

THE NAIADES OR FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE)  
OF THE TIPPECANOE RIVER, INDIANA

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## ABSTRACT

A survey for mussels (Unionidae) at 16 sites in the Tippecanoe River (Wabash River Drainage) was conducted in the summer and fall of 1987. Thirty-four species were found living and an additional six species were represented by shells only. An examination of the literature and museum specimens increased the total number of species recorded from the drainage to 51. A total of 1,499 specimens was collected in 64 collector-hours of sampling. The three most common species in order of abundance were *Quadrula pustulosa* (I. Lea, 1831), *Amblema plicata* (Say, 1817), and *Ptychobranchus fasciolaris* (Rafinesque, 1820), but species dominance varied widely among sites. Many species considered rare, threatened or endangered at both the federal and state levels were found.

**Key words:** Unionidae, Tippecanoe River, distribution, rare, threatened and endangered species.

## INTRODUCTION

Mussel surveys conducted in the Wabash River drainage over the past century have revealed a rich unionid fauna (Call, 1900; Blatchley & Daniels, 1903; Daniels, 1903, 1914; Baker, 1922; Goodrich & van der Schalie, 1944; Meyer, 1974; Matteson & Dexter, 1966; Parmalee, 1967; Clark, 1976, 1987). More than 70 species have been recorded, including many that are presently thought to be extinct or in danger of extinction. Specific data from upstream tributaries in the drainage are scarce, and most, including the Tippecanoe River, have never been systematically sampled for mussels. Published information on the Tippecanoe River drainage is limited to lists of species without specific locality data (Daniels, 1903) and from papers on the molluscan fauna of the headwater lakes in the drainage (Blatchley, 1901; Headlee & Simonton, 1904; Headlee, 1906; Wilson & Clark, 1912; Evermann & Clark, 1918, 1920; Allen, 1922; Scott, 1926).

In 1985, a survey of the fishes of the Tippecanoe River was conducted and mussel shells were incidentally collected from many of the sites (Keevin *et al.*, 1985). Among these collections were shells of *Pleurobema clava* (Lamarck 1819), a candidate for federal listing as endangered or threatened, and *Quadrula cylindrica* (Say 1817), endangered in Indiana. In addition to the naiades, the collection of several rare, threatened or endangered fishes (IDNR, 1988) including *Ammocrypta pellucida* (Putnam), *Etheostoma camurum* (Cope), *E. maculatum*, Kirtland, *E. tippecanoe* Jordan & Evermann, and *Percina evides* (Jordan & Copeland), indicated that high-quality aquatic habitat was present in the Tippecanoe River and that an abundant mussel fauna might also occur there.

As pointed out by many authors, the North American unionid fauna has been declining alarmingly over the past century (Heard, 1970; Stansbery, 1970, 1971; Starrett, 1971; Clarke, 1981). Several species are presumed extinct (Stansbery, 1970; Turgeon *et al.*, 1988, Appendix 2), others face extinction, and the numbers and geographic range of many naiades have been drastically reduced. Surveys of remaining populations are an important step toward preserving the fauna. As part of a larger study of the freshwater mussels of the Wabash River drainage in Indiana, a survey of the Tippecanoe River was initiated during the summer of

1987. Its primary objective was to determine the present status of mussels in the Tippecanoe, especially those species listed or under consideration for listing as threatened or endangered.

### STUDY AREA

The Tippecanoe River is a medium-sized tributary of the Wabash River, draining approximately 1890 square miles of northern and west-central Indiana (Wright 1932a). It originates in Whitley and Noble counties and flows west-southwest for about 110 kilometers to its confluence with the Wabash River near the city of Lafayette in Tippecanoe County. The upper portion of the drainage is dotted with glacial lakes and wetlands, many of which have been developed for recreation. Two large impoundments (Lake Shafer and Lake Freeman) have been constructed on the lower portion of the river. Substrate in much of the river consists of clean gravel, sand, and occasionally, mud. Large boulders are present in some areas. The banks of the Tippecanoe River are wooded throughout most of its length, and the upstream portion of the river seems to have been less adversely affected by agricultural run-off than is commonly observed in most midwestern streams. The physiography and geological history of the basin has been treated in detail by other authors (Scovell, 1909; Leverett & Taylor, 1915; Scott, 1916; Tucker, 1922; Wright, 1932a, 1932b).

### METHODS

Sixteen sites were sampled for mussels in the Tippecanoe River from 25 July to 15 October 1987 (Fig. 1, Table 1). The sites were located approximately eight kilometers apart

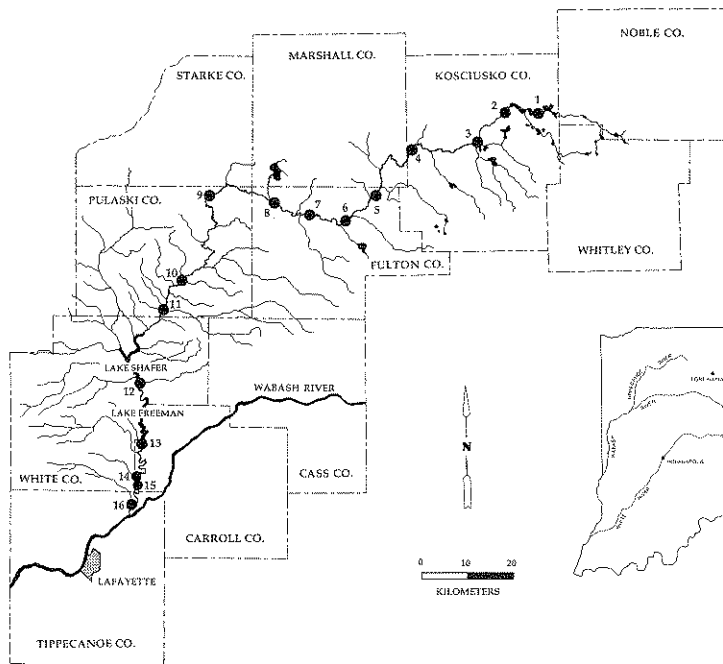


FIG. 1. Collection sites (solid circles) on the Tippecanoe River, 1987. Locality numbers are identified in Table 1.

