

PLEISTOCENE FRESHWATER MOLLUSKS ON THE FLOOR OF OWENS LAKE PLAYA, EASTERN CALIFORNIA

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ABSTRACT

Patches of shelly sediments on the floor of Owens Lake playa contain a freshwater molluscan fauna dominated by two planorbid snails, *Helisoma newberryi* (Lea) and *Vorticifex effusa* (Lea). Other less common species include the valvate snails, *Valvata utahensis* Call and *Valvata humeralis* Say; the planorbid, *Gyraulus parvus* (Say); and a sphaeriid clam, *Pisidium* sp. The assemblage is indicative of a fully developed pluvial lake. Other studies have demonstrated that the late Pleistocene (probably early Wisconsinan) source beds for these mollusks are folded and faulted in the vicinity of Point Bartlett, with the shells having been eroded and reworked during late Wisconsinan and Holocene lake level highstands. A trench excavated in this area confirms this complex pattern of reworking from truncated limbs of folded Pleistocene lake beds. In this way, older Pleistocene mollusks have "leaked" into younger Pleistocene and Holocene depositional environments, potentially mixing fossils from different pluvial cycles.

INTRODUCTION

The floor of Owens Lake, now an intermontane playa in the southwestern Great Basin, is dotted with small patches of shelly sediments. In the vicinity of Point Bartlett and the old Pittsburgh Plate Glass Company soda plant in the northwestern portion of the playa (Figures 1, 2), the shelly patches are roughly circular to elongate in outline and generally less than 3 m in longest dimension. On first inspection the shelly patches appear to be windrows, bars and thin blankets of littoral lake deposits containing thousands of planorbid snails, formed during the last series of Holocene highstands of lake level (see Smith and Street-Perrott, 1983). Trenching reveals, however, that some of the shelly patches are surface "leaks" where older Pleistocene mollusks have been reworked into younger Pleistocene and Holocene de-

positional environments. Other shelly areas in the same part of the playa are, in fact, Holocene littoral bars and sediment veneers containing shells presumably derived from the leaks. This suggests a complex pattern of exposure and redistribution of freshwater fossils, and their incorporation in much younger deposits—a potentially important process in tectonically active lacustrine basins.

In this paper I describe the mollusks from a series of samples collected "offshore" from Point Bartlett, in an area of folded and faulted Pleistocene lake beds (structures described in detail by Carver, 1969). This is the only complete inventory of Pleistocene freshwater mollusks documented for Owens Lake, although mollusks from the lake and other localities in the region have been mentioned in biogeographic studies (e.g., Taylor, 1985). I will compare characteristics of shells collected from patches apparently located at two surface leaks with shells from sediments not directly associated with a leak, to determine if shells show any obvious signs of reworking, exposure, and redeposition. Results of trenching across one surface leak also are described. All gastropods and bivalves used in this study have been deposited in the Invertebrate Paleontology Collection, Academy of Natural Sciences of Philadelphia.

Point Bartlett Study Site. — Owens Lake playa is located at the southern end of Owens Valley, a Late Cenozoic graben bounded by the Sierra Nevada on the west and the Inyo Mountains on the east (Figure 1a). The lake basin occupies the widest part of the graben and is filled with over 2500 m of mostly fine-grained sediments (Smith and Pratt, 1957; Hollett *et al.*, in press). In the northwestern corner of the playa, lake beds are folded and disrupted by faults probably related to the Owens Valley fault zone (Carver, 1969). The conspicuous ridge-and-swale topography in this area is the surface expression of the folded Pleistocene beds. At Point Bartlett

