Distribution of Unionoid (Bivalvia) Faunas in Minnesota, USA

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ABSTRACT

The freshwaters of Minnesota are significant because they form the conjunction of three major drainage systems: the Mississippi, the St. Lawrence, and Hudson Bay; 46 species of freshwater mussels (Bivalvia: Unionoidea) inhabit these rivers and lakes. Of these, 31 are found only in the Mississippi River and its tributaries below Minneapolis. Nine species have distributions that include all of the state's drainage systems; 5 species have been reliably reported from only the Red River of the North and Lower Mississippi River drainage systems; and *Elliptio complanata* is found only in the Lake Superior Basin. Problematical records within the state are addressed.

Key words: Biogeography, Unionidae, Margaritiferidae, freshwater mussels.

INTRODUCTION

> No equal area on earth has such a diversity of Naiad life or such magnificent shells. Here are found the largest species in the world; here are forms with knobs, pustules, angles, lobes, and concentric sculpture. The nacre of many of them is wonderfully rich in tints of silver, pink, purple, salmon or red, and it is equaled in beauty by the elegant patterns of external painting, in stripes and mottlings and delicate hair lines.
>
> Charles T. Simpson (1896) on the Unionoidea of the Mississippi Valley

The distributions of the 46 species of freshwater mussels (Bivalvia: Unionoidea) that inhabit Minnesota were presented by Charlotte Webster Dawley in her doctoral thesis (1944) and a widely cited paper (Dawley, 1947). However, additional data have accumulated in the nearly half century since then. This paper seeks to update the literature record and establish the known distributions of these mollusks.

The life-cycle of a freshwater mussel involves the use of one or more species of fish or, in one case, an amphibian as a host for the parasitic larva or glochidium. In general, the major phase of dispersal occurs via parasitism of their host. Thus, barriers that inhibit the vagility of fish (drainage divides, waterfalls, etc.) also block the dispersal of the Unionoidea.

Hydrology of Minnesota. Minnesota's surface area of 218,500 km^2 is drained by three divergent watersheds (Figure 1). The Lake Superior System, the smallest, drains to the St. Lawrence River via Lake Superior. It is defined as the lake itself and all it's Minnesota tributaries. This system drains about 15,300 km^2 or 7% of the state.

The next largest watershed, draining 76,500 km^2 or 35% of the state, runs to Hudson Bay and is subdivided into the Red River System (the Red River of the North and all its Minnesota tributaries) and the Lake of the Woods System (the Rainy River and all Minnesota waters draining to Lake of the Woods). The two systems are confluent at Lake Winnipeg, Manitoba, but because they have different mussel faunas, they are considered separately.

The remaining 126,700 km^2 (58%) drains to the Gulf of Mexico via the Mississippi River. The basin is subdivided into the Upper and Lower Mississippi River Systems (following Underhill, 1989) based on their divergent histories and vastly disparate mussel faunas. The Upper Mississippi River System is that portion of the Mississippi River and all of its tributaries above the Falls of St. Anthony at Minneapolis. The Lower Mississippi River System is the river and all of its Minnesota tributaries below the Falls of St. Anthony. This includes not only those watersheds draining directly into the Mississippi River in Minnesota (the St. Croix, Minnesota, Zumbro, Cannon, and Root River Watersheds), but also those waters in southwestern Minnesota draining to the Missouri and Des Moines Rivers.

For the purposes of this study, state boundaries formed by streams extend to the opposite bank to relax possible political tensions among mussels on opposing sides of the same river.

These five drainage systems were in place following the final northward retreat of Glacial Lake Agassiz. Before that time, the enormous volumes of meltwater left

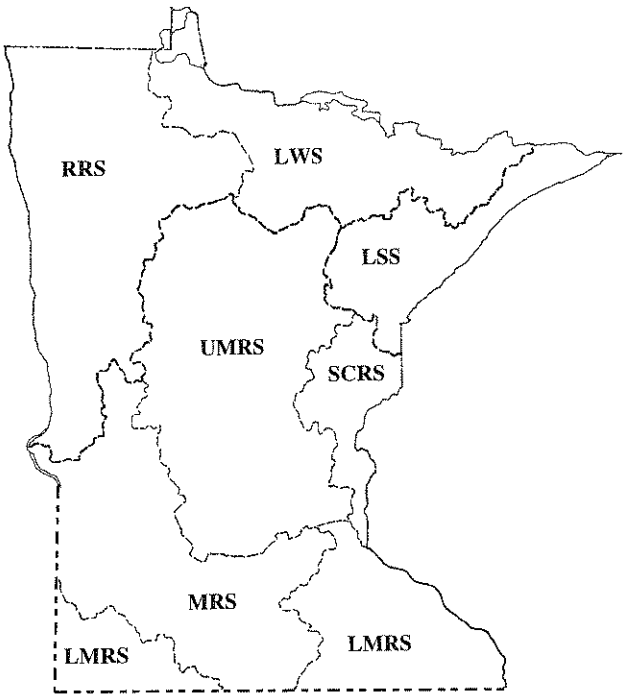

Figure 1. The Drainage Systems of Minnesota. The Red River System (RRS) and Lake of the Woods System (LWS) are confluent at Lake Winnipeg, eventually emptying to Hudson Bay. The Lake Superior System (LSS) drains to the Great Lakes. The remainder of the state drains via the Mississippi and is comprised of the Upper Mississippi River System (UMRS) and Lower Mississippi River, Minnesota River, and St. Croix River subsystems (LMRS, MRS, and SCRS, respectively). See text for explanation of the state's drainage systems.

in the wake of wasting glaciers over-ran present drainage divides and connected now dissociated basins. At such times, unionoids were free to migrate up the Mississippi River from southern refugia (Johnson, 1980) and into adjacent basins until water levels receded.

