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ABSTRACT

A New Rhinoceros from the Nebraska Miocene

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A new species of rhinoceros, *Menoceras marslandensis*, is here proposed. It is based upon a nearly complete skull from the upper part of the Marsland Formation, Hemingford Group (Miocene), of Box Butte County, Nebraska. The new species was probably derived from *Menoceras arikarense* (Barbour), collected from the Agate Springs Quarries (Arikaree Group, Harrison Formation) of Sioux County, Nebraska, with which both *Diceratherium niobrarensis* Peterson and *D. cooki* Peterson are likely synonymous. From *Menoceras arikarense*, the presumed ancestral stock, *Menoceras marslandensis* differs in possessing the following characters: (1) very long, fused but slightly cleft, nasals, with flattened, rugose areas at the tips for the support of the horns; and (2) a convex frontal, also roughened, indicating a base for a well-developed frontal horn. This new species provides additional evidence that the generic separation of *Menoceras* Troxell from *Diceratherium* Marsh is warranted, and these two genera evidently lived side-by-side in the Medial to Late Miocene of the Central Great Plains. Both stocks, each greatly modified, may have survived into the Pliocene.

CONTRIBUTION OF *the Division of Vertebrate Paleontology of the University of Nebraska State Museum.*

Tanner[1]

A New Rhinoceros from the Nebraska Miocene

INTRODUCTION

Knowledge of the Tertiary rhinoceroses of North America has proceeded rather slowly during the last thirty-five years, but this has not been due to the lack of new materials. Rather, because of the wealth of fossil rhinoceros specimens found in this period (particularly by expeditions from the University of Nebraska State Museum and the Frick Laboratory, American Museum of Natural History), there has developed a need for a complete revision of the family. This has been accompanied by a realization of the magnitude of the task and the futility of additional descriptions of new forms without a better understanding of the phylogeny.

Although such a revision has not been accomplished, there has been some progress toward it, and a tentative phylogenetic scheme has resulted (Fig. 1). It is the purpose of this paper to present some of the evidence that has accumulated with respect to the distinction of two Miocene rhinoceros genera, *Diceratherium* and *Menoceras*, and to place on record a new species of the latter.

DICERATHERIUM *versus* MENOCERAS

These Miocene rhinoceroses are quite distinct (Troxell, 1921, pp. 206–207), but they have become confused in the literature since

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1921 and generally have been considered inseparable (Matthew, 1931, p. 8; Simpson, 1945, p. 142). As with any group of fossil mammals, understanding at the generic level must begin with the types of the typical species, fitted into a modern frame of reference that is fundamentally stratigraphic and composed of all available specimens.

Diceratherium has priority, having been established by Marsh at the same time that he described the type species, *D. armatum*, from the "Miocene beds, near the John Day River, in Eastern Oregon" (Marsh, 1875, pp. 242–243). He considered the specimens available for *D. armatum* indicated "an animal about two-thirds the size of the Indian Rhinoceros," but he included a general description of the type skull and feet, together with a table of measurements.

This type skull (Y.P.M. 10003,[2] Figs. 2, 3, and 4) was kindly made available by the staff members of the Yale Peabody Museum for this study. Additional information regarding its derivation was furnished from the records of the Yale Peabody Museum: "The specimen was collected by L. S. Davis, in early 1874. In a letter dated 'May 12, 1874,' he notified Marsh of the shipment of fossils 'all from the Cove,' among which was the specimen in question. 'The Cove' is *Turtle Cove*, from which many of Marsh's John Day specimens came. (Personal communication from James A. Hopson, June 22, 1964)."

The correlation of the John Day sediments of Oregon with the rocks of the Great Plains has not been clearly established, but it must include an interval about equivalent to the Harrison Formation of Nebraska and eastern Wyoming. After the revision of several groups of oreodonts, Schultz and Falkenbach (1949, p. 92) concluded that their oreodont "examples from the John Day indicated a geologic age approximating that of the Harrison of Nebraska and Wyoming." Other discussions of the geologic placement of the type and referred specimens of *Diceratherium armatum* are to be found in the papers of Osborn (1898), Troxell (1921), Wood (1933), Green (1958, p. 591), and Macdonald (1963, p. 296).

