curves, in which the information contained in the spikes is preserved, has been carried out (*2*). The resulting plot of n versus T, for three assumed values of the hydrogen-to-helium ratio blanketing the expected range (see below), is shown in Fig. 2 for emersion. Our emersion observations correspond to a Jovian latitude of 58°S at a time just after local sunrise. The upper or dashed portions of these curves are entirely unreliable, and reflect the distance for the solutions to converge depending on the initial assumed boundary conditions (*4*). Within the errors of observation the results shown in Fig. 2 are consistent with ingress and egress observations on all channels. The results are reliable between 10^{15} cm^{-3} and almost 10^{13} cm^{-3}.

From the time delay of spikes in the three channels and the shape of the light curves, we are able to determine the composition of the Jovian atmosphere in this density range, assuming it is well mixed—that is, assuming that our observations apply to the region below the turbopause (*8*). We also assume that the atmosphere at this level is composed only of hydrogen and helium. The refractivities, spectroscopic abundances, and vapor pressures of all other plausible constituents show them to make a negligible contribution. A careful error analysis gives a ratio of refractivities in emersion channel 3 to emersion channel 2 of 0.9713 ± 0.0015. From the best available laboratory and quantum theoretical estimates of the refractivity of H_2 and He (*8*) the derived mean molecular weight is $2.32^{+0.30}_{-0.32}$, which corresponds to a helium fraction by number of $0.16^{+0.19}_{-0.16}$. The errors correspond to 1 standard deviation. Our compositional results are consistent with spectroscopic limits on helium on Jupiter (*9*), with solar spectroscopic ratios (*10*), with solar wind ratios (*10*), and with the expectations from big bang nucleosynthesis (*11*). They are inconsistent with the results deduced from the earlier occultation of Sigma Arietis by Jupiter (*12*), with the results of some lower quality observations of the Beta Scorpii event (*13*), and with inhomogeneous accretion models of Jupiter in which a massive accretion of helium occurs around a hydrogen core (*14*).

Between 10^{13} and 10^{14} cm^{-3} the atmosphere appears to first order to be isothermal, although the spike-related temperature fluctuations of 2° to 10°K are real. At altitudes below 10^{14} cm^{-3} a positive temperature gradient is indicated. Recent theoretical models of the Jovian thermosphere and mesosphere put the mesopause within an order of magnitude of the 10^{14} cm^{-3} level (*15*), that is, within the range of our measurements. However, from our measurements combined (Fig. 3) with preliminary Pioneer 10 results (*16*), it appears likely that the temperature minimum occurs at lower altitudes, somewhere between 10^{16} and 10^{17} cm^{-3}.

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Purgatorius, an Early Paromomyid Primate (Mammalia)

Abstract. *Fragmentary mandibles of* Purgatorius unio *Van Valen and Sloan from the Puercan (approximately early Paleocene), Garbani Locality, Montana, preserve associated postcanines. Their morphology indicates that this mammal was an early paromomyid primate and suggests that primate ancestry does not include currently known members of the palaeoryctid and leptictid Insectivora or of the Condylarthra.*

For many years the oldest records of Primates were from Torrejonian (approximately middle Paleocene), North American localities. In 1965 *Purgatorius* (*1*) was described and its species, Puercan *P. unio* and latest Cretaceous *P. ceratops*, greatly extended the order's paleontostratigraphic range. *Purgatorius unio* has been known hitherto from about 50 isolated teeth found at the type locality, Purgatory Hill, McCone County, Montana. *Purgatorius ceratops* is represented by an isolated, lower molar found at Harbicht Hill, McCone County. Because of this limited and fragmentary sample, problems inherent to identification of isolated teeth, and dental similarities to contemporaneous condylarths, the phylogenetic relationships of *Purgatorius* have been debated (*2*).

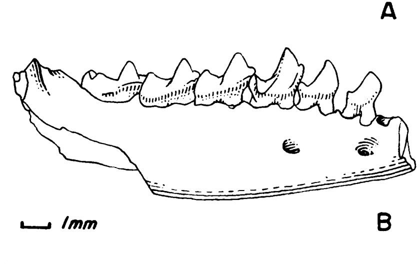

Fig. 1. *Purgatorius unio* (specimen UCMP 107406). (A) Occlusal and (B) labial views of right mandible showing alveoli of the canine (posterior rim) and P_1, and P_2 to M_3.

