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A NEW SPECIES OF *ANSOMYS* (RODENTIA; APLODONTIDAE) FROM THE LATE HEMINGFORDIAN (EARLY MIOCENE) OF NORTHWESTERN NEVADA

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ABSTRACT

A new species of the aplodontid rodent *Ansomys nevadensis* is described from the Hemingfordian (early Miocene) of Nevada. It has its greatest morphologic similarity to the Asian species *A. orientalis* from the middle Miocene. The occurrence of *A. nevadensis* fills a time gap between the early Oligocene and middle Miocene occurrence of the genus in North America. Its occurrence also suggests at least two migration events between North America and Eurasia for the genus.

INTRODUCTION

The late Hemingfordian mammalian fossils comprising the Massacre Lake local fauna were first recovered from the High Rock Sequence of the Big Basin, Washoe County, Nevada in 1961 (Evernden et al., 1964; Bonham, 1969). Prior published records of these fossils were only cursory until Morea (1981) provided a detailed account of the geologic setting and systematic paleontology of the Massacre Lake local fauna. Subsequently, Morea and Korth (2002) described a new eomyid rodent from the fauna. A revised faunal list is presented in Table 1.

The Massacre Lake local fauna was recovered primarily from unit Tts 4 of the High Rock Sequence, which consists of tan-yellowish brown silty tuff (Morea, 1981). The age of the Massacre Lake local fauna is confidently placed in late the Hemingfordian North American Land Mammal Age (NALMA) based on faunal correlation and an $^{40}Ar/^{39}Ar$ radiometric age of 16.60 ± 0.08 (corrected, see methods below) Ma for an ash flow tuff (anorthoclase) overlying the fauna (Morea, 1981; Swisher, 1992).

The purpose of this report is to document the discovery of a new species of the aplodontid rodent *Ansomys* Qiu, 1987, in the Massacre Lake local fauna. The specimen was recovered from an anthill within unit Tts 4 of the High Rock Sequence in northwestern Nevada. *Ansomys* is primarily known from the late Oligocene to middle Miocene of Eurasia (Hopkins, 2004) with only two species described previously from North America; *A. nexodens* (Korth, 1992) from the early Oligocene (Orellan NALMA) of Montana and *A. hepburnensis* Hopkins, 2004, from the middle Miocene (Barstovian NALMA) of Montana.

METHODS

Dental measurements were made to the nearest 0.01 mm with an AO optical micrometer. All measurements are in millimeters and all teeth were measured at their greatest dimensions. Dental formulae follow standard usage and terminology for the occlusal morphology of aplodontid teeth (Figure 1) follows Rensberger and Li (1986) and Hopkins (2004). Capital letters indicate upper teeth, lower cast letters indicate lower teeth. East Asia Land Mammal ages follow Qiu and Qiu (1995) and European Land Mammal ages follow McKenna and Bell (1997). Older $^{40}Ar/^{39}Ar$ ages were recalibrated relative to the Fish Canyon Tuff sanidine interlaboratory standard at 28.02 Ma and all radioisotopic ages include $\pm 2\sigma$ (deviation).

Abbreviations- A-P, anteroposterior; $^{40}Ar/^{39}Ar$, Argon/Argon; EALMA, East Asia Land Mammal age; ELMA, European Land Mammal age; LACM, Natural History Museum of Los Angeles County; Ma, million

years before present; NALMA, North American Land Mammal age; TR, transverse; UCMP, University of California, Berkeley, Museum of Paleontology, vertebrate fossil locality.

SYSTEMATIC PALEONTOLOGY

Order Rodentia Bowdich, 1821
Family Aplodontidae Trouessart, 1897
Subfamily Ansomyinae Qiu, 1987
Genus *Ansomys* Qiu, 1987
Ansomys nevadensis new species
(Figure 1)

Holotype--Partial left dentary with m1-2, LACM 151454.

Type Locality and Horizon--LACM 7554 (= UCMP V-6160 and RV-7043). Unit Tts 4, High Rock Sequence, Big Basin, Washoe County, Nevada (see Morea, 1981).

Age and Fauna--Late Hemingfordian NALMA, Massacre Lake local fauna.

