

OUTLINES OF
STRATIGRAPHIC PALÆONTOLOGY
FOR STUDENTS OF ZOOLOGY

London: C. J. CLAY AND SONS,
CAMBRIDGE UNIVERSITY PRESS WAREHOUSE,
AVE MARIA LANE.

AND

H. K. LEWIS,
186, GOWER STREET, W.C.



Glasgow: 222, ARGYLE STREET.
Leipzig: F. A. BROCKHAUS.
New York: THE MACMILLAN COMPANY
Bombay: E. SEYMOUR HALE

BY

ARTHUR SMITH WOODWARD,

ASSISTANT-KEEPER OF THE DEPARTMENT OF GEOLOGY
IN THE BRITISH MUSEUM.

CAMBRIDGE:
AT THE UNIVERSITY PRESS.

1898

[All Rights reserved.]

three digits of the pes are nearly uniform in size, and there are no rudiments of digits nos. 1 and 5. One of the best known species is *Titanotherium* (*Brontops*) *robustum* (fig. 190), between four and five metres in length and about two-and-a-half metres high. Its dental formula is $i. 2, c. 1, pm. 4, m. 3$. The generic name *Brontotherium* has been given to

those forms with two incisors above and below, with the upper canine close to the first premolar, and with this premolar lost in the mandible. Various remains occur in the Lower Miocene, not only of Dakota, but also of Nebraska, Wyoming, Colorado, and the region of the Cypress Hills, District of Assiniboia, Canada.

Palæosyops, from the Lower and Middle (Wind River and Bridger) Eocene of the United States, does not bear any horn-like prominences on the skull, and its premolars are all simpler than the molars (fig. 189). The facial region is somewhat more elongated than in *Titanotherium*; the frontal bears a large postorbital process; and the parietal region rises into a sagittal crest. The cerebral hemispheres of the brain are also proved to have been less convoluted than in *Titanotherium*. The skeleton is almost completely known, and much resembles that of the latter genus, though it is of more slender proportions. The typical species *Palæosyops paludosus*, from the Bridger Eocene of Wyoming, is an animal about two metres in length and one metre in height.

The rhinoceroses, or family *Rhinocerotidæ*, begin to be recognizable towards the close of the Eocene, both in Europe and North America; and the Miocene genera in both countries differ very little in their skeleton from the surviving rhinoceroses of the Old World at the present day. At first they are entirely hornless, and some of them retain a rudimentary fourth digit (no. 4) on the manus. The incisors and canines are also a more persistent feature in the earlier than in the later forms, and the premolars are sometimes simpler than the molars. In North America a normal horn does not appear to have ever been acquired, and the race disappeared before the close of the Pliocene without attaining a much higher degree of specialization than that exhibited by the Miocene *Aceratherium* of Europe. In the Old World, however, the gradual development of the horn can be clearly traced; the ancestry of the surviving rhinoceroses of Asia and Africa is revealed to a considerable extent by fossils both from Europe and Asia; and one northern rhinoceros (*Elasmotherium*), discovered in the Pleistocene deposits of Siberia and some parts of European

Russia, is specialized not only in the development of a great horn, but in the deepened (hypsodont) prismatic form of its grinding teeth.

The crowns of the molars and premolars in all the rhinoceroses are somewhat deeper than those of the other perissodactyls already noticed; but, except in the aberrant *Elasmotherium* just mentioned, the hollows between the ridges are not filled with cement. The hindermost upper molar is reduced to a triangular form by the partial atrophy of its posterior ridge; while the hindermost lower molar consists of never more than two crescents, like those in front of it. The

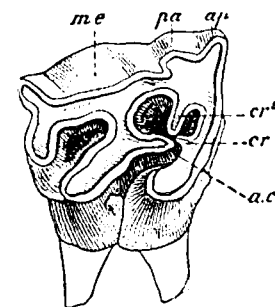


FIG. 191.

Second Right Upper Molar of *Rhinoceros*, much reduced. *a.cr.*, crochet; *ap.*, parastyle; *cr.*, anticrochet; *cr.*, crista; *me.*, metacone; *pa.*, paracone. (From Osborn, after De Blainville.)

upper molars (fig. 191), except in some of the earliest forms, are more or less complicated by the growth forwards of a prominence or "crochet" (*a.cr.*) from the posterior ridge, and by another similar prominence ("crista" or "combing plate," *cr.*) growing from the outer wall into the median valley; and these two points sometimes meet. A third prominence or "anticrochet" (*cr.*) also sometimes projects backwards from the anterior ridge to meet the others. There is always a diastema in front of the premolars; while the canines and incisors are very variable in development, sometimes even absent. The orbital cavity is never separated by bone from the temporal fossa. There are always three functional digits on each foot.