Menoceras was proposed by Troxell (1921, p. 206–207), with *D. cooki* Peterson (1906c, p. 282) as the type species; the latter is here considered to be a synonym of *D. arikarense* Barbour (1906a). Both types have been available for study. These are but a part of a large

[2] The following abbreviations are utilized to refer to institutions cited: A.M.N.H., American Museum of Natural History, New York City; C.M., Carnegie Museum, Pittsburgh; S.D.S.M., South Dakota School of Mines, Rapid City; U.N.S.M., University of Nebraska State Museum, Lincoln; U.S.N.M., United States National Museum, Washington, D. C.; and Y.P.M., Yale Peabody Museum, New Haven.

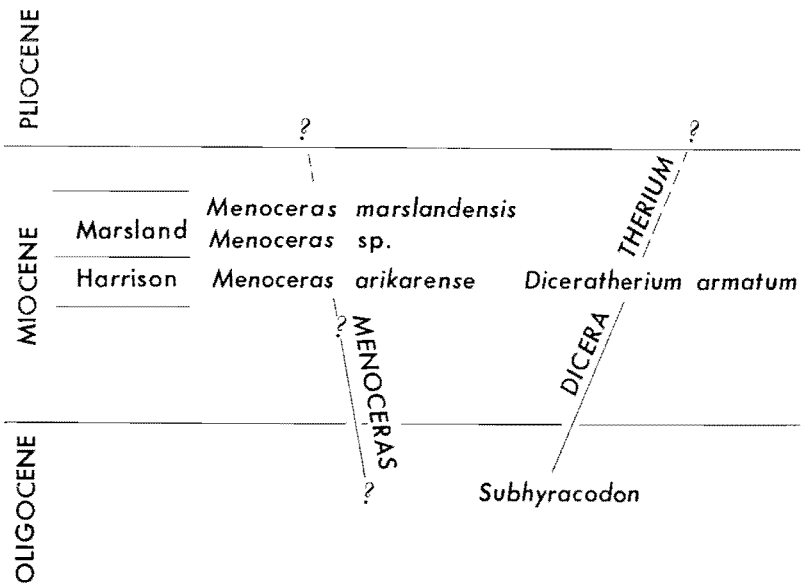

FIG. 1—The two lineages of diceratheres in the Miocene (Arikaree and Hemingford) sediments of the Central Great Plains (High Plains) of Nebraska and adjacent states.

sample from the famous locality near Agate, Sioux County, Nebraska (Peterson, 1906a–c; Schultz, 1966; and Roberts, 1966), now authorized as the "Agate Fossil Beds National Monument." The University of Nebraska State Museum expeditions, under the leadership of Erwin H. Barbour, Captain James Cook, and Harold J. Cook, together with the Carnegie Museum party of O. A. Peterson, developed the fossil quarries here during the early 1900's. However, many other institutions and individuals worked at Agate during this same period of time (Schultz, 1966). The principal museums of the world display one or more specimens from these sites. The fossiliferous level of the three quarries (designated "A," "B," and "C" by Holland and Peterson, 1913, Fig. 1) is in the Harrison Formation, in the upper part of the Arikaree Group, and this horizon is usually correlated as medial Miocene (Schultz and Stout, 1961, pp. 6–8, 30, 49, Figs. 2–3, 21–22, also Fig. 10, *this paper*).

There are two composite mounted skeletons of *Menoceras arikarense* in the collections of the University of Nebraska State Museum[3] from the Agate Springs Fossil Quarries (U.N.S.M. 1147 and 1250), one of which is now on display at the University of Nebraska Trailside Museum at Fort Robinson, near Crawford, Nebraska

[3] The "panel mount" figured by Barbour (1909, Pl. 1) may have been disassembled after the fire of March 6, 1912.

(Tanner, 1962). In addition, the Museum's study collection now contains five skulls, several mandibular rami, and much other skeletal material of this species. Of particular interest in the present study is the excellent skull of a mature male (U.N.S.M. 1251).