Diagnosis--*Ansomys nevadensis* differs from *A. heburnensis* by having: 1) m1 metaconid not shifted as far labially; 2) m2 with distinct ectostylid; 3) m2 with small accessory crest that connects mesostylid crest to entoconid crest; 4) m1-2 entoconid crest curved; 5) m1-2 mesostylid crest curved; 6) m1-2 secondary mesostylid lacking; 7) m1-2 metalophulid II better developed with anterolingual accessory crest of metalophulid II extending further lingually and connecting with posterolingual aspect of metaconid; 8) the m1-2 more expanded transversely, with greatest TR width larger than greatest A-P length; and 9) slightly larger in size (m1 area = 2.73 mm^2 versus mean m1 area of 2.57 mm^2 for *A. heburnensis*). Differs from *A. nexodens* by having: 1) m1 lacking lingual crest connection between mesoconid and metastylid; 2) m1 entoconid crest curved; 3) m2 mesostylid relatively larger, similar in size to entoconid; 4) m2 with distinct ectostylid; 5) m1-2 secondary mesostylid lacking; 6) m1-2 anterolingual accessory crest of metalophulid II complete, connecting to metaconid; 7) m1-2 posterolingual accessory crest of metalophulid II complete, connecting with mesostylid crest; 8) m1-2 with small accessory crest that connects anterolingual crest of the metalophulid II to mesostylid crest; 9) m1-2 anterior crest of hypoconulid does not connect with mesostylid crest; and 10) significantly smaller in size (mean m1 area of *A. nexodens* = 3.80 mm^2). Differs from *A. descendens* by having: 1) m1 lacking lingual crest connection between mesoconid and metastylid; 2) m2 lacking small, anteriorly hooked crest on lingual aspect of entoconid; 3) m2 with distinct ectostylid; 4)

Table 1. Revised faunal list of the late Hemingfordian Massacre Lake local fauna (Morea, 1981; Kelly, 1995; Janis and Manning, 1998a, 1998b; Korth, 2000; Lander, 1998; Webb, 1998; Wang et al., 1999; Wright, 1998; Morea and Korth, 2002; this paper).

- Soricomorpha
  - Soricidae
    - *Pseudotrimylus* n. sp.
    - *Antesorex compressus*
- Rodentia
  - Aplodontidae
    - *Ansomys nevadensis*
    - *Liodontia n. sp.*
  - Mylagaulidae
    - *Alphagaulus vetus*
  - Eomyidae
    - *Megapeomys bobwilsoni*
  - Sciuridae
    - *Protospermophilus angusticeps*
    - *Protospermophilus* n. sp. A
    - *Protospermophilus* n. sp. B
    - *Miospermophilus wyomingensis*
    - *Miospermophilus* n. sp.
  - Castoridae
    - Castoridae, n. gen. and sp.
- Carnivora
  - Canidae
    - *Paracynarctus kelloggi*
    - *Tomarctus optatus*
    - *Tomarctus* n. sp.
  - Amphicyonidae
    - *Amphicyon* sp.
  - Ursidae
    - *Ursavus elmensis*
  - Procyonidae
    - Procyoninae, n. gen. and sp.
- Proboscidea
  - Mammutidae
    - *Zygolophodon* sp.
- Perissodactyla
  - Eqiudae
    - *Parahippus pawniensis*
    - *Anchitherium* sp.
    - *Parapliohippus carrizoensis*
    - "*Merychippus*" sp.
  - Chalicotheriidae
    - *Moropus* sp.
  - Rhinocerotidae
    - *Aphelops* sp.
- Artiodactyla
  - Tayassuidae
    - "*Cynorca" sociale*
    - *Hesperhys pinensis*
    - *Hesperhys* cf. *H. vagrans*
  - Merycoidodontidae
    - *Merychyus* sp.
    - *Ticholeptus* cf. *T. zygomaticus*
  - Dromomerycidae
    - *Bouromeryx submilleri*
    - *Bouromeryx milleri*
    - *Dromomeryx scotti*
  - Moschidae
    - Blastomerycinae, n. gen. and sp.
  - Antilocapridae
    - *Paracosoryx wilsoni*

