Preliminary Description of a New Microvertebrate Assemblage from the Arikareean (Early Miocene) John Day Formation, Central Oregon
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PRELIMINARY DESCRIPTION OF A NEW MICROVERTEBRATE ASSEMBLAGE FROM THE ARIKAREEAN (EARLY MIOCENE) JOHN DAY FORMATION, CENTRAL OREGON

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ABSTRACT--Productive wet-screen-sieved microvertebrate sites are notably rare from nearly all of the middle Eocene through late Miocene strata within the John Day Basin. However, recent work from atypical exposures of the late Arikareean "Kimberly Member" of the John Day Formation north of the classic localities has yielded a new assemblage consisting of thousands of specimens. Preliminary analysis suggests that several represented lineages have stronger Asiatic affinities than previously considered. Notable additions to the John Day fauna include a new protosciurine, a new last appearance datum for the didelphid *Copedelphys*, new species of *Proscalops* and *Leptodontomys*, and possibly the first North American record of *Apeomys*. The quarry samples exceed previously described numbers of *Herpetotherium*, *Proscalops* and other erinaceoids, and include new records of *Petauristodon*, *Campestrallomys*, *Plesiosminthus*, *Leptodontomys*, and *Wilsonsorex*. These additions are a result of isochronous depositional variability within the geographic extent of the sequence and a disproportionate number of presumed fossorial inhabitants preserved in a non-zeolitized matrix that permits disaggregation and recovery.

INTRODUCTION

The John Day Basin has been a source of remarkable suites of Arikareean vertebrate fossils for over 140 years, largely from a number of historically important localities within obvious, even spectacular, exposures of zeolitized tuffaceous claystones (Leidy, 1870; Merriam, 1901; Rensberger, 1971; Fremd et al., 1994). These predominantly late Oligocene exposures have produced the bulk of what is generally alluded to as "the John Day fauna," a characterization that overlooks the presence of suites of assemblages spanning over 40 million years deposited in multiple volcaniclastic depositional environments. Despite repeated attempts by several workers to locate productive localities to overcome collecting biases and recover statistically significant microvertebrate faunas, no *in situ* sites suitable for standard, wet-screen-sieving strategies had been located throughout the entire 45-million year stratigraphic sequence until work on Hemphillian-aged assemblages in the Rattlesnake Formation were conducted (Martin, 1983; Martin and Fremd, 2001). Here we report preliminary taxonomic assessment of a new early Miocene microvertebrate assemblage found in the Lonerock area, and previously alluded to as the Campbell Ranch local fauna (Pajak et al., 2001).

The Lonerock area of central Oregon (Fig. 1) contains small and visually unimpressive exposures of "Kimberly" strata of the John Day Formation as currently subdivided (Fisher and Rensberger, 1972). It is scarcely surprising that early workers bypassed these exposures on their way to the famous beds exposed near the Painted Hills and Turtle Cove areas. However, a single rodent tooth assigned to *Entoptychus basilaris* (AMNH 7104) and listed as being collected by Cope is housed at the AMNH with accompanying unpublished data that merely notes "John Day Lone Rock Valley, Wasco County, Or." To our knowledge, the area received no more attention until the mid-1990s when Mr. Dwight Hoy, a resident of Lonerock (a small town currently in Gilliam County, OR), discovered important new large fossils *in situ* low in the local exposures later determined to overlie the 28.7 Ma Picture Gorge Ignimbrite (PGI). These materials include complete, well-preserved skulls of rhinocerotids, a beautiful skull representing a new species of large nimravid, a complete skull with an associated partial vertebral column of the canid *Enhydrocyon*, and a very large oreodont. Intrigued by these discoveries and noting the absence of any

