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ART. III.—*New Species of Hyracodon*; by EDWARD L. TROXELL.

[Contributions from the Othniel Charles Marsh Publication Fund, Peabody Museum, Yale University, New Haven, Conn.]

INTRODUCTION.

Hyracodon, a genus of rhinoceros-like animals, is known only in the Oligocene. Because of the slender limbs, long neck, and relatively small skull, it was early characterized by Scott and Osborn as cursorial, and it is probable that these light-running ungulates held the place in the economy of nature now filled by the antelope and others of the small ruminants.

Because of the already great reduction of the lateral toes, *Hyracodon* had reached a state of development almost equal to that of *Protohippus*, and, the race persisting, might well have become monodactylous, like the modern horse.

Four species of *Hyracodon* have been made known, only one of which has had figures accompanying the description. Leidy in 1850 gave us the first information of these animals; his later drawings (1852, 1854) have shown a widely diversified group, therefore *H. nebrascensis* in its broadest sense may apply to almost any hyracodont, and the species is virtually synonymous with the genus. The other known species are: *H. arcidens* Cope, *H. major* Scott and Osborn, and ? *H. planiceps* Scott and Osborn.

DISCUSSION OF KNOWN SPECIES.

Hyracodon nebrascensis (Leidy).

"A species founded upon a great portion of the face, containing all the superior molar teeth; an inferior maxilla with six molars; and three superior, apparently deciduous molars. It is about the same size as the *R. minutus* of Cuvier.

"Length of line of seven superior molars 4 7/10 inches [119.4 mm.]
 Length of line of six inferior molars 4 2/10 inches [106.7 mm.]
 Breadth of jaws from the first superior true molar teeth of one side to the other 3 8/10 inches [96.7 mm.]"¹

It is evident from this and subsequent descriptions that Leidy did not limit himself to one single species, but included specimens with varied features.

Hyracodon arcidens Cope.

The holotype is primarily based on a maxillary with the premolars and M¹ of a very young animal. Cope says:²

"The species is about the size of the *H. nebrascensis*, and differs in the form of the inner lobes of the molars and of the first premolar. All the molars have the outer longitudinal and inner transverse crests, the posterior short, the anterior much curved backward round it, and thus forming the inner boundary of the tooth-wall."

This is apparently the first true specific description we have of a hyracodont; it is obviously similar to certain phases of *H. nebrascensis*—it could hardly be otherwise—but applies to that distinctive group, moderate in size, which have the anterior crest much curved backward.

Hyracodon major Scott and Osborn.

The type of this species is a fairly complete skeleton in the Princeton Museum. The species description³ is based on a fore foot and therefore can not be compared to the new species described later in this paper; unfortunately it does not give any tooth characters and so we know little more than the proportional size of the specimen.

¹ Joseph Leidy, Proc. Acad. Nat. Sci. Phila., 5, 121, 1850.

² E. D. Cope, Pal. Bull. No. 15, 2, 1873.

³ W. B. Scott and H. F. Osborn, Bull. Mus. Comp. Zool., vol. 13, 170, 1887

The published measurements show this species to be a half larger than "*H. nebrascensis*"; it even surpasses the large *H. leidyani*, sp. nov.

? *Hyracodon planiceps* Scott and Osborn.

This is a very large rhinoceroid which, by the authors,¹ is doubtfully referred to *Hyracodon*.

DESCRIPTION OF NEW SPECIES.

Hyracodon arcidens mimus, subsp. nov.

(FIG. 1.)

Holotype, Cat. No. 11174, Y. P. M. Oligocene, Deadwood, South Dakota.

The holotype consists of both maxillaries with all premolars in excellent preservation. It is evident that this is near the species Leidy first described in 1850, because the measurements are close; it corresponds in turn to the specimen figured in plate XII A, 1852⁵ and

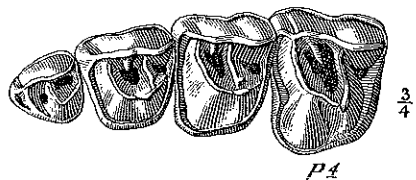


FIG. 1.—Upper premolars of *Hyracodon arcidens mimus*, subsp. nov. Holotype. Cat. No. 11174, Y. P. M. $\times 3/4$. Note especially the continuous internal loops, the cristæ, and the prominent deuterocone of P⁴.

resembles the maxillary shown in plate XIV, figs. 4-6, 1854.⁶ Cope's description of *H. arcidens* shows it to have the same sort of looping protoloph, but his slightly larger holotype is not figured, so no close identification is possible.

A summary of the distinctive features is: strong crista on the larger premolars; protoloph joins the tetartocone and on P^{2,3} it completely encloses the thin straight metaloph; deuterocone and tetartocone united in P⁴ but with a deep double groove on the outside; cingula completely

¹ Scott and Osborn, op. cit., p. 171.

⁵ Joseph Leidy, in Owen's "Report of a geological survey of Wisconsin, Iowa, and Minnesota," etc.