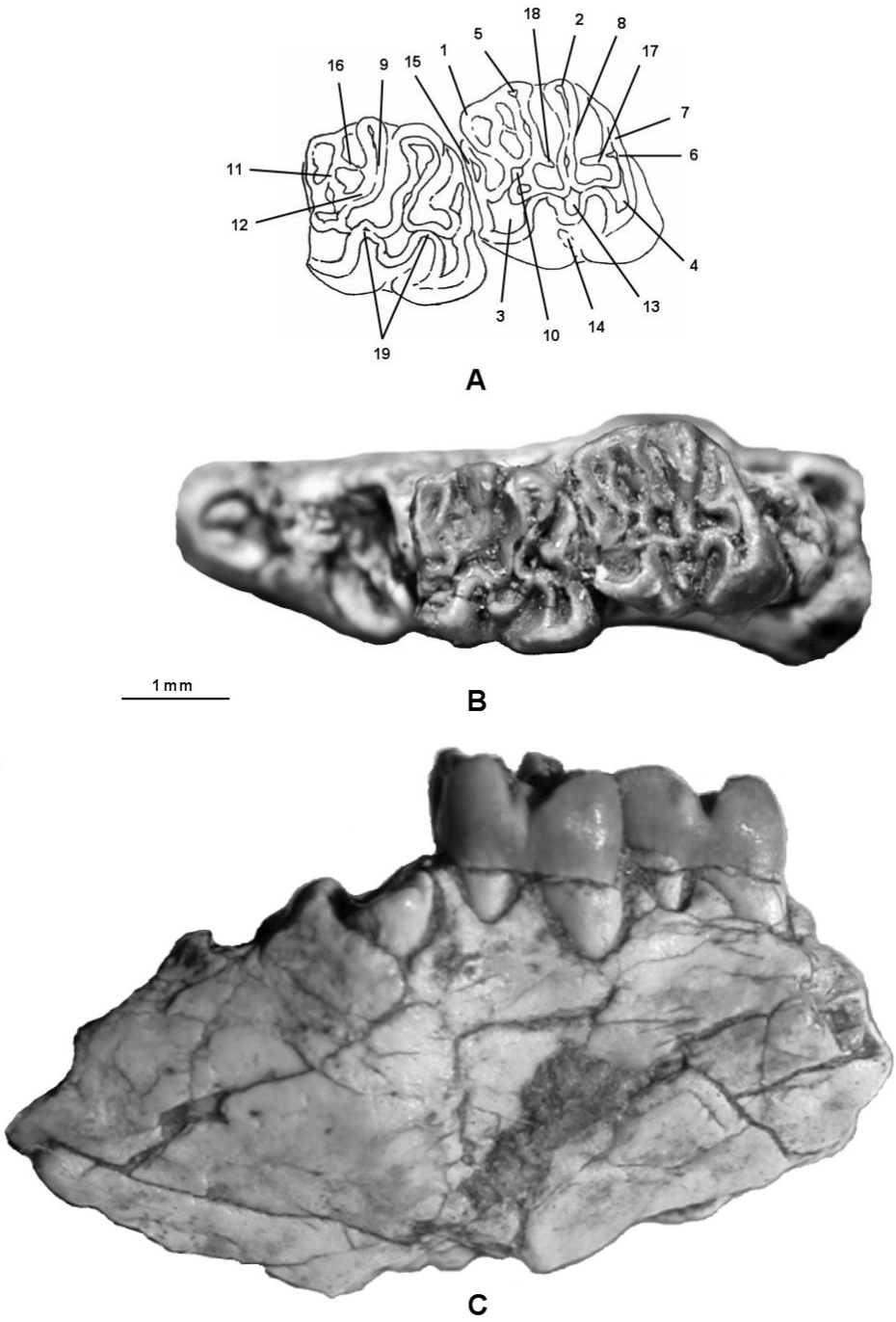

FIGURE 1. *Ansomys nevadensis* new species from late Hemingfordian Massacre Lake local fauna. A-C, Holotype, partial left dentary with m1-2, LACM 151454. A, Line drawing of m1-2 showing dental terminology, occlusal view. B, macrophotograph, occlusal view. C, macrophotograph, labial view. Key: 1, metaconid; 2, entoconid; 3, protoconid; 4, hypoconid; 5, mesostylid; 6, hypoconulid; 7, posterior cingulid; 8, entoconid crest (= hypolophid); 9, mesostylid crest (= mesolophid); 10, metalophulid II; 11, anterolingual accessory crest of metalophulid II; 12, posterolingual accessory crest of metalophulid II; 13, mesoconid; 14, ectostylid; 15, anterior cingulid; 16, accessory crest connecting anterolingual accessory crest of metalophulid II with mesostylid crest; 17, anterior accessory crest of hypoconulid; 18, accessory crest connecting mesostylid with entoconid crest; and 19, ectolophid.