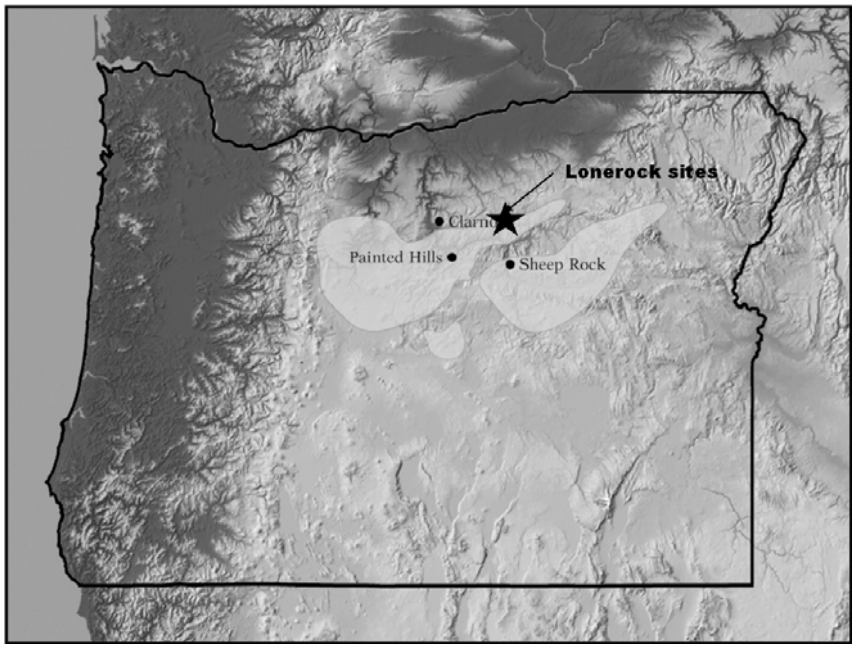

Figure 1. Index map showing location of Lonerock site relative to outcrop pattern of the "Kimberly" facies of the John Day Formation. The site occurs several miles north of the more typical, well known outcrops of this stratigraphic interval.

small vertebrate remains, in 1995 we visited several of the over 50 sites that Mr. Hoy worked and we discovered the presence of small vertebrates, such as an isolated *Meniscomys* tooth, high in the upper part of the section (>200 m above the PGI). Encouraged by these finds, Mr. Hoy began an extensive program of underwater screen-sieving which resulted in the recovery of thousands of isolated teeth representing over 30 microvertebrate taxa (including multiple species of *Meniscomys* and *Entoptychus*) from a geographically isolated locality. This locality (Fig. 2) is immediately subjacent to a massive previously unrecognized welded ash-flow tuff. Radioisotopic age analysis of this tuff has not yet been undertaken, but clearly the strata lie well above the series of dated tuffs (such as the PGI) found in better-known exposures to the south (Fremd et al., 1994).

The majority of the matrix from this upper section resembles a "loess" or other aeolian-derived, thick, massive deposit with interbedded fine sandstones, silts, and angular-grained particles consistent with a wind-blown, dune/barcan feature. The geometry of an overlying ash-flow tuff suggests a broad, arch-sided basin, but details of the depositional environment will require further investigation. Taphonomically the bulk of the microvertebrate material is consistent with owl middens (Pajak et al., 2001), but this material may also represent an "in fauna" of burrowing organisms.

MATERIALS AND METHODS

Initially, coarse prospecting of the entire outcrop by D. Hoy for large vertebrates resulted in a compilation of nearly 50 sites at several horizons scattered over an area of roughly 10 km^2 (Fremd, 1995). Preliminary stratigraphic assessment revealed a complex package of sediments spanning a considerable temporal range, including red paleosols and lacustrine facies in the lower part equivalent to the Big Basin Member of the John Day Formation exposed further to the south and well below the prominent PGI (Fig. 3). Most of the large mammals, however, (to be discussed in a separate report) were found in strata well above the lower units. In this study we focus only on the distinctive uppermost horizon that produced the microvertebrates, but no larger taxa. Our description is limited primarily to a locality known simply as "Site 50." Nearly 5000 specimens were recovered during careful sorting of the washed concentrate, all of which are currently housed in collections at John Day Fossil Beds National Monument.

Figure 2. Typical exposures at the Lonerock locality with star marking a site where some of the richest concentrations of teeth were collected.

It is likely that the underwater screen-sieving efforts biased the sample toward larger members of the microfauna due to the initial use of coarse (window) screens. Smaller taxa (e.g., *Copedelphys* n. sp. and *Leptodontomys* n. sp.) may have been entirely missed if not for the recovery of partial jaws, as individual teeth would have passed through the window screen mesh. Interestingly, our samples of surface matrix contained a few representatives indicative of Quaternary 'contamination,' but this material was readily identifiable and did not confound study of the older lithosympatric assemblage. The sedimentary regime, microstratigraphy, and accumulation mechanisms all present a complex depositional and taphonomic history. Future work on this assemblage promises to yield additional small taxa that can be more precisely placed in the sequence.

