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THE WESTERN LAKE SUPERIOR FRESHWATER MUSSEL (BIVALVIA: UNIONIDAE) COMMUNITY AND ITS ORIGIN

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ABSTRACT. Nine species of freshwater pearly mussels (Bivalvia: Unionidae) occur in the western Lake Superior basin. All of these species, except *Elliptio complanata* (Lightfoot), entered the Superior drainage from the Interior Basin via Late Wisconsin high-water spillways; the chronology of availability of these channels is described. *E. complanata* invaded in the Recent from the eastern Great Lakes. A new record of *Utterbackia imbecillis* (Say) is reported, and the anomalous distributions of *Amblema plicata* (Say) and *Strophitus undulatus* (Say) are discussed.

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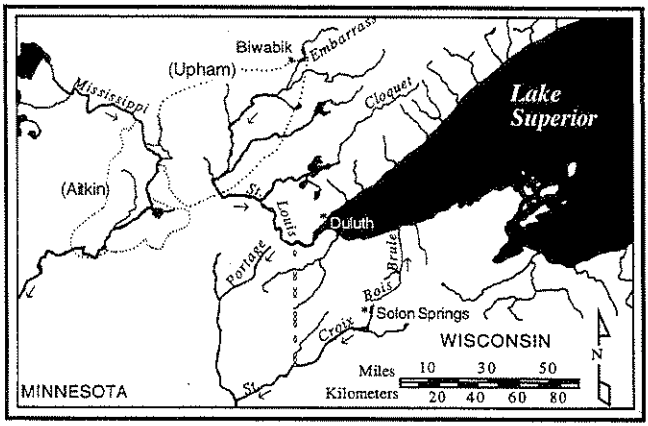

Figure 1. Map of the western Lake Superior basin and adjacent drainage systems. Dotted lines indicate the shores of Late Wisconsin glacial lakes (teste *Hobbs, 1983*)*; arrows indicate the present direction of flow.*

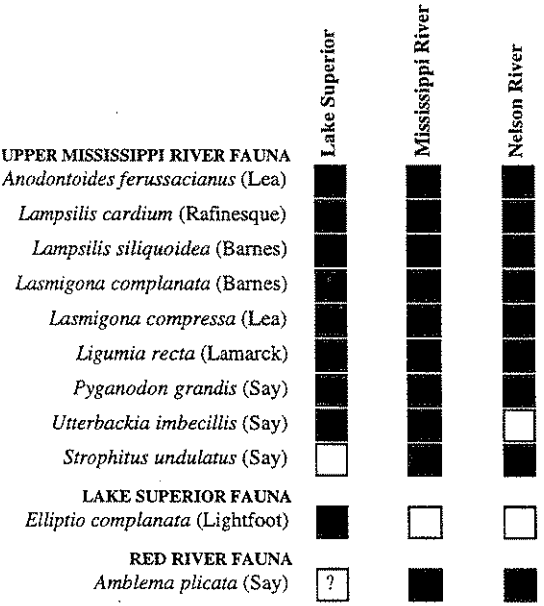

Figure 2. The freshwater pearly mussel community of the western Lake Superior drainage and its distribution in that and neighboring watersheds. Shaded box = present; black box = new record; empty box = not reported; ? = a spurious record.

INTRODUCTION

Nine species of freshwater pearly mussels (Bivalvia: Unionidae) have been previously recorded from the western Lake Superior basin. However, even such a depauperate assemblage is of zoogeographical significance. Our purpose is to describe the distribution and origin of this community.

The western Lake Superior basin is defined as that portion of the Lake watershed extending west from the arbitrary boundary of 90° W (Figure 1). That area is relevant as a region of confluence between the Great Lakes, Nelson River and upper Mississippi River during the final stages of Wisconsin glaciation.

METHODS AND MATERIALS

Unionid distributions were determined using deposited specimens and the available literature. The holdings of the James Ford Bell Museum of Natural History (JFB), University of Minnesota were searched using *The Bell Museum of Natural History Collection Database* (Graf *et al.*, unpublished) for Lake Superior System mussels. Literature on the Unionidae of Lake Superior in general (Goodrich and van der Schalie, 1932; van der Schalie, 1961; Johnson, 1980), the western Lake drainage (Grant, 1887; Baker, 1928; Dawley, 1944, 1947; Smith and Moyle, 1944; Moyle, 1947; Mathiak, 1979), and others (Dall, 1905; Walker, 1913; Graf, 1997a) were reviewed. Taxonomy follows Williams *et al.* (1993) and these mollusks were figured by Clarke (1973) and Baker (1928).

Short expeditions were undertaken in 1994 and 1996 to sample the St. Louis River drainage and its tributaries. Both live and dead unionids were collected by wading and

snorkeling. Vouchers have been deposited in the JFB and the Museum of Comparative Zoology, Cambridge, Mass.