m1-2 entoconid crest curved and much better developed with entoconid crest complete, connecting to mesoconid; 5) m1-2 metalophulid II much better developed with anterolingual accessory crest of metalophulid II complete, connecting to metaconid, and posterolingual accessory crest of metalophulid II complete, connecting with mesostylid crest; 6) m1-2 with small accessory crest that connects anterolingual accessory crest of metalophulid II to mesostylid crest; 7) m1-2 more expanded transversely, with greatest TR width larger than greatest A-P length; 8) m1-2 anterior face of entoconid cusp not concave; 9) m1-2 mesoconid not connected to hypoconid by accessory crest along labial margin; and 10) larger in size (mean m1 area of *A. descendens* = 2.38 mm^2). Differs from *A. orientalis* by having the following: 1) m2 with distinct ectostylid; 2) m1-2 lacking secondary mesostylid; 3) m1-2 entoconid crest curved; 4) m1-2 mesostylid crest curved; 5) m1-2 with small accessory crest that connects anterolingual accessory crest of metalophulid II to mesostylid crest; 6) m1-2 more expanded transversely, with greatest TR width larger than greatest A-P length; 7) m1-2 anterior crest of hypoconulid does not connect with mesostylid crest; and 8) slightly smaller in size (mean m1 area of *A. orientalis* = 2.99 mm^2). Differs from *A. shanwangensis* by having: 1) m2 with distinct ectostylid; 2) m2 small accessory crest present that connects mesostylid crest to entoconid crest; 3) m2 lacking small anteriorly hooked crest on lingual aspect of entoconid; 4) m1-2 secondary mesostylid lacking; 5) m1-2 entoconid crest curved; 6) m1-2 mesostylid crest curved; 7) m1-2 with small accessory crest that connects anterolingual accessory crest of metalophulid II with mesostylid crest; 8) m1-2 with distinct accessory crest extending anteriorly from hypoconulid; 9) m1-2 more expanded transversely, with greatest TR width larger than greatest A-P length; and 10) much smaller in size (mean m1 area of *A. shanwangensis* = 4.20 mm^2). Differs from *A. shantungensis* (known only from a single lower molar) by having: 1) m2 mesostylid large, similar in size to entoconid; 2) m2 with small distinct ectostylid; 3) m2 small accessory crest present that connects mesostylid crest to entoconid crest; 4) m2 lacking small anteriorly hooked crest on lingual aspect of the entoconid; 5) m1-2 secondary mesostylid lacking; 6) m1-2 entoconid crest curved; 7) m1-2 mesostylid crest curved and much better developed; 8) m1-2 anterolingual accessory crest of metalophulid II complete, connecting to metaconid; 9) m1-2 posterolingual accessory crest of metalophulid II complete, connecting with mesostylid crest; 10) m1-2 with small accessory crest that connects anterolingual accessory crest of metalophulid II to mesostylid crest; 11) m1-2 anterolingual aspect of metastylid higher and slightly better developed resulting in more closed condition at lingual aspect of trigonid; 12) m1-2 more expanded transversely, with greatest TR width larger than greatest A-P length; and 13) smaller in size (mean m1 area of *A. shantungensis* = 3.29 mm^2). Comparison to *A. crucifer* difficult because species known only from single isolated p4, but judging from relative proportions of p4's to m1's of other species of *Ansomys*, *A. nevadensis* is smaller in size.

Etymology--Named for its occurrence in Nevada.

Description--LACM 151454 is a partial left dentary containing m1-2 and the two roots of p4 (Figure 1). The lower molars are in moderate wear and are complete except for a small portion of the anterior enamel wall of the m1 anterior cingulid. The molars are brachydont and anteroposteriorly compressed (the greatest TR width is larger than the A-P length).

