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THE GIANT MARMOT *PAENEMARMOTA SAWROCKENSIS* (NEW COMBINATION) IN HEMPHILLIAN DEPOSITS OF NORTHEASTERN NEBRASKA

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Lower dentitions essentially identical to the holotype of *Marmota sawrockensis* Hibbard, 1964, are described from the Santee and Devils Nest Airstrip local faunas (very late Hemphillian) in Knox County, Nebraska. These, along with newly-collected upper cheekteeth (previously unknown for this taxon), show that the species should be transferred to the genus *Paenemarmota* Hibbard and Schultz, 1948. *P. sawrockensis* appears to be structurally intermediate between ?*Marmota nevadensis* of the early Hemphillian and *P. barbouri*, a latest Hemphillian and Blancan species.

INTRODUCTION

Marmots (Family Sciuridae, genus *Marmota*) are large terrestrial squirrels with a very poor fossil record in the North American Tertiary (Black, 1963). Their current distribution approaches the Great Plains both from the east (woodchucks, *Marmota monax*) and the west (yellow-bellied marmots, *M. flaviventris*), but they are primarily woodland animals that avoid the open grasslands that form the biological core of the plains (Hoffman and Jones, 1970, *Figs. 9, 11*).

The otherwise rich Cenozoic fossil deposits of Nebraska have produced only three published records of marmots: 1) the solitary type specimen of *Marmota vetus* (Marsh, 1871) for which both the exact locality and age are uncertain (Black, 1963: 162–163); 2) part of the genoholotypic hypodigm of the giant *Paenemarmota barbouri* Hibbard and Schultz, 1948, from the early Blancan Lisco local fauna, Garden County, Nebraska; and 3) a specimen from the Litchfield local fauna (late Rancholabrean, Sherman County) reported as *Marmota* sp. by Voorhies and Corner (1985: 132).

Isolated teeth, jaw fragments, and postcranial elements of a very large marmot-like rodent have been collected at two fossil localities in northeastern Nebraska during the past two decades by field parties from the University of Nebraska State Museum (hereinafter UNSM). Taxonomic assignment of the material proved difficult until the writer discovered a well-preserved lower jaw of the animal at UNSM locality Kx 113 (Devils Nest Airstrip), which has produced a rich but still largely unpublished vertebrate fauna of very late Hemphillian age, approximately 5 million years old. The specimen closely resembles the holotype and only previously known dentary of *Marmota sawrockensis* as described by Hibbard (1964) from the Saw Rock Canyon local fauna, late Hemphillian of Kansas. Dental characteristics of the Nebraska and Kansas samples, especially the presence of very prominent metalophids and rugose talonid basins on the lower cheekteeth, support reassignment of the species to the genus *Paenemarmota* (Hibbard and Schultz, 1948; Repenning, 1962). Nothing in the known morphology of *P. sawrockensis* (new combination) would remove it from a lineage leading to *P. barbouri*, the large, terminal species of the genus, well known from early and medial Blancan (approximately 3 to 4 million years old) deposits in the western United States and slightly older (latest Hemphillian) deposits in Mexico (Repenning, 1962; Lindsay et al., 1984).

MATERIALS AND METHODS

The Hemphillian samples studied here are catalogued in the UNSM fossil vertebrate collection. They were obtained by surface pickup and screening at two localities, Santee (Kx 111) and Devils Nest Airstrip (Kx 113) (see below). Comparisons were made with materials of Recent *Marmota* species in the UNSM zoology collection and with fossil dentitions of *Paenemarmota barbouri* (Hibbard and Schultz, 1948) from the Lisco local fauna in the UNSM fossil vertebrate collection. Other comparisons refer to illustrations and descriptions in the published literature. Measurements were made with dial calipers following the method of Repenning (1962: 546). Dental terminology follows Black (1963).