The characters of *Menoceras arikarense* shown by this mature skull (Figs. 5–6) are: (1) a saddle-shape when viewed from the side, with a slight convexity in the anterior part of the frontal; and (2) paired nasal bosses, as round and rugose knobs situated near the tips of the nasals, with the rugosity limited superiorly. The female of this species was probably nearly hornless, since only vestigial knobs are present on skulls with undistorted nasals.

By contrast, the male characters for the very much larger *Diceratherium armatum*, as shown by the type skull (Figs. 2–4), are: (1) only a slight concavity in the frontal region when viewed in profile; and (2) paired nasal bosses are elongate and elevated ridges, instead of near-spherical knobs, and situated far behind rather than over the nasal tips.

TABLE 1

CONTRASTED SKULL CHARACTERS FOR MALES OF *Menoceras* AND *Diceratherium*.

Menoceras	*Diceratherium*
1. Approximately one-third smaller than *Diceratherium*	Much larger than *Menoceras*
2. In side view, saddle-shaped	In profile, only slightly concave, *not* saddle-shaped
3. Frontal convex	Frontal flat
4. Frontal rugose	Frontal probably smooth
5. Narial notch retracted, above P^2	Narial notch not retracted, situated above P^1
6. Nasal bosses subrounded knobs	Nasal bosses elongate, elliptical ridges
7. Nasal bosses above and near tips of nasals	Nasal bosses posterior to tips of nasals
8. Palate narrow and deep	Palate broad and shallow
9. Zygomata expanded posteriorly and roughened	Zygomata smooth
10. Complicated dental patterns	Relatively simple dental patterns
11. Cristae present on M^3, with only faint cingulae	Cristae absent on M^3, with cingulae moderately developed
12. Diameter of M^1–M^3 = 223 mm.	Diameter of M^1–M^3 = 254 mm.

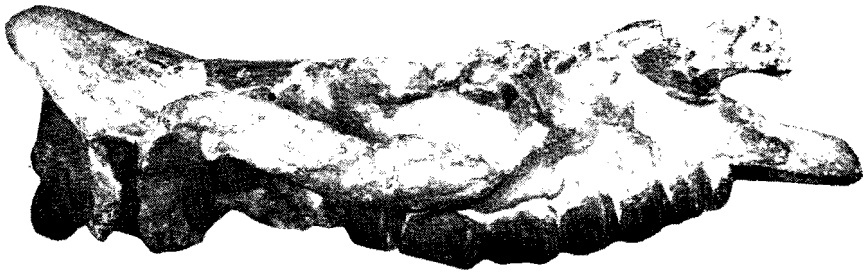

FIG. 2—Lateral view of holotype male skull (Y.P.M. 10003) of *Diceratherium armatum* Marsh, from the John Day Miocene of Oregon: X ¼

FIG. 3—Dorsal view of the same skull shown as Fig. 2: X ¼

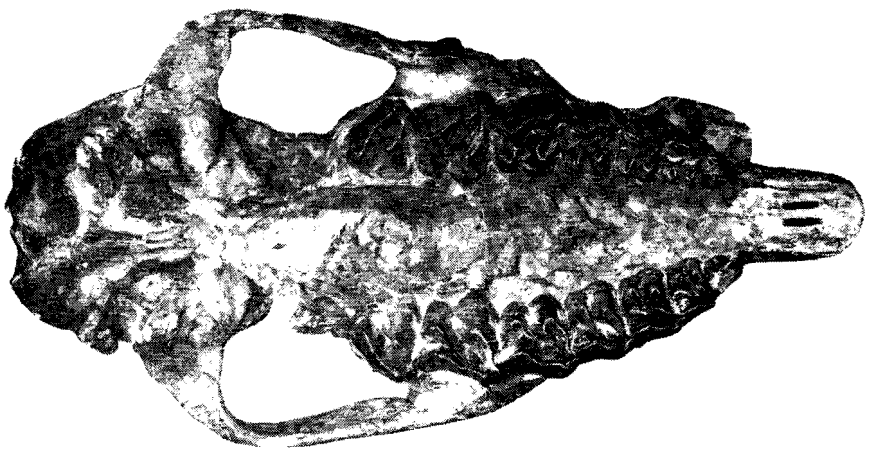

FIG. 4—Palatal view of the same skull shown as Figs. 2 and 3: X ¼

FIG. 5—Lateral view of male skull (U.N.S.M. 1251), referred to *Menoceras arikarense* (Barbour), from the Agate Springs Fossil Quarries (Harrison Formation), Sioux County, Nebraska: X 1/3

