

A Small Mammal Fauna from the Touchet Beds of Walla Walla County, Washington: Support for the Multiple-Flood Hypothesis

Abstract

Recent work in southeastern Washington has challenged the long-accepted hypothesis that the late Pleistocene Touchet Beds were deposited by one or a few colossal glacial outburst floods from glacial Lake Missoula in western Montana. Work conducted for this study in the northern portion of the Walla Walla Valley has revealed the presence of a diverse and exceedingly well-preserved small-mammal fauna from the middle portion of these flood-related sediments. The remains are preserved with fragile bone elements and dentition intact and virtually no evidence for post-mortem transport or reworking. Biogenic structures interpreted as rodent burrows are prevalent throughout the section. Sedimentary structures and textures preserved at the fossil collection site suggest that the sediments were deposited under conditions of considerable turbulence, and that there were periods of time between depositional episodes characterized by erosion and colonization by small mammals. The data are overwhelmingly supportive of a hypothesis which invokes multiple flood episodes separated in time by decades-long periods of exposure for deposition of the Touchet Beds.

Introduction

The Touchet Beds (late Pleistocene) are widespread in the Walla Walla Valley of southeastern Washington (Figure 1), mantling the

Miocene Columbia River Basalt Group and covering the Pliocene and earlier Pleistocene valley fill deposits. The Touchet Beds and associated erosional topography of the Channeled Scablands

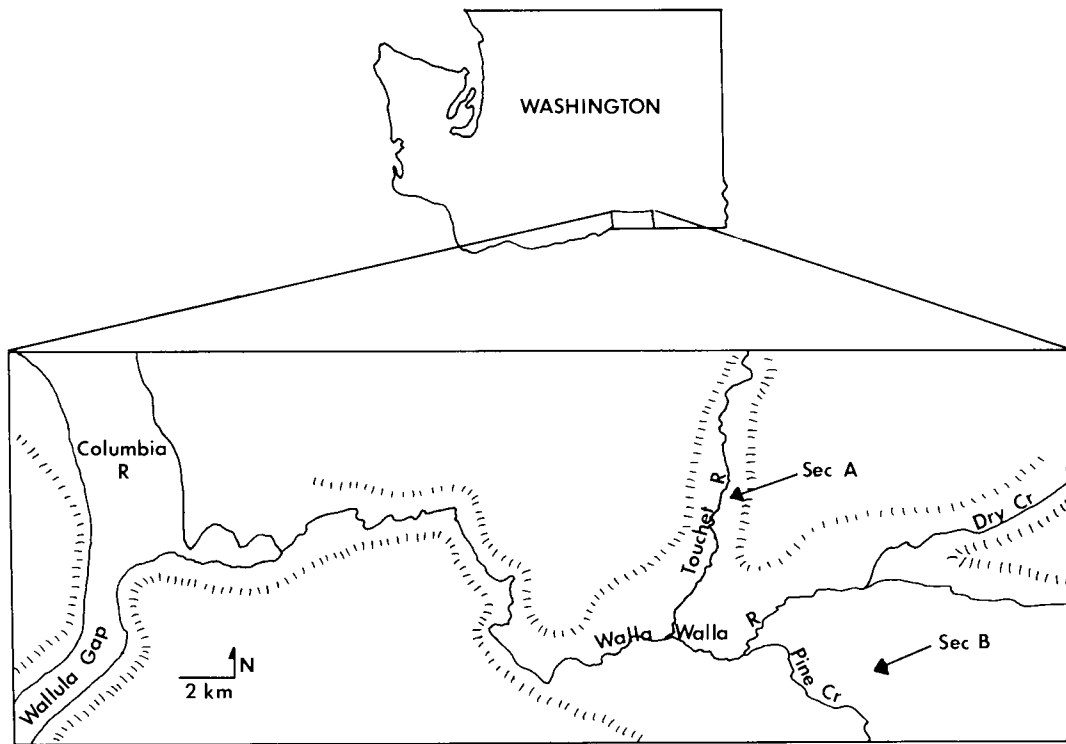


Figure 1. Index map of the Walla Walla Valley showing approximate limits of distribution of the Late Pleistocene Touchet Beds (hatch marks), and location of study sections. Section A represents the Touchet River section, section B the Burlingame Canyon section. After Bjornstad (1980).

have long been recognized as having resulted from flood waters released from the ice-dammed glacial Lake Missoula in western Montana. Exposures of the Touchet Beds in the Pasco Basin and Walla Walla Valley of southeastern Washington comprise a distinctive sequence of graded rhythmites laid down as water backed up behind a hydraulic dam at Wallula Gap, the only outlet for water entering the region (Figure 1).

