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A NEW SPECIES OF *PROTOSPERMOPHILUS* GAZIN (RODENTIA, SCIURIDAE) FROM THE MIOCENE OF NEBRASKA

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ABSTRACT

A new species of *Protospermophilus*, *P. minimus*, is named for a late Barstovian (middle Miocene) squirrel from Nebraska. It differs from all other species of the genus in its smaller size, the presence of buccally oriented lophulids from the metastylids, and partial hypolophids on the lower molars. The markedly smaller size of *P. minimus* supports the idea of a distinct radiation of *Protospermophilus* separate from other marmotine ground squirrels, which are characterized by a generally larger body size.

INTRODUCTION

The record of the squirrel *Protospermophilus* Gazin, 1930, ranges from the Arikareean through the Clarendonian (late Oligocene to early late Miocene) of North America (Goodwin, 2008). The earlier species of the genus were reported mainly from the west coast to the Rocky Mountains, but by the Barstovian (middle Miocene) the record spreads eastward to Florida, the central Great Plains, and Texas (Goodwin, 2008). In general, the species of *Protospermophilus* are intermediate to large in size and believed to be ground-dwelling in habit (Bryant, 1945; Black, 1963). A specimen of *Protospermophilus* from western Nebraska is markedly smaller than any of the known species of the genus and is the basis for a new species.

Dental terminology modified from Wood and Wilson (1936) and Black (1963). Lower teeth are indicated by lower-case letters (e.g., i1, m2). Institutional abbreviation: F:AM, Frick Collections, American Museum of Natural History.

SYSTEMATIC PALEONTOLOGY

Order Rodentia Bowdich, 1821
Family Sciuridae Fischer de Waldheim, 1817
Protospermophilus Gazin, 1930
Protospermophilus minimus new species

Type and Only Specimen—F:AM 144255, left mandible with i1, and p4-m2 (Figure 1).

Locality—Paleo Quarry, Sheridan County, Nebraska (Skinner and Johnson, 1984; fig. 2A).

Age—Late Barstovian or early Clarendonian. Skinner and Johnson (1984:289) tentatively placed this quarry in the early Clarendonian Burge Member of the Valentine Formation, based on its lithology (loose sand and gravel in a channel cut). Some species identified from Paleo Quarry are elsewhere exclusive to the Clarendonian: *Prodipoides burgensis* (Korth, 2002, 2007) *Ceratogaulus anecdotus* (Korth, 2000), and *Paratomarctus euthos* (Wang et al., 1999). However, nearly all of the remaining identified species are known from both the late Barstovian and Clarendonian: *Ustatochoerus medius* (Schultz and Fahlkenback, 1941), *Ischyrocyon gidleyi* (Hunt, 1998), *Pterogaulus* sp. (Korth, 2000), *Aphelops megalodus* (Prothero, 2005), and *Leptocyon vafer* (Tedford et al., 2009).

A number of species have been recognized from this quarry that makes its age somewhat questionable. A recent detailed re-analysis of the equids from this quarry (R. Evander, pers. comm., 2013) suggests that the fauna is from an earlier horizon and may be referable to the late Barstovian rather than early Clarendonian, and although similar in lithology to the Burge Member, the deposit is more likely an unrelated localized channel fill.

Diagnosis—Smaller than all other species of the genus (Table 1; Figure 2); partial hypolophids on lower molars; accessory loph running into center of talonid from metastylid on lower cheek teeth.

Etymology—Latin, *minimus*, least.

Description—The mandible is deep (7.46 mm below p4) and robust. The masseteric scar is U-shaped and ends anteriorly at mid-depth of the mandible below the boundary between p4 and m1. The diastema is shallow, dipping only slightly below the alveolar margin and 5.4 mm in length, slightly shorter than the length of p4-m2. There is a single mental foramen at

mid-depth of the mandible below the center of the diastema.

The lower incisor is greatly compressed (L/W ratio = 2.4). The length is nearly two and a half times greater than the width. It is flattened medially and only slightly rounded on the lateral side. The enamel is restricted to the anterior and approximately half of the lateral side. Along the lateral side of the enamel are a series of distinct grooves and ridges that run the length of the tooth.