TAXONOMY OF THE LONE ROCK ASSEMBLAGE

Here we provide an annotated list and general description of the small vertebrate taxa identified to date (Table 1). A thorough "Systematic Paleontology" section, including figures of specimens, is postponed until a more comprehensive analysis is undertaken and after all specimens are catalogued into the collections at John Day Fossil Beds National Monument.

AMPHIBIA Gray, 1825
CAUDATA Fisher von Waldheim, 1813
?PLETHODONTIDAE Gray, 1825

Typical of modern plethodontids are a few fairly complex and robust salamander vertebrae that are elongate with low neural spines and a low neural arch with short rib-bearing processes that lack additional ornamentation.

SQUAMATA Oppel, 1811
BOIDAE Gray, 1825
cf. *OGMOPHIS* sp.

There are a number of snake vertebrae with characteristic boid morphology consistent with species of *Ogmophis*: short, heavy centra; low neural arches; low, stout neural spines that occupy about one half the length of the neural arch; and low, flat heamal spines.

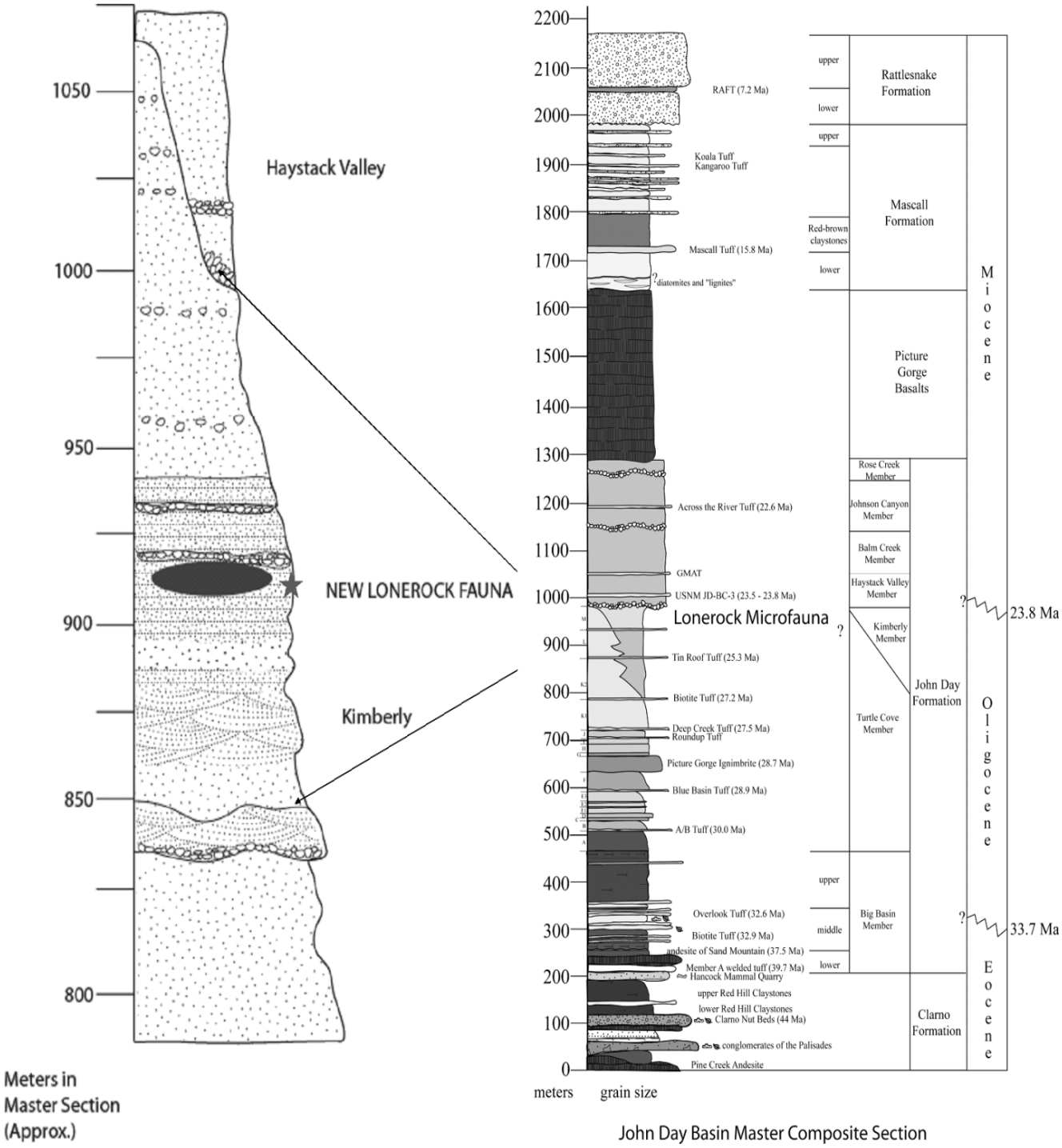

Figure 3. Stratigraphic cartoon of the volcaniclastic sequence in the upper Lonerock sedimentary package (left) and correlation with the composite section of John Day basin lithostratigraphic units exposed to the south of the study area.

ANGUIDAE Gray, 1825

Indeterminate anguine sp.

Quadrate to rectangular dermal osteoscutes with external ornamentation typical of anguines are present, but more specific identification is not possible based on the material currently available.

MAMMALIA Linnaeus, 1758
MARSUPIALIA (Illiger, 1811)
DIDELPHIMORPHIA Gill, 1872
DIDELPHIDAE Gray, 1821
HERPETOTHERIUM Cope, 1873
HERPETOTHERIUM MERRIAMI (Stock and Furlong, 1922)

Tooth morphology matches that of *H. merriami* (Korth, 1994a), but size is on the lower end of that species' range.

COPEDELPHYS n. sp.

Smaller than described species of *Herpetotherium* (McGrew, 1937; Green and Martin, 1976; Korth, 1994a); size of *Copedelphys titanelix* Korth (1994a) and *C. stevensoni* Korth (1994a); characters of this species diagnostic of *Copedelphys* include subdued stylar cusps with cusps B, C, and D of equal height, and cusp D elongate. Previously restricted to the Chadronian and Orellan, the Lonerock record represents a considerable and significant range extension for the genus.