MATERIALS AND METHODS

Species have been assigned to watersheds using not only specimens housed in the University of Minnesota's James Ford Bell Museum of Natural History (JFB) Invertebrate Collection but also from an extensive literature survey. In the Appendix, for each species, a single lot is listed for each basin when available, generally those used by earlier authors.

The following literature references where utilized to establish the distributions of the Unionoidea in each of the above defined Minnesota drainage systems. No archeological or fossil literature has been included.

Lake Superior System: Dall (1905), Dawley (1944, 1947), Goodrich and van der Schalie (1932: Lake Superior in general), Moyle (1947), Walker (1913).

Lake of the Woods System: Baker (1929, 1935), Clarke (1973), Dawley (1944, 1947).

Red River System: Baker (1929), Clarke (1973), Coker and Southall (1915), Cvancara (1966, 1967, 1970, 1977, 1979, 1983), Cvancara *et al.* (1981), Daniels (1909), Dawley (1944, 1947), Grant (1885), MN DNR (1984, 1986), Radke (1992), Sargent (1895), Wilson and Danglade (1914).

Upper Mississippi River System: Baker (1929), Bright (1988), Dawley (1944, 1947), Grant (1885), Moyle (1940), Sargent (1895), Wilson and Danglade (1914).

Lower Mississippi River Subsystem: Baker (1928), Bright (1988), Bright *et al.* (1989), Coon *et al.* (1977), Cooper (1834), Davis (1990), Dawley (1944, 1947), Fuller (1978, 1980), Grant (1885), Grier (1922, 1926), Grier and Mueller (1922); Havlik (1981), Holzinger (1887), Hornbach *et al.* (1992), Johnson (1980), Mathiak (1979), Nachtrieb (unpublished), Southall (1925), Thiel (1981), van der Schalie and van der Schalie (1950), Wilson and Danglade (1914).

Minnesota River Subsystem: Bright *et al.* (1990), Dawley (1944, 1947), Grant (1885), MN DNR (1985), Nachtrieb (unpublished), Wilson and Danglade (1914).

St. Croix River Subsystem: Baker (1928), Bright (1988), Cooper (1834), Dawley (1944, 1947), Fuller (1978, 1980), Imlay (1972), Mathiak (1979), Stern (1983), Wilson and Danglade (1914).

Wilson and Danglade (1912) and Ellis (1931), provided only vernacular names, but these have been reworked in a scientific context by Wilson and Danglade (1914) and van der Schalie and van der Schalie (1950), respectively. Grant (1887) reported collecting unnamed *Anodonta* and *Lampsilis* from unspecified watersheds of the Arrowhead Region of northeastern Minnesota. Few data are available on the Unionoidea of the Lake Superior System. Of the general Great Lakes literature reviewed (e.g., van der Schalie, 1961; Walker, 1913), most study has centered on the eastern lakes, emphasizing Lake Erie. The references cited above provide almost no information on the mussels found in the streams of the North Shore of Lake Superior (with the exception of the St. Louis River). Smith and Moyle (1944), however, surveyed the fauna of these streams, including the macrobenthos, and reported no unionoids. Since Moyle, in his other reports (1940, 1947), has provided mussel data it can be assumed that no unionoids are present in these streams.

For mussel distributions adjacent to Minnesota, the reader is referred to the following references: North Dakota: Cvancara (1966, 1967, 1970, 1975, 1976, 1983), Cvancara *et al.* (1966, 1972, 1976); South Dakota: Coker and Southall (1915), Over (1913); Canada: Clarke (1973, 1981); Wisconsin: Baker (1928), Havlik and Stansbery, (1977), Mathiak (1979), Stern (1983).

RESULTS

Figure 2 presents the distributions of the Unionoidea in Minnesota. For each species, the systematic assignment follows Williams *et al.* (1993), which claims to provide