The m1 metaconid is a small, but distinct, anteroposteriorly compressed cusp positioned at the anterolingual corner of the tooth and only shifted slightly labially with respect to the mesostylid and entoconid. The metaconid is lower in height than the mesostylid and entoconid. The protoconid is a well-developed cusp that is slightly anteroposteriorly compressed and positioned more lingually relative to the hypoconid. The hypoconid is anteroposteriorly compressed with an anterolabial elongation or projection of the occlusal outline. The entoconid is well-developed cusp, larger than the mesostylid and metaconid, with a complete entoconid crest that extends labially connecting the entoconid to the mesoconid. The entoconid crest is curved with a somewhat sigmoidal occlusal pattern, wherein the entoconid crest first curves anteriorly from the entoconid to about the midline of the tooth and then curves labially to join the mesoconid. The mesostylid is anteroposteriorly compressed with a complete, robust mesostylid crest (= mesolophid). The metalophulid II is well developed, wherein it projects lingually from the protoconid and then bifurcates into an anterolingually directed accessory crest that forms a complete crest to the base of the posterolingual aspect of the metaconid and a posterolingually directed accessory crest that joins with the mesostylid crest forming a complete mesolophid. The end result is a somewhat "Y" shaped structure connecting the protoconid with the metaconid and mesostylid. The complete crest (= the posterolingual accessory crest of the metalophulid II plus the mesostylid crest) that connects the mesostylid to the protoconid is curved, wherein it extends first labially from the mesostylid and then turns anteriorly to join the protoconid. A secondary mesostylid is lacking. A smaller accessory crest is also present that extends from the labial aspect of the anterolingual accessory crest of the metalophulid II to the mesostylid

crest. The mesoconid is a robust cusp that is slightly anteroposteriorly compressed, but lacking a distinct labial projection as exhibited by some species of *Ansomys*. The ectolophid is complete, connecting the mesoconid with the protoconid and hypoconid. The ectolophid is positioned more labially than those of prosciurine aplodontids, with a deep labial inflection between the mesoconid and hypoconid. The hypoconulid is a robust cusp positioned on the posterior cingulid with a crest or projection that extends anteriorly to near, but not connected with, the base of the posterior wall of the entoconid crest. A distinct posterior cingulid is present that extends labially from the hypoconid to near the posterior lingual aspect of the entoconid, where it is separated from the entoconid by a small notch. Although the anterior wall of the anterior cingulid (= metalophulid I) is missing, based on the posterior wall, it appears to have extended from the protoconid labially to connect with the metaconid. A small, but distinct accessory anteroconid is present about midway along the anterior cingulid between the metaconid and the protoconid. In the m2 this cusp shows a wear facet.

The m2 is similar to the m1 in occlusal morphology, except for the following: 1) the metaconid is less distinct; 2) the entoconid is smaller relative to the mesostylid; 3) an additional accessory crest is present that projects posterolabially from the mesostylid crest and connects to the entoconid crest at about the same level as the hypoconulid; 4) the labial termination of the posterior cingulid is further separated from the entoconid; 5) a distinct, small ectostylid is present just anterolabially from the mesoconid; and 6) the anterior projection of the hypoconulid forms a more distinct crest.

The measurements for the lower molars are as follows: m1 A-P = 1.61 mm; m1 trigonid TR = 1.40 mm; m1 talonid TR = 1.70 mm; m2 A-P = 1.57 mm; m2 trigonid TR = 1.52 mm; m2 talonid TR = 1.74 mm.

DISCUSSION

Qiu (1987) first described and characterized the rodent genus *Ansomys* and assigned it to the subfamily Ansomyinae of the family Aplodontidae. Seven species of *Ansomys* have been previously recognized as follows (in geochronological order): 1) *A. nexodens* (Korth, 1992), from the early Oligocene (Orellan NALMA) of Montana; 2) *A. shantungensis* (Rensberger and Li, 1986) from the late Oligocene of China (Tabenbulkian EALMA); 3) *A. crucifer* Lopatin, 1997, (also see Lopatin, 2004) from the earliest Miocene (earliest Xiejian EALMA) of western Asia; 4) *A. descendens* (Dehm, 1950), from the early Miocene (lower Orleanian ELMA) of Germany and the Czech Republic (Fejfar et al., 2003); 5) *A. orientalis* Qiu, 1987, from the middle Miocene (early Shanwangian EALMA) of China; 6) *A. hepburnensis* Hopkins, 2004, from the middle Miocene (Barstovian NALMA) of Montana; and 7) *A. shanwangensis* Qiu and Sun, 1988, from the middle Miocene (late Shanwangian EALMA) of China. An additional Asian occurrence of the genus, referred to *Ansomys* sp., was recorded from the middle Miocene Tunggur Fauna of late Tunggurian (EALMA) age, or about 12 Ma (Qiu and Qiu, 1995). Hopkins (2004) provided the most recent phylogenetic analysis and revision of the genus.