EUTHERIA (Huxley, 1880)
LAGOMORPHA Brandt, 1855
OCHOTONIDAE Thomas, 1897
DESMATOLAGUS Matthew and Granger, 1923
cf. *DESMATOLAGUS* sp.

Based on isolated teeth it is difficult to distinguish ochotonid species, but upper and lower teeth distinctive of ochotonids are present.

LEPORIDAE Fischer de Waldheim, 1817
ARCHAEOLAGUS Dice, 1917
cf. *ARCHAEOLAGUS* sp.

Only a few isolated teeth are present, with no p3s that otherwise would permit conclusive generic identity.

RODENTIA Bowdich, 1821
APLODONTOIDEA Brandt, 1855
ALLOMYIDAE Marsh, 1877
ALWOODIA cf. *A. MAGNA* Rensberger, 1983

The sample of allomyines only includes a distinctive, large, and unique representative of what appears to be *Alwoodia* (Rensberger, 1983). Surprisingly, no other allomyine appears to be present, such as *Allomys* which is documented at many other localities of presumed lateral equivalence.

PROSCIURINAE Wilson, 1949
cf. *CAMPESTRALLOMYS* sp. (see Korth, 1989)

A sample of four isolated teeth are similar in size to *C. siouxensis* (Korth, 1989), but smaller than *C. dawsonae* (MacDonald, 1963). Diagnostic of *Campestrallomys* are the lower molars with multiple mesostylids.

APLODONTIDAE Brandt, 1855
MENISCOMYS spp.

Species of *Meniscomys* are difficult, if not impossible, to distinguish on the basis of isolated teeth, but ranges in size and varying dental morphology support the presence of multiple species in the Lonerock assemblage.

SCIURIDAE Fischer de Waldheim, 1817
PROTOSCIURUS Black, 1963

There are three distinctly different sized species of *Protosciurus* present. Upper molars are quadrate, conules are small or absent, and the metaloph and protoloph are connected to the protocone. Lower teeth are also nearly square in outline; they have a shallow buccal valley, and anterior cingulids and mesostylids are present.

PROTOSCIURUS CONDONI Black, 1963

This species is represented by a single m1, larger than samples referred to *Protosciurus rachelae* below.