The postcanine dentition of *P. unio* is now additionally documented by 13 dentulous, fragmentary mandibles, a fragmentary maxillary, and more than 50 isolated teeth from the Garbani Locality, about 30 km north of Jordan, Garfield County, Montana, and about 80 km west of Purgatory Hill (*3*). This site, discovered by paleontologists from the Natural History Museum of Los Angeles County, is now being studied jointly with members of the

University of California Museum of Paleontology (UCMP). It is one of several concentrations of fossils in channel fillings within the Tullock Formation that are capped by the W coal (*4*). The Garbani local fauna is closely similar in composition to the Purgatory Hill local fauna and is also of Puercan age.

The type of *P. unio*, a damaged upper molar, is essentially identical to teeth found at the Garbani Locality. Data from this sample (*5*) support Van Valen and Sloan's (*1*) identification of topotypic lower molars, and also demonstrate that the lower dentition of *P. unio* includes seven postcanines. The alveolus for the single root of P_1, crown unknown, is smaller than those for the canine or P_2 (Fig. 1). The second lower premolar is smaller than P_3; both are two-rooted. The fourth lower premolar is submolariform. A metaconid is lacking, although on some teeth slight thickenings of the enamel are present in this region. Talonid cusps are slightly differentiated. The first and second lower molars are approximately the same length (M_1, average length $\bar{x} = 1.93$ mm, $N = 13$; M_2, $\bar{x} = 2.00$ mm, $N = 9$); M_3 is longer ($\bar{x} = 2.32$ mm, $N = 7$). Widths of talonids of $M_{1\text{-}2}$ vary from less than to greater than widths of trigonids. Hypoconulid of M_3 is enlarged, salient, and on some teeth incipiently doubled by addition of a lingual cusp.

Specimen UCMP 107406 (Fig. 2), the most complete mandible yet discovered, is representative of the more insectivore-like individuals allocated to *P. unio*. On others specializations characteristic of later primates are more distinctly developed: trigonid cusps are of more bunodont form, paraconid and metaconid are in closer approximation, paracristids are more distinctly angulated, and hypoconulids are indistinctly delimited.

Although identifications of topotypic molars (*1*) appear verified by the new material, reference of typotypic premolars must be modified. A tooth regarded as a P_4 of *P. unio* (*1*) is most likely a P_3. Identification of an isolated upper premolar lacking a metacone as a P^4 (*6*) is erroneous. A P^4 of *P. unio*, associated with $M^{1\text{-}2}$ in a fragmentary maxillary found at the Garbani Locality (*5*), is smaller and has a small, distinct metacone.

Purgatorius unio has been compared with all paromomyid taxa [*sensu* Szalay (*7*)], from which it differs in the presence of P_1, and close resemblances were found to *Palaechthon alticuspis* and *Palaechthon nacimienti* (Torrejonian). The latter differ in slightly larger size, greater development of postcingulum, narrower stylar shelves, larger metacone on P^4 (*P. nacimienti*), small metaconid (*P. alticuspis* only) and minute or no paraconid on P_4, molar metaconids and protoconids more closely approximated, and M_3 hypoconulid clearly twinned. The lower dentition of *Palenochtha minor* (Torrejonian) also closely resembles that of *Purgatorius unio*. The most apparent morphological differences are relatively smaller paraconid on P_4 and larger, labial basal cingula on the cheek teeth. Upper molars of *Palenochtha minor* exhibit modifications of stylar shelf and postcingulum similar to those of *Palaechthon*. All other paromomyids show greater degrees of difference from *Purgatorius*. The mosaic of dental specializations warrants allocation of *Purgatorius* to the Paromomyidae (*8*) and favors a working hypothesis that it is an ancestor of *Palaechthon* and *Palenochtha*.