⁶ Joseph Leidy, *Smithson. Cont. Knowl.*, vol. 6, art. 7.

surrounding all teeth; deuterocone very prominent on P⁴ and set off by vertical grooves; this tooth is subtriangular. None of the premolars can be said to be molari-form.

Hyracodon selenidens, sp. nov.

(FIGS. 2-3.)

Holotype, Cat. No. 11173, Y. P. M. Middle Oligocene, Colorado.

This new species of *Hyracodon* is especially notable for its small size and the crescentic form of the deuterocone, hence the specific name. The holotype is about three fourths the size of *H. leidyani* described later, and is therefore the smallest of the Oligocene rhinoceroses. The species possesses certain features typical of *Cænopus* of an entirely different family, indicating parallel or convergent evolution; the complete enveloping of the metaloph by the protoloph, and the diminution of the former are seen in *C. allus* and reach an extreme in *C. nanolophus*, new forms described in a later paper of this series.

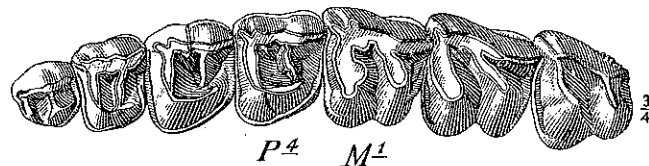


FIG. 2.—Upper cheek teeth of *Hyracodon selenidens*, sp. nov. Holotype. Cat. No. 11173, Y. P. M. $\times 3/4$. The smaller cross crest is completely encircled by the other on the premolars of this very small species.



FIG. 3.—Lower molars and premolars of the small *Hyracodon selenidens*, sp. nov. Holotype. $\times 3/4$.

P¹ departs from the pattern of the other premolars; its protoloph is scarcely more prominent than the cingulum posterior and is separated from the inner main cone; the metaloph bisects the tooth and ends in a cross on its outer end. The tooth forms roughly the half of an ellipse.

The anterior premolars increase rapidly in size and P^2 is a third wider than P^1 . P^2 is subquadrate, having three sides at right angles. On this tooth the protoloph exhibits the prominence which in part characterizes the species. Its form, however, is not that of a perfect crescent, for it shows an irregular curve and a ridge or pillar where it joins the tetartocone. The metaloph is a thin straight wall dividing the equal-sized medi- and postfossettes.

P^3 resembles P^2 in nearly every respect, but shows a greater decrease in the size of the metaloph and a smoother crescent. On P^4 the deutocone is set off by vertical grooves running up the sides; this cone shows a strong tendency to lean toward and to occupy the central portion of the tooth. The prominence of the base of the cone gives the tooth a somewhat triangular outline.

There is a small crista on P^3 and a small crochet on the metaloph of P^4 near the tetartocone, partly separating a portion of the medifossette or valley. There is evidence of a faint crista on M^2 , but the crochet seen on other specimens is undeveloped. The anterochet is not so conspicuous as in *H. leidymanus*, Cat. No. 11169.

The molars are smooth on their inner cones, and in general show extreme simplicity. The crowns are relatively low.

Hyracodon leidymanus, sp. nov.

(Figs. 4-5.)

Holotype, Cat. No. 11169, paratype, Cat. No. 11168, Y. P. M. Middle or Lower Oligocene, Crow Buttes, South Dakota.

The holotype of this species consists of a maxillary and ramus with tooth series P^1 to M^2 and P_2 to M_1 , inclusive. The paratype material includes two specimens; one may be a part of the holotype but that can not be demonstrated. The parts preserved are: second upper molar, atlas, vertebrae, numerous toe bones, tibia, astragalus, navicular, metatarsus, and broken parts of the calcaneum, radius, metacarpal III, another tibia, and a second metatarsus.

The holotype is unusual in its large size, smooth teeth, molariform premolars, and high crowns, together with the following additional features: The protoloph of P^1 joins more intimately with the metaloph than with the ectoloph and is very much decreased in size. The metaloph of P^2 , which is only submolariform, extends at right angles from the ectoloph and at its end hooks backward in

a way peculiar to *Hyracodon* alone. At a later stage of wear, the two inner lophs unite by a narrow bridge.

On the molars and large premolars there are developed sharp cristae and crochets, a feature which is well known in the totally unrelated later rhinoceroses, where the medifossette in its extreme form becomes a lake. New characters like these seem generally to arise on the outer edges of the cusps, and then in the course of evolution appear gradually more deep-seated. They are therefore quickly worn away from the tooth of a more primitive type.

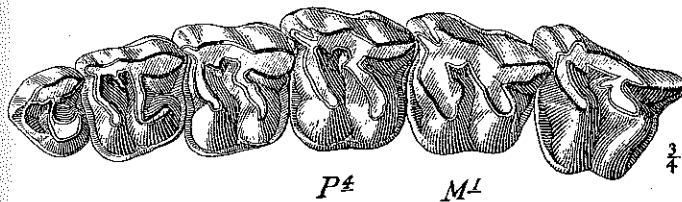


FIG. 4.—*Hyracodon leidymanus*, sp. nov. Holotype. Cat. No. 11169, Y. P. M. $\times 3/4$. In this large specimen the ridges of the premolars are parallel and the median valleys uninterrupted.

