and mandible (Pl. XXV. figs. 2, 3); Geological Museum, Cairo.

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* Von Reinach, "Schildkrötenreste aus dem ägyptischen Tertiär," Abhandl. Senckenberg. naturf. Gesell. vol. xxix. pt. 1 (1903) p. 34.

In this species, which is the type of the genus, the shell is more depressed, wider and more uniformly oval than in *S. libyca* from the beds above. It also differs in possessing a comparatively narrow nuchal bone, probably narrower than the anterior vertebral shield; in the later form the reverse is the case. From *S. podocnemioides*, Reinach, of the same horizon, this species is distinguished by the fact that the humeral shields are widely separated posteriorly by the intergular instead of terminating at the same point.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene) : north of Birket-el-Qurun.

Text-fig. 95.
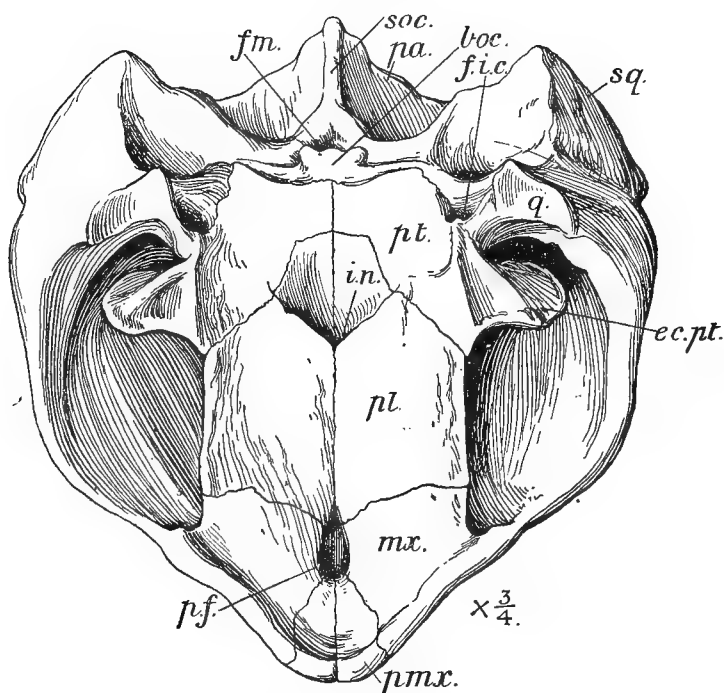
Palatal view of skull of *Stereogenys cromeri*, restored.

boc., basioccipital ; *ec.pt.*, ectopterygoid wing ; *f.i.c.*, fossa into which the internal carotid opens ; *f.m.*, foramen magnum ; *i.n.*, internal nares ; *mx.*, maxilla ; *p.f.*, palatine foramen ; *pa.*, parietal ; *pl.*, palatine ; *pmx.*, premaxilla ; *pt.*, pterygoid ; *q.*, quadrate ; *soc.*, supraoccipital ; *sq.*, squamosal. About ¾ nat. size.

The skull (Pl. XXV. figs. 1–3; text-fig. 95) in its general structure is closely similar to that of *Podocnemis*, but is broader and more depressed. The supraoccipital (*soc.*) is produced backwards into a large median process, the upper surface of which appears on the roof of the skull between the hinder ends of the parietals (*pa.*). These bones are very large, forming the greater part of the skull-roof; laterally they join the quadrato-jugals and jugals in a straight suture, forming with those bones a complete covering for the temporal fossæ, as in *Podocnemis*. The frontals (*f.*) are comparatively small, and extend forwards to about the middle point of the orbits, where they join the

prefrontals (*pr.f.*) in a transverse suture. The prefrontals form the upper borders of the orbits, and join an upward process of the maxillæ to complete the orbits in front. There were no nasals. Posteriorly the orbits are to a great extent cut off from the temporal fossa by a wall which, as in *Podocnemis*, seems to have been constituted by the upturned edges of the palatines (*pl.*) meeting processes of the jugal and perhaps also in part by the postfrontal (*po.f.*). The premaxillæ (*pmx.*) are small; they form the floor of the nasal opening, and appear to a considerable extent on the palate, extending back to form the anterior boundary of the cleft (*p.f.*) which runs back between the maxillæ; within and parallel to their sharp alveolar border there is, on the palate, another slight ridge. The maxillæ (*mx.*) form the greater part of the cutting-edge of the jaw and the anterior part of the palate; in the middle line they are separated by the narrow cleft above referred to, but their edges converge backwards, while in *Podocnemis* there is a wide open space between them, increasing in width backwards. The palatines join the maxillæ in an oblique suture; their arrangement differs widely from that seen in *Podocnemis*. Instead of merely forming the posterior portion of the border of the internal nares, they here send in palatine plates, which seem to have met in the middle line forming a secondary hard palate, as in the mammals, and thus carrying back the opening of the internal nares to a point rather behind the middle of the skull. In the type and some other specimens these palatine plates do not actually meet, but are separated by a narrow cleft; though probably this is due to slight distortion from pressure, since in one specimen at least they actually unite. This formation of a secondary hard palate and the consequent posterior position of the internal nares (*i.n.*) is correlated with the great width of the symphysis of the mandible: probably both the hard palate and the symphysis were covered with broad horny plates and were employed in crushing hard substances, such as the shells of Crustaceans or Molluscs. The form and relations of the palatines and internal nares in *Stereogenys* are shown in text-fig. 95. The pterygoids (*pt.*) join the palatines in an oblique suture and from the posterior ends of the palatine plates of the latter bones ridges run backwards and outwards towards the point of union of the former with the quadrates. The ectopterygoid processes (*ec.pt.*) are very large and together with the anterior upturned edge of the bones form the outer border of deep grooves (Pl. XXV. fig. 1, *g.*), which above lead into the orbits, into which they open immediately within the posterior wall above mentioned: the arrangement of these parts is almost exactly as in *Podocnemis*. Postero-laterally the pterygoid joins the quadrate (*q.*), immediately internal to which is a large foramen for the internal carotid (*f.i.c.*). In the middle line the pterygoids are to a considerable extent separated by the backward extension of the palatines, but behind this they meet for a short distance, probably covering the anterior part of the basioccipital. The quadrate (*q.*) differs from that of *Podocnemis* in being prolonged downwards, so that the mandibular articulation, which is strongly concave from side to side, is borne on a

short pedicle and is considerably below the level of the lower border of the completely closed tympanic ring, which is oval in outline. So far as can be determined, the form and relations of the squamosal, quadrato-jugal, and jugal do not differ in any important respect from those of the same elements in *Podocnemis*, and the same may be said for the bones of the side of the cranium. The large *foramen sphenoidale* (*f.s.*) is shown in Pl. XXV. fig. 1, opening in front of the epiotic.

The symphysial region of the mandible (Pl. XXV. fig. 3, *sym.*) is very large and massively constructed. In form it is roughly pentagonal, the two anterior sides forming the labial borders, the two laterals being produced upwards into strong pointed coronoid processes (*cor.*), while the posterior side is slightly concave. This posterior border is greatly thickened and deeply grooved; in front of it the bone thins gradually towards the labial borders. The lateral edges of the symphysis are also deeply grooved (*m.g.*), the groove being continued back on to the rami as far as the articulation. The ventral surface of the symphysis is very slightly convex in all directions; it is separated from the ventral surface of the rami by shallow grooves, and probably was covered by a single large horny plate. The rami are not only deeply grooved on the outer face, as already mentioned, but are also hollowed on the inner side. The articular surface (*art.*) for the quadrate is large; it is convex from side to side and slightly concave from before backwards : behind it there is a blunt angular process (*ang.*), the upper surface of which is concave.

The extraordinary massiveness of the symphysis and the great development of the processes and grooves for the attachment of the jaw-muscles indicate that the jaws with their horny covering must have formed a very powerful crushing-apparatus. A similar modification is observable in some Cyptodiran tortoises, e. g. *Lytoloma*, described and figured by Dollo [*].

Although in no case have the carapace and plastron been found associated with the skull in such a manner as to leave no doubt that they belong to the same individual, nevertheless the shell now to be described may be regarded with reasonable certainty as belonging to the present species. In the first place, this form of shell, like the skull, is the commonest occurring in the Qasr-el-Sagha beds, and in the second place it differs widely from the shell of *Podocnemis*, the only other Pleurodiran genus found at this horizon.

The most nearly complete specimen is a somewhat crushed shell (text-fig. 96), both carapace and plastron being so coated with gypsum that many of the sutures and most of the grooves between the epidermal plates cannot be seen. The *carapace* (text-fig. 96, A) is depressed, this being in part due to crushing, though it is clear that the shell was much wider and less convex than in the next species, *S. libyca*, approaching in this respect *S. podocnemioides* as described by Reinach. The number

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[*] Bull. Mus. Roy. Hist. Nat. Belge, vol. iv. (1886) p. 129. See also Lydekker, Proc. Zool. Soc. 1889, p. 60.

of neural bones cannot be determined, but it seems certain that, as in the next species, the neural series is separated both from the nuchal and pygal bones by the junction in the middle line of the anterior and posterior pairs of costals respectively. There are eight pairs of costal bones, but the number of marginals cannot be made out. The nuchal bone (*Nu.*) is large, but much narrower than in *S. libyca*, so that, as Reinach has pointed out, it seems improbable that the anterior vertebral shield was narrower than the nuchal as in that species. Scarcely any trace of the epidermal shields is preserved, but the two middle vertebrals seem to have been large and roughly hexagonal in outline.

Text-fig. 96.
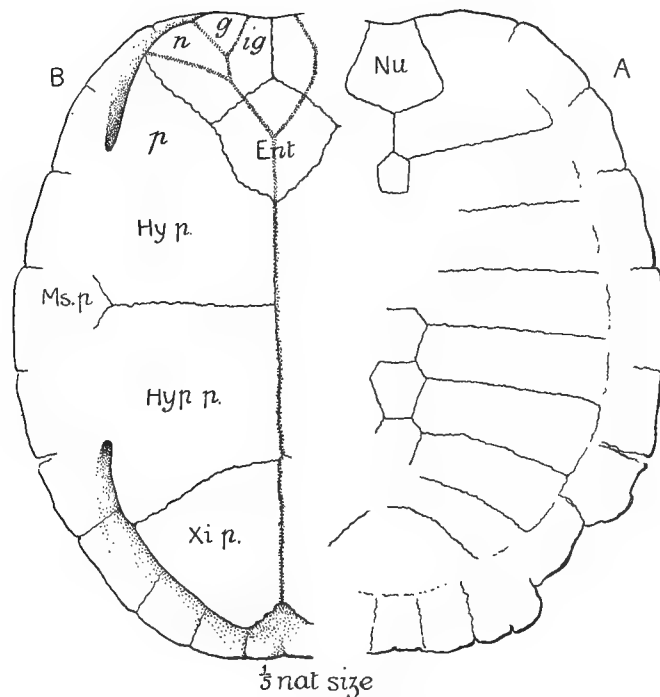
Carapace and plastron of *Stereogenys cromeri*: A, carapace ; B, plastron.

Ent., entoplastral bone ; *g.*, gular shield ; *Hy.p.*, hyoplastral bone ; *Hyp.p.*, hypoplastral bone ; *ig.*, intergular shield ; *Ms.p.*, mesoplastral bone ; *n.*, humeral shield ; *Nu.*, nuchal bone ; *p.*, pectoral shield ; *Xi.p.*, xiphiplastral bone. ⅕ nat. size.

(From the Ann. & Mag. Nat. Hist. [7] vol. xi.)

The *plastron* (text-fig. 96, B) is relatively large : the bridge is long, being in the specimen described about 20·5 cm. in length ; while the length of the anterior free lobe is only 11·5 cm., and that of the posterior lobe about 15 cm. The anterior border is slightly concave in the middle line. The entoplastral (*Ent.*) is large and rhomboidal, the sides being somewhat convex. The sutures between the epiplastrals and hyoplastrals are concave in front and run forwards, terminating on the edge of

the plastron in the groove between the humeral (*n.*) and pectoral (*p.*) shields. In some specimens the upper surface of the epiplastrals is raised into a sort of boss near their posterior angle, and from this a slight ridge is continued backwards to the axillary buttress. The suture between the hyo- (*Hy.p.*) and hypoplastrals (*Hyp.p.*) crosses the middle of the bridge and terminates at the inner angles of the small meso-plastrals (*Ms.p.*), which are irregularly hexagonal in outline and are wedged in between the outer ends of the hyo- and hypoplastrals and the marginals. The sutures between the hypoplastrals and xiphiplastrals (*Xi.p.*) make an angle of about 115° with the middle line, and are slightly convex forwards. The posterior border of the plastron seems to have been notched in the middle line as in *S. libyca*, but in no specimen is this region well preserved.

The arrangement of the horny scutes on the plastron is only known in the case of the anterior region. The intergular (*ig.*) is very large, its posterior point being about on the middle of the entoplastron. Both the gulars (*g.*) and humerals (*n.*) are very small and widely separated by the intergular. In *Stereogenys podocnemioides*, Reinach, the humerals are much larger and their posterior angles coincide with that of the intergular: this condition is transitional to *Podocnemis*, in which both the gulars and humerals meet in median suture behind the intergular.

C. 10027. Skull and mandible, found actually articulated with each other. The skull is somewhat crushed and is imperfect in the premaxillary region. Many of the sutures are obscured by a coating of gypsum. Type specimen described and figured in Geol. Mag. [4] vol. viii. (1901) pp. 442–3, fig. 4; also on Pl. XXV. figs. 2, 3. The dimensions (in centimetres) of this specimen are :—

Skull :

Extreme length in middle line	9·6
„ „ from end of the squamosals.	10·5
Greatest width (at tympanic opening).	9·8 *
Width between the ends of the ectopterygoid processes . .	6·5
„ „ outer ends of quadrate articulations . . .	7·5
„ of quadrate articulation	1·4
Distance from internal nares to tip of nose	5
Width of palate	4

Mandible :

Total length	7·1
Length of symphysis	4·3
Width at coronoid process	5·5
„ articular surfaces for quadrate	6·4

R. 3007. Plaster casts of the above specimens. *Made in the British Museum.*

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* This measurement is a little exaggerated, through the distortion due to crushing.