FIG. 6—Dorsal view of the same skull shown as Fig. 5: X 1/3

The distinctions between the two male skulls, when considered together with the great size difference, are believed to be of generic rank, indicative of two distinct lineages (Fig. 1; Table 1).

THE *MENOCERAS* LINEAGE

Assuming that there are two lineages of North American diceratheres, the male skull of *Menoceras arikarense* serves as a convenient point of reference for reconstructing the *Menoceras* lineage.

Moving upwardly in the Central Great Plains Miocene succession, the next higher horizon that has yielded remains of this genus is the base of the Marsland Formation, regarded also as the base of the Hemingford Group, and variously referred to the Medial or Late Miocene (Schultz and Stout, 1961, pp. 7–8, 51; Figs. 2–3, Fig. 10, *this paper*). This is the level of the Bridgeport Quarries of the University of Nebraska State Museum (U.N.S.M. Collecting Localities Mo-113, -114, -115, -116 and -118), in Morrill County, Nebraska, worked extensively by the expeditions of 1932–1935 and 1940. Two composite dicerathere skeletons from the Bridgeport Quarries, one with a male skull and the other a female skull, are on display in the University of Nebraska State Museum (U.N.S.M. 1238 and 1241), and there are additionally several thousand specimens in the study collections. The composite skeletons have been figured by Schultz (1943, p. 275) and later considered as a "geologic variety" of *Diceratherium niobrarensis* Peterson (Stecher, Schultz, and Tanner, 1962). Some teeth, probably from these same sites, were suggested, by Wood (1964, pp. 378–380), to be very similar to *Diceratherium* (*Menoceras*) *barbouri* Wood, the holotype of which is from the well known "Thomas Farm Locality" in Florida.

In order to clarify the status of "*Diceratherium niobrarense*" [sic] it should be noted that the type skull of this species came from near Agate, Sioux County, Nebraska, at a site Peterson designated "Quarry A" (Peterson, 1920, p. 425). He states that "Quarry A": ". . . is only a short distance (300 yards) to the north of the main quarries and may possibly represent a somewhat earlier time: or, more probably, the sediments accumulated at this spot represent a different stream which had its origin in, and flowed through a locality more favorable to this species." (Peterson, 1920, p. 431).

This same site (Quarry A) is shown with other quarries on an unscaled "Rough outline topographical map" drawn by W. J. Holland and published *in* Holland and Peterson (1913, p. 191, Fig. 1). These authors, in their history of excavations at the Agate Springs Fossil Quarries, relate that "Quarry A" was the first to be excavated: "A few days after the arrival of Mr. Peterson he was conducted by

Mr. Harold Cook, the oldest son of his host, to the locality just beyond the eastern limits of Mr. Cook's property, designated as 'Quarry A' in the map (Fig. 1) accompanying this memoir." (Holland and Peterson, 1913, p. 189).

After Peterson worked a few days at this locality, he examined "two small buttes" situated about 300 yards south of "Quarry A." These buttes were subsequently named "University Hill" and "Carnegie Hill" by E. H. Barbour (1908) and are now considered the "main quarries" at the Agate Springs Fossil Quarries. Three pits were opened on Carnegie Hill (Quarry B with Pits 1, 2, and 3). At University Hill ("Quarry C") the excavation was assigned number 4. (Holland and Peterson, 1913, p. 191, Fig. 1).

Quarry A seems to be stratigraphically close in time to Quarries B and C.