The Massacre Lake specimen can be confidently assigned to *Ansomys* because it exhibits the following suite of dental characters (Hopkins, 2004): 1) cheek teeth brachydont; 2) the main cusps of the lower teeth are anteroposteriorly compressed and transversely expanded, especially the m1 metaconid; 3) the basal part of the m1-2 hypoconid is posterolabially expanded; 4) the m1-2 entoconid crest is elongated labiolingually; 5) the m1-2 have accessory crests in the trigonid basin; 6) the m1 metaconid is shifted somewhat labially; and 7) the m2 metaconid is low and crest-like. Based on the suite of dental characters exhibited by the Massacre Lake specimen, which differ from those of each of the other recognized species of *Ansomys* (see diagnosis), it clearly represents a distinct species.

Ansomys is a rather rare taxon, often being represented only by isolated teeth or fragmentary dental material with small sample sizes. In fact, two species (*A. shantugensis* and *A. crucifer*) are only known from a single isolated tooth (Rensberger and Li, 1986; Lopatin, 2004). In spite of its rarity, it had a wide geographic distribution with records from Europe, western and eastern Asia, and western North America (Qiu and Qiu, 1995; Fejfer et al., 2003; Hopkins, 2004; Lopatin, 2004). In North America only two previous records of the genus have been recorded. *Ansomys nexodens* from the Orellan NALMA of Montana, originally assigned to the genus *Pseudallomys* by Korth (1992), but was subsequently referred to *Ansomys* by Hopkins (2004). Hopkins also described *Ansomys hepburnensis* from the Barstovian NALMA (middle Miocene) Hepburn's Mesa fauna of Montana. The occurrence of *A. nevadensis* in the Massacre Lake local fauna extends the geographic distribution of the genus to the Great Basin of western Nevada and is the first record of the genus in the late Hemingfordian NALMA (early Miocene) of North America.

Of the previously recognized species of *Ansomys*, *A. nevadensis* is most similar in occlusal morphology to *A. orientalis* of China by sharing the following dental characters: 1) the m1 mesoconid is usually lacking a lingual crest connection to the metastylid; 2) the m2 mesostylid is large, similar in size to the

entoconid; 3) the m2 entoconid is lacking a small, anteriorly hooked crest on the lingual aspect; 4) the m1-2 with a distinct anteriorly projecting accessory crest on the hypoconulid; 5) the m1-2 metalophulid II with a complete anterolingual accessory crest connecting to the mesoconid and a complete posterolingual accessory crest connecting to the mesostylid crest, resulting in a "Y" shaped occlusal outline for these crests; and 6) the m1-2 entoconid crest is complete, connecting the entoconid to the mesoconid. Hopkins (2004) noted that, probably because of the rarity of preservation, substantial gaps in the stratigraphic record of *Ansomys* occurred from the late Oligocene through the early Miocene. The new record of *A. nevadensis* from the late Hemingfordian NALMA of Nevada helps to close the stratigraphic gap in North America. Based on cladistic analyses and the geographic and stratigraphic distributions of *Ansomys* species, Hopkins (2004) proposed two possible immigration scenarios for the genus between Asia and North America. One possibility was that North America was invaded by the lineage, prior to the late Oligocene, and gave rise to *A. nexodens* and *A. hepburnensis*; a subsequent return to Asia reintroduced *A. orientalis*. The other scenario was that the two North America species represented separate immigrations from Asia. *Ansomys orientalis* is recorded from the early Miocene of Asia at about 17 to 18 Ma, whereas *A. nevadensis* occurs at about 16.6 Ma and *A. hepburnensis* occurs at about 15 Ma in North America. *Ansomys hepburnensis* is regarded as more closely related to a clade containing *A. orientalis* plus *A. nexodens* than to either *A. shanwangensis* or *A. shantungensis* of Asia (Hopkins, 2004). The evidence that *A. nevadensis* is morphologically more similar to *A. orientalis* than to *A. heburnensis* and *A. nexodens*, suggests that *A. nexodens* gave rise to *A. nevadensis* and the lineage that returned to Asia and lead to *A. orientalis*. Subsequent to this emigration event, *A. nevadensis* then gave rise to *A. hepburnensis*. However, as Hopkins (2004) noted, the apparent rarity of preservation allows only speculation as to the immigration history of the genus.

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