R. 3190. Imperfect skull, wanting roof of right temporal fossa and with palate much crushed. The dimensions (in centimetres) of this specimen are :—

Extreme length in middle line . . . . 11·4
„   „   from posterior end of squamosals . . . . 11·6
Greatest width . . . . 11 app.
Width between the ends of the ectopterygoid processes . . . 7·6
„   of palate . . . . 4·9
Distance from internal nares to tip of nose . . . . 5·8
Least width between the orbits 2

Presented by the Egyptian Government, 1904.

C. 10031. Nearly complete skull, wanting portions of the covering of the temporal fossæ and the left quadrate. The dimensions (in centimetres) of this specimen are :—

Extreme length in middle line . . . . 10·4 app.
„   „   from posterior ends of squamosals . . . . 11·5
Greatest width . . . . 10·3 app.
Width between ends of ectopterygoid processes . . . . . 7·2
„   of palate . . . . 4·3
Distance from internal nares to tip of nose . . . . 5·7

R. 3189. Imperfect skull, wanting the whole of the temporal arches and roof. Figured on Pl. XXV. fig. 1.

Extreme length in middle line . . . . 10+
Width of palate . . . . 4·2
Distance from internal nares to tip of nose . . . . 5·8

Presented by the Egyptian Government, 1904.

R. 3202. Posterior portion of two skulls, probably of young individuals of this species. The only notable difference observable between these and the type skull is, that the quadrate articulation is less markedly pedunculate. *Presented by W. E. de Winton, Esq., 1903.*

C. 10039. Carapace and plastron, somewhat crushed and much coated with gypsum. This specimen was described and figured in Ann. & Mag. Nat. Hist. [7] vol. xi. (1903) p. 119, pl. viii. fig. 1 (reproduced in text-fig. 96). The dimensions (in centimetres) of this specimen are :—

Carapace :
Greatest length . . . . 47·5
Length in middle line 45
Greatest width (increased by crushing) 41
Length of nuchal bone . . . . 7 app.
Width of nuchal bone . . . . 6·5 app.
Plastron :
Greatest length 44
Length in middle line . . . . 41·6
„   of bridge . . . . 20·5
„   of anterior lobe . . . . 11·5
Width of anterior lobe 24
Length of posterior lobe . . . . 15 app.
Width of posterior lobe 24

Plastron (*cont.*):

Length of entoplastral bone	8·7
Width of entoplastral bone	8·7
Length in middle line of hyoplastral	7·5
,, ,, hypoplastral	11
,, ,, xiphiplastral	9·5
Length of intergular shield	8

R. 3345. Anterior portion of plastron, showing the thickenings on the inner face of the epiplastrals. Width of anterior lobe 22 cm. ; length of ditto in middle line 8·2 cm. ; length of entoplastral 6·8 cm.

R. 3200. Anterior portion of plastron : the form of the entoplastral is rather different from that seen in the other two specimens, being more escutcheon-shaped. Width of anterior lobe of plastron 19 cm. app. ; length of ditto in middle line 8 cm. ; length of entoplastral 6 cm. app.   *Presented by W. E. de Winton, Esq.*, 1903.

R. 3347. Proximal half of a left humerus of a medium-sized tortoise, provisionally placed here. This specimen is similar to the humerus of *Podocnemis*, except that the ulnar crest is less developed and the head less rounded, though this latter character may be due to partial abrasion.

Stereogenys libyca, Andrews.

[Text-fig. 97.]

1903. *Stereogenys libyca*, C. W. Andrews, Ann. & Mag. Nat. Hist. [7] vol. xi. pp. 115–119, pl. vii.
1903.   ,,   ,,   A. von Reinach, Abhandl. Senckenberg. naturf. Gesell. vol. xxix. pt. 1, pp. 41–45, pl. xii., pl. xiii. figs. 1, 6–9.

Type Specimen.—A nearly complete shell (text-fig. 97) ; British Museum.

This species is distinguished from *S. cromeri* by possessing a more convex shell, somewhat expanded posteriorly, and a nuchal bone considerably wider than the first vertebral shield. From *S. podocnemioides* it differs in having the humeral shields widely separated posteriorly by the intergular.

Form. & Loc.—Fluvio-marine beds (Upper Eocene) : north of Birket-el-Qurun.

The specimen (text-fig. 97) upon which this species is founded is a very well-preserved shell, wanting only a portion of the left side of both the carapace and plastron ; the pelvic bones were found *in situ* in the shell. Although cracked in all directions this specimen seems to be quite undistorted and gives a good idea of the form of the living animal. In its general form the shell is very like that of *Podocnemis madagascariensis*, but rather more convex, particularly in the region covered by the last vertebral shield, where there is a well-marked prominence. The *carapace* is somewhat expanded posteriorly.

There are seven neural bones (text-fig. 97, A), the series being separated from the nuchal in front and from the suprapygal behind by the union in the middle line of

the anterior and posterior costals respectively. The distance between the anterior neural and the nuchal is 4·6 cm., that between the last neural and the suprapygal 1·9 cm. The anterior neurals are much longer than wide, but the series shortens

Text-fig. 97.
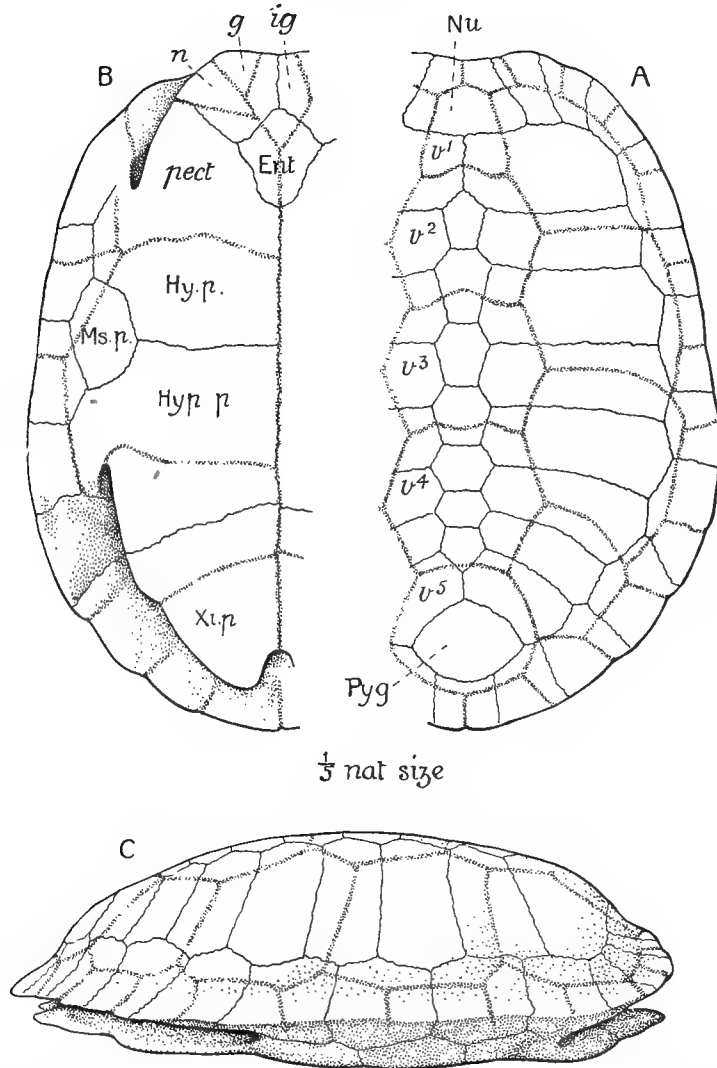
Carapace and plastron of *Stereogenys libyca*: A, carapace; B, plastron; C, shell from right side.

Ent., entoplastral bone; *g.*, gular shield; *Hy.p.*, hyoplastral bone; *Hyp.p.*, hypoplastral bone; *ig.*, intergular shield; *Ms.p.*, mesoplastral bone; *n.*, humeral shield; *Nu.*, nuchal bone; *pect.*, pectoral shield; *Pyg.*, pygal bone; *v.* 1–5, vertebral shields; *Xi.p*, xiphiplastral bone. ⅕ nat. size.

(From the Ann. & Mag. Nat. Hist. [7] vol. xi.)

from before backwards, so that the posterior ones are wider than long. They are hexagonal in outline, with the exception of the first and last, which are pentagonal,

owing to the suppression of the anterior and posterior faces respectively; in the anterior neurals the antero-lateral borders are much shorter than the postero-lateral ones.

There are eight pairs of costals: as already mentioned, the first and last pairs meet in the middle line (text-fig. 97, A). The nuchal (*Nu.*) is large and wider than long; it is wider than the anterior vertebral plate which overlaps it; the anterior border is emarginate. There are eleven pairs of marginals, of which 4, 5, 6, and 7 form the base of the bridge, and 5 and 6 unite with the mesoplastral (*Ms.p.*). The anterior free marginals have a rounded edge, the posterior ones are somewhat expanded and have a sharp edge. The axillary buttress is opposite the fourth marginal, the inguinal opposite the seventh: both buttresses are weaker and less developed than in most Pleurodirans, the inguinal being the stronger of the two.

The suprapygal (*Pyg.*) occupies the summit of the posterior prominence above referred to; it is roughly triangular in outline with convex sides and is of nearly the same shape as the overlying vertebral shield. The pygal is notched in the middle line by the furrow separating the posterior pair of marginal shields.

There are five vertebral shields (*v.*), the anterior of which is very narrow, being much narrower than the nuchal bone beneath it; in *Pelomedusa* and *Podocnemis* the reverse is the case. The remaining vertebrals are roughly hexagonal in form, the antero-lateral borders being slightly shorter than the postero-lateral. The posterior shield is very convex; like the underlying suprapygal it is triangular in form, but is much larger (text-fig. 97, A, C). There are four costal shields and twelve marginals: no nuchal shield is present. On the anterior borders of the carapace the extent to which the marginals are exposed is very small, but posteriorly, where the carapace is somewhat expanded, the area is much greater. The relations of the shields to the underlying bones are shown in the figure.

The *plastron* (text-fig. 97, B) is large; its posterior free portion is wider than the anterior and is more than half as long again. The length of the bridge is about equal to the width of the front lobe, but much greater than its length. The anterior border is gently concave. The upper surface in this region is also gently concave from side to side, the concavity being bounded by thickened ridges borne on the epiplastrals and anterior part of the hyoplastrals (*Hy.p.*). From this ridge the surface slopes gently away to the lateral border of the anterior lobe. It appears that the upper surface of the anterior lobe of the plastron was covered for some distance from its border by a series of epiplastral shields.

The entoplastron (*Ent.*) is a small escutcheon-shaped element, from the outer angles of which the sutures between the epiplastral and hyoplastral bones run forwards, making an angle of about 45° with the long axis of the shell and terminating on the border of the plastron in the notch marking the end of the groove between the humeral and pectoral shields. The suture between the hyo- and hypoplastra (*Hy.p.*, *Hyp.p.*) crosses at the level of the middle of the bridge and terminates externally

at the inner angle of the mesoplastra (*Ms.p.*), which are thus wedged in between marginals 5 and 6 and the outer ends of the hyo- and hypoplastra. The mesoplastra are longer than broad ; the two inner borders are strongly convex. The borders of the posterior lobe of the plastron are evenly curved to the posterior angles, except for a slight notch where the furrow between the femoral and anal shields crosses the edge. The sutures between the hypoplastra and the xiphiplastra (*Xi.p.*) run parallel with the femoro-anal furrows and about 3 cm. in front of them. There is a deep rounded notch between the posterior ends of the xiphiplastrals.

The intergular shield (*ig.*) is very large and extends back as far as the middle of the entoplastron, separating both the gulars (*g.*) and the humerals (*n.*). Both these plates are very small : the pectorals (*pect.*), on the other hand, are large ; the suture between them and the abdominals runs across about 3 or 4 centimetres behind the anterior end of the bridge. The limits of the abdominals, the femorals, and the anals are shown in the figure. The bones constituting the posterior lobe of the carapace have their upper surfaces raised into a ridge about 4·5 cm. from, and parallel with, their outer borders ; from this ridge they slope away to the thin edge, the sloping surface being evidently in great part covered by epidermal inguinal shields, which seem to have extended back to the posterior ends of the xiphiplastra.

The upper surface of the xiphiplastrals bears the bases of the pubes and ischia, as is usual in the Pleurodira, and when the type specimen was found the whole pelvis was *in situ*. The bases of the pubes are narrower and directed more forwards than in *Podocnemis*, and the same is the case to a less degree with the bases of the ischia.

The ilium is short and stout; it does not seem to have been much expanded at its upper end. In the middle of the shaft the bone has a flat antero-external surface and a rounded postero-internal surface ; it forms the greater part of the acetabulum. The pubis is flattened and united with the xiphiplastron by a long narrow base ; the anterior process is shorter than in *Podocnemis.* The ischium seems to have been slender, but the greater part is missing. The acetabulum is roughly triangular, one of the rounded angles being borne by each of the bones composing it, the angle on the pubis being the most strongly marked. The ilium forms about two-thirds of the cavity, the ischium constituting rather less than half of the remainder. The ilium of *Stereogenys podocnemioides* figured by Reinach is very similar.

R. 3039. Nearly complete carapace and plastron. Type specimen described and figured in Ann. & Mag. Nat. Hist. [7] vol. xi. pp. 115–119, pl. vii. (reproduced in text-fig. 97). The dimensions (in centimetres) of this specimen are :—

Length of carapace in middle line . . . .   41·5
Approximate width of shell   32
Length of nuchal bone (in middle line) . . . .   5·7
Width of nuchal bone   . . . .   7·5

Width of front of first vertebral shield . . . . 3·5
Greatest length of plastron 40
Length of plastron in middle line . . . . 36·5
    ,,   anterior lobe 9
Width of anterior lobe . . . . 17·4
Length of bridge . . . . 17·7
    ,,   posterior lobe 14
Width of posterior lobe . . . . 20·5
Length of entoplastral in middle line 6
    ,,   hyoplastral in middle line . . . . 8·5
    ,,   hypoplastral in middle line 9
    ,,   xiphiplastral in middle line 9
    ,,   intergular shield 6 5

R. 3100. Anterior portion of a plastron. The dimensions (in centimetres) are :—

Length of anterior lobe of plastron . . . . 9·5
Width of anterior lobe of plastron 19
Length of entoplastral . . . . 7·2
    ,,   intergular shield 7

Presented by W. E. de Winton, Esq., 1903.