The mechanisms responsible for deposition of the Touchet Beds have been argued for some time, and from this argument, two schools of thought have emerged. The first interprets the Touchet Beds as the result of a single massive flood or a few floods, with hydraulic surging of the floodwaters giving rise to the characteristic graded rhythmites (Bretz 1923, 1925, 1930, 1969; Bretz *et al.* 1956; Baker 1978; Carson *et al.* 1978; Waitt, 1978; Bjornstadt 1980). The second considers the Touchet Beds as having been deposited by as many as forty or more separate floods, each giving rise to a graded rhythmite, separated in time by decades-long periods of exposure. This view of the Touchet Beds was pioneered by Waitt (1980, 1984, 1985a, 1985b), and supported by Atwater (1984).

This paper will examine the vertebrate fauna and associated biogenic structures recovered from an exposure of the Touchet Beds in the northern Walla Walla Valley. In addition, the sedimentologic characteristics observed at the outcrop will be discussed and interpreted in light of the prevailing ideas regarding depositional mode of the Touchet Beds.

Vertebrate Fauna

Vertebrate fossils belonging to the Order Rodentia have been recovered from the Touchet River section (section A, Figure 1). Represented in the collection to date are members of the families Sciuridae (ground squirrel, 2 skulls), Cricetidae (vole, 1 skull), Heteromyidae (kangaroo rat, partial skull), and post-cranial remains of at least four other individuals from the Order Rodentia. Species-level taxonomy with such a paucity of material is unproductive; however, preliminary study of the fossils shows them to be indistinguishable from species which now inhabit the region.

One of the sciurid skulls in particular is worthy of special consideration because of its

unusually good preservation (Figure 2). This specimen was recovered from a clastic dike approximately 1 m below a thin tephra layer. Bjornstadt (1980) analyzed a tephra at a nearby locality, which occurred at the same apparent stratigraphic level and exhibited similar structures. He found this tephra to fall within the Mt. St. Helens set 'S' chemical group. The Mt. St. Helens set 'S' tephra has been dated at approximately 13,000 ybp (Mullineaux and Grandell 1981). The dike appears to originate from below the collection locality, and thus the skull most likely predates the tephra, which is here approximately 3 m below the modern topographic surface. The base of the Touchet Beds is not exposed in the Walla Walla Valley. At Burlingame Canyon (section B, Figure 1) the section extends for tens of meters below the St. Helens set 'S' tephra. It is, thus, likely that the original depositional locality for the skull is above the base of the Touchet Beds and below the St. Helens 'S' tephra.

Of particular interest is the state of preservation of the skull. All of the dentition is intact (Figure 3a). The zygomatic arches, likewise, are preserved without damage (Figure 3a). The auditory bullae, which are delicate features on recent skull material, are intact (Figure 3b) and the pterygoid processes (Figure 3b) are preserved with minimal damage. Finally, the skull exhibits virtually no evidence for abrasion as a result of post-mortem transport. Other cranial elements are not intact, but had disintegrated in outcrop. Post-cranial remains exhibit excellent preservation, with no evidence for abrasion.

If the Touchet Beds were the result of a single flood, or few floods characterized by hydraulic surging, then the presence of well-preserved, unabraded mammalian remains from the middle portion of the deposit is problematical. If the remains represent members of the local fauna entombed by the initial flood surge, they might be preserved in their present condition, but at or near the base of the deposit. If the remains were transported into the area by a later flood surge, they might be preserved in the middle of the deposit, but would certainly exhibit evidence of transport, such as abraded surfaces and/or broken features. The best explanation for the occurrence of a well-preserved mammalian fauna in the middle of the Touchet Beds is that it represents the remains of an established local fauna which experienced minimal (or no)



Figure 2. Sciurid skull recovered from a clastic dike in the Touchet River section of the Touchet Beds. A: dorsal view; B: ventral view; C: left lateral oblique view.