PROTOSCIURUS RACHELAE Black, 1963

This taxon is represented by 6 teeth: upper molars have very low lophs and they lack conules; lower molars have a low posterolophid.

?*PROTOSCIURUS* n. sp.

This morphotype is the most abundant 'squirrel' in the assemblage, with over 40 teeth collected. It is a small, chipmunk-sized animal, the size of *Nototamius hulberti* Pratt and Morgan, 1989, but it lacks the anterior and posterior fused roots present on lower molars of the latter. Cheek teeth are quadrate in outline, in contrast to the triangular outline seen in *Miospermophilus*, and upper molars have well developed lophs and cingula. The metaloph is connected to the protocone, in contrast to *Miosciurus* where it is not connected. A small protoconule and mesostyle are present in about half the specimens. The lower molars are rectangular in outline (square in *P. condoni*) with a distinct anteroconid (small in *Miospermophilus*).

This taxon appears to be the smallest recognized Arikareean 'squirrel.' It most closely approaches larger species of *Protosciurus* in general morphology, but the combination of characters probably justifies definition of a new genus, an exercise beyond the scope of this study.

PETROMYINAE Brandt, 1855

cf. *PETAURISTODON* sp. (see Engesser, 1979)

A single, large ?m3 with rounded, bulbous, primary cuspids and an open central valley with crenulated enamel most closely resembles m3s of described species of *Petauristodon* (Engesser, 1979).

CASTORIDAE Hemprich, 1820

CAPACIKALA Macdonald, 1963

CAPACIKALA sp.

Isolated teeth of a small castorid reminiscent of the type material of *Capacikala gradatus* (Cope, 1879) have been recovered with this sample, but require further study.

DIPODIDAE Fischer de Waldheim, 1817

PLESIOSMINTHUS Viret, 1926

PLESIOSMINTHUS CLIVOSUS Galbreath, 1953

Tooth morphology and size are similar to *P. clivosus*, but smaller than the smallest species of *Schaubemys*, *S. grangeri* Wood, 1935. The protoconule on M1 is well developed, as in later North American *Schaubemys*. In the lower molars, the mesolophid does not connect directly to protoconid, but to the protoconid-metaconid ridge - a feature considered characteristic of *Plesiosminthus*, but not *Schaubemys* (Korth, 1980). The metalophid connection resembles that of *S. grangeri* and European species assigned to *Plesiosminthu*s.

MURIDAE Illiger, 1811

PARACRICETODONTINAE Mein and Freudenthal, 1971

EUCRICETODONTINI Mein and Freudenthal, 1971

PACICULUS sp. (See Cope, 1879)

Represented by a single tooth with eucricetodontine morphology; otherwise distinguished by large size.

LEIDYMYS Wood, 1936
LEIDYMYS LOCKINGTONIANUS (Cope, 1881)
LEIDYMYS NEMATODON (Cope, 1879)
LEIDYMYS cf. *L. ALICAE* Black, 1961

Based primarily on size, there appears to be three different species of *Leidymys* in the assemblage, although many isolated teeth are intermediate in size. The larger species has an M1 with an average anteroposterior length of 2.8 mm; it is assigned to the largest described species of *Leidymys*, *L. lockingtonianus*. The mesostylid in m1 is longer and larger than the other two species, the anteroconid has a medial connection to the protoconid through a central anteroconid spur, and the anterior cingulid is more completely connected to the protoconid than it is in *L. nematodon*. The intermediate sized species, with an average M1 length of 2.3 mm, is assigned to *L. nematodon*. The m1s assigned to this species have the first connection of the anteroconid to the protoconid through the anterior cingulid rather than directly to the protoconid. The smallest species, with an average length of <2.1 mm, is larger than *L. parvus*, the smallest species of *Leidymys*, and closest in size to *L. alicea* (Black, 1961). There are also two slightly different arrangements of striae on the buccal surfaces of isolated lower incisors. The striae are more widely spaced in larger specimens assigned to *L. lockingtonianus* and more closely spaced in smaller specimens, assigned to *L. nematodon*.

EOMYIDAE Winge, 1887
LEPTODONTOMYS Shotwell, 1956
LEPTODONTOMYS sp. cf. *L. DOUGLASSI* (Burke, 1934)

This species is represented by a single, small, low crowned M1 or M2 with low lophs. The major cusps are only slightly elevated above the lophs; there is a small mesostyle, an anterior cingulum that is not connected to the protocone, and a lingual cingulum.