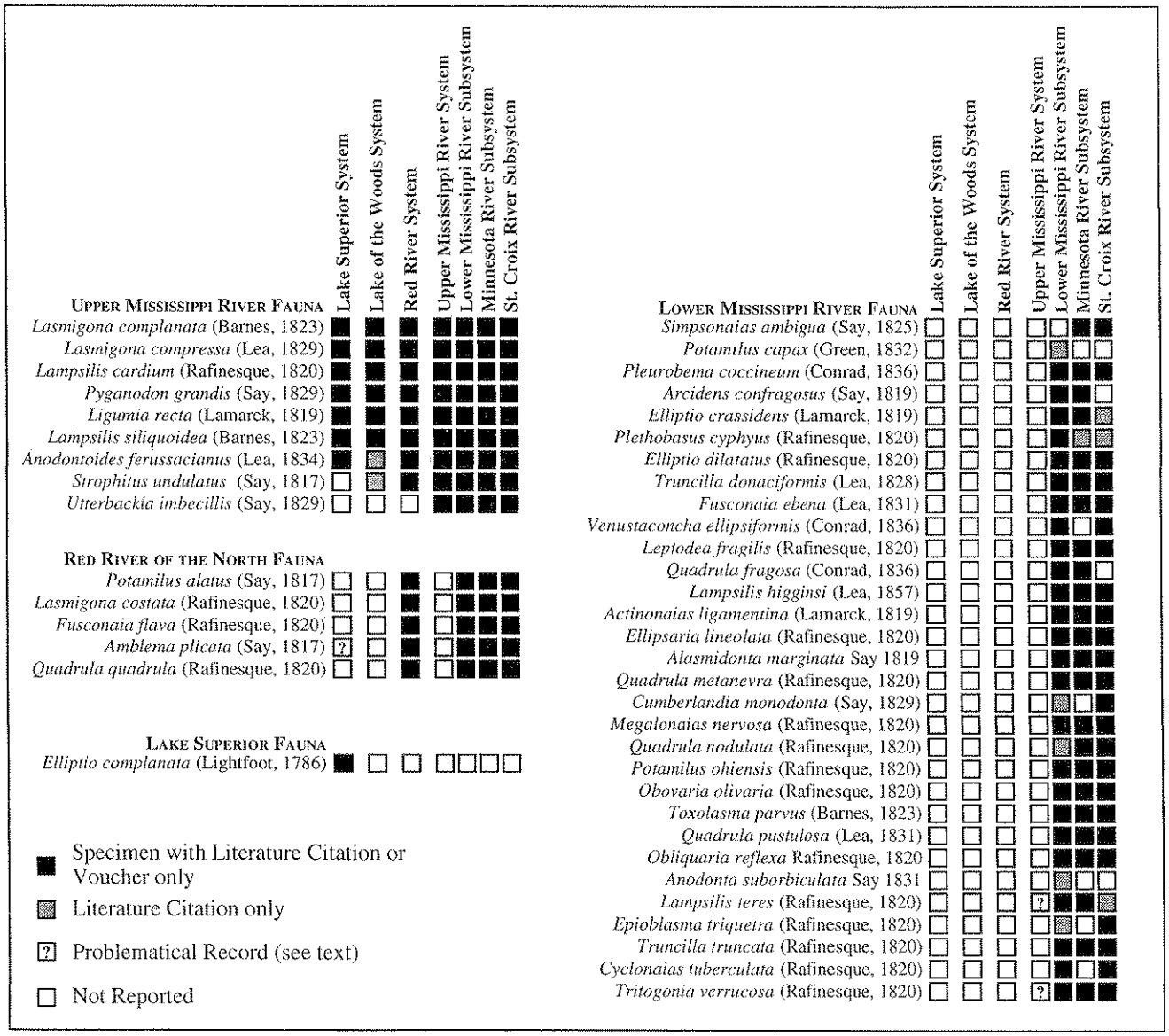

Figure 2. The Distribution of Unionoid Faunas in Minnesota.

the same list as Turgeon *et al.* (1988) but with spelling and other such errors corrected. Figures depicting these mollusks can be found in Cummings and Mayer (1992) and Fuller (1985). The only exception, *Elliptio complanata* (Lightfoot, 1786), is illustrated in Clarke (1973: 56–57, plate 3). The species list includes only those species verified to occur in Minnesota; distributions presented exclude erroneous records (see Problematical Records below).

The Lower Mississippi Drainage System is divided into three subsystems: the Lower Mississippi River Subsystem, excluding the Minnesota and St. Croix River watersheds; the Minnesota River Subsystem, which includes the main stem of the river and all its tributaries; and the St. Croix River Subsystem, also including the main stem of that river and its tributaries.

Questionable and Problematical Records. Problematical records, both from literature reports and JFB specimens, may lead to false hypotheses; those identified by the author are summarized and dealt with below.

Questionable Literature Records. Four species reported from the Red River System are supported by only a single literature citation each: *Quadrula pustulosa* by Coker and Southall (1915), *Pleurobema coccineum* by Wilson and Danglade (1914), *Elliptio dilatata* by Daniels (1909), and *Obliquaria reflexa* by Dawley (1944, 1947). However, no corroborating voucher specimens exist at the JFB and none of these species were collected by Cvancara (1966, 1967, 1970, 1975, 1976, 1983; Cvancara *et al.*, 1966; 1972; 1976) or others (e.g. Clarke, 1973) who have extensively surveyed basin. *Quadrula pustulosa, P. coc-*

cineum, and *E. dilatata* are likely incorrectly identified *Q. quadrula*, *Fusconaia flava*, and *Ligumia recta*, respectively. In the case of *O. reflexa*, both Cvancara (1970) and Clarke (1973) reported personal communications with Dawley in which she admitted her misidentification. The true distributions of these four species are probably limited to only the Lower Mississippi River System.