FOSSIL LOCALITIES

Location

The Santee and Devils Nest Airstrip sites are located in northcentral Knox County, northeastern Nebraska, on hills overlooking the Missouri River (Fig. 1). The Santee locality (Kx 111 in the UNSM site catalog) is a roadcut in the SW ¼ NW ¼ NE ¼ SW ¼ Sec. 24, T33N R5W. This location, taken from the Santee Quadrangle (U.S. Geological Survey 7½ minute Topographic Series, 1978) differs by approximately 0.8 km from that previously estimated by the writer from an earlier, larger-scale map (Voorhies, 1977: 129). Availability of the new topographic map also allows a more detailed location for the Santee Ash site of Boellstorff (1976: 63; see also Voorhies [1977: 129] and Holman [1982: 37]) to be given. It is an eastward-facing roadcut in the NW ¼ SW ¼ SW ¼ NE ¼ Sec. 35, T33N R5W.

Lying about 10 km east of Kx 111 is Kx 113, the Devils Nest Airstrip locality. As shown on the Bon Homme Colony Quadrangle (U.S.G.S., 1974) this feature is a 1.5 km long, NNW-trending unpaved landing strip with its north end near the center of SE ¼ NW ¼ SE ¼ Sec. 24, T33N and R4W and its south end at the center of SW ¼ NE ¼ SE ¼ Sec. 25, T33N R4W. Although now (1987) mostly overgrown with vegetation, fossiliferous Tertiary sediments were formerly well exposed in artificial cuts along both sides of the strip and these were visited periodically by UNSM field parties during the 1970s and early 1980s.

Stratigraphy

The stratigraphy of the Santee vicinity has been briefly described by Voorhies (1977). Lying unconformably beneath a mantle of glacial till and related Quaternary sediments, the unit of major interest in this study consists of unconsolidated fluvial clastic sediments deposited in a paleovalley cut into the Pierre Shale (Cretaceous), which forms the pre-Tertiary bedrock throughout Knox County. The basal contact of the fluvial unit (an unnamed, post-Cap Rock channel fill tentatively assigned to the Ogallala Group—undifferentiated) is well-exposed at the principal fossiliferous outcrop shown in the earlier paper (Voorhies, 1977, *Fig. 1*). The finer-grained upper portion of the paleovalley fill is well exposed at the Santee Ash site (UNSM Kx 142). A fission-track date of 5.0 ± 0.2 Ma (million years before present) was determined for glass shards in the vitric tuff in the upper part of the roadcut at this locality (Boellstorff, 1976, 1978). The *Paenemarmota* specimens from the Santee local fauna described in this paper were all collected near the base of the paleovalley fill from a small area identified as "squirrel lens" in the photograph of Kx 111 in Voorhies (1977: *Fig. 1*).