LEPTODONTOMYS n. sp.

Based on a mandible with m1-2, this very small species is smaller than any described species of *Leptodontomys*. It is about half the size of *L.* sp. cf. *L. douglassi* noted above, with strongly lophate cusps, a short mesolophid, a reduced anterior cingulid, and a central connection between the hypoconulid and protoconid.

APEOMYINAE Fejfar, Rummel, and Tomida, 1998
APEOMYS Fahlbusch, 1968
cf. *APEOMYS* n. sp. (Fahlbusch, 1968)
or
cf. *ARIKAREEOMYS* n. sp. (Korth, 1992)

Teeth size and superficial morphology resemble *Pseudotheridomys hesperus* (Wilson, 1960). The teeth are fairly high crowned with a tendency for major lophs (-ids) to remain separated by a deep, central valley with no medial connection, thus creating a bi-lobed tooth. Generally no more than four lophs (-ids) are present, even in early wear stages. Primary cusps (-ids) are submerged within the lophs (-ids), even in unworn specimens. This morphology is similar to *Arikareeomys skinneri* (Korth, 1992), the only described species of the genus, which is more than twice the size of the Lonerock species. There has been considerable discussion about the possible relationships of North American species of high crowned, lophodont eomyids and comparable Asiatic and European species (Engesser, 1979; Korth, 1992; Fejfar et al., 1998; Smith et al., 2006). The suite of isolated teeth from the Lonerock fauna display transitional characters that suggest an early tie between the Asiatic *Apeomys* and North American *Arikareeomys*.

GEOMYIDAE Bonaparte, 1845
ENTOPTYCHINAE Miller and Gidley, 1918

ENTOPTYCHUS spp. Cope, 1878

Based on the thousands of isolated teeth collected, the various species of *Entoptychus* are easily the most common taxa present in the fauna. However, they are also very difficult to accurately distinguish to species using only isolated teeth. On the other hand, once a thorough analysis is conducted, it is likely that a variety of species will be recognized.

HETEROMYINAE Gray, 1868

PROHETEROMYS Wood, 1932

PROHETEROMYS sp. cf. *P. SULCUS* Wilson, 1960

The teeth are moderately low crowned with isolated cusps in early wear. The sides of the teeth are convex when viewed from the occlusal surface. P4 has a single protocone, no protostyle, and no connection of protocone to metaloph. Upper molars have an open central valley and a weak posterior cingulum. Lower molars have an open central valley, an isolated hypostylid, and a short anterior cingulid. As Korth (1994b) pointed out, *Proheteromys* is somewhat of a scrap-basket taxon. Nonetheless, it displays distinct tooth morphology from the heliscomyines with low-crowned teeth and isolated cusps, from the geomyinines which are all higher crowned, and from the florentiamyids which generally are larger with bulbous cusps in early wear.

ERINACEOMORPHA Gregory, 1910

ERINACEOIDEA Fischer de Waldheim, 1817

ERINACEIDAE Fischer de Waldheim, 1817

AMPHECHININI Gureev, 1979

cf. *AMPHECHINUS* sp.

A single P4 closely resembles that of *Amphechinus horncloudi* (Macdonald, 1970; see Rich and Rasmussen, 1973) and to *Parvericius montanus* Koerner, 1940 (see Martin, 1976), but is considerably smaller. The protocone is a distinct and separate cusp, the hypocone is an expanded shelf with a smaller accessory cusp, the parastyle is well developed, and the paracone is the highest cusp. Lack of material precludes determination of the large parastyle and posterior cingulum characteristic of *Parvericius* molars.

TALPOIDEA Fischer de Waldheim, 1817

PROSCALOPIDAE Reed, 1961

PROSCALOPS Matthew, 1901

There are three distinctly different sized species of *Proscalops*. Some are represented by well preserved material including partial dentaries and maxilla with associated teeth. The P4 lacks a hypocone and all upper molars have a distinct, well developed “w”-shaped ectoloph and well developed hypocones, but lack posterior cingula. Lower molars have thin-walled crests with individual cusps at the ends of the crests.

PROSCALOPS sp. cf. *P. SECUNDUS* Matthew, 1909

Largest of the species present, represented by a single upper molar (see Wilson, 1960).