R. 3120. Imperfect anterior lobe of plastron, probably of this species.

Presented by W. E. de Winton, Esq., 1903.

Order SQUAMATA.

Suborder *OPHIDIA.*

Family BOIDÆ.

According to Boulenger[*] this family includes snakes in which the maxillary, palatine, and pterygoid bones are movable; transpalatine present; pterygoid extending to quadrate or mandible; supratemporal present, attached scale-like to cranium, suspending quadrate; prefrontal in contact with nasal. Mandible with coronoid bone. Teeth in both jaws. Vestiges of pelvis and hind limbs usually terminating in a claw-like spur visible on each side of the vent.

[*] Catal. Snakes Brit. Mus. vol. i. (1893) p. 71.

Genus **GIGANTOPHIS**, Andrews.

[Geol. Mag. [4] vol. viii. (1901) p. 438.]

This genus includes very large snakes, distinguished from the recent Pythons in having vertebræ in which the neural spine is less developed and the articular surfaces of the zygosphene and prezygapophyses and of the zygantrum and the postzygapophyses respectively are nearly parallel with one another.

Gigantophis garstini, Andrews.

[Plate XXVI. figs. 1–3.]

1901. *Gigantophis garstini*, C. W. Andrews, Geol. Mag. [4] vol. viii. p. 438, fig. 1.

Type Specimen.—A series of about twenty associated vertebræ, with some fragments of ribs (Pl. XXVI. fig. 1); Geological Museum, Cairo.

The type and only known species, distinguished by its large size, it having attained a length of about thirty feet (rather more than 9 metres), if the proportions of the vertebræ compared with the length of the body were as in *Python molurus.*

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

Remains of this large Ophidian are very common in the Qasr-el-Sagha beds, occurring usually as isolated and much-weathered vertebræ. In the type specimen the vertebræ remain united in groups, one of which is figured on Pl. XXVI. fig. 1. These vertebræ are closely similar to those of *Python*, the chief differences being that the neural spine is less developed, being confined to the posterior part of the arch, and that the planes of the articular surfaces of the zygosphene and prezygapophyses and of the zygantrum and postzygapophyses respectively are more nearly parallel with one another.

In the procœlous centrum the transverse diameter of the anterior cup is slightly longer than the vertical one; the posterior ball is of corresponding form, and looks a little upwards instead of directly backwards; on the posterior half of the ventral surface there is a low, blunt, hypapophysial ridge (*hyp.*). The neural arch is extremely massive, and on its posterior half it bears a small, stout, neural spine (*n.sp.*). The anterior zygapophyses (*a.z.*) form strong prominences, continuous below with the transverse processes; their articular surfaces are roughly triangular in outline, and look rather more inwards than in *Python*, in which they are nearly horizontal. The zygosphene (*zs.*) is a greatly thickened prominence, the articular facets of which look outwards and downwards and are nearly parallel with the surfaces of the anterior

zygapophyses which they face. The posterior zygapophyses (*p.z.*) are strongly prominent trihedral processes, the posterior face of which is nearly vertical, the lower bears the oval articular surface, while the upper is continuous with the upper surface of the arch ; their upper angles are continued as ridges to the base of the neural spine ; on the posterior face there is a shallow pit (*f.*). The zygantral facets form the sides of the deep zygantrum (*za.*) in the posterior end of the arch ; they are oval in outline and inclined to the surfaces of the posterior zygapophyses at a very acute angle. The transverse processes (*t.p.*) are very short and stout ; at their extremities they bear the vertically elongated rib-facets, which are convex in all directions above, but concave from above downwards below, as in *Python* ; their lower angles are on a level with the ventral border of the centrum. The trefoil-shaped neural canal is very small, relatively much smaller than in the recent genus.

A rib associated with the type vertebræ shows that, while the articular end is just as in *Python*, the shaft is more compressed from before backwards.

The posterior portion of a left ramus of a mandible (Pl. XXVI. fig. 3) of a reptile found close to the type vertebræ may belong to this species. The specimen includes the angular and articular region, in front of which it is broken away. The articular surface (*art.*) is convex from side to side, and concave from before backwards ; it is wider in front than behind, where it terminates in a point ; its anterior border runs inwards and forwards, so that the whole surface is somewhat oblique, much as in *Python*. The angle (*ang.*) is thick and not very prominent ; it differs from that of the mandible of *Python* in being less sharply marked off from the region in front. The inner plate of the jaw, which if complete would run up anteriorly to the coronoid process, is broken away, but enough remains to show that probably it was separated from the outer plate by a deep channel as in *Python*. The apparent sculpturing of the surface of some of the bones (see Pl. XXVI. fig. 3 A) appears to be due merely to the etching of the surface by drifting sand. If this mandible did actually belong to *Gigantophis garstini*, then, judging from its size compared with any vertebræ found, it would seem that the head in this animal was relatively much larger than in recent snakes ; but more satisfactory material is necessary before any definite conclusion can be arrived at.

C. 10022. Associated series of about twenty vertebræ and portions of two ribs. Type specimen, described and figured *loc. cit. suprà* ; also figured Pl. XXVI. fig. 1. The dimensions (in centimetres) of one of these vertebræ are :—

Greatest height from top of neural spine to end of hypapophysis.   5 app.
,, width (between ends of transverse processes) . . .   5·7
Width between outer angles of posterior zygapophyses . . .   5·5
,, ,, upper angles of zygosphene . . . .   2·1
,, of articular cup of centrum . . . .   2·3
Height of articular cup of centrum . . . .   1·9

Width of articular ball of centrum . . . . 2·4
Extreme length of centrum 4
Width of neural canal . . . . 1·7
Height of rib-facets . . . . 1·8 app.

The combined length of the four united vertebræ figured on Pl. XXVI. fig. 1 is about 12·8 cm.

R. 3188. Large and nearly complete vertebra, figured Pl. XXVI. fig. 2. The dimensions (in centimetres) of this specimen are :—

Greatest height from top of neural spine to end of hypapophysis . 5·7
„ width (between the ends of the transverse processes) . 6·3
Width between outer angles of posterior zygapophyses . . . 6·3
„ „ upper angles of zygosphene . . . . 2·9
„ of articular cup of centrum . . . . 2·3
Height of articular cup of centrum . . . . 1·9
Width of articular ball of centrum . . . . 2·3
Extreme length of centrum 4
Width of neural canal . . . . 1·5
Height of rib-facets . . . . 2·2

C. 10210. A number of similar vertebræ.

R. 3010. Three similar vertebræ.   *Presented by the Egyptian Government*, 1903.

C. 10023. Posterior portion of left ramus of a mandible, possibly belonging to this species. Figured on Pl. XXVI. fig. 3.

Family PALÆOPHIDÆ.

Large snakes, probably of marine habits. Vertebræ with tall neural spines; costal articulation placed low down on the centrum. Hæmal carina on centrum not unfrequently terminating on anterior and posterior processes. This family is probably nearly related to the Pythonidæ.

Genus **PTEROSPHENUS**, Lucas.

[Proc. U.S. National Museum, vol. xxi. (1899) p. 637.]

1901. *Mœriophis*, C. W. Andrews, Geol. Mag. [4] vol. viii. p. 438.

The snakes belonging to this genus are distinguished from other members of the family by the presence on the posterior end of the arch above the zygantrum of a pair of strong pointed processes directed upwards and backwards. On their anterior face

a ridge runs downwards and forwards to the base of the anterior zygapophyses (see Pl. XXVI. fig. 4 B). These processes, which may perhaps be described as enormously developed anapophyses, are present, though of very small size, in some of the vertebræ of *Palæophis*. The genus was founded by Lucas for the reception of the species *P. schucherti*, a large snake from the Eocene of Alabama, where it occurs associated with remains of Zeuglodons. In the Eocene of Egypt, also, there is one species, likewise associated with the remains of *Zeuglodon*.

Pterosphenus schweinfurthi (Andrews).

[Plate XXVI. figs. 4–6.]

1901. *Mœriophis schweinfurthi*, C. W. Andrews, Geol. Mag. [4] vol. viii. p. 438, fig. 2.

Type Specimen.—A dorsal vertebra (Pl. XXVI. fig. 4); Geological Museum, Cairo.

This species is distinguished from *P. schucherti* by having the posterior face of the neural arch above the zygantrum considerably more expanded, so that the free portions of the postero-lateral processes are shorter.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

The vertebræ of this species occur in great numbers scattered along the Middle Eocene escarpment, but only in very rare cases are even two found united or so situated that they may be reasonably supposed to belong to the same animal.

The procœlous centrum is considerably elongated, and is about as wide as it is high; the anterior cup is deep and nearly circular in outline, except beneath the neural canal, where its border is straight; the posterior convexity is nearly hemispherical. On the ventral surface there is a strong median hypapophysial ridge (*hyp.*), usually produced into two forwardly and downwardly directed processes, one situated close to the anterior end of the centrum, the other near the middle. The transverse processes (*t.p.*) are short and situated ventro-laterally on the anterior end of the centrum, below which they project considerably; their outer ends bear the vertically elongated convex surfaces for the ribs, looking downwards and outwards. From the position of the rib-facets it appears that the body must have been laterally compressed to a considerable degree. From the upper ends of the transverse processes a ridge runs upwards and forwards to the anterior angles of the prezygapophyses (*a.z.*), which project considerably in front of the centrum; their oval articular facets are a little below the level of the floor of the neural canal, and look upwards and a little backwards. The articular surfaces of the zygosphene (*zs.*) are almost parallel with those of the prezygapophyses; they are borne on the ventral face of two prominent processes, the upper edges of which unite to form the anterior border of the neural spine. The postzygapophyses (*p.z.*) look downwards and a little forwards, their surfaces being about on a level with the top of the centrum. The zygantrum (*za.*)

is divided into two lateral pocket-like cavities, separated by a considerable interval; the articular surfaces look upwards and inwards. Above these cavities the posterior face of the neural arch is enormously expanded, concave from side to side, and produced upwards and backwards into two long pointed processes (*l.p.*), from the ends of which a ridge runs downwards and forwards to the base of the anterior zygapophyses; it is this expansion of the posterior part of the arch and the presence of these remarkable lateral processes that is especially characteristic of the genus, though the beginning of a similar arrangement occurs in the allied and contemporary *Palæophis* *. As in that genus also the neural spine (*n.sp.*) is high, strongly compressed laterally, but it seems to slope more backwards in the Egyptian form. Compared with the North-American species, *P. schucherti*, described by Lucas †, this form seems to differ only in having the posterior expansion of the neural arch considerably deeper, so that the free part of the lateral processes is shorter.

Among the vertebræ collected there is a considerable range of variation in size, but very little in structure, the chief points of difference being in the relative length and width of the neural spine (see Pl. XXVI. figs. 5, 6) and the degree of prominence of the lateral processes. In some also the anterior process of the hypapophysis is much smaller than the posterior, and may in some cases be entirely wanting.

The high neural spine and the downwardly directed articulation for the ribs seem to show that in this snake the body was laterally compressed and more or less ribbon-like, as in some recent aquatic snakes, in which the vertebræ are to some extent similar. The occurrence of the remains in association with remains of Sirenians, Zeuglodons, and Fishes lends further support to the belief that this species was aquatic or semi-aquatic in its habits.

C. 10194. Complete vertebra. Type specimen figured in Geol. Mag. [4] vol. viii. 1901, p. 439, fig. 2; also on Pl. XXVI. figs. 4, 4 A, 4 B. The dimensions (in centimetres) of this specimen are :—

Greatest height from top of neural spine to end of hypapophysis . 8·5
,, width (between ends of transverse processes) . . . 2·5
Width of articular cup of centrum . . . . 1·6
Height of articular cup of centrum . . . . 1·4
Width of zygosphene . . . . 1·9
Extreme length of centrum . . . . 3·1
Width between the ends of the lateral processes of arch . . 4 app.

R. 3258. Similar, though rather smaller, vertebra.

C. 10195. Smaller vertebra, with long slender spine and prominent lateral processes; the anterior end is somewhat abraded. Figured Pl. XXVI. fig. 5. Extreme height 6·5 cm.; extreme length of centrum 2 cm. app.

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* Owen, Reptilia of the London Clay, pt. iii. pl. xiii. figs. 5–7.
† Proc. U.S. National Museum, vol. xxi. (1899) p. 637, pl. xlv.

C. 10196. Large vertebra, with the summit of neural spine broken away. This specimen, in which the neural spine seems to have been very wide, is figured on Pl. XXVI. fig. 6. The length of the centrum is approximately 3·3 cm. Width of neural spine at base 2·3 cm.

R. 3009. Numerous vertebræ.

C. 10025. Numerous vertebræ.

R. 3360. Numerous vertebræ.   *Presented by the Egyptian Government*, 1904.

R. 3359. Smaller vertebræ.

R. 3361. Smaller vertebræ.   *Presented by the Egyptian Government*, 1904.

R. 3366. Numerous vertebræ.   *Presented by Baron Nopcsa*, 1905.

Class PISCES.

Remains of Fishes are fairly common in the Qasr-el-Sagha beds, but are rare in the Fluvio-marine (Upper Eocene) series above. The commonest forms from the lower horizon are large Siluroids and Sawfishes; these have been described by Dr. E. Stromer *, so that here it will only be necessary to give a brief account and list of the specimens in London and Cairo.

Subclass TELEOSTOMI.

Order ACTINOPTERYGII.

Suborder *OSTARIOPHYSI.*

Family SILURIDÆ.

Genus FAJUMIA, Stromer.

[Neues Jahrb. 1904, vol. i. (Abhandlungen) p. 3.]