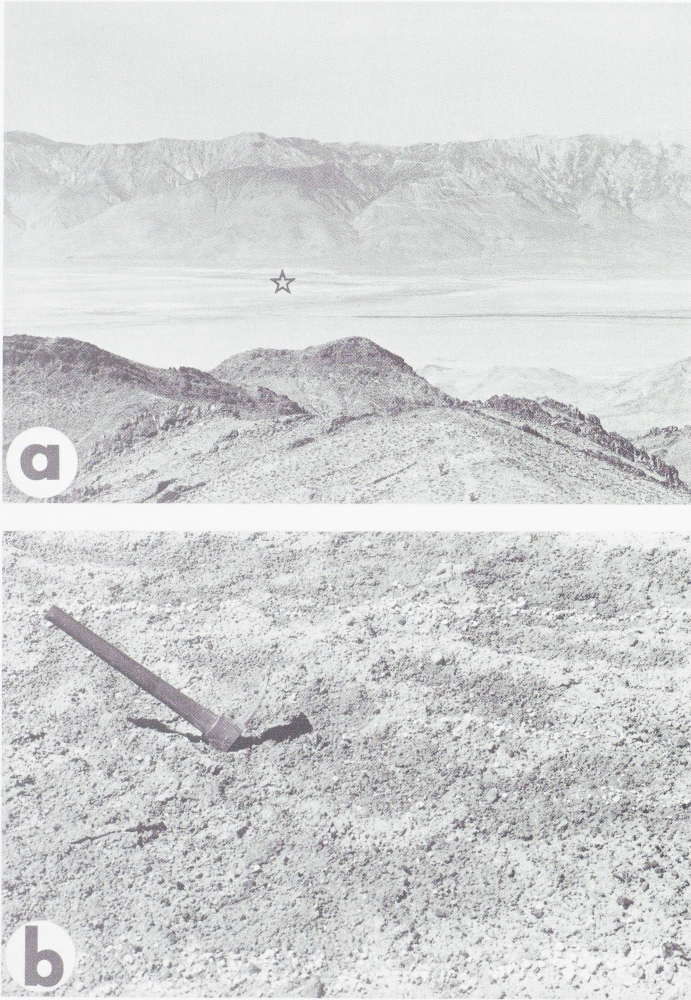


Figure 1. *a*, Point Bartlett study site (star) as seen from western slope of Cerro Gordo in the Inyo Mountains, with Sierra Nevada in the background; *b*, Linear shelly patches on the playa floor (handle of digging tool is approximately 0.5 m long).

(Figure 2), these beds are predominantly lacustrine muds with minor sand and gravel interbeds of early Wisconsinan age overlain by late Wisconsinan to Holocene beach deposits, nearshore bars, and thin veneers of windblown sand and evaporitic crusts (Carver, 1975; Saint-Amand *et al.*, 1987).

Three large bulk samples were collected southeast of Point Bartlett. Three different types of shelly surface deposits were collected: 1) a linear windrow-like shelly patch apparently located above a shell leak; 2) an elliptical patch, also apparently above a leak; and 3) a shelly sediment blanket covering the face of a 1-metre-high scarp and not directly associated with any obvious Pleistocene outcrops. A total of 16 litres of shelly sediments from the three different patches were wet-sieved on a screen with 2 mm openings, and all fossils were identified, counted, and general notes made on the condition of shells. Over 7700 specimens of mollusks were recovered, including nine species of gastropods and one bivalve. A few fish bones also were recovered. Table 1 contains inventories of the samples; Plate 1 illustrates the dominant taxa.

At a linear shelly patch (star in Figure 2) a trench was dug perpendicular to the patch to a depth of 0.5 m. This exposed what appeared to be steeply-dipping, light olive gray (5 Y 5/2) clay containing two shelly sand lenses (Figure 3). If the shell lenses are indicative of primary stratification, the beds here dip 74°W and strike N6°W. Alternatively, considering the steepness of apparent bedding and the blocky, fractured fabric of the mud, these shelly layers could be clastic dikes that brought shelly sand to the playa floor from several metres below the surface. Both interpretations are plausible because lake beds are folded and faulted near Point Bartlett. Moreover, Carver (1969, Plate 2) mapped bundles of fault scarps trending nearly north-south in this same area. A third possibility is that the shelly layers are really fissures in the blocky, dessicated Pleistocene mud that were filled from above with younger lacustrine sediments.

Because the surface deposits over much of this area are gravelly sands but shelly layers exposed in the trench wall lacked

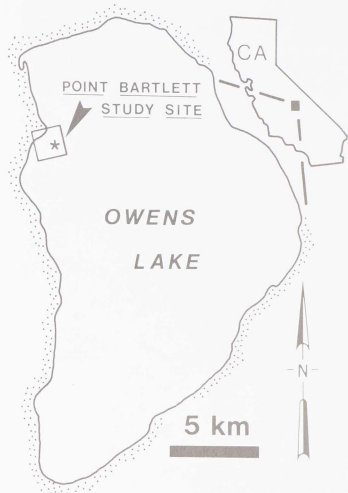


Figure 2. Location of Owens Lake playa and Point Bartlett study site. Star is location of trench shown in Figure 3.

gravel, leakage of younger into older lake beds probably can be ruled out. In addition, shell density (specimens/area of lake floor) is usually highest near the leaks, suggesting that the leaks are sources and not sinks for reworked shells. It is more difficult to determine if the trench exposed a clastic dike or steeply dipping shelly lenses. Possible evidence that the shelly layers are fracture-disrupted lenses includes grayish olive (10 Y 4/2) color mottles in the trench wall that were elongate and parallel to the lenses, suggesting stratification in the surrounding mud. At present, this particular shell leak is interpreted as the eroded limb of a fold (Figure 4). Other leaks could be clastic dikes. Only extensive trenching would decide which type of shell leakage is prevalent and the precise relationship to structural elements.