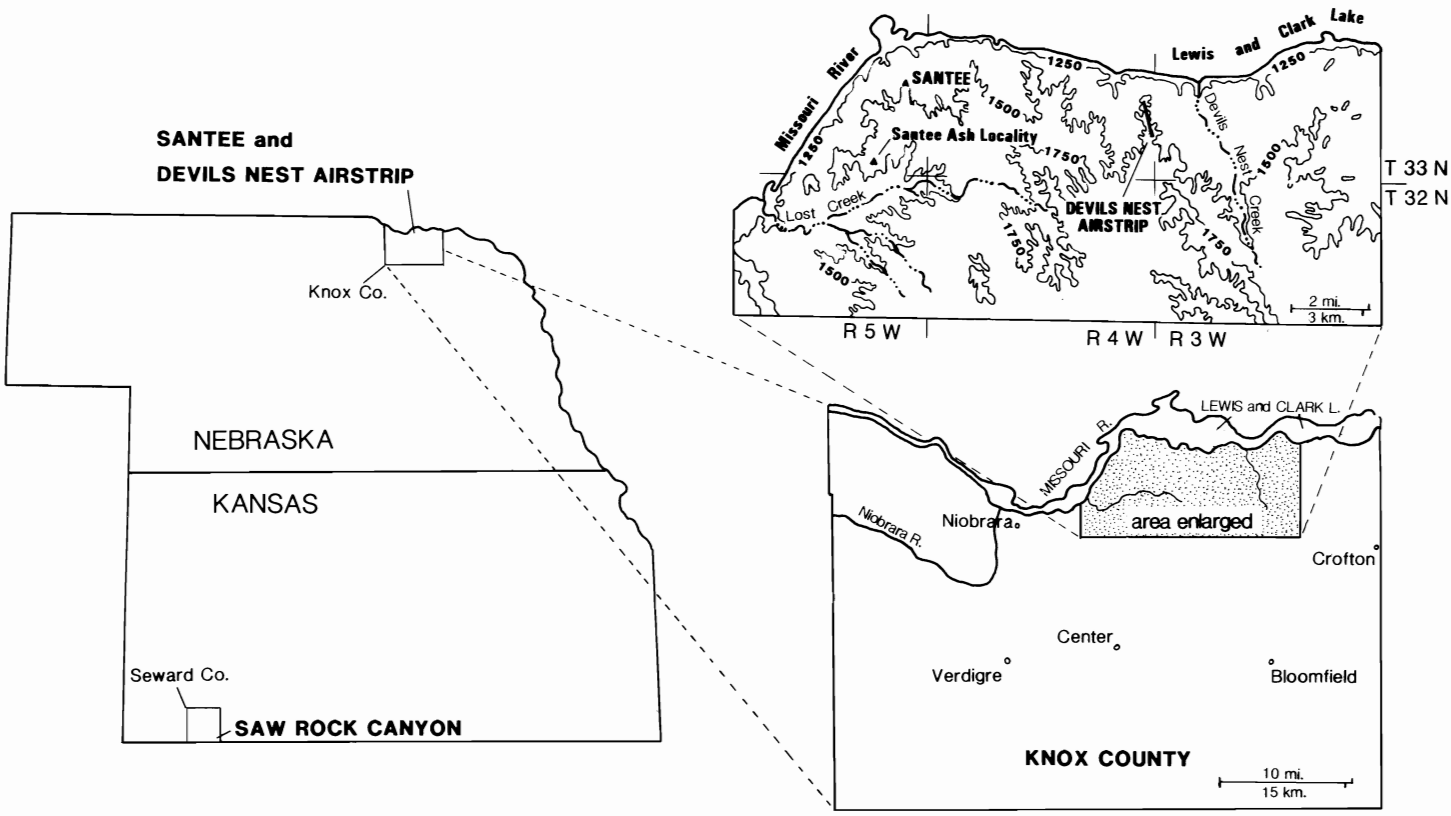

FIGURE 1. Index map showing locations of sites from which remains of the giant marmot *Paenemarmota sawrockensis* (Hibbard) have been recovered. Topographic contours (in feet above sea-level) on the detailed map of the Santee-Devils Nest area are taken from the Sioux City sheet (U.S. Geological Survey 1:250,000 Topographic Map Series, 1955).