This genus was established by Stromer for the reception of a species of Siluroid of which remains are very common in the Qasr-el-Sagha beds. It appears to be allied to *Arius*, one of the chief differences being that the complex vertebra is not fused with the skull, there being no subvertebral process at the junction.

Fajumia schweinfurthi, Stromer.

1904. *Fajumia schweinfurthi*, Ernst Stromer, Neues Jahrb. vol. i. (Abhandlungen) p. 3, pl. i. figs. 1, 2.

Type Specimen.—A skull; Palæontological Museum, Munich.

In this species the skull-roof is flat except in the supraoccipital region, where

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* Neues Jahrbuch, 1904, vol. i. p. 1; also Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xviii. (1905) pp. 37, 163.

it slopes away on either side of a median ridge. Most of the upper surface is covered with prominent tubercles, which show a tendency to arrangement in longitudinal rows. Two double rows of especially large tubercles run on either side of the fontanelle, converging in front of and behind it; the opening itself is situated towards the front of the skull and at the bottom of an elongated furrow, the sides of which are not tuberculate. The supraoccipital does not project far behind the rest of the skull and evidently united closely with the large interneural plate. The epiotic processes project strongly backwards and outwards, and bear on their postero-inferior face an elongated surface for union with the post-temporals. The ethmoid is broad, and its anterior border nearly straight, so that the snout appears to be abruptly truncated. The anterior complex vertebra is long and biconcave as usual; its ventral surface is deeply channelled for the dorsal aorta, and, in older specimens at least, the channel is completely enclosed in its middle region.

A pectoral spine, which probably belongs to this species, bears a row of transversely elongated tubercles along its convex border and near its extremity; the upper surface also is tuberculate.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

C. 10197. Nearly complete skull. The dimensions (in centimetres) of this specimen are :—

Length from basioccipital to tip of snout . . . . 32·5
Greatest width at posterior end . . . . 16·4 app.
„   „   anterior end. . . . . 17·5

C. 10198. Portion of skull-roof, well preserved posteriorly and showing the sculpture.

P. 10240. Well-preserved skull, with anterior complex vertebra still united. The dimensions (in centimetres) of this specimen are :—

Length from basioccipital to tip of snout . . . . 32·4
„   supraoccipital to tip of snout. 36
Greatest width at posterior end . . . . 20 app.
„   „   anterior end . . . . 19·4
Length of complex vertebra . . . . 10·8

Presented by the Egyptian Government, 1904.

P. 10250. Posterior half of a skull. The greatest width at the posterior end is 16 cm.

Presented by Baron Nopcsa, 1905.

P. 10251. Portions of two similar skulls.   *Presented by Baron Nopcsa, 1905.*

P. 10245. Portion of skull, in which the sculpture of the roofing-bones is well shown.

Genus SOCNOPÆA, Stromer.

[Neues Jahrb. 1904, vol. i. (Abhandlungen) p. 6.]

This genus was founded by Stromer for the reception of a single species of large Siluroid from the Qasr-el-Sagha beds. The basioccipital is said to bear paired processes for union with the post-temporal, as in *Bagrus*, to which this form is probably nearly related.

Socnopæa grandis, Stromer.

1904. *Socnopæa grandis*, Ernst Stromer, Neues Jahrb. vol. i. (Abhandlungen) pp. 6–7, pl. i. fig. 3.

Type Specimen.—An imperfect skull ; Palæontological Museum, Munich.

This species seems to have attained a very large size. The sculpturing of the skull-roof differs widely from that of *Fajumia*, and consists of numerous small tubercles arranged in longitudinal lines, there being no rows of specially enlarged tubercles at the sides of the median depression. This latter is long and sharply defined ; into it there open two fontanelles, one near its anterior end, the other near the middle. The supraoccipital region projects considerably behind the rest of the skull.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene) : north of Birket-el-Qurun.

C. 10199. Skull and large part of the skeleton of a very large individual. The principal parts preserved are :—(1) Skull, somewhat incomplete towards the outer angles of its anterior end, showing the characteristic sculpture ; (2) portions of the mandible and hyomandibular ; (3) part of the vertebral column, including the anterior complex vertebra and a series of about nineteen others ; (4) the interneural plate with the dorsal spine ; (5) portions of the two halves of the shoulder-girdle with the pectoral spine. This specimen shows that these Eocene Siluroids attained a large size, the skull being about 65 cm. long, about 21 cm. wide posteriorly, and 32 cm. wide in front ; the length from the basioccipital to the tip of snout is 56·5 cm. The complex vertebra is about 15 cm. in length, and the vertical diameter of the anterior end of its centrum about 5·7 cm. The arrow-head-shaped interneural plate is large, its length in the mid-dorsal line being 11 cm., length to posterior angles 17 cm., greatest width upwards of 12 cm. Its dorsal surface is covered with an ornamentation of rounded tubercles arranged more or less in lines, and rather larger and more prominent than those on the skull-roof. The posterior notch is occupied by the small supporting spine of the usual form, and behind this by the large dorsal spine ; this was probably about 20 cm. long and curved backwards ; it seems to have had a tuberculate anterior border and sides marked by fine irregular ridges. The width of the base of this spine from side to side is 4·3 cm., the width of its middle region from before backwards about 2·5 cm. The

2 s 2

pectoral spines are still articulated with the shoulder-girdle ; so far as can be seen the ornamentation was similar to that of the dorsal spine ; the length of these spines must have been about 17 cm., their width at the base 3·5 cm.

P. 10258. Large imperfect skull, wanting the posterior portion ; the greatest width of its anterior end is about 23 cm.   *Presented by the Egyptian Government*, 1904.

The following specimens belong to various Siluroid fishes, but cannot be more definitely determined :—

P. 10252. Anterior complex vertebra of a particularly long and slender form. Its length is 16·4 cm. ; the depth of the anterior face of the centrum about 6 cm.
                              Presented by Baron Nopcsa, 1905.

P. 10253. Three anterior complex vertebræ, similar in form but of smaller size than last.
                              Presented by Baron Nopcsa, 1905.

P. 10254. A number of anterior dorsal vertebræ with short disc-like centra. One of these measures 1·7 cm. in length at its ventral edge, while its height and width are about 5·3 cm.
                              Presented by Baron Nopcsa, 1905.

P. 10255. Vertebræ, probably from further back in the column. The centra are much larger than those just described. They are in most cases deeply biconcave, and laterally are excavated by a pair of dorso-lateral depressions and a pair of ventro-lateral depressions.
                              Presented by Baron Nopcsa, 1905.

P. 10241. Anterior complex vertebræ and the three succeeding disc-like vertebræ of an individual of large size. The length of the complex vertebra is 16·5 cm., the height of its anterior face about 6 cm.   *Presented by the Egyptian Government*, 1904.

P. 10242. A series of united dorsal vertebræ with very short centra. The processes are well preserved in some part of this column.   *Presented by the Egyptian Government*, 1904.

P. 10246. Two very large and massively constructed vertebræ. One of these bears well-developed zygapophyses, such as may be seen in the vertebral column of *Bagrus*. The peculiarity of these processes is that the articular surfaces of the anterior zygapophyses look outwards and downwards, those of the posterior, here sessile on the centrum, upwards and a little inwards, the opposite to what usually occurs in the higher Vertebrates.

C. 10201. Long and slender anterior complex vertebra, similar to P. 10252. Length 16 cm.

C. 10200. Much smaller and especially shorter complex vertebra. Length 9 cm.

C. 10052. Series of six dorsal vertebræ with disc-like centra.

C. 10049. Large, deeply biconcave vertebræ similar to P. 10255.

P. 10257. Imperfect pectoral spine. The anterior edge bears a row of transversely elongated tubercles near the tip ; the sides of the spine also are tuberculate. Length so far as preserved 16·4 cm.

Subclass ELASMOBRANCHII.

Order SELACHII.

Family PRISTIDÆ.

Genus PRISTIS, Latham.

[Trans. Linn. Soc. vol. ii. 1794, p. 276.]

Rostral teeth firmly implanted in sockets, forming square notches on the sides of the saw-like rostrum.

Pristis fajumensis, Stromer.

1897. *Propristis schweinfurthi*, F. Priem, Bull. Soc. Géol. France, [3] vol. xxv. p. 228 (*errore*).
1905. *Pristis fajumensis*, Ernst Stromer, Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xviii. p. 49, pl. vi. figs. 1–3.

Type Specimen.—Portions of a rostrum ; Palæontological Museum, Munich.

This species is a true *Pristis*, the teeth being set in calcified sockets, forming quadrate notches, about 23 in number, on the sides of the rostrum.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

C. 10203. A nearly complete rostrum (text-fig. 98). In this specimen there are 22–23 notches for teeth on either side ; posteriorly these are not opposite one another on the two sides,

Text-fig. 98.
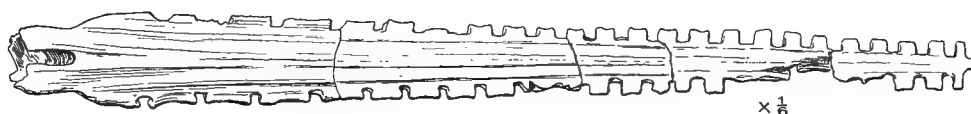
Rostrum of *Pristis fajumensis*. $\frac{1}{6}$ nat. size.

but to some extent alternate ; at the extreme anterior end the notches are opposite to one another. The dimensions (in centimetres) of this specimen are :—

Extreme length	87
Greatest width of base of rostrum	8·2
Width of tip of rostrum	1·3
Distance between two posterior teeth	4·1
,, ,, anterior teeth	1·5

C. 10204. Portion of a rostrum, with notches for teeth much more closely set than last. Possibly another species.

P. 10256. Portions of rostra, probably of this species.   *Presented by Baron Nopcsa,* 1905.

P. 10243. Proximal portion of a rostrum.   *Presented by the Egyptian Government,* 1904.

C. 10205. Rostral tooth, probably of this species.

From the Birket-el-Qurun series of the Zeuglodon Valley, to the south-west of the lake, a considerable number of large rostral teeth were collected by Mr. Beadnell, and are in the Geological Museum, Cairo. These probably belong to Stromer's species *Pristis ingens (tom. cit.* p. 47). ·

Genus **PROPRISTIS**, Dames.

[Sitzungsb. k. preuss. Akad. Wiss. Berlin, math.-phys. Cl. 1883, p. 136.]

In this genus the alveoli of the rostral teeth are not ossified, and their position is only marked by shallow indentations in the rostral margin.

Propristis schweinfurthi, Dames.

1883. *Propristis schweinfurthi,* W. Dames, *loc. cit.* vol. i. p. 136, pl. iii. figs. 1 *a–c,* 2.
1905.   „   „   E. Stromer, Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients,
                        vol. xviii. p. 53, pl. vi. figs. 17, 17 *a,* 17 *b.*

Type Specimen.—A portion of a rostrum; Royal Museum of Natural History, Berlin.

Remains of this species are not uncommon in the same beds as those from which rostra of *Pristis fajumensis* are obtained.

Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

C. 10206. A portion of a rostrum, closely resembling that figured by Stromer, *tom. cit.* pl. vi. fig. 17.

P. 10244. A similar portion of a rostrum.   *Presented by the Egyptian Government,* 1904.

Genus **EOPRISTIS**, Stromer.

[Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xviii. (1905) p. 52 (as a subgenus of *Pristis*).]

This form seems to be as distinct from *Pristis* as is *Propristis,* and on that account it is here regarded as of generic rank. In this genus there is no trace of alveoli for the teeth on the sides of the rostrum.

Eopristis reinachi, Stromer.

1905. *Eopristis reinachi*, E. Stromer, *loc. cit.* p. 52, pl. vi. fig. 15.

Type Specimen.—Portion of a rostrum; Palæontological Museum, Munich.
Form. & Loc.—Qasr-el-Sagha beds (Middle Eocene): north of Birket-el-Qurun.

P. 10247. Proximal portion of a rostrum very similar to the type specimen.

Family MYLIOBATIDÆ.

Genus AËTOBATIS, Müller & Henle.

P. 10249. Lower tooth-plate of a species of this genus; similar to that figured by Stromer (Beitr. Pal. u. Geol. Oesterreich-Ungarns u. d. Orients, vol. xviii. pl. v. fig. 8). Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

Family LAMNIDÆ.

Genus CARCHARODON, Müller & Henle.

P. 10248. Tooth of a species of this genus. (?) Fluvio-marine beds (Upper Eocene): north of Birket-el-Qurun.

INDEX.

[The asterisk indicates that a figure is given on that page.]

PLATE I.

ao.f., antorbital foramen.

b.v., b.v.', impressions of blood-vessels.

c., alveolus of canine.

e.a.m., external auditory meatus.

exo., exoccipital.

f.h., frontal horn.

f.l.a., foramen lacerum anterius.

fr., frontal.

i. 1–3, incisors or their alveoli.

ju., jugal.

l., lachrymal.

m. 1–3, molars.

mes., prenasal bar.

mx., maxilla.

na., nasal.

nar., external nares.

n.h., nasal horn.

on.f., orbito-nasal foramen.

pa., parietal.

pgl., postglenoid process.

pl., palatine.

pm. 1–4, premolars or their alveoli.

pmx., premaxilla.

p.p., paroccipital process.

pt., pterygoid.

pty., post-tympanic process.

sq., squamosal.

st.r., supratemporal ridge.

II., optic foramen.

PLATE 1.

CATAL. TERTIARY VERT. FAYÛM.

ARSINOITHERIUM ZITTELI.

$\frac{1}{5}$

G.M.Woodward del.et lith.

West Newman imp.

a.o.f., antorbital foramen.

a.p.f., anterior palatine foramen.

bo., basioccipital.

bsp., basisphenoid.

c., canine alveolus.

e.a.m., external auditory meatus.

exo., exoccipital.

f.h., frontal horn.

gl., articular surface for mandible.

i. 1–3, incisors or their alveoli.

m. 1–3, molars.

mes., prenasal bar.

m.p.f., maxillo-palatine foramen.

mx., maxilla.

na., nasals.

nar., external nares.

n.h., nasal horn.

orb., orbit.

pgl., postglenoid process.

pl., palatine.

pm. 1–4, premolars or their alveoli.

pmx., premaxilla.

pp.f., posterior palatine foramen.

pt., pterygoid.

pty., post-tympanic process.