Hyracodon. The parietal region of the skull in this, as in the other primitive rhinoceroses, is raised into a sharp sagittal crest: the freely projecting nasal bones are slender and smooth. The complete series of 44 teeth is present, and the premolars resemble the molars, while the canines are uniform with the incisors; but there is a short diastema in both jaws between the premolars and the canine. The molars do not exhibit the "crochet" and "crista." The skeleton denotes a slightly-built animal, with longer limbs and a longer neck than are characteristic of the true rhinoceroses. Both feet are definitely proved to have been tridactyl. The genus occurs in the Lower Miocene (White River Formation) of Nebraska and Colorado, and the typical species, *Hyracodon nebrascensis*, has a skull about 0.25 m. in length. Some molar teeth from an early Tertiary Formation in Siebenbrunnen, Hungary, have also been referred to this genus.

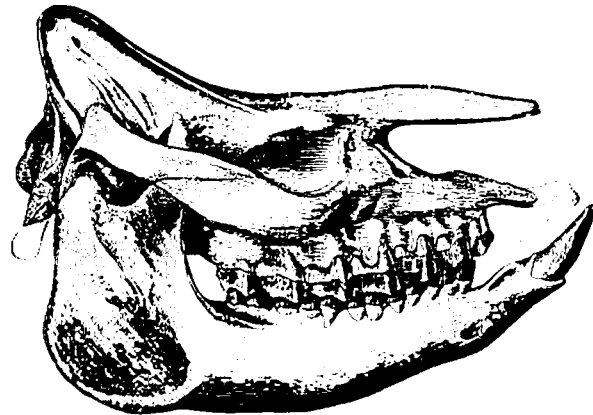


FIG. 192.

Aceratherium (Aphelops) megalodus; skull and mandible, one-sixth nat. size.—
U. Miocene (Loup Fork Formation); Colorado. (After Cope.)

Aceratherium (fig. 192). The earliest remains apparently of rhinoceroses found in Europe (detached teeth and limb-bones from the Upper Eocene or perhaps Lower Miocene Phosphorites of Quercy, France) are too fragmentary for discussion; but the Miocene and Pliocene remains are more satisfactory, and a hornless rhinoceros, *Aceratherium*, with a rudimentary fourth toe (no. v) on the fore foot can be clearly recognized. The sagittal crest of the skull is not acute, but always more or less flattened, and the nasal bones are small, freely projecting. The premaxillary region is slender and elongated. The dental formula of the more typical species is

i. 1, c. 0, pm. 4, m. 3.

i. 1, c. 1, pm. 3, m. 3.

The upper incisors are large chisel-shaped teeth elongated antero-posteriorly; while the lower incisors are pointed and diminutive between the pair of large procumbent canines which meet the upper incisors. The upper molars are scarcely complicated with crests and crochets. Digit no. v on the manus is represented not only by its metacarpal but also by two phalanges; but it is comparatively small and must have been almost functionless. The finest remains of *Aceratherium* hitherto discovered are those from the Middle Miocene of Sansan and other French localities, and from the Lower Pliocene of Eppelsheim, Hesse Darmstadt. There are also traces of the genus in the Lower Pliocene of Pikermi (Greece), the island of Samos, Maragha (Persia), the Siwalik Hills (India), and in China; and detached teeth have been identified in the Red Crag of Suffolk. The typical species is *Aceratherium incisivum*, with a skull about half a metre in length, best known from Eppelsheim. Nearly complete skeletons of very similar rhinoceroses are known both from the Lower Miocene (White River Formation) and the Upper Miocene (Loup Fork Series) of North America; and some of these (e.g. *Aphelops*) are clearly destitute of a fourth digit in the manus.

Diceratherium. One small American rhinoceros closely resembling *Aceratherium*, exhibits a slight eminence on each nasal bone, as if the animal had been provided with a pair of callosities (scarcely true rhinocerotine horns) placed side by side. The nearly complete skeleton of *Diceratherium armatum*, with four digits in the manus, is known from the Middle Miocene (John Day Formation) of Oregon. In the Lower Miocene of France and Germany there seem to be traces of a nearly similar animal (the *Rhinoceros minutus* of Cuvier).

Rhinoceros (fig. 193). Typical rhinoceroses with a well-developed horn date back in Europe as far as the Middle Miocene of France (*Rhinoceros sansaniensis*); and fine skulls of a similar form have been found in the Lower Pliocene of Eppelsheim, Hesse Darmstadt (*Rhinoceros schleiermacheri*). The horns, of course, are never preserved under the ordinary circumstances of fossilization; but the bone is always roughened where they are attached, and so their original presence or absence can be determined. It appears from this criterion that the Miocene species just mentioned possessed two horns, one behind the other; and as they are likewise characterized by the presence of one pair of incisors above and below and well-developed procumbent lower canines, they may be placed in the same group (sub-genus *Ceratorhinus*) as the existing *R. sumatrensis* of Sumatra, Borneo, and certain parts of the adjoining Asiatic continent. One-horned rhinoceroses are unknown among fossils, except in the Indian region of which they are now characteristic (*R. unicornis* and *R. sondaicus*). *R. sivalensis* and *R. palawindicus* from the Lower Pliocene of the Siwalik Hills seem to be their ancestors. The two-horned rhinoceroses in which the front teeth are quite rudimentary or wanting (sub-genus