Problematical Voucher Specimens. The presence of *Tritogonia verrucosa* in the Upper Mississippi River System is indicated by an unpaired valve (JFB 3190) collected by John Moyle (1940). Moyle believed the valve to be evidence of Lower Mississippi species overcoming the Falls of St. Anthony but not surviving because of poor habitat. Dawley (1944, 1947) considered the presence of *Tritogonia* to be an accident, and her opinion is likely correct. Thus, the distribution of *T. verrucosa* is limited to only the Lower Mississippi River System. An unpaired valve of *Amblema plicata* (JFB 7567) was collected from the Cloquet River in the Lake Superior System. However, since *A. plicata* has otherwise not been reported from that system in Minnesota or even from the Lake Superior Basin in general, this single specimen is probably not a remnant of a population and is assumed to be trash or the remains of some introduced individual or individuals. *Amblema plicata* has been reliably reported from only the Red and Lower Mississippi River Systems, and this presumably reflects the mussel's true distribution within the state.

The problematical distribution of *Actinonaias ligamentina* in the Minnesota has been addressed by Clarke (1973). Dawley's Red River specimen could not be located, but records of *A. ligamentina* reported by her (1944, 1947: JFB 2863), Moyle (1940: JFB 2872), and Radke (1992: JFB 7569) have been re-identified as *Lampsilis siliquoidea*. Cvancara (1970) disregarded Dawley's Red River voucher, reporting that in a personal communication, she agreed that her record was probably an error. Thus, *Actinonaias* is limited to only the Lower Mississippi River System.

The single lot, JFB 2332 *Lampsilis teres*, labeled as coming from Leech Lake in the Upper Mississippi River System is likely the result of a cataloging error. Since Dawley (1944, 1947) apparently ignored it, the validity of this record is questionable.

Other Problematical Data. *Utterbackia imbecillis* has never been reported from any of the Lake Superior or Hudson Bay drainage systems. This makes *U. imbecillis* unique among species reliably reported from the Upper Mississippi River System. Also making *U. imbecillis* distinctive is the fact that it may complete its reproductive cycle with or without a glochidial host (Dawley, 1944; Fuller, 1985). This would hamper its upstream vagility, and perhaps *U. imbecillis* could not extend beyond the Upper and Lower Mississippi River Systems before drainage connections were severed.

The presence of *Anodontoides ferussacianus* in the Lake of the Woods System is not supported by a specimen in the JFB, though both Baker (1935) and Dawley (1944, 1947) reported the species from that basin.

Strophitus undulatus has never been reported from the Lake Superior System and its presence in the Lake of the Woods System is supported by only a single literature record: Clarke (1973). Dawley (1944, citing Lefevre & Curtis, 1911) noted that *S. undulatus* is another mussel that can complete its life-cycle independent of a glochidial host. However, the mussel is not obligately anomalous in its reproduction; its widespread distribution indicates that it probably is dispersed by fish at least some of the time. Three of its published glochidial hosts (Hoggarth, 1992) are found in the that watershed as well as Minnesota's four other drainage systems (Underhill, 1989), providing a means of statewide distribution. The apparent absence of *S. undulatus* may actually be the result of the lack of an adequate survey of the St. Louis River System.

DISCUSSION

There is a pattern to the distributions of the Unionoidea in Minnesota. Species with similar distributions can be grouped into faunas; members of each fauna are hypothesized to have shared modes and tempos of dispersal into the state's drainage systems. Ninety-eight percent of the species (45 of 46) are found in the Lower Mississippi River System, supporting the hypothesis that the freshwater mussel fauna of Minnesota dispersed northward from southern refugia by way of the Mississippi River at the close of the Pleistocene (Johnson, 1980). The remaining species, *Elliptio complanata*, appears to have migrated into the state via Lake Superior from the St. Lawrence watershed.

Of the 45 species of unionoids reported from the Lower Mississippi River System, 30 have been reliably recorded from only that system; these mussels constitute the Lower Mississippi River Fauna (Figure 2). Much of this fauna is made up of mussels ecologically limited to larger rivers that were unable to extend their ranges beyond the Lower Mississippi and the lowest reaches of the Minnesota and St. Croix Rivers (e.g., *Fusconaia ebena*, *Ellipsaria lineolata*). Others of the species characteristic of the Lower Mississippi River System may be relatively recent arrivals to the state (e.g., *Anodonta suborbiculata*, *Quadrula nodulata*) since they were not reported by earlier authors.

Those freshwater mussels commonly found above the Falls of St. Anthony are collectively known as the Upper Mississippi River Fauna (Figure 2). The Upper Mississippi River Fauna must have been present at a time when all of the states watersheds were connected. Of the 9 species that belong to this assemblage, only *Utterbackia imbecillis* and *Strophitus undulatus* have not been reported from all five of Minnesota's drainage systems (discussed above).

Five mussel species are found only in the Red and Lower Mississippi River Systems; these belong to the Red River of the North Fauna (Figure 2). At the close of the

Pleistocene, with the formation of Glacial Lake Agassiz, these two drainage systems were connected more than once, and this allowed the dispersal of the Red River of the North Fauna from the Minnesota River basin into that of the Red River of the North.