PLATE II.

i 1.
i 2.
v 3.
c
pm 1
pm 2
pm 3
pm 4
m 1.
mx
m 2.
pt
m 3.
m p

p mx.
a.p.f.

n.x.
nes
prx.
o.n.
orl.
mx

J. M. Woodward del et lith.

West, Newman imp

ARSINOITHERIUM ZITTELI.

PLATE III.

al.c., alisphenoid canal.
a.o.f., antorbital foramen.
dm. 4, fourth milk-molar.
e.a.m., external auditory meatus.
exo., exoccipital.
f.h., frontal horn.
fr., frontal.
ju., jugal.
la., lachrymal.
m. 1–2, molars.
ms.g., mesethmoid groove.
mx., maxilla.
na., nasal.
nar., external nares.

n.h., nasal horn.
orb., orbit.
pa., parietal.
pgl., postglenoid process.
pl., palatine.
pm. 1–3, premolars.
pmx., premaxilla.
p.p., paroccipital process.
pt., pterygoid.
pty., post-tympanic process.
so., supraoccipital.
sq., squamosal.
II., optic foramen.

PLATE III

A H Searle del. et lith

West Newman imp

ARSINOITHERIUM ZITTELI.

PLATE IV.

a., angle of mandible.
c., canine.
cd., condyle.
c.p., coronoid process.
i. 1–3, incisors or their alveoli.

m. 1–3, molars.
m.f., mental foramen.
pm. 1–4, premolars.
s., symphysis of mandible.

A.H. Searle del et lith

1. 1ᴬ, ARSINOITHERIUM ZITTELI.
2. 2ᴬ, 3. 3ᴬ, ARSINOITHERIUM ANDREWSI.

PLATE V.

a.c., anterior column of molars.	*ms.*, mesostyle.
ae., antero-external cusp.	*p.c.*, posterior column of molars.
ai., antero-internal cusp.	*pe.*, postero-external cusp.
a.r., anterior root.	*pi.*, postero-internal cusp.
c., cingulum.	*p.r.*, posterior root.
c.', postero-internal portion of cingulum.	*ps.*, parastyle.
dm. 2–4, second, third, and fourth milk-molars.	*x.*, inner face of tooth.
m.r., middle root.	

ARSINOITHERIUM ZITTELI

PLATE VI.

ac.s., anterior accessory styles.	*ms.*, mesostyle.
ac.s.', posterior accessory styles.	*msd.*, metastylid.
ae., antero-external cusp.	*mts.*, metastyle.
ai., antero-internal cusp.	*pe.*, postero-external cusp.
c., canine.	*pi.*, postero-internal cusp.
hs., hypostyle.	*pl.p.*, palatine process of premaxilla.
i. 1–3, incisors or their alveoli.	*pm.* 1–4, premolars.
i. 1', posterior end of *i.* 1.	*ps.*, parastyle.
m. 1–3, molars.	*t.*, talon.

PLATE VI.

G.M.Woodward del.et.ith

West Newman imp.

1 & 2. MEGALOHYRAX EOCÆNUS.

3 & 4. SAGHATHERIUM MAGNUM.

5.   ,,   (?) MAJUS.

6.   ,,   ANTIQUUM.

PLATE VII.

a.e., antero-external cusp.
a.i., antero-internal cusp.
c., canine.
fr., frontal.
hs., hypostyle.
i. 1–2, first and second incisors.
m. 1–3, molars.
ms., mesostyle.
msd., metastylid.

mts., metastyle.
pa., parietal.
p.e., postero-external cusp.
p.i., postero-internal cusp.
pm. 1–4, premolars.
ps., parastyle.
so.p., supraorbital process.
t., talon of third lower molar.

PLATE VII.

G. M. Woodward del. et lith.

West, Newman imp.
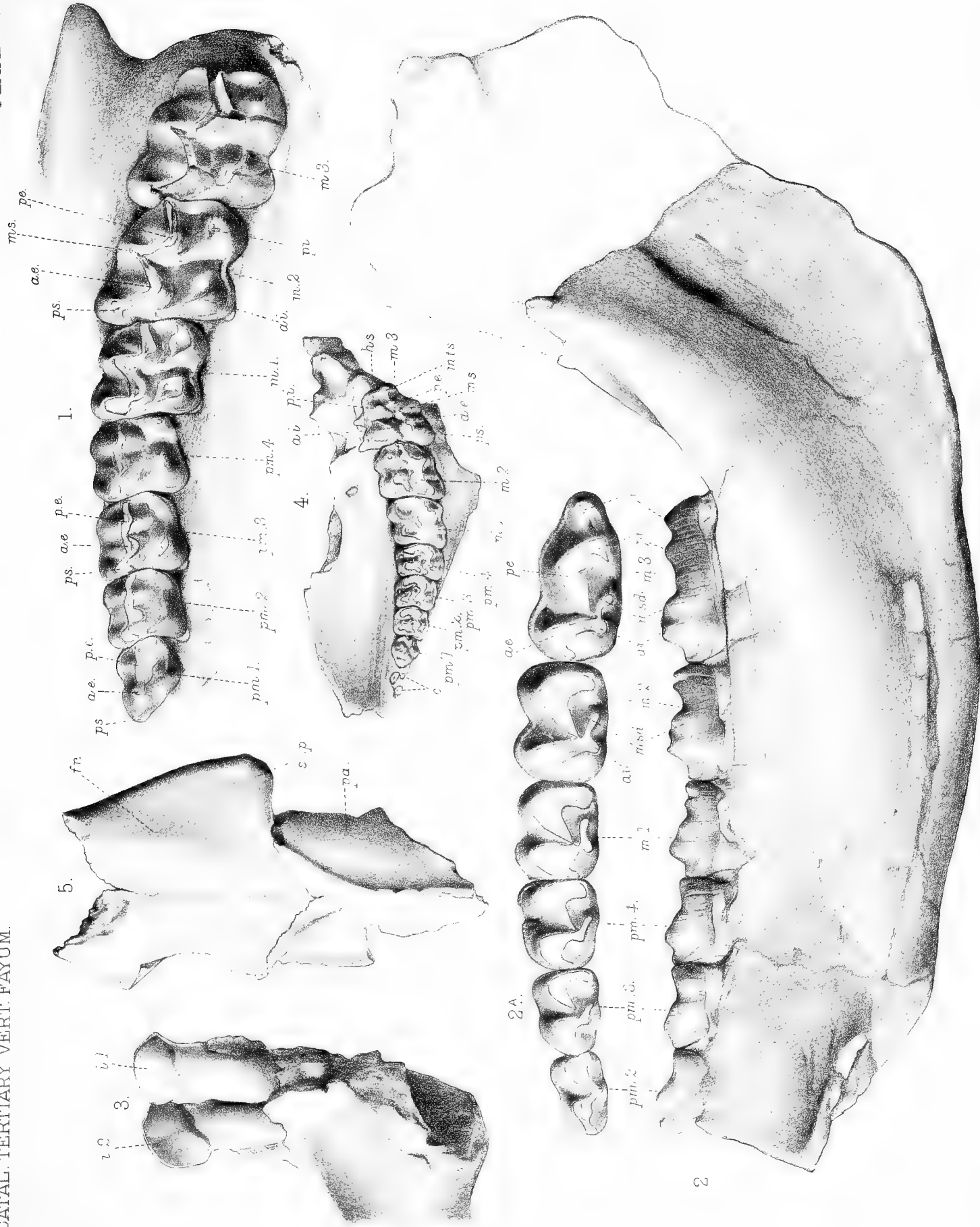
1. 2. 3. MEGALOHYRAX MINOR.
4. 5. SAGHATHERIUM ANTIQUUM.

PLATE VIII.

bo., basioccipital.

c., canine alveolus.

cond., exoccipital condyles.

e.a.m., external auditory meatus.

exo., exoccipitals.

f.l.p., foramen lacerum posterius.

for., foramina in squamosal.

fr., frontal.

gl., glenoid surface for mandible.

i. 2–3, second and third incisors or their alveoli.

ju., jugal.

m. 1–3, molars.

mx., maxilla.

n., nasal.

orb., orbit.

pa., parietal.

pl., palatine.

pm. 2–4, second to fourth premolars.

pmx., premaxilla.

p.p., paroccipital process.

pty., post-tympanic process.

soc., supraoccipital.

sq., squamosal.

PLATE VIII

J. Green del. et lith.

MŒRITHERIUM LYONSI

PLATE IX.

ae., antero-external cusp.

ai., antero-internal cusp.

a.o.f., antorbital foramen.

e.a.m., external auditory meatus.

exo., exoccipital.

fr., frontal.

i. 2, second upper incisor.

ju., jugal.

m. 1–3, molars.

mx., maxilla.

na., nasal.

nar., external nares.

orb., orbit.

pa., parietal.

pe., postero-external cusp.

pm. 2–4, premolars.

pmx., premaxilla.

p.p., paroccipital process.

ps., parastyle.

pty., post-tympanic process.

soc., supraoccipital.

sq., squamosal.

PLATE IX.

1 ½

1-4. MŒRITHERIUM LYONSI.
5.   „   TRIGONODON.

J. Green del.et lith

PLATE X.

a.o.f., antorbital foramen.

c., canine.

cond., condyle of mandible.

cor., coronoid process.

e.a.m., external auditory meatus.

exo., exoccipital.

i. 1–3, incisors or alveoli of incisors.

m. 1–3, molars.

m.f., mental foramen.

mx., maxilla.

na., nasals.

nar., external nares.

orb., orbit.

pa., parietal.

pm. 2–4, premolars.

pmx., premaxilla.

poc., paroccipital process.

soc., supraoccipital.

sq., squamosal.

cond

1. ½

m 3   m 2.   m 1   pm 4   pm 3   pm 2   i 2   i. 1

3. ½

m.x.   nar   m.x   i.vt   ori.   v.of   pm 4   pm 3   pm 2   i 3   pm r   i. 1   i. 2   soc

exo   soc.   4. ½   pa.

4 A. ½   pa.   sq.   poc   exo.   m.3   5. ½

m 2   pm 4   pm 3   pm 2   m l   cond

1A. ½   m.3   m 2.   m 1   pm 4   pm 3   pm 2   i. 2   i. 1   m.f.

pm. 2.   pm. 3.   pm. 4.   m. 1.   m. 2.   2. ½

MŒRITHERIUM LYONSI.

PLATE XI.

a., acetabulum.

a.t., surface for axis.

a.z., anterior zygapophysis.

c., coracoid process.

c.b., coracoid border.

c.f., coronoid fossa (fig. 6 A), capitular facet
  (fig. 4 A).

c.i., crista ilii.

cond., condylar facets.

d., deltoid crest.

g.b., glenoid border.

g.c., glenoid cavity.

g.tr., great trochanter.

h., head of humerus and femur.

h.y., hypapophysis.

i.c., inner condyle.

is., ischium.

is.t., ischial tuberosity.

l.t., pit for *ligamentum teres.*

l.tr., lesser trochanter.

n.sp., neural spine.

od., odontoid process.

o.f., olecranon fossa.

ol., olecranon process.

pu., pubis.

p.z., posterior zygapophysis.

r., surface for radius.

s., spine of scapula.

t.f., tubercular facet.

t.p., transverse process.

v.c., vertebrarterial canal.

PLATE XI.

MŒRITHERIUM LYONSI.

PLATE XII.

al., alisphenoid.

al.c, alisphenoid canal.

ao.f., antorbital foramen.

bsp., basisphenoid.

e.a.m., external auditory meatus.

eu., eustachian opening.

exo., exoccipital.

f.l.a., foramen lacerum anterius.

f.l.m., foramen lacerum medium.

f.l.p., foramen lacerum posterius.

f.m., foramen magnum.

f.o., foramen ovale.

for., foramina opening into air-sinuses.

i.c.c., foramen for internal common carotid.

ju., jugal.

m. 1–3, molars.

mx., maxilla.

pa., parietal.

pl., palatine.

pm. 2–4, premolars.

p.p., paroccipital process.

pp.f., posterior palatine foramen.

pt., pterygoid.

pty., post-tympanic process.

s.c., sagittal crest.

soc., supraoccipital.

sq., squamosal.

st.m., stylomastoid foramen.

PLATE XII

J.Green del.et lith

Hunter. Bros imp

PALÆOMASTODON BEADNELLI

ao.f., antorbital foramen.	*mx.*, maxilla.
fr., frontal.	*na.*, nasal.
i., incisor.	*nar.*, external nares.
ju., jugal.	*orb.*, orbit.
lac., lachrymal.	*pal.*, palate.
mes.g., mesethmoid groove.	*pmx.*, premaxilla.
mm. 2–4, milk-molars.	*zyg.*, zygomatic process of maxilla.

1. ¾.

i

pmx.

mes.g.

a.o.f.

mx.

pmx.

na.

nar.

ju.

fr.

1ᴮ

mm 2

mm 3.

pal.

mm.4.

lac.

fr.

na.

nar.

pmx.

1ᴬ ¾.

orb.

ju.

zyg.

i.

a.o.f.

mm.2.

mm.3.

mm.4.

J. Green del et lith

Mintern Bros. imp.

PALÆOMASTODON BEADNELLI.

i., incisor.   *pm.* 3–4, premolars.

m. 1–3, molars.   *sym.*, symphysis.

PLATE XIV.

i.

1.

pm. 3.

pm. 4.

m. 1.

m. 2.

m. 3.

Sym.

pm. 3.

$3. \frac{1}{2}$

1A.

pm. 3.

pm. 4.

m. 1.

m. 2.

m. 3.

$2 \frac{2}{3}$

pm. 3.

pm. 4.

m. 1.

m. 2.

m. 3.