The lower cheek teeth are brachydont, cuspate and squared in occlusal outline. The p4 is comparable in size to m1 (Table 1), but is narrower anteriorly than posteriorly. The metalophid consists of two cusps. The protoconid and metaconid are large and round in shape. The protoconid is slightly smaller than the metaconid. Anterior to these cusps is an oval anteroconid along the anterior border of the tooth. The talonid basin has some faint crenulations. The metastylid is along the posterolingual slope of the metaconid and is a distinct cusp with a small lophid extending in a slight curve posterobuccally. There is a deep valley separating the metastylid from the entoconid. On the buccal side of the tooth, the mesoconid is very small and separated from both the protoconid and hypoconid by narrow valleys. There is no continuous ectolophid. The hypoconid is the largest of the cusps and is continuous with the posterolophid that runs the entire width of the tooth along its posterior border, and then fuses with the entoconid. The entoconid is as large as the protoconid and metaconid, and only slightly smaller than the hypoconid. It is oval in outline and anterolingually-posterobuccally compressed. It forms a squared posterolingual corner on the tooth.

The m1 is only slightly wider than long (Table 1). The metaconid is positioned slightly more anteriorly than the protoconid. The anterior cingulid (metalophulid I) extends buccally from the metaconid and ends before reaching the protoconid, forming a narrow obliquely oriented valley separating them. The posterior arm of the protoconid (metalophulid II) extends lingually into the talonid basin from the protoconid ending even with the center of the anterior margin of the tooth. The mesostylid is distinct and attached to the posterior slope of the metaconid and is separated by a deep valley from the entoconid. As in p4, there is a short, low lophid extending posterolingually from it. The mesoconid is as in p4. The entoconid differs from that of p4 in that it is only weakly connected to the posterolophid, and a short, low hypolophid that parallels the posterolophid extends buccally from it. There are no crenulations or rugosities in the talonid basin as in p4. The posterolingual corner of the tooth is squared as in p4.

The m2 is similar in morphology to m1, but is proportionally wider than long (Table 1). The arrangement of the cusps and lophs resemble that of m1 except that the mesostylid is slightly larger and its associated lophid is higher and extends directly buccally. There is a more distinct valley separating the mesostylid from the metaconid. The mesoconid is slightly larger than in m1. All other morphologies are as in m1.

TABLE 1. Dental measurements of the holotype of *Protospermophilus minimus*, F:AM 144255. Measurements in mm. Abbreviations: L, anteroposterior length; W, transverse width. All measurements are maximum dimensions.

	L	W
i1	3.31	1.36
p4	1.87	1.91
m1	1.80	2.07
m2	1.99	2.30

Discussion—F:AM 144255 is referable to *Protospermophilus* as diagnosed by Black (1963) and Goodwin (2008) in having lower cheek teeth that: 1) are wider than long; 2) have a large, distinct entoconid that makes the posterolingual corner of the teeth squared; 3) have a minute mesoconid; and 4) have a large metastylid. It also has a lower incisor that is laterally compressed and has a series of grooves and ridges that run the entire length of the tooth; features found in some species of *Protospermophilus* (Bryant, 1945; Black, 1963). In marmotines and tamiines, the entoconid is reduced and incorporated into the posterior cingulid (=posterolophid), and the posterolingual corner is rounded. Other sciurids that have distinct entoconids, such as *Protosciurus*, *Arctomyoides*, and *Sciurus* have lower molars that are nearly equal in width and length, not broadened and shortened as in *Protospermophilus* and marmotines. *Palaearctomys* also has squared lower molars, but the distinctly heavier mandible and deep diastema of this genus are not present on the type of *P. minimus*.

Protospermophilus minimus is smaller than any other species of the genus (Table 1), ranging from 20 to 40% smaller in the dimensions of the lower cheek teeth than other species (see appropriate tables in Black, 1963). The distinct loph running buccally from the metastylid on the lower cheek teeth of *P. minimus* is not found in any other species of the genus as well. The partial hypolophids present on the lower molars of *P. minimus* are not known in any other species of *Protospermophilus* but occur elsewhere among sciurids asvin the late Eocene (Chadronian) *Douglassciurus* and Oligocene (Orellan) *Cedromus*. However, the molars of these much earlier genera are proportioned differently (nearly equal in length and width), their

zygomassteric structure is not sciruomorpous, and they do not have the laterally compressed lower incisor of *Protospermophilus*, among other differences (see Emry and Korth, 1996; Korth and Emry, 1991).

Wilson (1960) described several isolated teeth from the early Hemingfordian of Colorado as "*Sciurus* sp. A". Later, these few specimens were referred to *Protospermophilus* sp. and figured by Black (1963; pl. 12, fig. 2). The lower molar referred to the latter is similar in morphology to the m1 and m2 of *P. minimus* but lacks the partial hypolophid and mesostylid loph, and is slightly larger (Wilson, 1960:63; Black, 1963:170).