Sloan and Van Valen placed *Protungulatum donnae* in the Condylarthra, considering it (*9*, p. 226) as "being an ultimate ancestor in the real rather than structural sense for the various orders of ungulates." The possibility of close phylogenetic relationships between *Protungulatum donnae* and *Purgatorius unio* has been considered (*1*). On molars of *Protungulatum donnae*, unlike *Purgatorius unio*, the

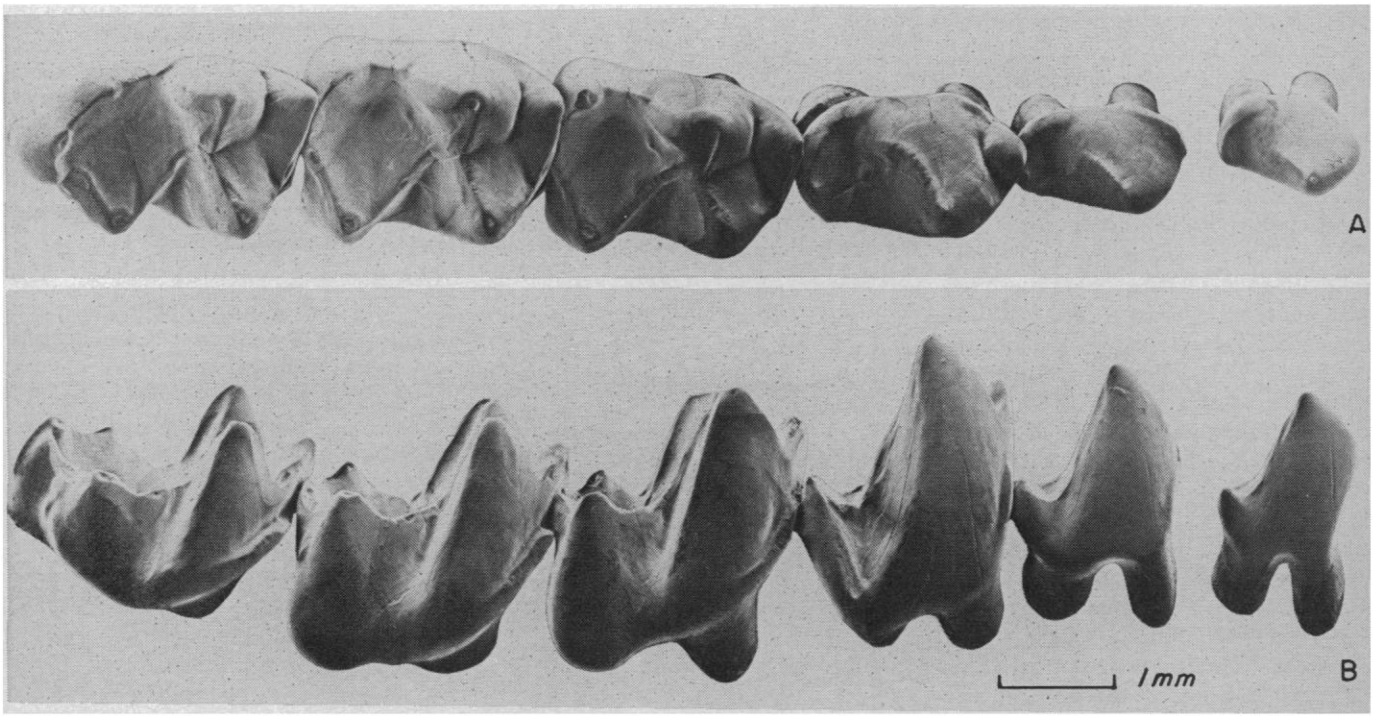

Fig. 2. *Purgatorius unio*. (A) Occlusal and (B) labial views of right P_2 to M_3 preserved in UCMP 107406. Scanning electron micrographs were taken by M. T. Maglio, University of California, San Francisco, and the montage was prepared by J. P. Lufkin and D. Cook, University of California Museum of Paleontology. Because of the length of the specimen, perspectives, microscope voltages (5 to 10 kv), and angles of incidence (5° to 20°) vary from tooth to tooth.

postcingulum is well separated from the protocone, does not tend to swing ventrally toward the apex of the protocone (*10*), and can carry a small hypocone. Molar trigonids exhibit a different style of inflation, involving marked swelling ventral and anterior to the metaconid. Talonid basins are open lingually by a deep notch and labial, basal cingula are better developed. Because of uncertainties concerning characteristics of primitive eutherian dentitions, differences in structure of P^4_4—presence of metaconid and postcingular development—cannot be clearly evaluated. Although they are possibly closely related, contrasting patterns of molar specialization suggest that *Purgatorius* probably was not derived from *Protungulatum donnae* or its descendants.