J. Green del. et lith.
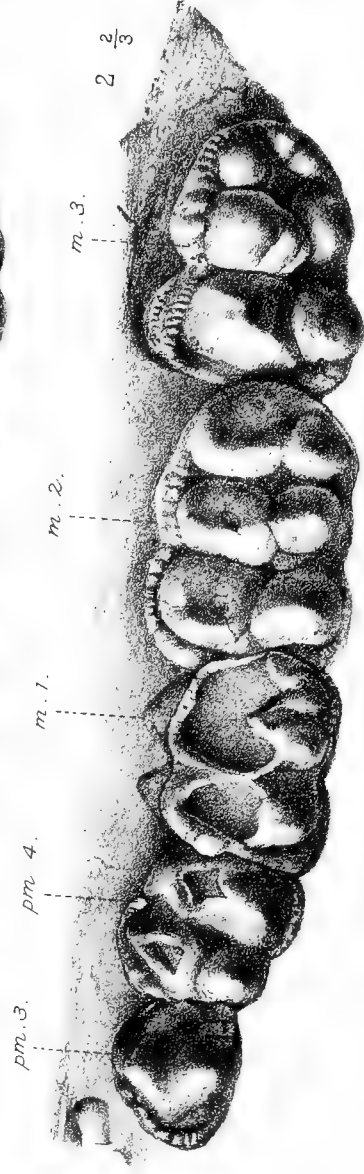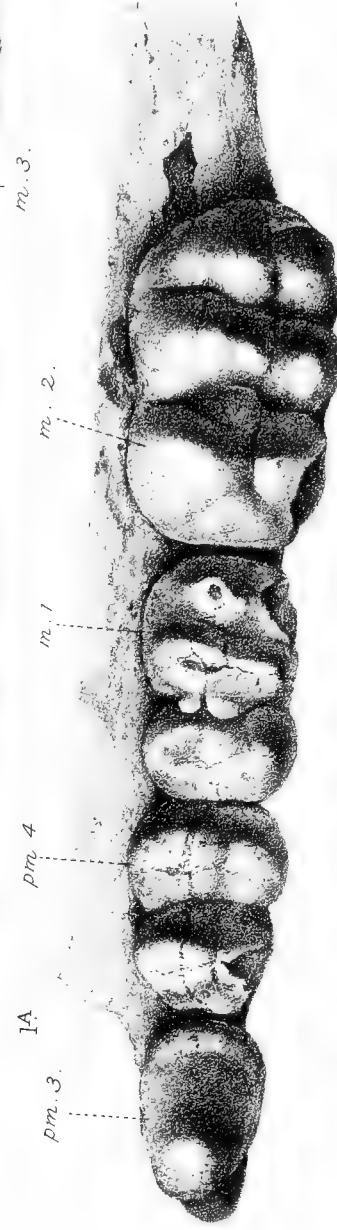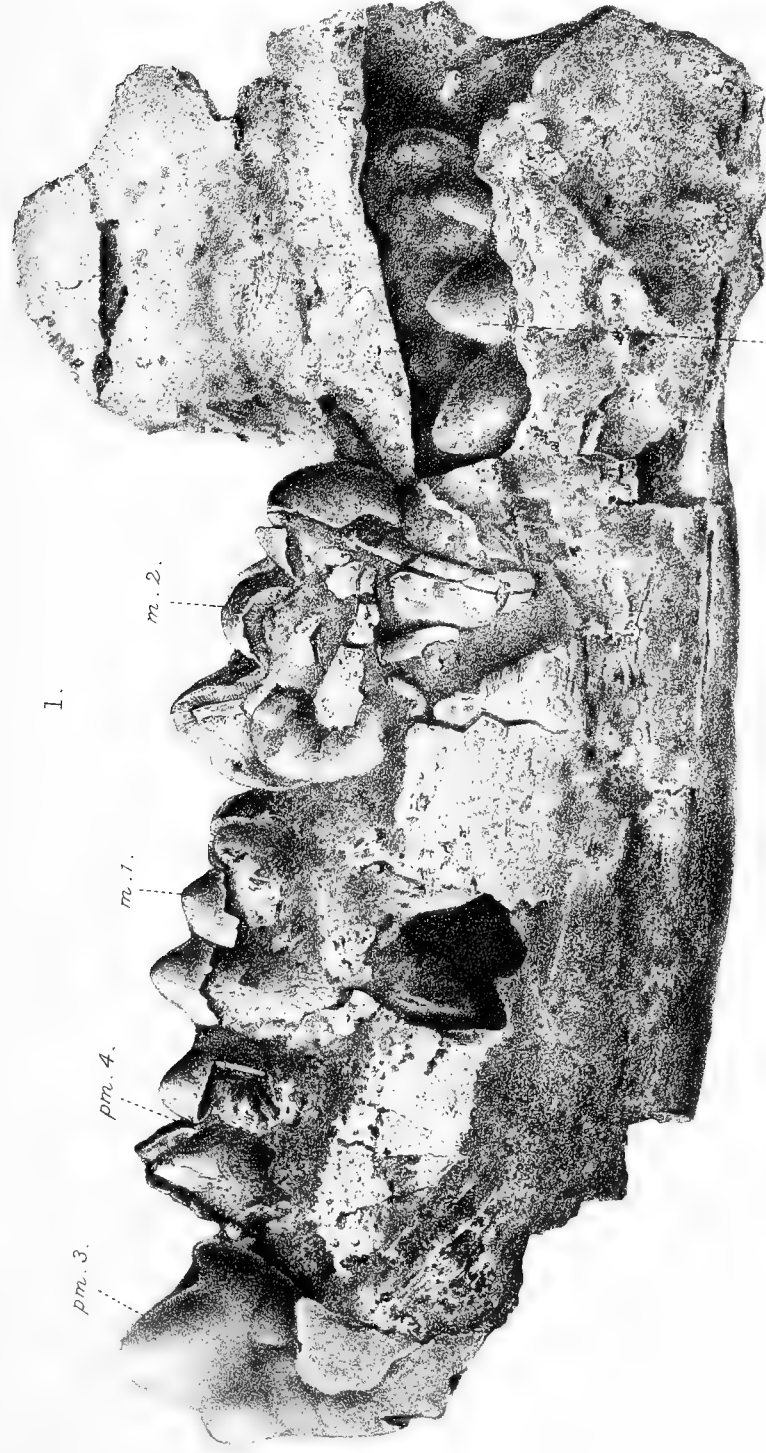
Mintern Bros. imp.

1. PALÆOMASTODON MINOR.
2 & 3.   ,,   BEADNELLI.

PLATE XV.

cond., surfaces for occipital condyles.
i., socket of incisor.
m. 1–3, molars.
m.f., mental foramen.
mx., maxilla.
n.c., neural canal.
n.sp., neural spine.

od., socket for odontoid process.
pal., palate.
pm. 3–4, premolars.
sym., symphysis of mandible.
t.p., transverse process.
v.c., vertebrarterial canal.
zyg., base of zygomatic process of maxilla.

PLATE XV.

CATAL. TERTIARY VERT. FAYÛM.

1. ⅓

i.

sym.

m.f.

pm.3. pm.4.

m.1.

m.2.

m.,3. n.sp.

3. ⅓

n.c.

cond.

od.

v.c.

t.p.

2. ⅓

m.x

zyg.

m.3.

m.2. pal.

1A. ⅓

pm.3.

pm.4.

m.1.

m.2.

m.,3.

m.f.

i.

GM Woodward del. et lith.

West, Newman imp

PALÆOMASTODON BEADNELLI.

PLATE XVI.

c.f., coronoid fossa.

cn., cnemial crest.

d., deltoid crest.

g.t., great trochanter.

h., head.

i., inner articular surface of upper end of tibia.

i.c., inner condyle.

i.m., internal malleolus.

n.sp., neural spine.

o., outer articular surface of upper end of tibia.

o.c., outer condyle.

od., odontoid process.

o.f., olecranon fossa.

sp.r., supinator ridge.

t.p., transverse process.

tr., trochlear surface of femur.

t.t., third trochanter.

PLATE XVI.

CATAL. TERTIARY VERT. FAYÛM.

GM Woodward del et lith

West, Newman imp.

PALÆOMASTODON BEADNELLI.

PLATE XVII.

c., alveolus of canine.	*mx.*, maxilla.
c.b., coracoid border.	*o.*, outer proximal facet of radius.
c.f., coronoid fossa.	*o.c.*, outer condyle.
cor., coronoid process (fig. 5) and coracoid process (fig. 9).	*ol.f.*, olecranon fossa.
	pl., palatine.
d., deltoid process.	*pm.* 2–4, premolars.
exo., exoccipital.	*pmx.*, premaxilla.
g.c., glenoid cavity.	*pr.*, protuberance on mandible.
i., inner proximal facet of radius (fig. 8 A).	*s.*, spine of scapula.
i. 1–3, incisors.	*sc.*, facet for scaphoid.
i.c., inner condyle.	*soc.*, supraoccipital.
lu., facet for lunar.	*sq.*, squamosal.
m. 1–3, molars.	*s.r.*, supinator ridge.
m.f., mental foramen.	*zyg.*, zygomatic process of maxilla.

PLATE XVII.

G. M. Woodward del et lith.

West, Newman imp.

1.–3. MŒRITHERIUM GRACILE.
4.–9. BARYTHERIUM GRAVE.

PLATE XVIII.

c., alveolus of canine.
cond., condyle of mandible.
cor., coronoid process.
i. 1–3, incisors or their alveoli.

m. 1–3, molars.
pm. 1–4, premolars.
sym., symphysis of mandible.

PLATE XVIII.

G.M Woodward del.et lith.
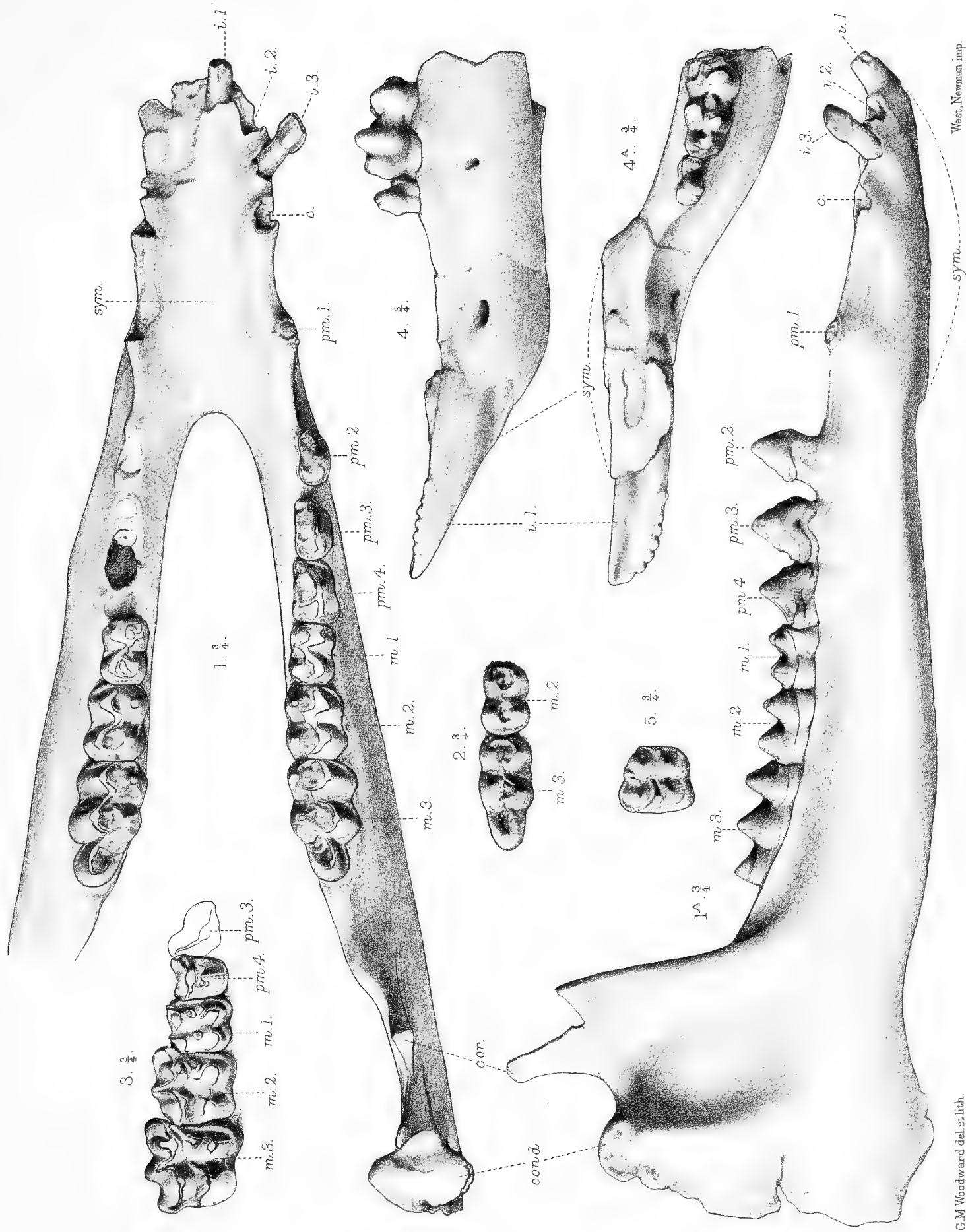
West, Newman imp.

1. 2. 3. ANCODUS GORRINGEI.
4. PHIOMIA SERRIDENS.
5. BUNODONT UNGULATE.

PLATE XIX.

c., socket of canine.
e.f., entepicondylar foramen.
i. 1–3, incisors.
i.c., inner condyle.
m. 1–3, molars.

m.f., mental foramina.
ol.f., olecranon fossa.
pm. 1–4, premolars.
pr., process from lower border of mandible.

PLATE XIX.

CATAL. TERTIARY VERT. FAYÛM.

G.M. Woodward del. et lith.