Figure 3. A: Upper left dentition and zygomatic arch of sciurid (ground squirrel) skull. B: Auditory bullae (1) and pterygoid process (2) of sciurid skull. Specimen from Touchet River section. Scale bar equals 0.5 cm.

transport during a distinct flood episode. This is consistent with other physical and biogenic evidence presented in the following section and is supportive of the hypothesis which invokes multiple flood episodes with decades-long exposure between floods.

Sedimentology

Two well-exposed sections of Touchet Beds were sampled for this study (see location map, Figure 1). Stratigraphic control within the sections is provided by the occurrence of Mt. St. Helens set 'S' tephra at the top of each sampled interval. The Burlingame Canyon section (section B, Figure 1) represents what is considered to be typical of the Touchet Beds in this region. The Touchet River section (section A, Figure 1), from which the fossils were recovered, represents somewhat different sedimentologic conditions as interpreted from differences in grain size parameters, physical sedimentary structures, and geographic location.

The Burlingame Canyon section, where there are as many as 40 rhythmites exposed, displays well-developed graded bedding within each rhytmite, with the basal sand giving way upward to silt representing standing water, and in some cases, a thin veneer of massive silt capping the rhytmite. Mean grain size for samples representing the base, middle, and top of rhythmites reflects this fining-upward trend (Figure 4, lower right). Values for standard deviation (a measure of sorting) show corresponding variation within each rhytmite (Figure 4, upper right). Samples from the Touchet River section do not show the same trends in grain size distribution. Mean grain sizes generally show low or erratic variability within rhythmites as well as consistently smaller mean grain size (Figure 4, lower left). Similarly, sorting values are considerably more consistent, again with little apparent trend within rhythmites (Figure 4, upper left). In addition, rhythmites from the Touchet River section do not have clear upper and lower boundaries and were difficult to distinguish visually while in the field.

Plots of standard deviation (sorting) versus mean grain size are shown in Figure 5. Samples from the Burlingame Canyon section (Figure 5, right) allow reasonable grouping of data points into lower, middle, and upper rhythmites. The Touchet River section (Figure 5, left), by contrast,

shows relatively tight grouping of all data points, and poor separation of lower, middle, and upper rhythmites. The graphic data supports the field observation that rhythmites are poorly developed in the Touchet River section as compared to the Burlingame Canyon section.

Sedimentary Structures: Primary sedimentary structures observable in outcrops can be used to interpret the conditions of deposition in the two study sections. The Burlingame Canyon section shows, from base to top within each rhytmite, a transition from planar bedding (lower-upper flow regime transition) to ripples and climbing ripples, and finally to massive bedding reflecting deposition from suspension and/or eolian deposition. These structures suggest an initial flood surge and deposition of a traction load followed by rapidly decreasing energy. In addition, paleocurrent directions are consistently up-valley for the lower to middle portions of rhythmites. The Touchet River section, while displaying moderately well-developed ripples and cross-stratification, shows no clearly definable transition in flood energy within rhythmites. Planar beds were not noted, and massive bedding at the tops of rhythmites was irregularly preserved. In addition, ripples did not show a consistent orientation, suggesting that paleocurrent directions were highly variable.

Biogenic sedimentary structures, primarily small-diameter cylindrical features attributed by Waitt (1980) to burrowing activity of rodents, are prevalent throughout both sample sections. Alcorn (1940) has indicated that modern rodents burrow to a maximum depth of 2 m below ground surface. The presence of burrows throughout thick sections of the Touchet Beds suggests that they are a result of burrowing which was contemporaneous with deposition, rather than a result of the burrowing activity of modern rodents. In addition, Waitt (1980) pointed out that the burrow-filling sediment is compacted to a degree equivalent to that of the surrounding sediment, suggesting contemporaneous compaction of the Touchet Beds and the burrow-filling sediment. The St. Helens set 'S' tephra is extensively perforated by small diameter (less than 1 cm) features, which Spencer (1987) suggested might be insect burrows and which may indicate exposure or near exposure subsequent to deposition of the tephra. An alternative explanation for these features was presented by Bjornstad (1980):