THE MUSSEL COMMUNITY OF THE WESTERN LAKE SUPERIOR BASIN AND ITS ORIGIN

Nine species of freshwater pearly mussels have been previously noticed in the western Lake Superior drainage (Figure 2; see references above). In addition to these, we collected *Utterbackia imbecillis* in Embarrass Lake at Biwabik, Minnesota on separate occasions in 1994 and 1996. Until now, *U. imbecillis* has not been known in the Great Lakes basin west of Lake Michigan (Baker, 1928; Mathiak, 1979; Goodrich and van der Schalie, 1932).

During the Pleistocene, any unionid community that existed in Lake Superior and its tributaries was eliminated by glacial advance. As the last Wisconsin ice wasted north, the meltwater liberated was impounded into large glacial lakes that bridged present-day drainage divides. Such breeches between the Mississippi and Lake Superior drainages allowed mussels (via their host fish) to disperse into the latter from unglaciated southern refugia (Johnson, 1980).

For the ten mussel species recorded from the Lake Superior basin, three basic patterns of distribution are evident (Figure 2). Nine of these species also occur in the adjacent Mississippi basin; of these, only *A. plicata* is not found in that watershed above St. Anthony Falls at Minneapolis, Minnesota. Graf (1997a) considered the anomalous distribution of this unionid spurious, and since its presence in the Lake Superior basin is suggested by only a single valve, we concur.

The remaining eight species have been united as the Upper Mississippi River Fauna (UMRF) by Graf (1997a) based on their common occurrence in the Mississippi above

St. Anthony Falls. *Strophitus undulatus* was also included in this assemblage but has not been reported from the Lake Superior basin (see discussion below).

A single species, *Elliptio complanata*, occurs only in Lake Superior and no other adjacent catchment; it is the lone member of the Lake Superior Fauna (LSF) (Figure 2). While mussels of the UMRF occur in Lake Superior and its western tributaries, the LSF is confined to the Lake proper.

The earliest Unionidae to re-invade the western Lake Superior drainage were those of the UMRF. Beginning around 11,300 years before present (bp) (Clayton and Moran, 1982), invasion of the Lake basin occurred via any of three late Pleistocene breeches in the Great Lakes-Mississippi divide. The first breech lasted until 11,000 bp (Hobbs, 1983) and was formed by a short-lived pair of glacial lakes known as Aitkin and Upham (Figure 1). Their confluence at the highest lake levels united the Mississippi and Lake Superior basins.

The second and third breeches of the Mississippi-Lake Superior divide occurred while Lake Superior overflowed via two distinct channels to the St. Croix River, a tributary of the Mississippi River (Figure 1). The lake in the Superior basin, ice-dammed to a level higher than at present, spilled via the Portage River near Moose Lake, Minnesota and reversed the flow of the Bois Brule River at Solon Springs, Wisconsin. Thus, members of the UMRF migrated up the St. Croix-Portage or St. Croix-Brule spillways to the south shore, or they dispersed up the Mississippi through Glacial Lake Aitkin-Upham to the St. Louis River and other north shore streams to gain access to the western Lake Superior basin.

Although there is some disagreement regarding the sequence of availability of the two overflow channels (*e.g.*, Clayton, 1983; Farrand and Drexler, 1985), direct confluence

between the Superior Basin and Mississippi below St. Anthony Falls was permanently arrested around 9500 bp (Clayton and Moran, 1982). By that time, the ice dam at its outlet to the eastern Great Lakes had wasted, and Lake Superior shrank to its present level.

Besides these reasonably well-dated breeches, Martin (1911) suggested that the initial retreat of glacial waters in the western lake basin left the Cloquet and upper St. Louis rivers flowing southwest to the Mississippi rather than southeast to the lower St. Louis River. Eventually the upper St. Louis was captured by the headward migration of the lower St. Louis (Ojakangas and Matsch, 1982). The chronology of such a connection is unclear, but it was certainly a post-Aitkin-Upham event. Since it would have also succeeded the formation of St. Anthony Falls (Graf, 1997b), no unionids other than those UMRF could have used it.

Within the last 80 years or so, *E. complanata* has moved into the western Lake Superior drainage from the eastern Great Lakes (Graf, 1997a). *E. complanata* will likely remain limited to only the Lake proper since the St. Louis River and other north shore tributaries are isolated by waterfalls which limit unionid dispersal.

CONCLUSIONS AND COMMENTS

The western Lake Superior basin (indeed, the Lake Superior basin in general), in terms of unionid species composition, is very similar to the upper Mississippi River drainage. Of the 10 species of freshwater pearly mussels that occur in the Upper Mississippi River and western Lake Superior drainages, eight are present in both (Figure 2). *E. complanata* is found only in Lake Superior; however, this mussel invaded in the Recent from the east, so its absence in

the Mississippi River is expected. *Strophitus undulatus* occurs in the Mississippi River but has not been recorded in the Lake Superior basin. However, the mussel's absence may only be apparent; the widespread distribution of *S. undulatus*, its association with the UMRF, and the distributions of its known glochidial hosts (Hoggarth, 1992; Underhill, 1989) suggest its presence in the Lake. *Strophitus* may be revealed with further study.

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