PROSCALOPS sp. A.

This moderate sized species is smaller than specimens assigned to *P. secundus*, but with similar tooth morphology. The teeth are within the lower range of the specimen assigned to *P. secundus*, but they appear to represent a distinct species within the Lonerock assemblage. This is the most abundant species present.

PROSCALOPS n. sp.

Smaller than any described species of *Proscalops* and smaller than species of *Scalopoides*. M1 has a more triangular outline than other species. Lower molars have thin-walled crests and a reduced talonid.

TALPIDAE Fischer de Waldheim, 1917
SCALOPINI Troussart, 1879
SCALOPOIDES sp. Wilson, 1960

Similar in size to *Proscalops* n. sp. above, but the teeth have a more delicate appearance, the lophs are thinner, the upper molars have multiple cusps on the protoconal/hypoconal shelf, the protocone is more lingually positioned, and there is a strong mesostylid on lower molars.

SORICOMORPHA Gregory, 1910
SORICIDAE Fischer de Waldheim, 1817
HETEROSORICINAE Viret and Zapfe, 1951
cf. *DOMNINA* sp. Cope 1873

The teeth resemble those of *Domnina* with a strong entoconid crest and an entoconid separated from the hypolophid.

WILSONOSOREX sp. cf. *W. CONULATUS* Martin, 1978

Smaller than cf. *Domnina* sp. above. The size and morphology of the M1 resembles that of *W. conulatus*. The M1 is quadrate due to expansion of the hypocone and anterior cingulum, the paraconules and metaconules are distinct, and the inner cusps are anteroposteriorly compressed.

Table 1. Microvertebrates recovered from screen-washing the Lonerock site. Taxa in ***bold*** represent new records and/or range extensions.

Class AMPHIBIA		
	Family	?PLETHODONTIDAE
Class REPTILIA		
	Family	BOIDAE
		cf. *Ogmophis* sp.
	Family	ANGUIDAE
		Indeterminate anguine sp.
Class MAMMALIA		
Order MARSUPIALIA		
	Family	DIDELPHIDAE
		Herpetotherium merriami
		***Copedelphys* n. sp.**
Order LAGOMORPHA		
	Family	OCHOTONIDAE
		Desmatolagus sp.
	Family	LEPORIDAE
		Archaeolagus
Order RODENTIA		
	Family	ALLOMYIDAE
		Alwoodia cf. *A. magna*
		***cf. Campestrallomys* sp.**
	Family	APLODONTIDAE
		Meniscomys spp.
	Family	SCIURIDAE
		Protosciurus condoni
		Protosciurus rachelae
		?*Protosciurus* n. sp.
		cf. *Petauristodon* sp.
	Family	CASTORIDAE
		Capacikala sp.
	Family	DIPODIDAE
		Plesiosminthus clivosus
	Family	MURIDAE
		Paciculus sp.
		Leidymys lockingtonianus
		Leidymys nematodon
		Leidymys sp. cf. *L. alicae*
	Family	EOMYIDAE
		Leptodontomys* sp. cf. *L. douglassi
		***Leptodontomys* n. sp.**
		cf. *Apeomys* n. sp. or
		cf. *Arikareeomys* n. sp.
	Family	GEOMYIDAE
		Entoptychus sp.
		Proheteromys sp. cf. *P. sulcus*
Order ERINACEOMORPHA		
	Family	ERINACEIDAE
		cf. *Amphechinus* sp.
	Family	PROSCALOPIDAE
		Proscalops sp. cf. *P. secundus*
		***Proscalops* sp. A.**
		***Proscalops* n. sp.**
	Family	TALPIDAE
		Scalopoides sp.
Order SORICOMORPHA		
	Family	SORICIDAE
		cf. *Domnina* sp.
		Wilsonosorex* sp. cf. *W. conulatus

CONCLUSIONS

We report here a previously overlooked site in an area that has been the subject of extensive research for 140 years. The discovery of new localities containing such diverse and well preserved microvertebrate faunas in the classic John Day sequence will likely prove to be of significant biostratigraphic and biogeographic importance upon detailed study. Our objective was to provide a preliminary analysis of this remarkable assemblage to correct the long-held belief that there were no "washable" *in situ* sites in the John Day series, and hopefully, to draw attention to the potential for future studies, particularly of the geomyids for which a statistically robust sample has been acquired.

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