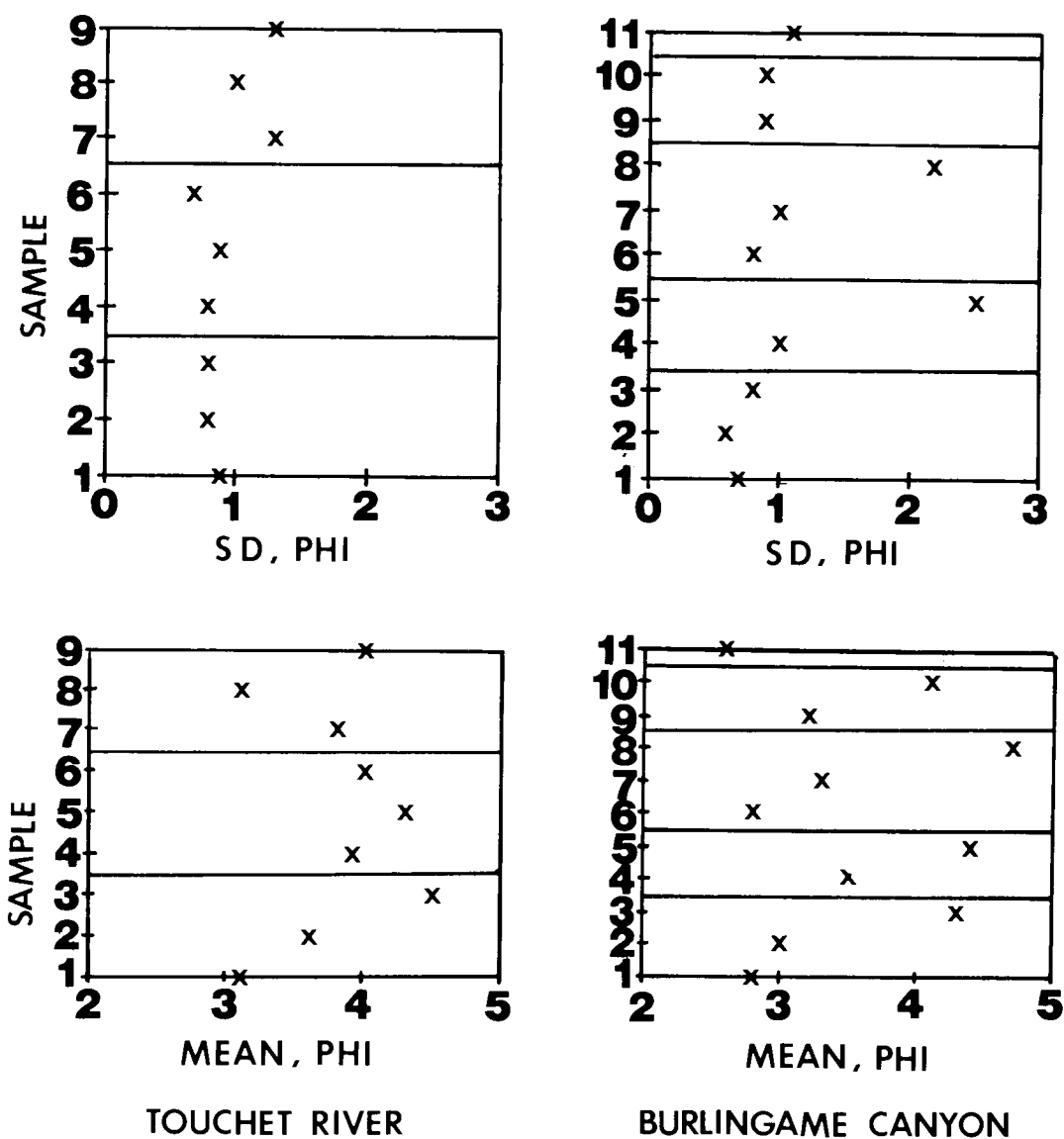


Figure 4. Plots of Standard Deviation versus sample (upper graphs) and Mean grain size versus sample (lower graphs) for the Touchet River section (left) and the Burlingame Canyon section (right). Solid horizontal lines represent rhythmic boundaries. Mount St. Helens set 'S' tephra located at top of each sampled interval.

he proposed that they represent hydroplastic injection structures.