The exact allocation of the specimens from the Bridgeport Quarries is still uncertain, despite the availability of the holotype of Peterson's *Diceratherium niobrarensis* for the present study. The type skull, described by Peterson (1906c, pp. 466, 468, Fig. 2) from the Harrison Formation was examined in 1965, through the courtesy of the staff members of the Carnegie Museum, Pittsburgh. The illustrations of this young male skull (C.M. 1271) given by Peterson do not show the slight convexity on the frontal just behind the fronto-nasal suture, but a weak frontal convexity is present. This character is less pronounced than for specimens from the Marsland, which is to be expected, as the holotype came from the Harrison Formation.

A second partial skull in the Carnegie Museum collection from this same "Quarry A" (C.M. 1273) is of an older male, and it displays a more definite convexity on the frontal, together with slight depressions for the nutritive arteries radiating from the apex of this convexity. The nasal bosses are also markedly rugose anteriorly. The "free portion" of the nasals, from the narial notch to the tips of the nasals, measures 94 mm., and the narial notch is situated above the front margin of the second upper premolar.

It now seems clear that Peterson's species should be considered a synonym of *Menoceras arikarense* (Barbour), and that most of the dicerathere specimens from the Bridgeport Quarries should be separated from it, tentatively as *Menoceras* sp. From these quarry sites, all situated at the same geologic and topographic level in the lower part of the Marsland Formation, one skull (U.N.S.M. 62006) has been selected to demonstrate the male characters at this horizon. These are: (1) larger size than for *M. arikarense*, with the occipito-nasal length, from the rear margins of the occipital condyles to the

tips of the nasals, being 447 mm. compared with 350 mm. for the latter species; (2) a similar, saddle-shaped skull, but with a noticeable frontal convexity, and with flaked and crescentic ridges at the anterior margin of the frontal; and (3) nasal bosses located behind the tips of the nasals and more elevated, being swollen anteriorly as well as quite rugose. In each of these characters, and most noticeably in size, the skulls from the basal Marsland are intermediate between specimens (*M. arikarense*) from the Harrison Formation and specimens from the upper part of the Marsland Formation. The latter constitute the basis for a new species.

A NEW SPECIES OF *MENOCERAS*

Menoceras marslandensis, new species

Figs. 7–9

Holotype.—A nearly complete skull, U.N.S.M. 62003 (Figs. 7–9). The left premaxilla and both of the upper premolars are lacking, but the alveoli for these missing premolars are preserved. The right paroccipital process and right occipital condyle are absent.

Type Locality.—From about four miles east and six miles north of Hemingford, Nebraska, at U.N.S.M. Coll. Loc. Bx-28 (in the SW. ¼, NE. ¼, SW. ¼, sec. 12, T. 28 N., R. 49 W.), Box Butte Northwest Quadrangle (7.5 minute series, U.S. Geol. Survey map), Box Butte County.

Type Level.—From the upper part of the Marsland Formation (Fig. 10), in a light gray ashy sand (quarry level) situated 45–60 feet below the top of the Marsland and 5–15 feet above the upper of two volcanic ash beds. Variously considered as Medial or Late Miocene.

Diagnosis.—Male skull, larger in nearly all measurements than male skulls of either *Menoceras arikarense* (Barbour) or *M. niobrarensis* (Peterson); *see* Table 2. Unlike *M. arikarense*, the frontal probably supported a horn, evidenced by the presence of a rugose convexity on the anterior part of the frontal from which flaked and crescentic ridges radiate (Fig. 8). Also in the new species, there are flattened, rugose areas at the tips of the very long, fused but slightly cleft nasals. The length of the "free portion" of the nasals, from the narial notch to the tips of the nasals, measures 194 mm., compared with 87 mm. for *M. arikarense* (U.N.S.M. 1147) and 94 mm. for the referred skull of *M. niobrarensis* (C.M. 1273). In the holotype of the proposed new species, the nasals and maxillar region

behind the narial notch are noticeably heavier, and there are both lateral expansion and heavier rugosity of the posterior portion of the zygomata. Associated with these strengthened characters, there was a marked weakening of the premaxillae and apparent loss of

TABLE 2

MEASUREMENTS (IN MILLIMETERS) OF THE TWO MALE SKULLS OF *Menoceras marslandensis*, NEW SPECIES, COMPARED WITH MALE SKULLS OF *M. arikarense* (BARBOUR), AND *Diceratherium armatum* MARSH.