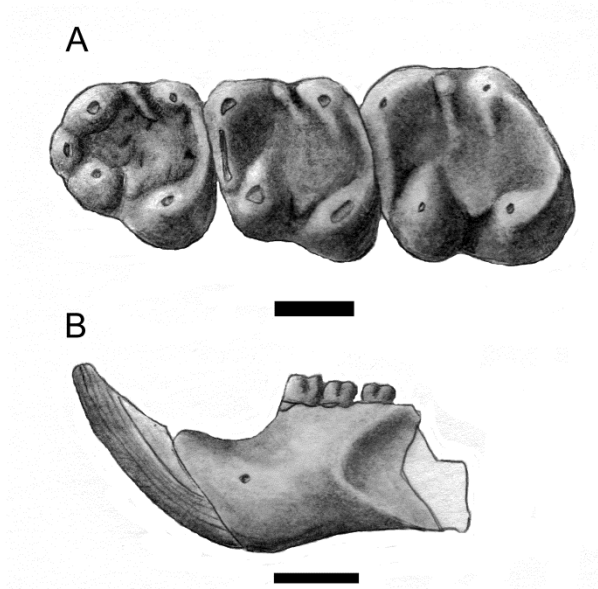

FIGURE 1. Holotype of *Protospermophilus minimus*, F:AM 144255. A, occlusal view of p4-m2. B, lateral view of mandible. Bar scale below each figure = 1 mm.

DISCUSSION

The systematic position of *Protospermophilus* is currently uncertain. Bryant (1945:386) did not use formal classification, but included the genus in informal groupings: "Terrestrial Squirrel and Chipmunk Division of Terrestrial Squirrel Section of the Ground Squirrel and Prairie Dog Suprageneric Group". Black (1963) placed the genus in the Tribe Marmotini within the Subfamily Sciurinae. Although no postcranial skeletal elements are known for any species of the genus, he used taphonomic context, size, and functional morphology of the cheek teeth and skull to suggest that these medium to large squirrels were terrestrial, and therefore should be included with the marmotine ground squirrels. However, Black (1963) suggested that *Protospermophilus* was possibly a separate branch of the marmotines that originated at approximately the same time as the branch of the tribe (represented by *Miospermophilus*) that ultimately led to the most advanced members of the tribe. Goodwin (2008:362) included *Protospermophilus* and several other genera in what he termed "Basal Terrestrial Squirrels", and proposed that they were not closely related to the marmotines as previously suggested, thus making the morphological similarities with the Marmotini a result of parallelism.

The recognition of the chipmunk-sized *Protospermophilus minimus* demonstrates a much larger size range for the species of *Protospermophilus*, thus eliminating the use of the large size of the species of the genus to relate *Protospermophilus* to the terrestrial marmotines. This also suggests that the genus was a distinct lineage unrelated to the main branch of the Marmotini. Whether *Protospermophilus* simply represents a separate lineage of the Marmotini (as suggested by Black, 1963) or is a distinct branch of Sciurinae not related to the marmotines (as suggested by Goodwin, 2008) cannot be resolved at this time.

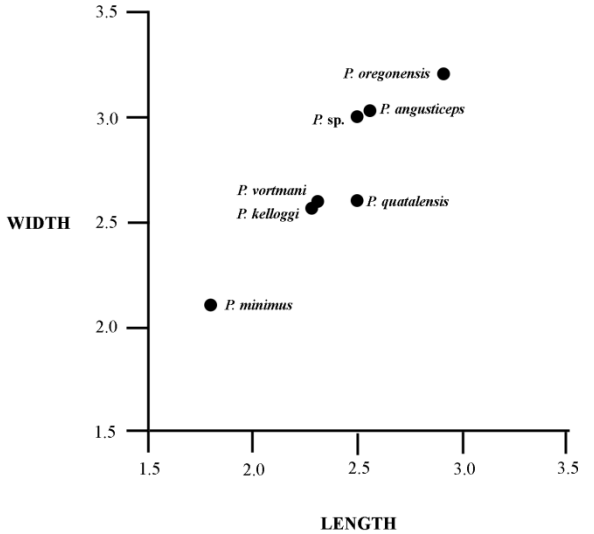

FIGURE 2. Relatvie size of m1 of species of *Protospermophilus* Scales in mm. Measurements of species other than *P. minimus* taken from Black (1963). Point for *P. kelloggi* represents mean measurement.

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