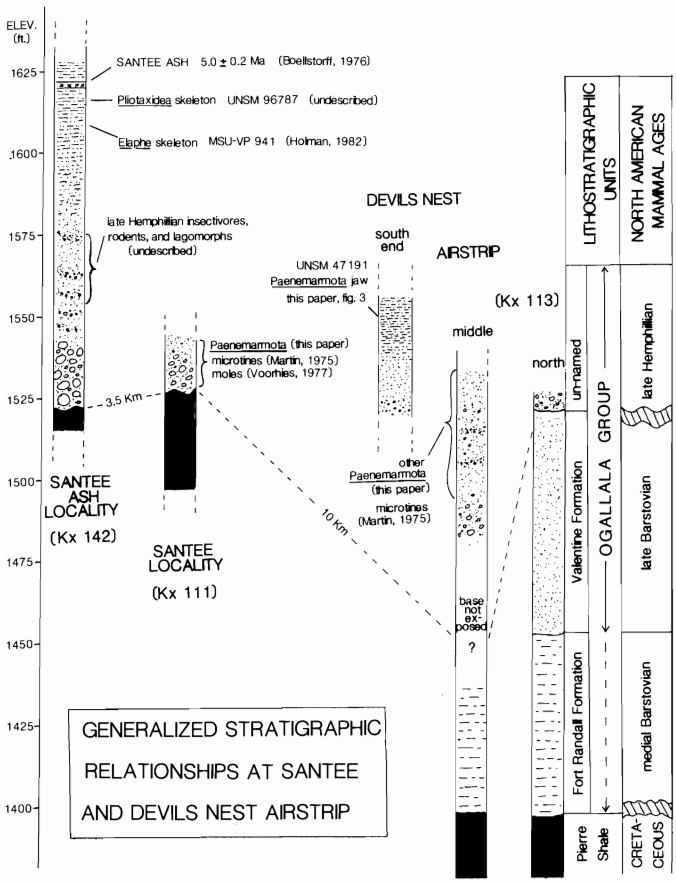

FIGURE 2. Diagramatic illustration of stratigraphic relationship between UNSM fossil localities that produced the *Paenemarmota* specimens described in this paper. Overlying Quaternary sediments are not shown. Based on sections measured by the author. See Fig. 1 for locations. Elevations are from Santee Quadrangle and Bon Homme Colony Quadrangle (U.S.G.S., 7½ minute Topographic Series).

Stratigraphic relationships at Devils Nest Airstrip are essentially similar to those in the Santee area. The fossiliferous sequence can be described as a fining-upward paleovalley fill with cobble-gravel and coarse sand at the base, overlain by finer sands and silts. No volcanic ash has been recognized in the upper, silty beds at the airstrip, however. A further difference between the two areas is that remnants of older Tertiary sediments are present beneath the channel fill deposits at the airstrip whereas at Santee the latter rest directly on the Pierre Shale bedrock. A more detailed report on the stratigraphy of the Devil's Nest Airstrip area is in progress by the writer; for present purposes Figure 2 illustrates the general lithostratigraphic relationship between the Santee and Devils Nest Airstrip areas as currently understood.

Age

Taken by itself, the 5.0 ± 0.2 Ma date on the Santee Ash indicates a very late Hemphillian age according to current radiometric calibration of the North American Mammal Ages and the fauna as now known from both Santee and Devils Nest Airstrip strongly supports this designation. Lindsay et al. (1984) have synthesized much recent data on the late Hemphillian through Blancan time interval (approximately 7 to 2 Ma). Based primarily on their paleomagnetic analyses of important fossiliferous sequences in Arizona and northern Mexico, they place the Hemphillian/Blancan boundary at 4.3 Ma. Briefly commenting on the Santee fauna, the latter authors note (*op. cit.*, p. 481) that "Fission-track dates on glass are usually slightly younger than other radiometric dates taken on the same volcanic rock, which suggests that the Santee fauna might be placed near the Gilbert/Chron 5 boundary [5.3 Ma]." Even if Lindsay et al.'s correction is applied, the Santee ash would have fallen within the last million years of the Hemphillian mammal age. The fauna, all derived from beneath the ash, is of course older but probably not much older than the ash; the limited number of vertebrate fossils taken from fine-grained strata a few meters below the ash (see Fig. 2) are taxonomically identical to those collected in much greater abundance in the stratigraphically-lower sands and gravels.