Elliptio complanata is the only unionoid of the Lake Superior Fauna. It is known only from the Lake Superior System. It has probably migrated into Minnesota in the last 80 years or so from the eastern Great Lakes.

The problematical species discussed above are difficult for exactly the reason that they don not fit neatly into any of the four described unionoid faunas. However, except for the case of *Actinonaias ligamentina,* these problems are the result of single specimens.

Further study of the unionoid faunas of the Lake of the Woods, Lake Superior, and Upper Mississippi River systems promises to advance our knowledge on the distributions of freshwater mussels of the Minnesota region.

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APPENDIX

Figure Citations and Specimens Examined

Provided below are figure references and the James Ford Bell Museum of Natural History (JFB) specimens used to construct Figure 2. For each lot, its catalog number and collection locality are provided. Whenever possible, specimens cited by previous authors have been selected, and these references are cited below. Also provided are corrections and re-identifications with regard to JFB specimens of historical significance.

The following drainage system abbreviations are used:
LMRS = Lower Mississippi River Subsystem
LSS = Lake Superior System
LWS = Lake of the Woods System
MRS = Minnesota River Subsystem
RRS = Red River System
SCRS = St. Croix River Subsystem
UMRS = Upper Mississippi River System

Actinonaias ligamentina (Lamarck, 1819). Figures: Cummings & Mayer (1992:105), Fuller (1985:36). LWS: Dawley's (1944, 1947) Sturgeon River record is JFB 2863 *Lampsilis siliquoidea*. RRS: Radke's (1992) Otter Tail River record is JFB 7569 *Lampsilis siliquoidea*. UMRS: Dawley (1944, 1947) and Moyle's (1940) Crow Wing River record is JFB 2872 *Lampsilis siliquoidea*. LMRS: JFB 2847 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 2859 Minnesota River, New Ulm, Brown Co.: Dawley (1944, 1947). SCRS: JFB 2878 Kettle River, Rutledge, Pine Co.: Dawley (1944, 1947).

Alasmidonta marginata Say, 1819. Figures: Cummings & Mayer (1992:85), Fuller (1985:42). LMRS: JFB 2766 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947), Holzinger (1887). MRS: JFB 2763 Minnesota River: Dawley (1944, 1947). SCRS: JFB 2769 St. Croix River at the mouth of Sunrise River, Chisago Co.: Dawley (1944, 1947).

Amblema plicata (Say, 1817). Figures: Cummings & Mayer (1992:41), Fuller (1985:50). LSS: JFB 7567 Cloquet River, Brimson, St. Louis Co. RRS: JFB 3105 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 3083 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 3093 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 3112 St. Croix River at the mouth of Sunrise River, Chisago Co.: Dawley (1944, 1947).

Anodonta suborbiculata Say, 1831. Figures: Cummings & Mayer (1992:77), Fuller (1985:58).

Anodontoides ferussacianus (Lea, 1834). Figures: Cummings & Mayer (1992:81), Fuller (1985:57). LSS: JFB 2709 Cloquet River, St. Louis Co. RRS: JFB 6582 Cormorant Lake, Becker Co.: Radke (1992). UMRS: JFB 3995 Rum River, Anoka, Anoka Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 2717 Cedar River, Austin, Mower Co.: Dawley (1944, 1947). MRS: JFB 2742 Cottonwood River, Garvin, Lyon Co.: Dawley (1944). SCRS: JFB 2753 Rush Creek: Dawley (1944, 1947).

Arcidens confragosus (Say, 1819). Figures: Cummings & Mayer (1992:89), Fuller (1985:51). LMRS: JFB 2771 Mississippi River, Red Wing, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 2773 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885).

Cumberlandia monodonta (Say, 1829). Figures: Cummings & Mayer (1992:23), Fuller (1985:16). SCRS: JFB 6690 Rush Creek, Rush City, Chisago Co.

Cyclonaias tuberculata (Rafinesque, 1820). Figures: Cummings & Mayer (1992:49), Fuller (1985:10). LMRS: JFB 3198 Mississippi River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 3199 St. Croix River at the mouth of Sunrise River, Chisago Co.: Dawley (1944, 1947).

Ellipsaria lineolata (Rafinesque, 1820). Figures: Cummings & Mayer (1992:107), Fuller (1985:45). LMRS: JFB 2916 Mississippi River, Nininger, Dakota Co.: Dawley (1944, 1947). MRS: JFB 2915 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 4200 St. Croix River, Taylors Falls, Chisago Co.

Elliptio complanata (Lightfoot, 1786). Figures: Clarke (1973:56–57, plate 3). LSS: JFB 3258 Lake Superior, Duluth, St. Louis Co.: Dawley (1944, 1947).

Elliptio crassidens (Lamarck, 1819). Figures: Cummings & Mayer (1992:67), Fuller (1985:14). LMRS: JFB 3249 Lake Pepin, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 3245 Minnesota River: Dawley (1944, 1947).