West, Newman imp.
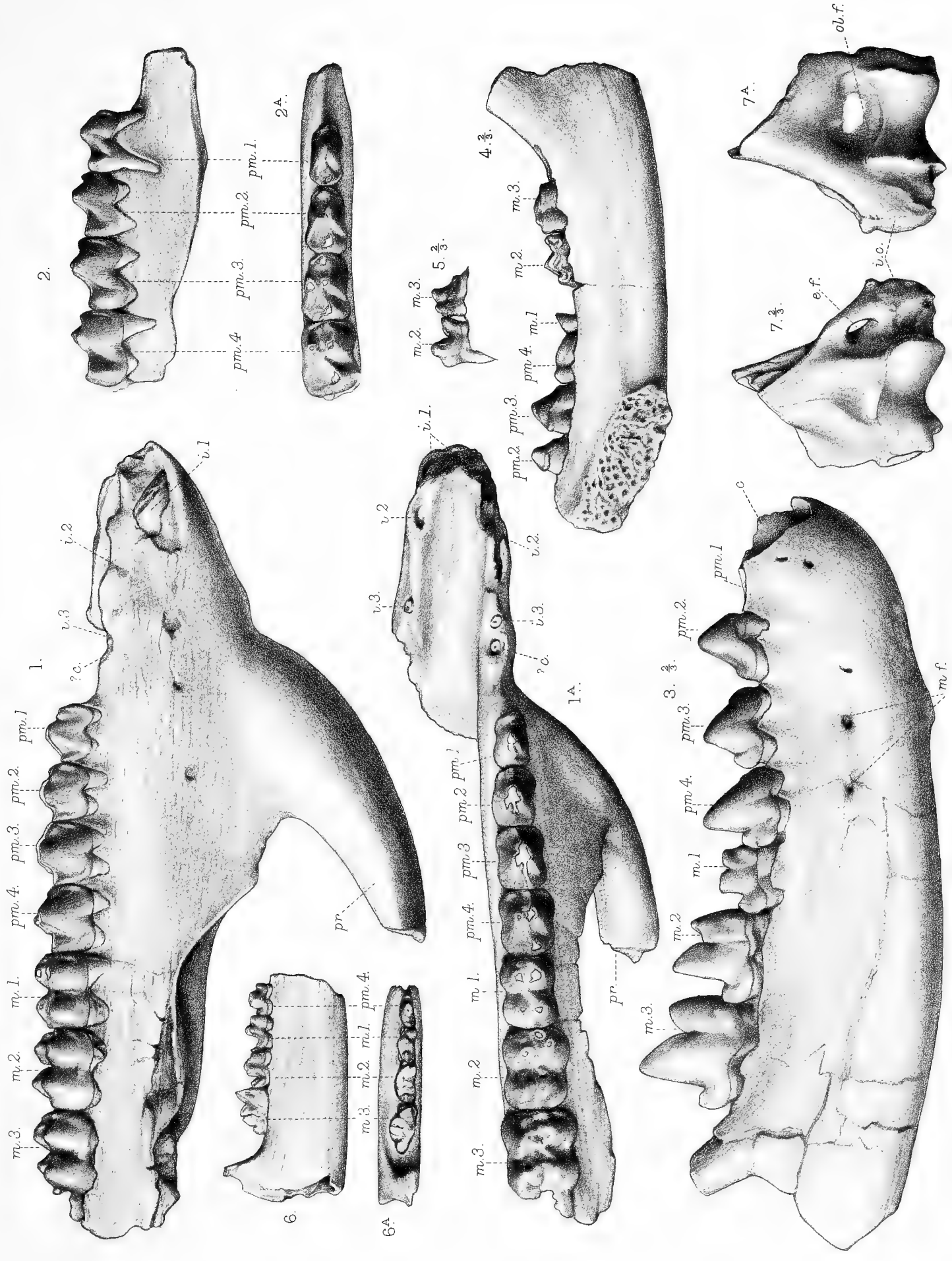
1. GENIOHYUS MIRUS. 2. GENIOHYUS FAJUMENSIS. 3,7. PTERODON AFRICANUS.
4, 5. APTERODON MACROGNATHUS. 6.? SINOPA ETHIOPICA.

a.p.f., anterior palatine foramen.

a.z., prezygapophyses.

b.g., bicipital groove.

c., canine.

c.b., coracoid border.

cond., occipital condyle.

cor., coracoid process.

d., deltoid crest.

exo., exoccipitals.

f.m., foramen magnum.

fr., frontals.

gl., glenoid cavity of scapula.

g.t., greater (outer) tuberosity.

i. 1–3, incisors.

i.c., inner condyle.

l.c., lambdoidal crest.

l.t., lesser (inner) tuberosity.

m.f., mental foramen.

mx., maxilla.

na., nasals.

nar., external nares.

pa., parietals.

pm. 1–2, premolars.

pmx., premaxilla.

s.c., sagittal crest.

soc., supraoccipital.

sp., spine of scapula.

sq., squamosal.

s.r., sacral rib.

sym., symphysis of mandible.

tr., distal articulation of humerus.

zyg., zygomatic process.
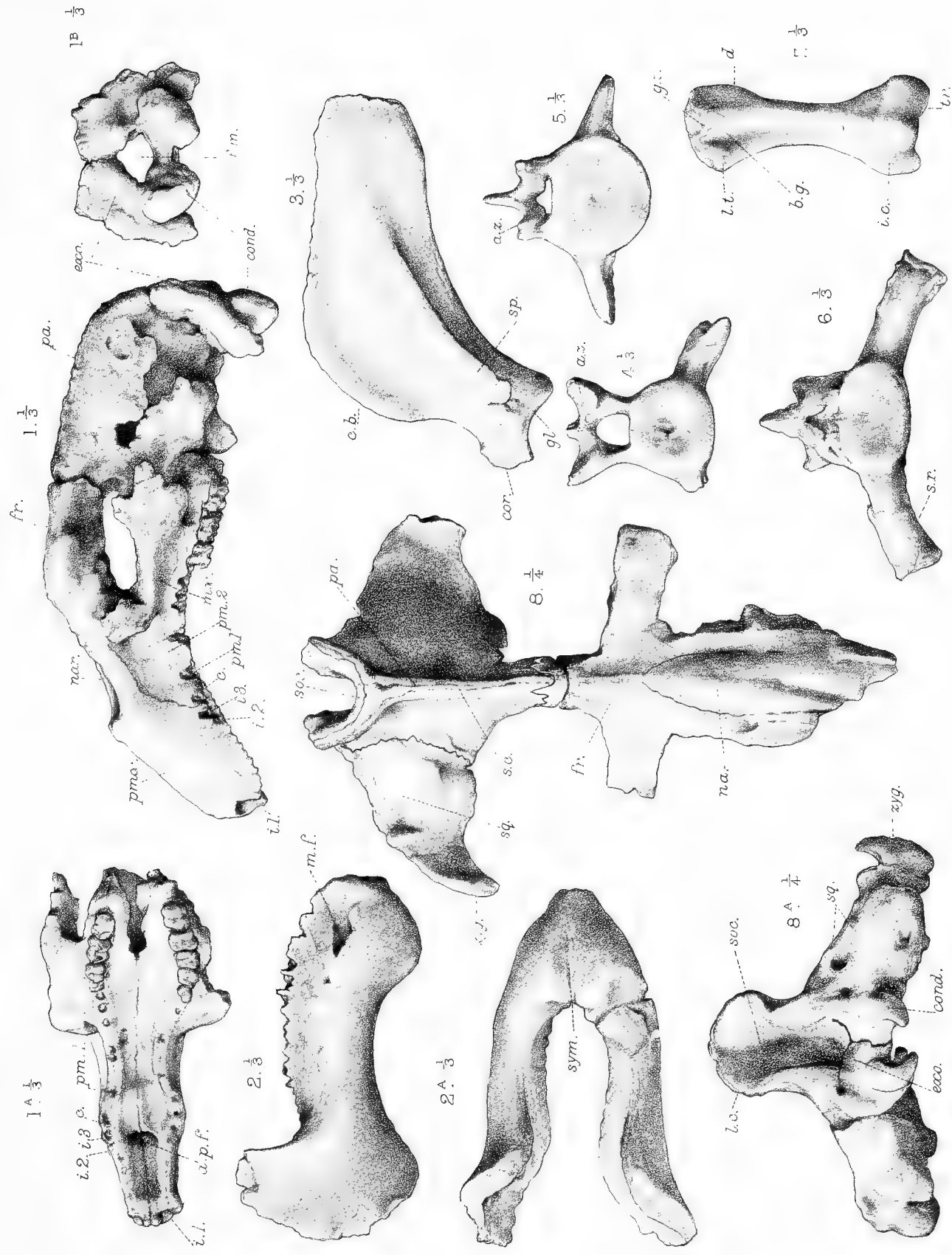
PLATE XX.

G.M Woodward. del. et lith.

West, Newman imp.

1-7 EOSIREN LIBYCA.
8. ZEUGLODON OSIRIS.

PLATE XXI.

al., alisphenoid.

a.o.f., antorbital foramen.

art., articular region of mandible. (The dotted line shows the point of union of this part of the mandible with that which has been separated.)

c., canine.

cond., occipital condyle.

exo., exoccipital.

f., fossæ for the reception of the points of the lower teeth.

fr., frontals.

i. 1–3, incisors.

ju., jugal.

la., lachrymal.

m. 1, first molar.

mx., maxilla.

na., nasal.

nar., external nares.

o.n.f., orbito-nasal foramen.

opt., optic foramen.

os., orbitosphenoid.

pa., parietals.

per., periotic.

pgl., postglenoid process.

pl., palatine.

pm. 1–4, premolars.

pmx., premaxilla.

soc., supraoccipital.

sq., squamosal.

zyg., zygomatic process of the squamosal.

PLATE XXI.

G. Mʳ Woodward del et lith.
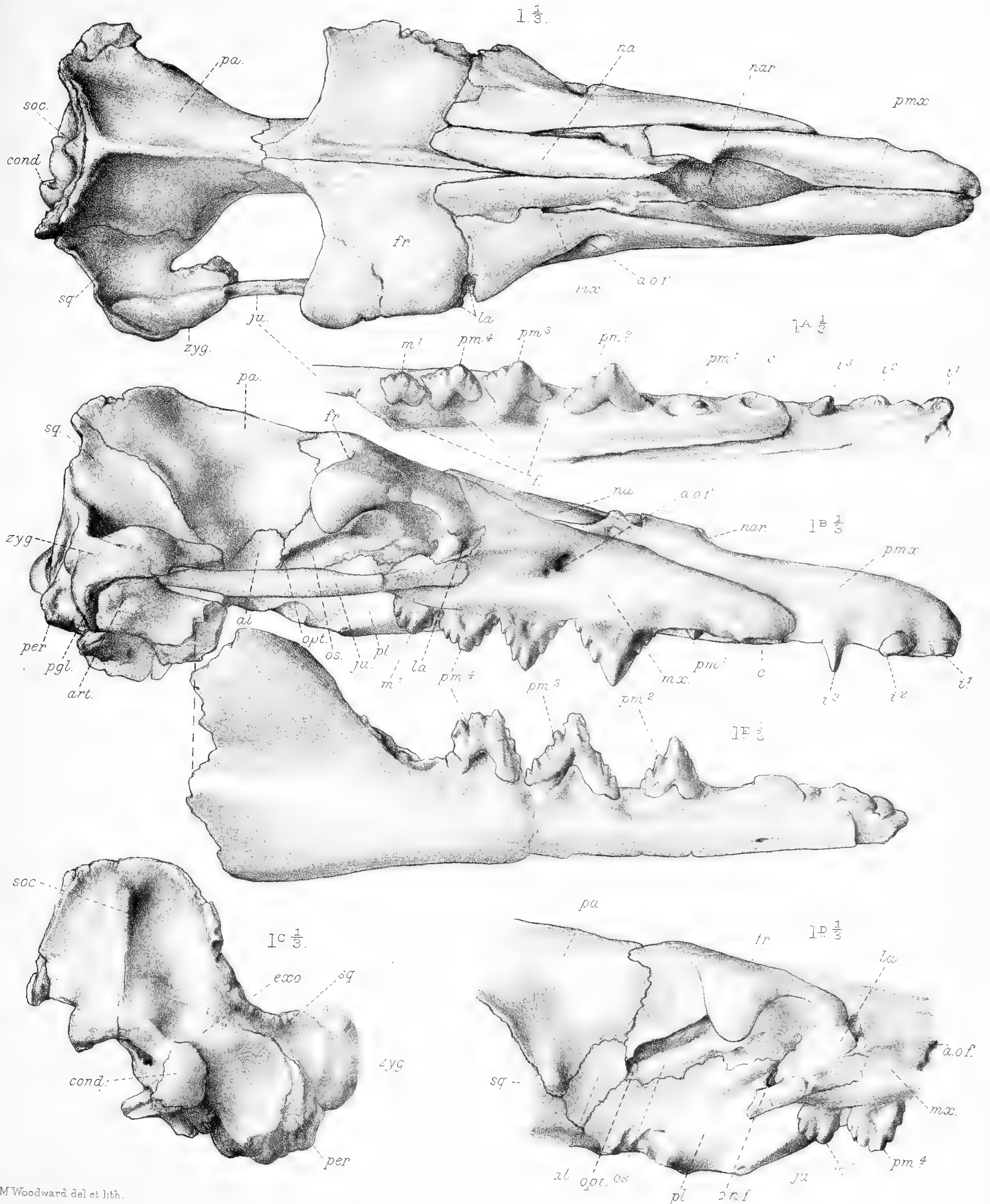
PROZEUGLODON ATROX

West, Newman imp.

PLATE XXII.

ang., angular.	*pal.*, palatine.
art., articular.	*pmx.*, premaxilla.
dent., dentary.	*pr.f.*, prefrontal.
mx., maxilla.	*s.ang.*, surangular.
na., nasals.	*spl.*, splenial.
orb., orbit.	*tr.*, transverse bone.

1. ⅓

pmx.   mx.   na.   pr.f   orb.