POINT BARTLETT MOLLUSKS

Taxonomic Composition. – Most of the



Figure 3. Trench dug through a linear shelly patch (L) showing shell lenses or possibly clastic dikes (S) intersecting playa floor. Pencil near edge of trench is 14 cm long.

specimens in the samples were the distinctive planorbid snails, *Helisoma newberryi* (Plate 1, figs. 1a, b) and *Vorticifex effusa* (Plate 1, figs. 3a, b). Both species are common in Quaternary deposits of western

North America, with *H. newberryi* restricted to the Interior Basin Drainage (see Burch, 1982; Taylor, 1985). The widely distributed planorbid, *Gyraulus parvus* (Plate 1, fig. 4), was uncommon in the samples. Next in importance to planorbids were the valvatid snails, *Valvata utahensis* and *Valvata humeralis* (Plate 1, figs. 5 and 6). *Valvata utahensis* is another species restricted to the Interior Basin, but *V. humeralis* is more widely distributed in western North America (Burch, 1982; Taylor, 1985). A single unidentified species of *Pisidium* made a strong showing in one sample and was the only bivalve recovered (Plate 1, fig. 7). Other mollusks, including another small planorbid, at least one species of hydrobiid, a physid, and a lymnaeid, were represented by only a few specimens (Table 1).

The Owens Lake fauna described here is dominated by taxa of Taylor's (1985, Table 3) environmental "Group C", which includes snails of large freshwater lakes and permanent rivers. These taxa are *Helisoma newberryi*, *Valvata utahensis*, and probably *Vorticifex effusa*. Other taxa, including *Valvata humeralis*, *Gyraulus parvus*, and *Physa* sp., are more typical of Taylor's "Group E", snails of small or seasonal freshwater lakes and streams. This suggests that the Point Bartlett samples contain mixtures of snails from a large, fully developed lake together with snails from shallow, perhaps peripheral ponds and streams. Occurrence of the mixed molluscan fauna in sand lenses (Figure 3) might indicate overlap of the ranges of snails within the same lacustrine basin as lake level fell following a "pluvial maximum." At Owens Lake, such sand layers sometimes are succeeded vertically by gravelly intervals denoting progradation of alluvial fan deposits during interpluvial periods (G.A. Carver, person. comm.). Considering the abundance of taxa such as *Helisoma newberryi*, however, conditions must have been closer to fully pluvial when the shelly lenses were deposited, with Owens Lake forming a link in the chain of late Pleistocene intermontane lakes that occupied the Owens, China, Searles, Panamint, and Death Valley basins (see Smith and Street-Perrott, 1983, p. 197-199). The same mollusks are

Table 1. Pleistocene fossils from the floor of Owens Lake near Point Bartlett (see Figure 2).

TAXA ¹	ORGANISM TYPE ²	HABITAT ³	PLEISTOCENE SHELL LEAKS		SCARP FACE SAMPLE (7 litres)
			Linear (4.3 litres) ⁴	Elliptical (5 litres)	
<i>Helisoma newberryi</i> (Lea, 1858)	G : Pl	LPW	1276 (92.1%) ⁵	2568 (47.7%)	559 (73.3%)
<i>Vorticifex effusa</i> (Lea, 1856)	G : Pl	LPW	47 (3.4)	2086 (38.7)	84 (11.0)
<i>Valvata utahensis</i> Call, 1884	G : Va	LPW	34 (2.5)	383 (7.1)	27 (3.5)
<i>V. humeralis</i> Say, 1829	G : Va	SPW	27 (1.9)	295 (5.5)	77 (10.1)
<i>Gyraulus parvus</i> (Say, 1817)	G : Pl	SPW	1 (0.1)	27 (0.5)	4 (0.5)
? <i>Ammicola</i> sp.	G : Hy	?	-	6 (0.1)	12 (1.6)
<i>Physa</i> sp.	G : Ph	SPW	-	15 (0.3)	-
? <i>Planorbula</i> sp.	G : Pl	?	-	1 (0.02)	-
Lymnaeid indet.	G : Ly	?	-	1 (0.02)	-
<i>Pisidium</i> sp.	B : Sp	?	223	9	37
Fish bones	T : ?	?	rare	rare	rare

1 - Sources used to identify mollusks: Henderson, 1929; Hanna 1963; Burch, 1975, 1982
2 - G : Pl = Gastropoda: Planorbidae; G : Va = Gastropoda: Valvatidae; G : Hy = Gastropoda: Hydrobiidae; G : Ph = Gastropoda: Physidae; G : Ly = Gastropoda: Lymnaeidae; B : Sp = Bivalvia: Sphaeriidae; T : ? = Teleostei: family unknown
3 - LPW = large perennial waters; SPW = seasonal or small perennial waters (after Taylor, 1985)
4 - Volume of bulk sediment sample
5 - Relative abundance of snails only

found in Quaternary deposits throughout this system of lacustrine basins (Hanna, 1963; Taylor, 1985).