	M. marslandensis[a]		*M. arikarense*[b]	*M. arikarense*[c]	*D. armatum*[d]
Occipital condyles to tips of nasals	438	474	351	450	(512)
Midpoint occipital crest to tips of nasals	408	416	348	...	(503)
Anterior margin of P^1 to occipital condyles	388	402	320	392	452
Narial notch to occipital crest	323	324	295	...	453
Palatal notch to foramen magnum	238	234	205	228	272
Palatal notch to palatal foramina	153	154	107	117	170
Narial notch to tips of nasals	93	164	87	94	...
Zygomatic breadth (maximum)	245	250	236	258	278
Width across palate to buccal sides M^2	158	132	121	...	174
Orbital breadth (between notches)	167	143	133	...	210
Occipital height, base condyles to crest	135	140	122	160	159
Occipital width (maximum)	148	145	135	...	150
Condylar width (outer margins occ. cond.)	80	...	72	99	107
Tooth row, P^1–M^3 (midline, to rear of M^3)	223	212	165	...	254
Tooth row, P^2–M^3 (midline, to rear of M^3)	203	200	150	...	...
Premolars (midline, alveolus of P^1)	107	100	80	...	123
Premolars along buccal ridges	109	...	82	...	127
Length P^2–P^4 (midline, to rear of P^4)	88	...	63	...	95
Length P^2–P^4 (along buccal ridges)	94	88	69	...	98
Molars (midline, to rear of M^3)	118	112	89	113	133
Length P^1 (maximum)	20	...	13.5	...	27
Width P^1 (maximum)	18	...	13.5	...	23
Length P^2 (maximum)	24	28	20	...	27
Width P^2 (maximum)	31	35	27	...	37
Length P^3 (maximum)	30	28	20	...	33
Width P^3 (maximum)	28	41	34.5	...	43
Length P^4 (maximum)	30	30	23	...	31
Width P^4 (maximum)	25	46	38	...	47
Length M^1 (maximum)	35	32	27.5	...	47
Width M^1 (maximum)	25	52	40	...	52
Length M^2 (maximum)	35	40	32	...	50
Width M^2 (maximum)	25	52	40	...	56
Length M^3 (maximum)	...	38	34.5	...	37
Width M^3 (maximum)	...	47	36	...	47

[a] Young male at left, U.N.S.M. 62004; holotype at right, U.N.S.M. 62003.
[b] Referred, U.N.S.M. 1147.
[c] Young male, holotype of *Diceratherium niobrarensis* Peterson, C.M. 1271.
[d] Holotype, Y.P.M. 10003.
( ) Estimated dimension.

FIG. 7—Lateral view of holotype male skull (U.N.S.M. 62003) of *Menoceras barbouri*, new species, from a fossil quarry northeast of Hemingford (U.N.S.M. Coll. Loc. Bx-28), Box Butte County, Nebraska (upper part of Marsland Formation): X 11/32