Only a small fraction of the very large faunal collections from Kx 111 and Kx 113 has been formally described. Martin (1975) described a new species of arvicoline rodent, *Propliophenacomys parkeri,* based on fossils from both Kx 111 and 113. Although the genus *Propliophenacomys* has since been shown to be invalid (Voorhies, 1984), the species *"P." parkeri,* which appears to be closely allied to the European genus *Cseria,* is clearly more derived than any other known species of Hemphillian arvicoline save *Ogmodontomys sawrockensis* (see Zakrzewski, 1967). A late but not latest Hemphillian age is consistent with its characters. The same is true for the species of mole described from Kx 111, *Scalopus (Hesperoscalops) mcgrewi* (Voorhies, 1977) which was interpreted by the author as being very close to, but slightly more primitive than, the latest Hemphillian *S. (H.) sewardensis* (Reed, 1962), also from the Saw Rock Canyon local fauna. The only other mammalian fossils described from the Santee-Devils Nest area are the archaeolagine lagomorphs studied by White (1987). The latter author recognized two species of *Hypolagus (H. ringoldensis* and *H. regalis)* and named a new genus and species *(Lepoides lepoides)* on the basis of UNSM specimens from Kx 113 (Devils Nest Airstrip). Through a typographical error the specimens were listed as coming from Kx 111 (Santee). The Kx 111 lagomorph sample has since been studied and found to contain the same three taxa: *L. lepoides, H. regalis,* and *H. ringoldensis* (John A. White, personal communication, 1987). White (1987: *Fig. 12*) assigned a very late Hemphillian age (lower part of Chron 4) to the Santee local fauna.

Other elements of the Santee and Devils Nest Airstrip local faunas, still undescribed, also support a very late Hemphillian age. As interpreted by the writer these faunas contain the stratigraphically highest (latest) occurrences of the following taxa in Nebraska: rhinocerotids *(Teleoceras, Aphelops),* mylagaulids *(Epigaulus),* plesiosoricids *(Meterix),* dromomerycids *(Pediomeryx),* and the stratigraphically-lowest (earliest) occurrences of the following taxa: Cervidae, *Buisnictis, Brachyopsigale, Sminthosinis, Trigonictis* and *Repomys.* Other taxa known from Kx 111 and Kx 113, but which are also found in older Hemphillian faunas in Nebraska *(Castor, Ochotona, Paraneotoma,* and *Pliotaxidea),* are also regarded as late Hemphillian arrivals in North America (Lindsay et al., 1984; Voorhies, in preparation). The specimens assigned to *Paenemarmota sawrockensis* in this paper fully support a late Hemphillian age assignment.

A book dealing with North American mammalian biochronology (Woodburne, 1987) contains a number of references to the age of the Santee local fauna but was received too late to be discussed in detail here. Suffice it to say that the Santee and Devils Nest Airstrip local faunas fall clearly within the "Late Hemphillian" as defined by Tedford et al. (1987: 194) in their chapter, which covers the Arikareean through Hemphillian intervals. In the chapter dealing with microtine rodents, Repenning (1987: *Fig. 8.1*) assigns both the Santee and Devils Nest Airstrip local faunas to the latest Hemphillian (early part of the Gilbert Paleomagnetic Chron, between 4.8 and 5.4 Ma). Lundelius et al. (1987: 216) refer to the Santee local fauna as one of the two "youngest radiometrically dated Hemphillian faunas" but appear to favor a slightly lower position within the paleomagnetic chronology (Gilbert/Chron 5 boundary, see their *Fig. 7.3*). Both Repenning and the Lundelius committee regard the Saw Rock Canyon local fauna as younger than those at Santee and Devils Nest Airstrip but whereas Repenning assigns the Kansas fauna to the Blancan, Lundelius et al. assign it to the Hemphillian, the usage followed here. Paleomagnetic studies, which can probably be satisfactorily accomplished on the finer-grained units at both Santee and Devils Nest, would be very helpful in resolving some of the remaining questions of intra-Hemphillian correlations.