Preservation of Shells. - Characteristics of the four numerically dominant snails were evaluated to identify differences between shells occurring at the leaks and shells not directly associated with a surface exposure. Criteria used in the comparison were: 1) taxonomic composition; 2) abundance of shells (specimens/litre of sediment); 3) maximum size of specimens; 4) fragmentation; and 5) surface condition and diagenetic alteration of shells. Matrix lithology also was compared. These are essentially the criteria suggested by Johnson (1960) for evaluation of taphonomic history of shelly fossil deposits.

All samples were dominated by the same four species of snails, although relative abundances varied (Table 1). Both thin, fragile shells and more robust, thicker-shelled specimens were found in all three samples. There was no obvious difference in proportion of broken shells; all samples

consisted of 20-25% of specimens as fragments, and these were mostly the thin-shelled juveniles.

Abundance of shells from the linear surface leak was 322 shells/litre, while that of the elliptical leak was 1076 shells/litre. In the sample from the sediment veneer covering the scarp face, abundance was only 102 shells/litre (Table 1). All three samples contained complete growth series of the two most abundant snails, *Helisoma newberryi* and *Vorticifex effusa*, but maximum size for both species was greater in the shell leak samples. The largest *Helisoma* shells were 19.5 mm in diameter in both leak samples, but 16 mm in the scarp sample. *Vorticifex* had maximum diameters of 10.5 and 11.0 mm in the leak samples, but only 8.5 mm in the scarp material. Both the differences in abundance and maximum sizes could reflect winnowing during the erosion of Pleistocene lake beds, or could represent primary characteristics of the source deposits. The most striking difference was in diagenetic alteration of shells. Approximately 90% of shells

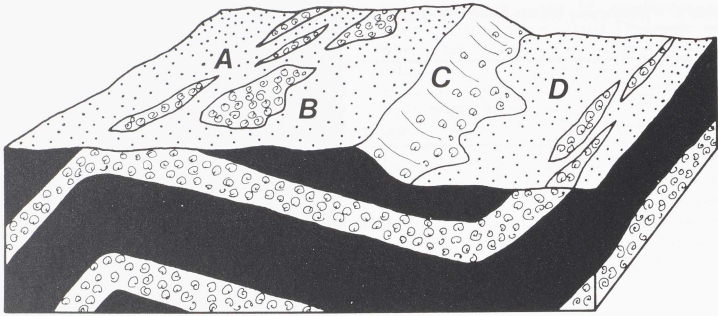


Figure 4. Interpretive block diagram showing linear shelly patches (A) and elliptical shelly patches (B) as surface leaks resulting from erosion of folded lake beds. Sparsely fossiliferous sediment covers the face of a small scarp (C) and pebbly sand surrounds all the shelly areas (D). (Not drawn to scale.)

from the scarp sample were discolored (Plate 1, fig. 2), resembling "black shells" from palimpsest and relic deposits on modern marine continental shelves (Pilkey *et al.*, 1969). Fewer than 5% of the shells in the other samples were blackened. As in the case of continental shelf fossils, the discoloration is probably the result of partial replacement by iron monosulphide and pyrite. Mollusk shells collected from anaerobic zones of modern lakes typically are blackened in this way (A. E. Bogan, person. comm.). Finally, the matrix in the leak samples was olive gray (5 Y 3/2), fine-medium sand; the scarp was covered with olive brown (5 Y 4/4) to yellowish gray (5 Y 7/2), pebbly sand.

Although the differences between near-source samples and material not directly associated with an outcrop seem fairly clear here, it is not known if characteristics such as diagenetic alteration are reliable

guides to prolonged exposure of shells. In fact, any of the characteristics mentioned above could have been imprinted on the shells from the scarp sample prior to the late Pleistocene or Holocene erosion and redistribution. There is still the preliminary indication, however, that shells not directly associated with a leak show more signs of exposure and alteration, suggesting a more complex taphonomic history compared to shells from near outcrops.