Elliptio dilatata (Rafinesque, 1820): the spike. Figures: Cummings & Mayer (1992:69), Fuller (1985:15). LMRS: JFB 3225 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947), Holzinger (1887). MRS: JFB 3242 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 3244 St. Croix River, Pine Co.: Dawley (1944, 1947).

Epioblasma triquetra (Rafinesque, 1820). Figures: Cummings & Mayer (1992:163), Fuller (1985:44). SCRS: JFB 5701 St. Croix River, Sand Is., Chisago Co.

Fusconaia ebena (Lea, 1831). Figures: Cummings & Mayer (1992:43), Fuller (1985:12). LMRS: JFB 3057 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 6437 Minnesota River, Scott Co.: Bright *et al.* (1990). SCRS: JFB 4044 Lake St. Croix, Washington Co.

Fusconaia flava (Rafinesque, 1820). Figures: Cummings & Mayer (1992:47), Fuller (1985:11). RRS: JFB 3014 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 3045 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947). MRS: JFB 3044 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 3047 St. Croix River, Marine on St. Croix, Washington Co.: Dawley (1944, 1947).

Lampsilis cardium (Rafinesque, 1820). Figures: Cummings & Mayer (1992:157), Fuller (1985:28). LSS: JFB 2448 Lake Superior, Minnesota Point, Duluth, St. Louis Co.: Dawley (1944, 1947). LWS: JFB 2411 Sturgeon River, Little Fork River watershed, St. Louis Co.: Dawley (1944, 1947). RRS: JFB 2396 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). UMRS: JFB 2400 Mississippi River, Brainerd, Crow Wing Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 2397 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 2404 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2415 St. Croix River, Marine on St. Croix, Washington Co.: Dawley (1944, 1947).

Lampsilis higginsi (Lea, 1857). Figures: Cummings & Mayer (1992:153), Fuller (1985:33–34). LMRS: JFB 2454 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947). MRS: JFB 6396 Minnesota River, Carver Co.: Bright *et al.*, 1990 (cf. *L. higginsi*); Dawley's (1944, 1947) record is JFB 2455 *Obovaria olivaria*. SCRS: JFB 2453 Lake St. Croix, Washington Co.: Dawley (1944, 1947).

Lampsilis siliquoidea (Barnes, 1823). Figures: Cummings & Mayer (1992:151), Fuller (1985:29). LSS: JFB 2291 Cloquet River, St. Louis Co.: Dawley (1944, 1947). LWS: JFB 2983 Sturgeon River, Little Fork River watershed, St. Louis Co.: Dawley (1944, 1947). RRS: JFB 2305 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). UMRS: JFB 2242 Mississippi River, Brainerd, Crow Wing Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 2307 Rollingstone Creek, Minnesota City, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 2253 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2261 St. Croix River at the mouth of Sunrise River, Chisago Co.: Dawley (1944, 1947).

Lampsilis teres (Rafinesque, 1820). Figures: Cummings & Mayer (1992:149), Fuller (1985:31). UMRS: JFB 2232 Leech Lake, Cass Co. LMRS: JFB 2239 Mississippi River, Red Wing, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 2236 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885).

Lasmigona complanata (Barnes, 1823). Figures: Cummings & Mayer (1992:93), Fuller (1985:39). LSS: JFB 3308 Lake Superior, Minnesota Point, St. Louis Co.: Dawley (1944, 1947); Baker (1928): reporting Lea's type-locality. LWS: JFB 3305 Sturgeon River, Little Fork River watershed, St. Louis Co.: Dawley (1944, 1947). RRS: JFB 3302 Red Lake River, Crookston, Polk Co.: Dawley (1944, 1947). UMRS: JFB 7507 Mississippi River, Little Falls public access, Morrison Co. (collected by Bright *et al.*); reported by Dawley (1944) & Grier & Mueller (1922) that Wilson & Danglade (1914) found it in the UMRS; however, the data can not be located in that publication. LMRS: JFB 3301 Mississippi River, Minneiska, Wabasha: Dawley (1944, 1947). MRS: JFB 3299 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 3289 Lake St. Croix: Dawley (1944, 1947).

Lasmigona compressa (Lea, 1829). Figures: Cummings & Mayer (1992:97), Fuller (1985:41). LSS: JFB 3262 Cloquet River, St. Louis Co.: Dawley (1944, 1947). LWS: JFB 3261 Fall Lake, Lake Co.: Dawley (1944). RRS: JFB 7196 Otter Tail River, Otter Tail Co. (collected by Bright *et al.*). UMRS: JFB 3265 Sauk River, Stearns Co.: Dawley (1944, 1947), Moyle (1940). LMRS: JFB 5251 North Branch Middle Fork Zumbro River, Highway 57 Bridge, Dodge Co.: Bright *et al.* (1989). MRS: JFB 6017 Min-

nesota River, Yellow Medicine Co.: Bright *et al.* (1990). SCRS: JFB 3266 St. Croix River at the mouth of Sunrise River, Chisago Co.: Dawley (1944, 1947).