TAXONOMY

Order RODENTIA Bowdich 1821

Family SCIURIDAE Gray 1821

Tribe MARMOTINI Simpson 1945

Genus ***Paenemarmota*** Hibbard and Schultz, 1948

Type species: Paenemarmota barbouri Hibbard and Schultz, 1948
(= *Marmota mexicana* Wilson, 1949)
Referred species: P. sawrockensis new combination, this paper
(= *Marmota sawrockensis* Hibbard, 1964)

Revised diagnosis: Largest of the terrestrial squirrels. Dentition as in *Marmota* except that 1) base of lower incisor extends well behind M/3; 2) cheekteeth larger, more hypsodont, and with more inflated cusps; 3) talonid basins of lower cheekteeth are strongly rugose; 4) deep "basin trench" (Repenning, 1962) present along ectolophid and metalophid margins of talonid basins of lower cheekteeth; 5) protoconid large, equalling or exceeding metaconid in height and basal area; 6) prominent metalophid present on all lower cheekteeth, sometimes enclosing a small trigonid basin; 7) P4/ as large or larger than M1/; 8) metaconule well-developed on P4/, absent or slightly-developed on molars; 9) posterior cingulum stronger on P4/-M2/, and 10) M3/ with well-developed metaloph.

Distribution: Western North America (Chihuahua, Michoacán, Arizona, Idaho, Kansas, Nebraska, Texas, Washington).

Age: Pliocene (very late Hemphillian through medial Blancan), approximately 5 million to 3 million years ago.

Paenemarmota sawrockensis new combination

Marmota ? sp. Hibbard, 1953, p. 392

Marmota sawrockensis Hibbard, 1964, pp. 118–119, *Fig. 1*

Holotype: University of Michigan Museum of Paleontology no. 45775, part of right incisor and P/4-M/3. (Paratype: RP3/ and upper incisor.)

Type locality: Saw Rock Canyon near center of west section line of Sec. 36, T34S, R31N, Seward County, Kansas (Fig. 1). Collected "from stream-laid sandy silts across the canyon from the type locality of *Osteoborus progressus* and up the canyon a short distance from the main quarry of the Saw Rock Canyon local fauna" (Hibbard, 1964: 118).

Revised diagnosis: Distinguished from *P. barbouri* by: 1) smaller size; 2) P/4 smaller and less molariform compared with M/1; 3) metalophids on all lower cheekteeth attach to metaconid at higher level, resulting in earlier formation of trigonid basin.

Age and Distribution: Very late Hemphillian (approximately 5 million years) of central Great Plains (Seward County, Kansas, and Knox County, Nebraska).

Referred specimens from Nebraska: From Devils Nest Airstrip (UNSM locality Kx 113); UNSM 47191, L dentary with I, P/4-M/3 (Fig. 3), associated postcranial fragments; UNSM 93963, RP/4; UNSM 94984, RM/1; UNSM 94985, LM/1 ? (broken); UNSM 94986, R. lower incisor; UNSM 94979, R maxilla with P4/-M1/; UNSM 96786, LP3/; UNSM 94981, LP4/; UNSM 94980, LM1/; UNSM 94982, LDP4/; UNSM 93964, 93965, 94987, upper incisors; UNSM 94990, L clavicle.

From Santee (UNSM locality Kx 111): UNSM 27671, R dentary fragment with broken P/4; UNSM 27680, L dentary fragment (edentulous); UNSM 27670, RM/1; UNSM 27683, 27686, LM/3's; UNSM 27675, L lower incisor; UNSM 27685, 27687, LM1/'s; UNSM 27677, LM2/?; UNSM 27684, 27672, partial M3/'s.