The tephra itself may be used to suggest exposure or near exposure at the time of its deposition. It is difficult to envision an airfall tephra accumulating to a thickness of a few centimeters if the valley was occupied by deep, turbulent waters resulting from a single flood. The thick-

ness and purity of the tephra suggests a valley which was drained or nearly drained at the time of deposition.

The sedimentologic data is best explained as a result of the size and location of tributary valleys (Touchet River section) with respect to the Walla Walla Valley (Burlingame Canyon section). The center of the Walla Walla Valley (section B,

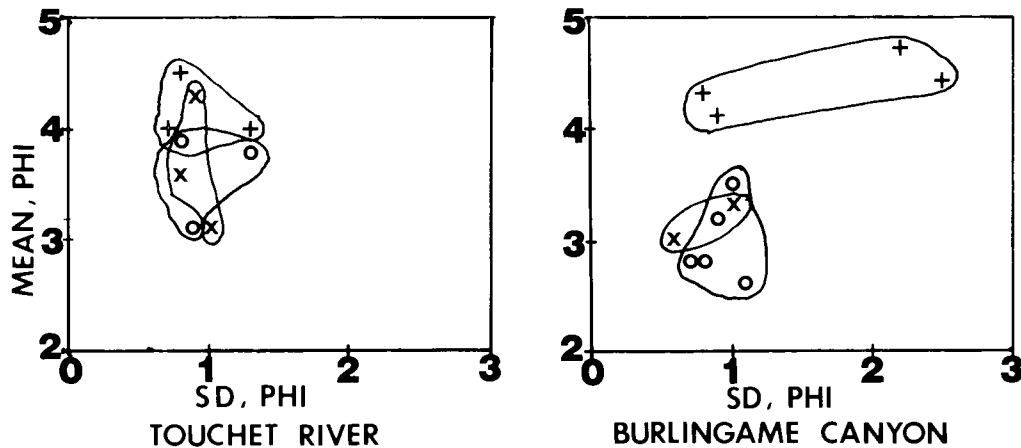


Figure 5. Plots of Standard Deviation versus Mean grain size for the Touchet River section (left) and the Burlingame Canyon section (right). Samples grouped according to position within rhythmite (+: upper; x: middle; o: lower).

Figure 1) would be expected to experience the most variability in conditions during advancing floods. In these areas, sedimentary structures and statistical parameters of sediments reflect rapidly changing energy conditions during flooding. Tributary valleys (Touchet River section, section A, Figure 1) would be expected to be more continuously turbulent (conditions more uniform) as a result of the fact that they are both shallower and narrower than the main valley. In addition, the higher elevation tributary valleys would be the first to drain after a flood episode, and would experience more intense post-flood erosion, and thus removal of upper rhythmites, as a result of their higher gradient. Observed structures and statistical parameters for the Touchet River section reflect these phenomena.

Conclusions

Small-mammal fossils recovered from an exposure of the late Pleistocene Touchet Beds are exceedingly well-preserved, with fragile bone elements and dentition preserved unbroken. In addition, the fossils show no evidence for abrasion or reworking, suggesting little or no transport prior to burial and fossilization. Associated with the fossils, and present throughout both study sections, are abundant rodent burrows. The available evidence indicates that the fossils represent the remains of members of an established local community of mammals

which was destroyed during a distinct flood episode.

Sedimentologic parameters for samples from two measured sections of the Touchet Beds suggest that the conditions of deposition of these sediments were variable dependent upon geographic location within the Walla Walla Valley region. The Burlingame Canyon section, located in the center of the Walla Walla Valley, was characterized by rapidly decreasing energy during flood episodes, which resulted in well-developed graded rhythmites. The Touchet River section, located in a narrower, shallower tributary valley, was characterized by uniformly turbulent conditions during deposition, which resulted in poorly-developed graded rhythmites. In addition, the higher elevation and steeper gradient of the tributary valley gave rise to more rapid drainage, and more vigorous post-flood erosion. This, in turn, resulted in removal of the fine-grained upper portion of the rhythmites in the Touchet River section.

The presence of a well-preserved small-mammal fauna within these sediments strongly supports the hypothesis which invokes multiple flood episodes, separated by decades-long periods of exposure characterized by erosion and/or non-deposition, to explain the deposition of the Touchet Beds.

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Received 12 July 1988

Accepted for publication 1 February 1989