Gypsonictops, the only known latest Cretaceous leptictid insectivore, has been cited (*11*) as representative of the ancestry of Primates. Extensive molarization of P^4_4 and their functional relationships (*12*), sharp differentiation of postcingulum from protocone, and anteroposterior compression of high trigonids are specializations suggesting that known species of *Gypsonictops* are not involved in primate ancestry.

Latest Cretaceous palaeoryctid insectivores—*Cimolestes, Procerberus,* and particularly *Batodon* [considered an erinaceotan insectivore by some (*7*)]—have been posited as ancestors of Primates. Their dentitions, exhibiting modifications emphasizing puncturing and shearing, show no evidence of the trends toward more bunodont cusps and emphasis on crushing characterizing the evolution of early primate dentitions. Similarities appear to be common inheritances from the primitive eutherian tribosphenic dentition, which is characterized by: tribosphenic organization with sharp cusps and crests; a premolariform or submolariform P^4_4 [that is, lacking or with a poorly differentiated metaconid or metacone (*13*)]; pronounced difference in trigonid-talonid heights; M_3 talonid not distinctly elongated; and upper molars of transverse proportions, lacking hypocones or postcingula.

Recent speculations on origins of the Primates tend to ebb and flow toward favoring either a leptictid or palaeoryctid ancestry within Late Cretaceous Insectivora. Considerations of dental morphology as well as basicranial and bullar evolution suggest that the ancestry of Primates did not include latest Cretaceous members of these families. Fox (*14*) has demonstrated the presence of a third, erinaceotan insectivore lineage in latest Cretaceous faunas and this now appears to be a better candidate for the ancestral stock of the Primates.

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Holocene Stratigraphy and Archeology in the Middle Missouri River Trench, South Dakota

Abstract. *Shoreline erosion along man-made lakes in North Dakota and South Dakota has led to the discovery of stratified preceramic cultural remains in an area where previously few such materials have been found. One important exposure, the Walth Bay site, contains a 7000-year sequence of alluvial and eolian deposition capping an abandoned Missouri River terrace. Three distinct soil profiles are associated with successive Late Paleo-Indian, Plains Archaic, and Plains Village Tradition occupations.*

No other geographic area in North America has been the focus of so large a federal archeological salvage program, yet produced so little evidence of preceramic human activity, as has the Middle Missouri area in North Dakota and South Dakota (*1, 2*). This picture is suddenly changing, however, as a result of shoreline erosion along the series of man-made reservoirs spanning the middle Missouri River trench (*3*). Wave action and massive slumping of unconsolidated shoreline formations are exposing and destroying numerous sites (*4*); many undoubtedly contain Pleistocene and Holocene stratigraphic records and associated archeological remains (*2, 5*). One such important site is at Walth Bay on the eastern shore of the Oahe Reservoir in Walworth County, South Dakota. The Walth Bay site is on the western edge of a high terrace about 22 m above the preinundation level of the Missouri River (*6*).

Fieldwork was initiated in 1970 to test the intensive Extended Coalescent Variant occupation of the site (*1*, pp. 115–130). In 1971 several typologically and technologically early stone artifacts were found along the adjacent reservoir shoreline, apparently eroding from a number of subsurface cultural horizons exposed in the reservoir cutbank. Subsequent sampling included removal of a soil monolith from the cutbank for pedological and palynological analysis and excavation of two 1.52-m (5-foot) squares to the base of the cultural deposits, with all matrix water-screened over 1.59-m (1/16-inch) square-mesh screen.

The soil monolith is in the group Ustorthent (*7*), which is basically a vegetation-supporting, structureless sediment exhibiting little or no alteration. Three distinct divisions of the monolith are made on the basis of color (wet), texture, and general information (Fig. 1A). With minor variations in thickness, general site stratigraphy parallels that in the monolith (Fig. 1C). Two recognizable A soil horizons (A_1 and IIA_{1B}/IIA_{3B}) exist throughout the site, and a third ($IIIA_{3B}$) is found locally in areas where it has not been removed by erosion (Fig. 1C).