1ᴬ ⅓

tr.

pal.   1ᴮ ⅓   mx.   pmx.

tr.

art.

s. ang.

dent.   spl.   2 ⅓

2ᴬ. ⅓   s. ang

dent   ang

PLATE XXIII.

ang., angular.	*n.sp.*, neural spine.
art., articular.	*orb.*, orbit.
boc., basioccipital.	*pa.*, parietal.
c.f., facet for head of rib.	*pmx.*, premaxilla.
cond., occipital condyle.	*pr.f.*, prefrontal.
dent., dentary.	*q.*, quadrate.
exo., exoccipital.	*s.ang.*, surangular.
f., frontal.	*soc.*, supraoccipital.
hyp., hypapophysis.	*spl.*, splenial.
mx., maxilla.	*s.t.f.*, supratemporal fossa.
na., nasal.	*t.f.*, facet for tubercle of rib.
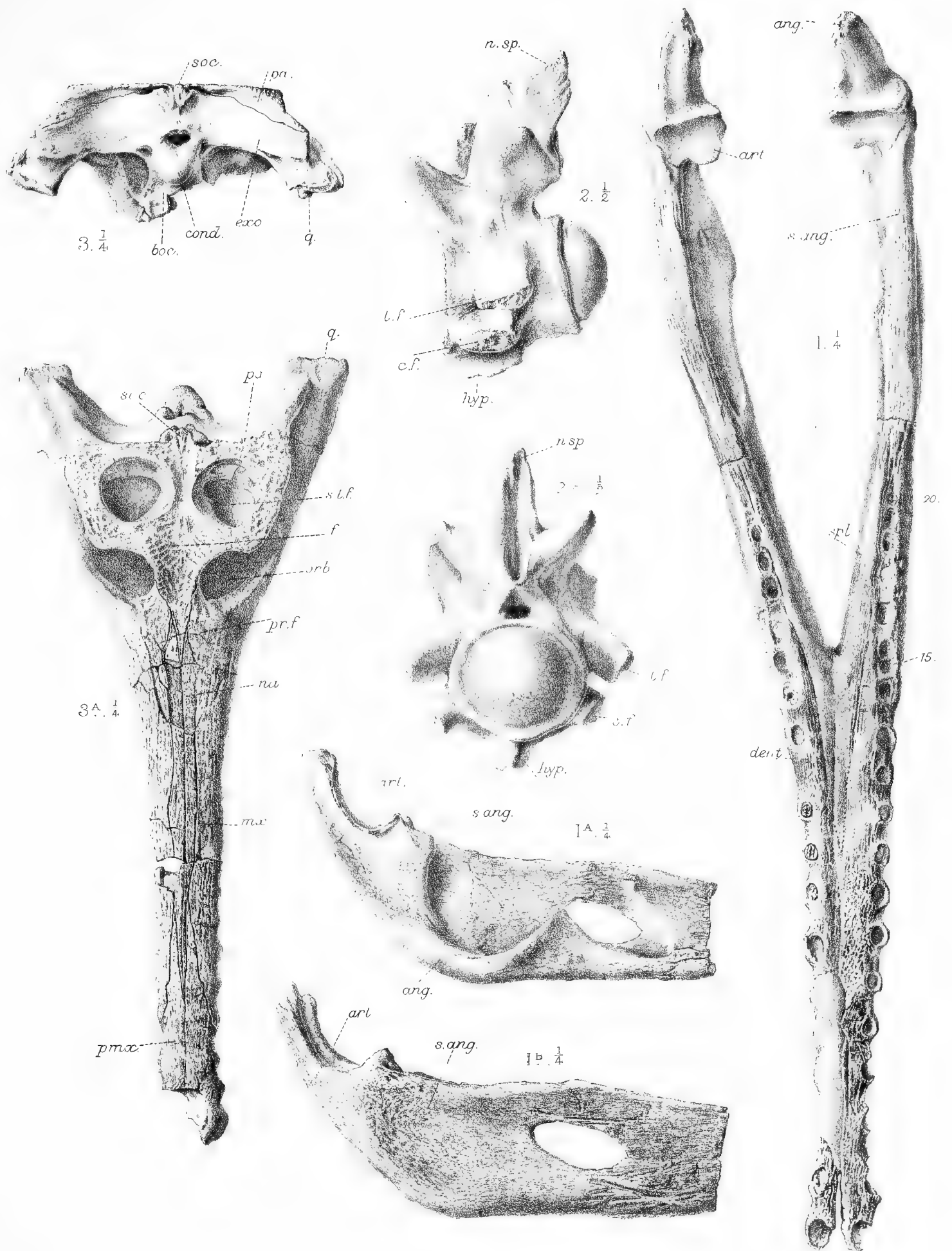
PLATE XXIII.

1. 2. TOMISTOMA AFRICANUM
3   GAVIALOIDES

abd., abdominal shield.	*Hyp.p.*, hypoplastral bone.
an., anal shield.	*n.* 1–4, neural (vertebral) shields.
Ent., entoplastral bone.	*N.* 1–8, neural bones.
Ep., epiplastral bone.	*nu.*, nuchal shield.
fem., femoral shield.	*Nu.*, nuchal bone.
gu., gular shield.	*pect.*, pectoral shield.
hum., humeral shield.	*Py.*, pygal bones.
Hy.p., hyoplastral bone.	*Xiph.*, xiphiplastral bone.

TESTUDO AMMON (? female

PLATE XXV.

ang., angular process of mandible.

art., articular surface of mandible.

boc., basioccipital.

cor., coronoid process of mandible.

ec.pt., ectopterygoid process of pterygoid.

e.n., external nares.

ep.o., epiotic.

exo., exoccipital.

f., frontal.

f.c.i., internal carotid foramen.

f.s., foramen sphenoidale.

g., groove leading to inner side of orbit.

i.n., internal nares.

m.g., groove on side of mandible for muscle-
    attachment.

mx., maxilla.

o.o., opisthotic.

or., orbit.

pa., parietal.

pl., palatine.

pmx., premaxilla.

po.f., postfrontal.

pr.f., prefrontal.

pt., pterygoid.

q., quadrate.

soc., supraoccipital.

sq., squamosal.

sym., symphysis of mandible.

t.o., tympanic opening.
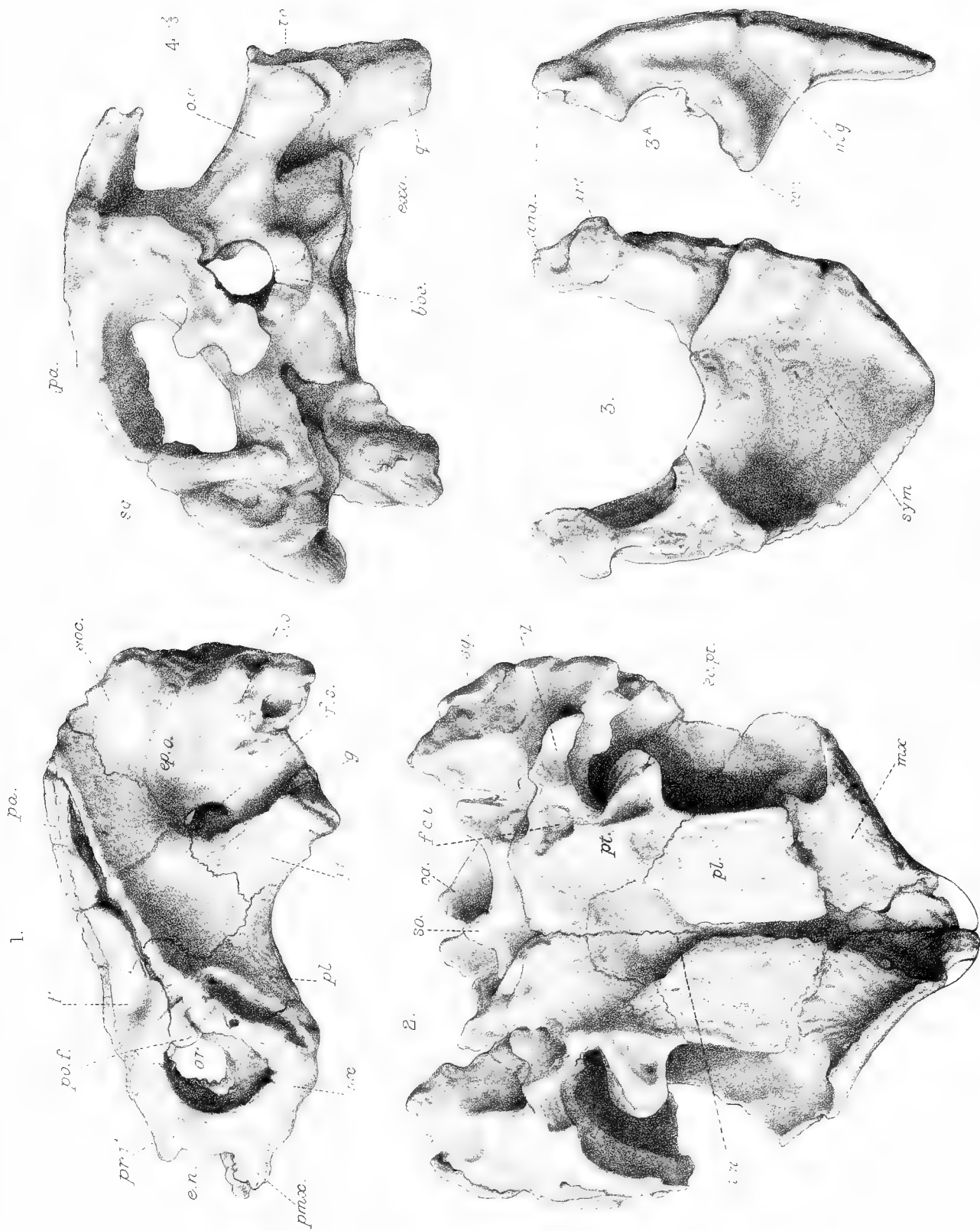
PLATE XXV.

1. 2. 3. STEREOGENYS CROMERI

4. THALASSOCHELYS LIBYCA

G.M. Woodward del. et lith.

West Newman imp.

PLATE XXVI.

ang., angular process of mandible.
art., articular surface of mandible.
a.z., anterior zygapophyses.
f., pit on posterior face of arch.
hyp., hypapophysis.
l.p., postero-lateral process.

n.sp., neural spine.
p.z., posterior zygapophyses.
t.p., transverse processes.
za., zygantrum.
zs., zygosphene.

PLATE XXXVI.

CATAL. TERTIARY VERT. FAYÛM.
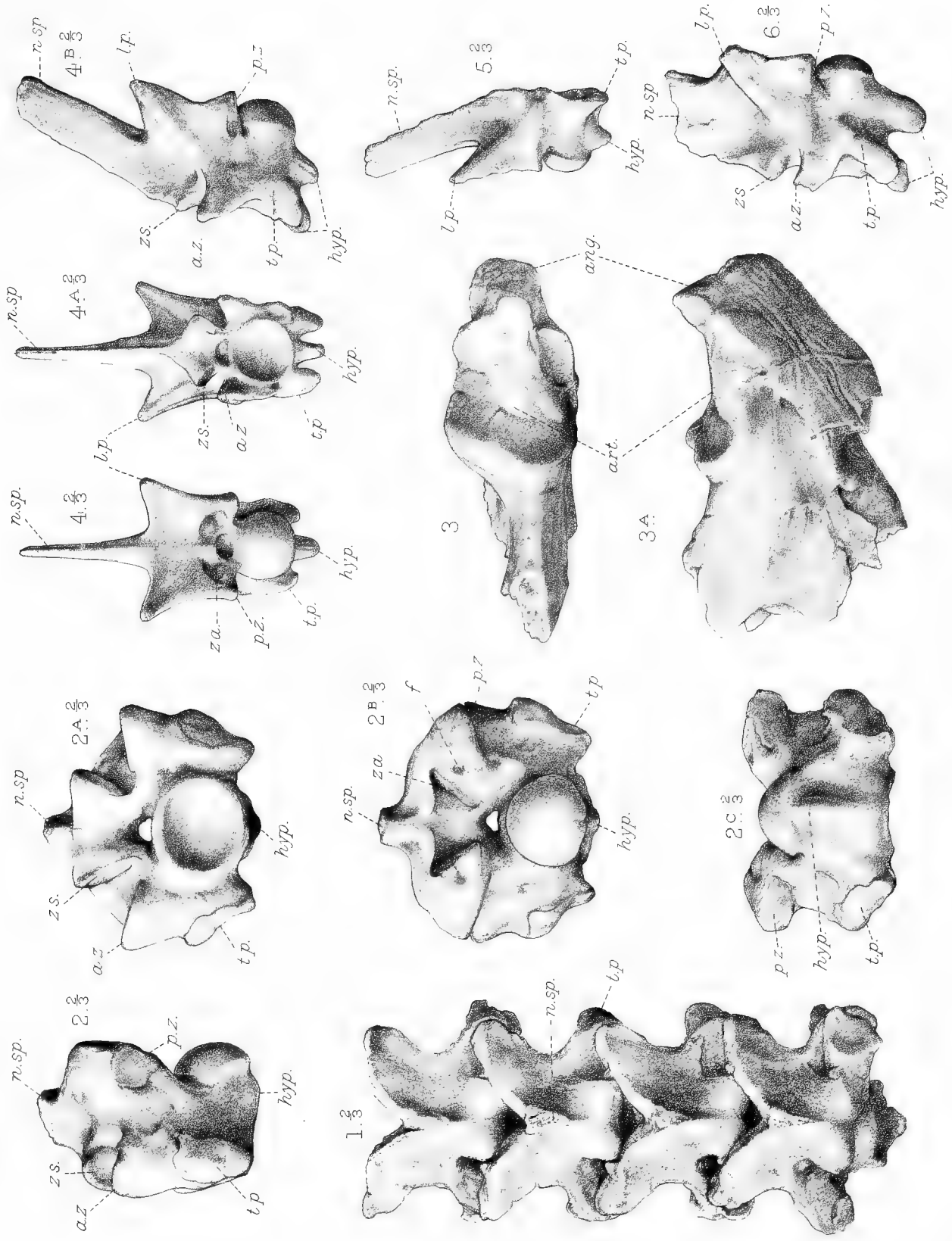
G.M.Woodward del. et lith.

West, Newman imp.

1, 2, 3. GIGANTOPHIS GARSTINI.
4, 5, 6. PTEROSPHENUS SCHWEINFURTHI.