FIG. 8—Dorsal view of the same skull shown as Fig. 7; X 11/32

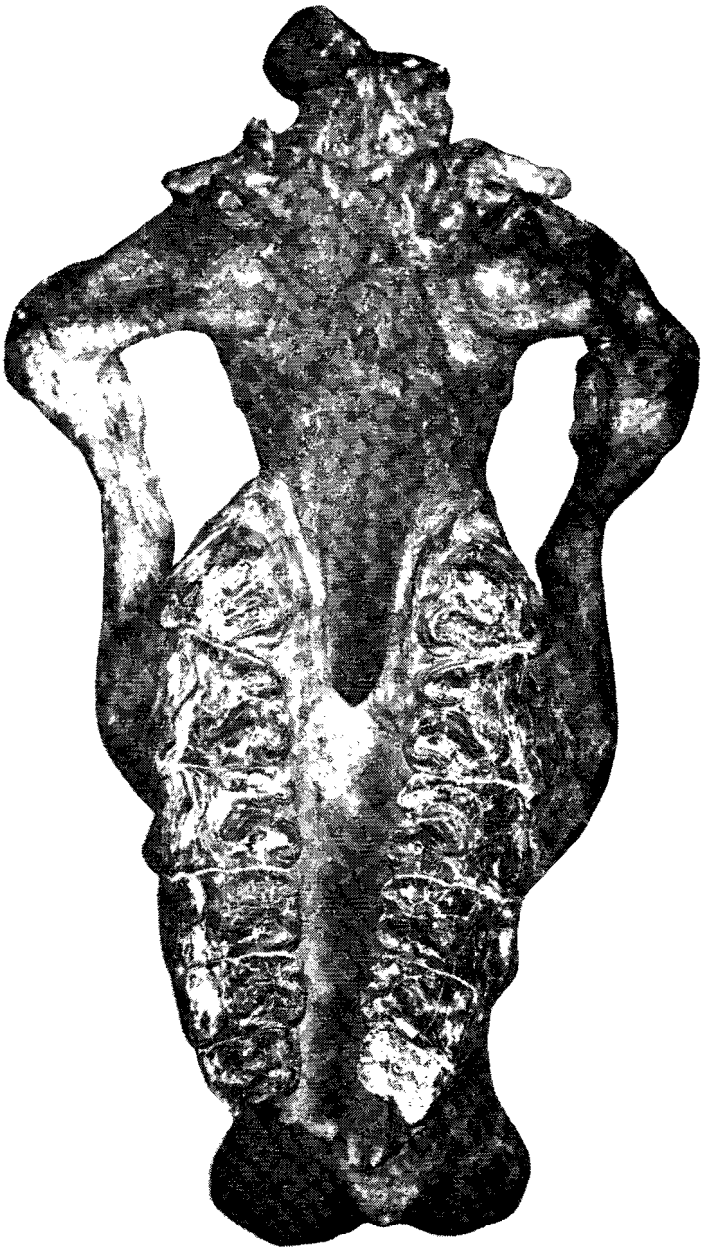

FIG. 9—Palatal view of the same skull shown as Figs. 7 and 8; X 11/32

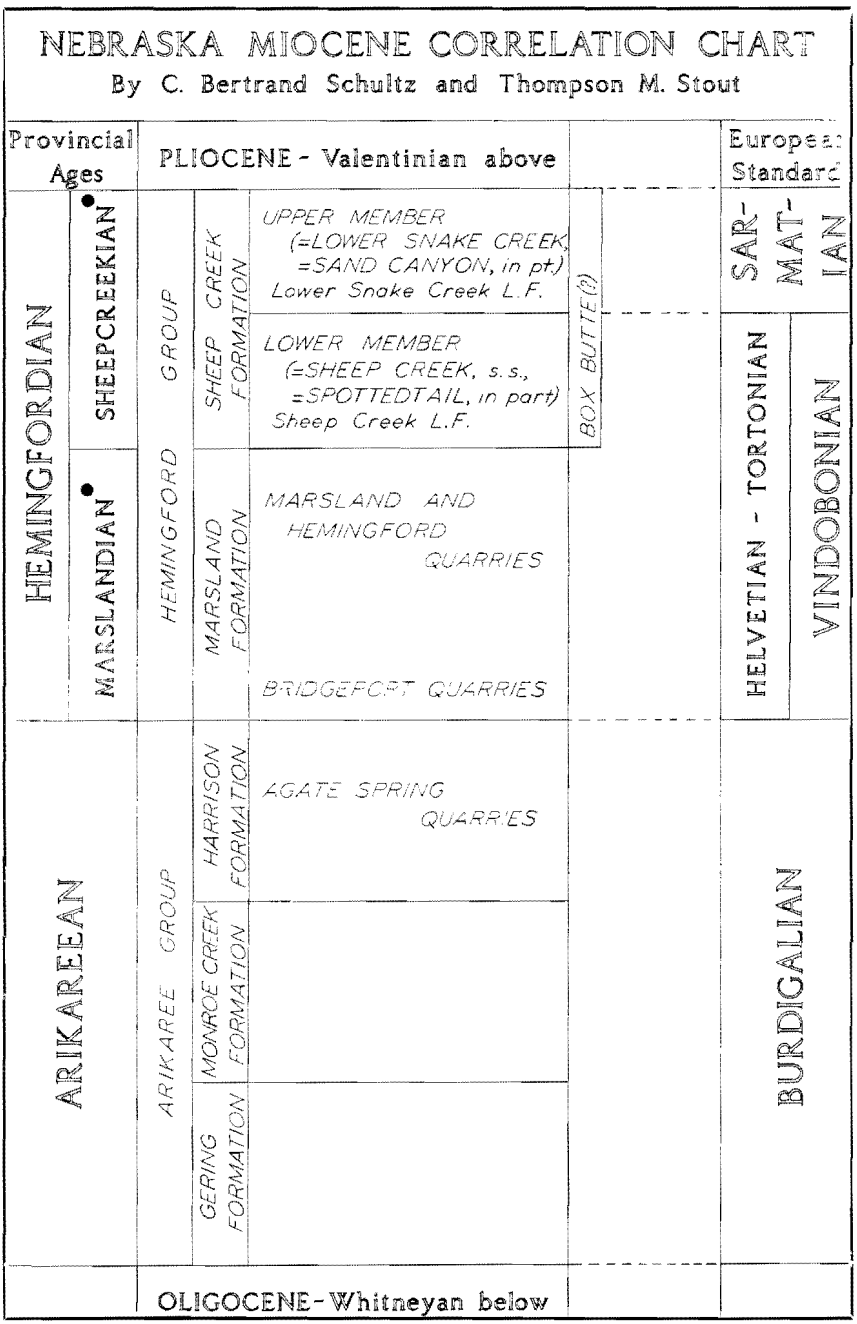

FIG. 10—Correlation chart of the Miocene of the Central Great Plains (High Plains) of Nebraska and adjacent states, showing the geologic placement of the principal fossil quarries that yield diceratheres. (From Schultz and Stout, 1961, Fig. 3). The black dots indicate suggested "Provincial Ages."

the upper incisors, compared with the normal condition of these characters in *M. arikarense*. Further, the bosses for the prominent nasal horns have become more rugose anteriorly, more spatulate, and situated farther forward with respect to the nasal protuberance; these accentuate the saddle shape when the cranium is viewed from the side (Fig. 7).

SUMMARY

Two lineages of diceratheres seem to be present in the Miocene sediments of Nebraska and adjacent states, as proposed by Troxell (1921) but were confused by later workers. These are considered to represent two distinct genera, *Diceratherium* Marsh and *Menoceras* Troxell, each with successional species.

The new species here proposed, *Menoceras marslandensis*, from fossil quarries near Marsland and Hemingford in western Nebraska, is believed to be a direct descendant of the best-known dicerathere, *Menoceras arikarense* (Barbour), from the geologically older Agate Springs Fossil Quarries. The latter name preoccupies Peterson's "*Diceratherium niobrarensis*" and "*D. cooki*." An undescribed, possibly new, species of *Menoceras* occurs in the geologically intermediate Bridgeport Quarries, and it is taken to be the intermediate species in this *Menoceras* lineage. *Diceratherium*, originally established on *D armatum* Marsh, from the John Day Miocene of Oregon, is not only larger than *Menoceras* but anatomically distinct. *Diceratherium armatum* has also been reported from the Miocene deposits of the Central Great Plains. The *Menoceras* and *Diceratherium* lineages may have both survived into the Late Miocene and Pliocene, but more study regarding this is necessary. Similarly, the Oligocene ancestors need clarification, although it now seems virtually certain that *Subhyracodon occidentalis* (Leidy), from the Medial Oligocene (Orella Member of the Brule Formation), gave rise in the High Plains Miocene to *Diceratherium*.

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