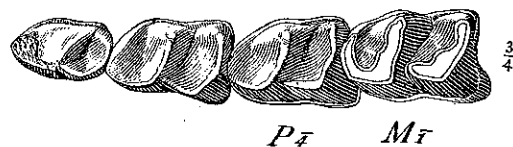


FIG. 5.—Lower molars of *Hyracodon leidymanus*, sp. nov. Holotype. $\times 3/4$.

The anterochet on M^{1-2} is very strong and a sharp vertical groove divides it from the protocone. Two grooves thus mark off the protocone, while one appears to limit the hypocone. The cingular ridges do not cross the bases of the inner cones of the molars as they do the premolars.

The lower cheek teeth, like the upper, are notable for their general simplicity, subdued cingula, high crowns, flat outer surface, and lack of angularity. In *Hyracodon* there is not a great difference in the height of the anterior and posterior lobes of the lower molars, as there is in *Cenopus* or even *Trigonias*.

In the lower jaw, an alveolus reveals the former presence of P_1 or Dp_1 , which as a permanent tooth is seen in no other specimen of *Hyracodon* at hand, indicating in general the advanced evolution of this genus.

The external vertical groove of the lower teeth curves backward in a way unlike that of any other specimen observed, and, especially in the two larger premolars, continues into the cingular ridge instead of ending abruptly against it.

SUMMARY.

There are three families of extinct rhinoceros-like animals: the true Rhinocerotidae, giving rise to our modern animals; the Amynodontidae, culminating in *Metamynodon* in early Oligocene time; and finally, the Hyracodontidae, represented by the single genus *Hyracodon*, found in the Lower and Middle Oligocene of the Great Plains. This genus is easily distinguished by its small size, its slender proportions, and the presence of all canine and incisor teeth. The trend of its evolution seems to have been toward the loss of the lateral toes, a cursorial adaptation.

Two new species and one subspecies have been established here in order to set forth features which either have been ill defined, or are entirely new in the genus.

Measurements of Holotypes.

	H. <i>mimus</i> mm.	H. <i>leidyani</i> mm.	H. <i>selenidens</i> mm.
Upper jaw:			
Premolar series, length	67	74	57
Molar premolar series, length	129*	142*	110
P ¹ , length	13	14	11
Width	14	16	12
P ² , length	16	18	14
Width	19	21	16
P ³ , length	18	21	15
Width	23	25	19
P ⁴ , length	20	22	16
Width	26	27	21
M ¹ , length		24	19
Width		25	21
M ² , length		27	20
Width		27	21
M ³ , length			17
Width			21
Lower jaw:			
Length of three premolars		61	46
Length of three premolars and M ₁		85	63
Length of molar premolar series			101

*Estimated.

ART. IV.—*Cænopus*, the Ancestral Rhinoceros; by
EDWARD L. TROXELL.

[Contributions from the Othniel Charles Marsh Publication Fund, Peabody Museum, Yale University, New Haven, Conn.]

INTRODUCTION.

Until very recent times there were two great groups of extinct rhinoceroses mentioned in the literature, *Aceratherium* Kaup and *Diceratherium* Marsh, and specimens from Lower Oligocene to Middle or Upper Miocene, both in the Old and New World, were classified according to the nasal bones, whether or not they had rugose thickenings designed to support horns. Due to the work of Osborn, Scott, Loomis, Cook, and especially of Peterson, it now appears that the two classes are simply the hornless females and the horned males of a variety of genera. There are, however, two important exceptions to this general rule: (1) the early Oligocene species which did not show the horn rugosities in the males, and (2) those recent animals (excepting *Rhinoceros sondaicus*) in which both males and females may have horns.

Peterson shows that in *Diceratherium cooki* the horns belonged to the mature males alone; the females and young males were hornless. In the Peabody Museum there are horned and hornless specimens of *Diceratherium* from the John Day beds of Oregon. The mature animals may be either, but the very young individuals always have smooth nasals. Osborn (1898) has demonstrated that *Cænopus tridactylus* also has this sexual distinction, following the discovery by Hatcher (1894) of "*D.*" *proavatum* with horns in the males in a very primitive state. The name of *Diceratherium* therefore ceases to have its original sense, all inclusive, and is now limited to one phase of the horned rhinoceroses, the type of which is *D. armatum* Marsh. Other species of "diceratheres" may be, and some are, widely separated in their classification, as will be shown later.

¹ For obvious reasons, space is not given to the publication of all references; the reader is therefore directed to the memoirs by Osborn ("The extinct rhinoceroses", Mem. Amer. Mus. Nat. Hist., vol. 1, 75-164, pls. 12A-20, 1898) and by Peterson ("The American diceratheres", Mem. Carnegie Mus., vol. 7, 399-477, pls. 57-66, 1920), in which detailed descriptions, fine reproductions of all important types, and full bibliographies are published.