SIGNIFICANCE

Lacustrine paleoecology is undergoing a revival, as shown by the number of recent papers, symposia, and entire journal numbers dedicated to the biota of lakes (e.g., Smiley, 1985; Forester, 1987; Gray, 1988). In step with this revival of interest is an increasing awareness of the taphonomic problems unique to different types of lakes and to varied lacustrine depositional envi-

PLATE 1

Figures

- 1 a, b. *Helisoma newberryi* (Lea). Height 6.5 mm, diameter parallel to aperture 7.0 mm.
2. Blackened apical fragment of *H. newberryi*. Width measured horizontally 8.0 mm. Compare with 1b.
- 3 a, b. *Vorticifex effusa* (Lea). Height 4.5 mm, diameter 7.5 mm.
4. *Gyraulus parvus* (Say). Diameter 2.9 mm.
5. *Valvata utahensis* Call. Height 3.7 mm.
6. *Valvata humeralis* Say. Height 2.5 mm.
7. *Pisidium* sp. Height 3.3 mm, length 3.2 mm.

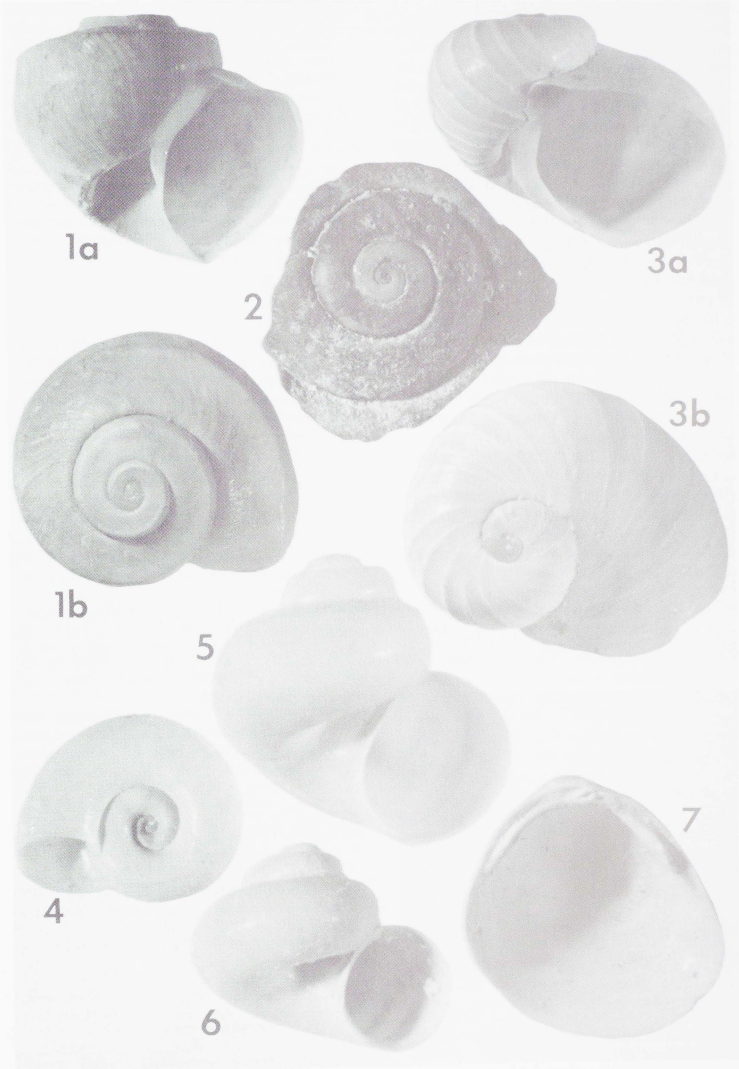


PLATE 1

ronments. The shell leaks at the floor of Owens Lake playa illustrate a potentially important process of reworking that could influence the compilation of fossil sequences in tectonically active lacustrine basins. This type of reworking would go unnoticed if angular unconformities are not obvious, if incompatible environmental signals (*e.g.*, snails of large freshwater lakes + littoral bedforms and beach deposits + evaporitic crusts) are not detected, or in cases where mollusks have long stratigraphic ranges. As shown in this study, it may not be possible to identify unequivocally reworked shells based solely on the condition of specimens, although it is likely that reworked and redistributed material will be altered in ways suggestive of recycling (*e.g.*, size-sorting, fragmentation, and possibly black shells). Temporal mixing would be especially hard to detect in subsurface cores that sample thick sequences of mostly massive muds (see Smith and Pratt, 1957). Reworking of mollusks on this scale does not merely blend many generations of organisms or the fauna of different benthic communities into time-averaged assemblages, but could result in the comingling of fossils from different pluvial cycles.

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