Lasmigona costata (Rafinesque, 1820). Figures: Cummings & Mayer (1992:95), Fuller (1985:40). RRS: JFB 3279 Red Lake River, Crookston, Polk Co.: Dawley (1944, 1947). LMRS: JFB 3280 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947). MRS: JFB 3274 Minnesota River: Dawley (1944, 1947). SCRS: JFB 4003 Snake River at the mouth of the Groundhouse River, Kanabec Co.

Leptodea fragilis (Rafinesque, 1820). Figures: Cummings & Mayer (1992:121), Fuller (1985:20). LMRS: JFB 2919 Lake Pepin: Dawley (1944, 1947). MRS: JFB 2923 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 4613 St. Croix River, Marine on St. Croix, Washington Co.

Ligumia recta (Lamarck, 1819). Figures: Cummings & Mayer (1992:137), Fuller (1985:18). LSS: JFB 2205 Lake Superior: Dawley (1944, 1947). LWS: JFB 2214 Lake of the Woods, Pine Is., Lake of the Woods Co.: Dawley (1944). RRS: JFB 2201 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). UMRS: JFB 2994 Mississippi River, Brainerd, Crow Wing Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 2989 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947), Holzinger (1887). MRS: JFB 2998 Blue Earth River: Dawley (1944, 1947). SCRS: JFB 2213 Kettle River, Rutledge, Pine Co.: Dawley (1944, 1947).

Megalonaias nervosa (Rafinesque, 1820). Figures: Cummings & Mayer (1992:25), Fuller (1985:52). LMRS: JFB 3071 Mississippi River, Red Wing, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 3065 Minnesota River, Cedar Ave., Hennepin Co.: Dawley (1944, 1947). SCRS: JFB 3063 St. Croix River, Hudson, St. Croix Co., Wisconsin: Dawley (1944, 1947). Lower Mississippi River below Minnesota: Baker (1903).

Obliquaria reflexa Rafinesque, 1820. Figures: Cummings & Mayer (1992:101), Fuller (1985:48). LMRS: JFB 2808 Lake Pepin, Lake City, Wabasha Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 2489 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2804 Lake St. Croix, Washington Co.: Dawley (1944, 1947).

Obovaria olivaria (Rafinesque, 1820). Figures: Cummings & Mayer (1992:109), Fuller (1985:35). LMRS: JFB 2829 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 6520 Minnesota River, Pike Is., Hennepin Co.: Bright *et al.*, 1990; Dawley's (1944, 1947) record is JFB 2832 *Fusconaia ebena*. SCRS: JFB 2826 St. Croix River at the mouth of Sunrise River, Chisago Co.: Dawley (1944, 1947).

Plethobasus cyphyus (Rafinesque, 1820). Figures: Cummings & Mayer (1992:51), Fuller (1985:49). LMRS: JFB 3203 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885).

Pleurobema coccineum (Conrad, 1836). Figures: Cummings & Mayer (1992:59), Fuller (1985:13). LMRS: JFB 3212 Lake Pepin, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 6068 Minnesota River, Chippewa Co.: Bright *et al.* (1990). SCRS: JFB 3219 Snake River: Dawley (1944, 1947).

Potamilus alatus (Say, 1817). Figures: Cummings & Mayer (1992:125), Fuller (1985:25). RRS: JFB 2946 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 2945 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 2941 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2957 Snake River, Kanabec Co.: Dawley (1944, 1947).

Potamilus capax (Green, 1832). Figures: Cummings & Mayer (1992:129), Fuller (1985:27). LMRS: Johnson (1980) reporting Green's type locality at St. Anthony Falls, Minneapolis. Lower Mississippi River below Minnesota: Grier & Mueller (1922:9): ". . .the consensus of opinion is that it ordinarily does not go much north of Davenport, Iowa."

Potamilus ohiensis (Rafinesque, 1820). Figures: Cummings & Mayer (1992:123), Fuller (1985:22–23). LMRS: JFB 2963 Mississippi River, Red Wing, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 2964 Minnesota River, Ft. Snelling: Dawley (1944, 1947); Grant's (1885) record is JFB 2920 *Leptodea fragilis*. SCRS: JFB 5543 St. Croix River, Interstate Park, Chisago Co., Minnesota; Dawley's (1944, 1947) record is JFB 2962 *Leptodea fragilis*.

Pyganodon grandis (Say, 1829). Figures: Cummings & Mayer (1992:79), Fuller (1985:60). LSS: JFB 2471 Comstock Lake, St. Louis Co.: Dawley (1944, 1947). LWS: JFB 2625 Sturgeon Lake, St. Louis Co.: Dawley (1944, 1947). RRS: JFB 2568 Red Lake River, Crookston, Polk Co.: Dawley (1944, 1947). UMRS: JFB 2560 Rum River, Milaca, Mille Lacs Co.: Dawley (1944, 1947), Moyle (1940). LMRS: JFB 3327 Zumbro River, Wabasha, Wabasha Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 2664 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2660 Oxbow Lake, Marine on St. Croix, Washington Co.: Dawley (1944, 1947).