Description: The best preserved specimen is the left dentary of a young adult, slightly less worn than the holotype, lacking only portions of the ascending ramus and alveolar border (Fig. 3). It is a remarkably thick and robust bone compared with rami of Recent *Marmota monax* and *M. flaviventris* examined by the writer. The masseteric crest is weakly developed as in *Paenemarmota* (Repenning, 1962) not sharp as in *Marmota*. The incisor, which clearly extends to a point posterior to the third molar, is striated with longitudinal grooves anteriorly, more so than in any *Marmota* examined. The lower cheekteeth increase in size from P/4 through M/3. P/4 is transversely narrower anteriorly than posteriorly. A low anterior cingulum ("protolophid" of Repenning, 1962) and a higher metalophid connect protoconid and metaconid ensuring that a distinct trigonid basin would eventually form with wear. A small but distinct mesoconid and a mesostylid are both present. A deep, trenchlike fold marks the anterior, labial, and posterior margins of the talonid basin, the center of which is elevated and strongly rugose. M/1 is more equidimensional than P/4 but is still slightly narrower anteriorly than posteriorly. It has a more elevated anterior cingulum which is firmly united with the metaconid as is the metalophid, forming a distinct trigonid basin. The floor of the talonid basis is complicated by heavy corrugation and outlined by a deep 'basin trench.' M/2 is nearly square in occlusal outline, but is otherwise similar to M/1 save for its slightly weaker metalophid which connects with the metaconid at a lower elevation than does that of M/1; the trigonid basin that will soon form with further wear is therefore smaller and shallower than that of M/1. M/3 has a more elongate talonid basin than M/2 but is otherwise similar to M/2 except for its weaker metalophid, which joins the metaconid at an even lower elevation. The trigonid basin that would eventually form with further wear would therefore be even smaller and more fleeting than that on M/2.

The isolated lower teeth referred here add little to the above description except for providing examples of more advanced wear stages and some indication of the range of tooth size within the Nebraska population (Table I).

A few upper teeth and a maxillary fragment (Fig. 4) are believed to represent the otherwise unknown upper dentition of *P. sawrockensis* on the basis that 1) they are of appropriate size to occlude with the lower jaw and 2) they are very much like the well-known superior dentition of *Paenemarmota barbouri* except for being 10 to 20% smaller (see Table II). The best specimen is UNSM 94979, a maxilla with P4/ and M1/ in an early stage of wear. The teeth are approximately equal in occlusal area but P4/ is both absolutely and relatively longer than M1/, mostly as a result of its more prominent anterior cingulum. The posterior cingula of both teeth are high and ridgelike and separated from the metaloph by a deep valley, an important distinction

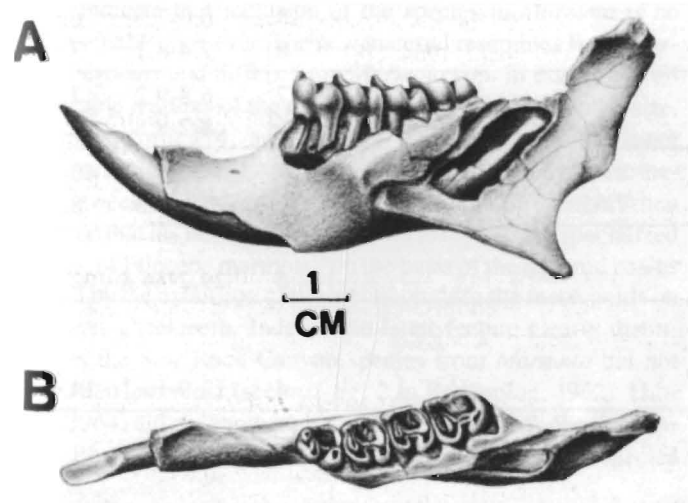

FIGURE 3. Left dentary of *Paenemarmota sawrockensis* (new combination) UNSM 47191, collected from weakly consolidated siltstone at the south end of Devils Nest Airstrip (see Fig. 2). *A*. Lateral view. *B*. Occlusal view.