Atelodus) had a very wide distribution in the Pliocene and Pleistocene periods, though they are now exclusively confined to Africa (*R. bicornis* and *R. simus*). They seem to appear first in the Lower Pliocene of Pikermi, Greece (*R. pachygnathus*), and become common over the greater part of southern Europe in the Upper Pliocene (*R. etruscus*)—the latter ranging as far north as the Forest Bed of Cromer, Norfolk. The Upper Pliocene species bore horns so large that the septum between the nares began to ossify for their support; and the same ossification is to be noticed in the slender-nosed *R. leptorhinus* or *hemitachus* (fig. 193) from the early Pleistocene of the Thames Valley and parts of the adjoining

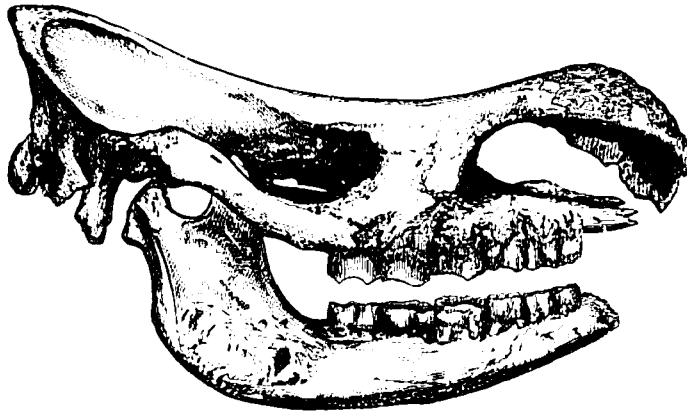


FIG. 193.

Rhinoceros leptorhinus; skull and mandible, one-eighth nat. size.—Pleistocene; Ilford, Essex. (After W. Davies.)

continent. The ossification of the nasal septum, however, attained its maximum development in the great Woolly, or Tichorhine Rhinoceros (*R. antiquitatis*), which is found in the English caves and river-deposits, in the old river-deposits at the bottom of the present North Sea, and ranged throughout northern Europe and Asia, wandering even within the Arctic Circle. Mummified remains discovered in the frozen earth of northern Siberia prove this animal to have been thickly clothed with hair and wool; and its huge horns are preserved in the same deposits.

Elasmotherium. This is an aberrant rhinoceros, which ranged over Siberia and part of south European Russia in the Pleistocene period. The nasal bones are slender, but the nasal septum is ossified, and there is an enormous bony prominence on the frontal region above the eye, which must have borne a relatively large horn. The nasal region may perhaps

have also carried a minute horn. The front teeth are completely absent, and the two anterior premolars have also disappeared. The remaining teeth (pm. 3, 4, m. 1—3) are deepened (hypsodont) and prismatic in shape, like those of a horse; the valleys between the ridges are completely filled with cement; and the ridges themselves are elaborately crimped. The known limb-bones are quite rhinocerotid in type. The only known species, *E. sibiricum*, has a skull at least a metre in length.

The true horses, or **Equidæ** in the most restricted sense of the term, appear first in the Upper Miocene of North America and in the Lower Pliocene of Europe. They are all agile animals with one large functional digit on each foot, and a pair of lateral digits, which are sometimes complete though small, sometimes mere splint-like rudiments. The incisors are chisel-shaped, with the apex folded into a longitudinal pit; the canines are diminutive; and the grinding teeth are deepened (hypsodont), the valleys always filled with the cement, and the two ridges (homologous with those of Palæotheriudæ, etc.) connected by a cross-crest. The premolars 2—4 resemble the molars, and the foremost premolar is rudimentary or absent. The orbit is completely surrounded by bone.

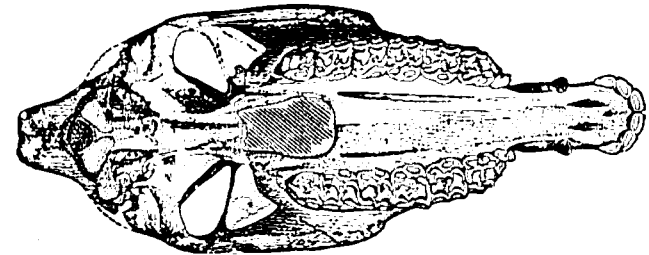


FIG. 194.

Protohippus sejunctus; palatal aspect of skull, one-third nat. size.—U. Miocene (Loup Fork Formation); Colorado. (After Cope.)

Protohippus (figs. 182, 194). In the early American genus, *Protohippus* or *Merychippus*, from the Upper Miocene (Loup Fork Series) of Nebraska and Colorado, the grinding teeth of the adult resemble those of a generalized *Equus*, only they are somewhat less hypsodont; but the milk-molars are curiously similar to those of *Anchitherium*. The small lateral digits are complete, but the ulna and fibula are already imperfect.