Quadrula fragosa (Conrad, 1836). Figures: Cummings & Mayer (1992:29). LMRS: JFB 3127 Mississippi River, Nininger, Dakota Co. [collected November, 1886 by Winchell; reported as *Q. quadrula* by Dawley (1944, 1947)]. MRS: JFB 6356 Minnesota River, Sibley Co.: Bright *et al.* (1990).

Quadrula metanevra (Rafinesque, 1820). Figures: Cummings & Mayer (1992:35), Fuller (1985:6). LMRS: JFB 3152 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 6357 Minnesota River, Sibley Co.: Bright *et al.* (1990). SCRS: JFB 4607 St. Croix River, Marine on St. Croix, Washington Co.

Quadrula nodulata (Rafinesque, 1820). Figures: Cummings & Mayer (1992:37), Fuller (1985:8). MRS: JFB 6424 Minnesota River, Scott Co.: Bright *et al.* (1990).

SCRS: JFB 4578 St. Croix River, Coppermine Dam, Douglas Co., Wisconsin.

Quadrula pustulosa (Lea, 1831). Figures: Cummings & Mayer (1992:39), Fuller (1985:9). LMRS: JFB 3136 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947), Holzinger (1887). MRS: JFB 3144 Minnesota River, Ft. Snelling: Dawley (1944, 1947). SCRS: JFB 3147 St. Croix River, Marine on St. Croix, Washington Co.: Dawley (1944, 1947).

Quadrula quadrula (Rafinesque, 1820). Figures: Cummings & Mayer (1992:31), Fuller (1985:7). RRS: JFB 3125 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). LMRS: JFB 3121 Mississippi River, Red Wing, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 3122 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 4911 St. Croix River, Stillwater, Washington Co.

Simpsonaias ambigua (Say, 1825). Figures: Cummings & Mayer (1992:91), Fuller (1985:56). MRS: JFB 6074 Minnesota River, Chippewa Co.: Bright *et al.*, 1990. SCRS: JFB 5063 St. Croix River, Marine on St. Croix, Washington Co.

Strophitus undulatus (Say, 1817). Figures: Cummings & Mayer (1992:83), Fuller (1985:61). RRS: JFB 2784 Red River, 20 mi. N of Breckenridge, Wilkin Co.: Dawley (1944, 1947), Grant (1885). UMRS: JFB 7415 Mississippi River, Crow Wing State Park, Crow Wing Co. (collected by Bright *et al.*). LMRS: JFB 2793 Mississippi River, Red Wing, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 6075 Minnesota River, Chippewa Co.: Bright *et al.* (1990). SCRS: JFB 2795 Grindstone River, Kettle River watershed, Pine Co.: Dawley (1944, 1947).

Toxolasma parvus (Barnes, 1823). Figures: Cummings & Mayer (1992:131), Fuller (1985:54–55). LMRS: JFB 2974 Mississippi River, Wacouta, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 2976 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2973 St. Croix River, Marine on St. Croix, Washington Co.: Dawley (1944, 1947).

Tritogonia verrucosa (Rafinesque, 1820). Figures: Cummings & Mayer (1992:27), Fuller (1985:53). UMRS: JFB 3190 Sauk River, St. Cloud, Stearns Co.: Bright (1988), Dawley (1944), Moyle (1940). LMRS: JFB 3189 Mississippi River, Dresbach, Winona Co.: Dawley (1944, 1947), Grant (1885). MRS: JFB 3181 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 3191 St. Croix River, Taylors Falls, Chisago Co.: Dawley (1944, 1947).

Truncilla donaciformis (Lea, 1828). Figures: Cummings & Mayer (1992:117), Fuller (1985:47). LMRS: JFB 4307 Mississippi River, Northern States Power Prairie Is. Nuclear Generating Plant, 1.5 miles upstream of Lock & Dam #3, Goodhue Co. MRS: JFB 2933 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 4610 St. Croix River, Marine on St. Croix, Washington Co.

Truncilla truncata (Rafinesque, 1820). Figures: Cummings & Mayer (1992:115), Fuller (1985:46). LMRS: JFB 2896 Mississippi River, Winona, Winona Co.: Dawley (1944, 1947), Holzinger (1887). MRS: JFB 2897 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2900 St. Croix River, St. Croix Falls, Polk Co., Wisconsin: Dawley (1944, 1947).

Utterbackia imbecillis (Say, 1829). Figures: Cummings & Mayer (1992:75), Fuller (1985:59). UMRS: JFB 2683 Mississippi River, Fridley, Anoka Co.: Dawley (1944, 1947), Moyle (1940). LMRS: JFB 2682 Lake Pepin, Wacouta, Goodhue Co.: Dawley (1944, 1947). MRS: JFB 2679 Minnesota River, Ft. Snelling: Dawley (1944, 1947), Grant (1885). SCRS: JFB 2768 Oxbow Lake, Marine on St. Croix, Washington Co.: Dawley (1944, 1947).

Venustaconcha ellipsiformis (Conrad, 1836). Figures: Cummings & Mayer (1992:141), Fuller (1985:38). LMRS: JFB 5280 Cascade Creek, Zumbro River watershed, Rochester, Olmsted Co.: Bright *et al.* (1989). SCRS: JFB 5736 St. Croix River, Polk Co., Wisconsin.