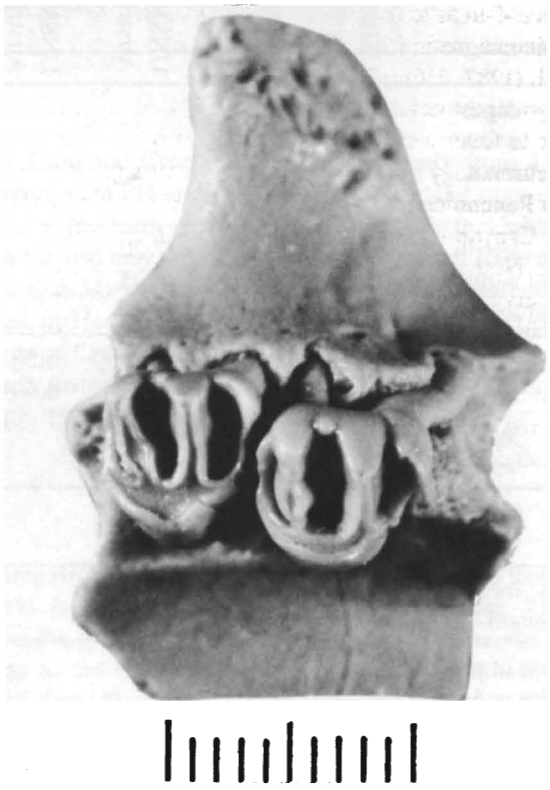

FIGURE 4. Right maxillary fragment of *Paenemarmota sawrockensis* (with P4/ and M1/), UNSM 94979, collected from a lens of unconsolidated sand and gravel exposed near the middle of Devils Nest Airstrip (see Fig. 2). Anterior is to the right. Scale is graduated in mm.

from *Marmota* (see *text-fig. 4* in Repenning, 1962). A distinct mesostyle is present on P4/ but only a faint indication of one can be seen on M1/. The mesostyle on UNSM 27685, an isolated M1/, is also weak, whereas those on UNSM 27687 and 94980 are prominent. No M2/'s or M3/'s complete enough to warrant description are present in the collection, but a broken RM3/, UNSM 27684, provides the important information that a high, distinct metaloph, separate from the protocone until late wear, is present on this tooth as in *Paenemarmota barbouri* but not in *Marmota* (Repenning, 1962, *text-fig. 4*).

A few rather undiagnostic postcranial elements (distal half of radius, midshaft of ulna, metapodials, phalanges, vertebral fragments) were collected from the same block of matrix as the lower jaw. They are larger than but similar to equivalent parts of *Marmota*. UNSM 94990, an isolated clavicle lacking only the scapular extremity, is a remarkably robust bone approximately 20% larger than but morphologically very much like that of a large male *Marmota monax*.

TABLE I. Measurements of *Paenemarmota* Lower Dentition

	Paenemarmota sawrockensis								*P. barbouri*		
Specimen	UMMP 45775 (Holotype) Saw Rock Canyon local fauna	UNSM 47191 Devils Nest Airstrip local fauna	UNSM 93963 Devils Nest Airstrip	UNSM 94984 Devils Nest Airstrip local fauna	UNSM 27670 Santee local fauna	UNSM 27686 Santee local fauna	UNSM 27675 Santee local fauna	UNSM 94986 Devils Nest Airstrip local fauna	various faunas (from Repenning, 1962)		
Measurement									N	O.R.	$\bar{X}$
Incisor depth	6.0	6.85					6.70	6.65	7	7.0-8.7	7.7
width	4.0	4.40					4.20	4.45	7	4.7-5.8	5.2
curvature radius	—	40					41	40	5	41-54	47
P/4 length	(6.9)*	6.95	7.20						5	7.5-8.5	8.0
trigonid width	(5.5)*	5.65	5.95						4	7.0-8.7	7.7
talonid width		6.70	6.70						5	7.2-9.0	8.1
M/1 length	6.25	6.35		6.50	6.25				8	6.0-7.9	6.9
width	6.4	6.75		6.60	6.50				8	7.4-8.1	7.9
M/2 length	6.75	6.90							7	6.8-9.2	7.8
width	8.0	7.90							6	8.2-8.8	8.4
M/3 length	8.5	8.95				8.45			7	9.2-11.0	10.0
width	7.7	8.40				7.65			6	7.8-9.3	8.7
P/4-M/3 inclusive length	(30)*								5	29.2-34.4	32.7
Thickness of ramus at anterior end of masseteric fossa	12.0								4	13.9-16.1	14.7
Length of ramus between incisor alveolus and posterior margin of incisor capsule (approx.)	60								4	65.5-71.9	67.9

*Estimated from Hibbard (1964, *Fig. 1*)

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