Table 1. Collection sites on the Tippecanoe River, Indiana, 1987.

Site	Location
1	Tippecanoe River, 0.8 km SW North Webster at county road 750E bridge, Kosciusko County, Indiana. T33N, R7E, sec. 15.
2	Tippecanoe River, 1.6 km SW Oswego, Kosciusko County, Indiana. T33N, R6E, sec. 14.
3	Tippecanoe River, 1.6 km NW Warsaw at county road 300N, Kosciusko County, Indiana. T33N, R6E, sec. 30.
4	Tippecanoe River, 3.2 km S Etna Green at Ind. Route 19, Kosciusko County, Indiana. T32N, R4E, sec. 10.
5	Tippecanoe River, at Talma, Fulton County, Indiana. T31N, R3E, sec. 12.
6	Tippecanoe River, 4.8 km N Rochester, at Route 31 bridge, Fulton County, Indiana. T31N, R3E, sec. 29.
7	Tippecanoe River, 3.2 km N Pershing, Fulton County, Indiana. T31N, R2E, sec. 21.
8	Tippecanoe River, at Delong, Fulton County, Indiana. T31N, R1E, sec. 9.
9	Tippecanoe River, at Tippecanoe River State Park, Pulaski County, Indiana. T31N, R1W, sec. 19.
10	Tippecanoe River, 2.4 km NE Pulaski, Pulaski County, Indiana. T29N, R2W, sec. 3.
11	Tippecanoe River, 6.4 km E Lakeside, Pulaski County, Indiana. T29N, R3W, sec. 30.
12	Tippecanoe River, at Norway below Lake Shafer spillway, White County, Indiana. T27N, R3W, sec. 21.
13	Tippecanoe River, at Lake Freeman spillway (Oakdale Dam), Carroll County, Indiana. T26N, R3W, sec. 34.
14	Tippecanoe River, at Springboro, at Ind. Route 18 bridge, 8 km W Delphi, Carroll County, Indiana. T25N, R3W, sec. 21.
15	Tippecanoe River, 8 km SW Delphi, Carroll County, Indiana. T25N, R3W, sec. 33.
16	Tippecanoe River, 1.6 km N Americus, Tippecanoe County, Indiana. T24N, R3W, sec. 9.

and were chosen based upon accessibility and/or because historical data were available. All sites were located in free-flowing reaches, and none of the natural or artificial impoundments of the Tippecanoe River drainage were sampled for mussels. All habitat types present at each site, including pools, runs, gravel bars, and riffles were sampled. Living mussels and valves of dead specimens were collected by hand at each station. Sampling was quantified to the extent that, at each of the 16 sites, sampling time multiplied by the number of collectors totalled four collector-hours.

In addition to the 16 sites mentioned above, data were obtained from shoreline collections made by Illinois Natural History Survey biologists at seven sites within the drainage in 1984 while sampling for fishes. Historical data on the fauna were verified by examination of specimens in the Academy of Natural Science of Philadelphia (ANSP), the Field Museum of Natural History, Chicago (FMNH), the Ohio State University Museum of Zoology (OSUM), the University of Illinois Museum of Natural History (UIMNH), University of Michigan Museum of Zoology (UMMZ), and the United States National Museum (USNM). Vouchers of all species collected were deposited in the Mollusk Collection of the Illinois Natural History Survey (INHS), Champaign, Illinois. Diversity as

measured by Shannon's  $H'$  was calculated according to the method given by Lloyd *et al.* (1968).

Nomenclature used in this report follows a list of common and scientific names of mollusks prepared by the Committee on Scientific and Vernacular Names of Mollusks of the Council of Systematic Malacologists - American Malacological Union (Turgeon *et al.*, 1988), except as follows: 1) subspecies are not recognized, and 2) nomenclature for members of the *Pleurobema cordatum* species complex follows Stansbery (1983).

## RESULTS

Sampling at 16 sites in the Tippecanoe River yielded 34 species of live mussels, including three not previously recorded from the drainage. An additional six species were collected as shells only (Table 2). A total of 1,499 live mussels was collected during 64 collector-hours of sampling in the 1987 survey. *Quadrula pustulosa* (I. Lea 1831) was the most abundant species, accounting for 13.7% of the total collection, followed by *Amblema plicata* (Say 1817) (10.3%), *Ptychobranchnus fasciolaris* (Rafinesque 1820) (8.7%), *Pleurobema sintoxia* (Rafinesque 1820) (7.9%), and *Actinonaias ligamentina* (Lamarck 1819) (7.8%). Fourteen species were represented by fewer than 10 individuals each, but only two species were represented by a single individual. Live mussels were present at all sites sampled. The highest number of live species collected at one site was 17 (sites 13 and 16) and the lowest was 10 (sites 4 and 6). The number of live mussels collected per site ranged from 35 (site 15) to 210 (site 12).

No one species was found alive at all 16 sites, but five species; *Lampsilis cardium* Rafinesque 1820, *Lasmigona costata* (Rafinesque 1820), *Pleurobema sintoxia*, *Quadrula pustulosa*, and *Strophitus undulatus* (Say 1817) each were collected from 13 sites. The mussel communities were rather heterogeneous in that the dominant species varied from site to site. Seven different species were most abundant at various locations: *Quadrula pustulosa* was most common at five sites (6, 10, 11, 12, and 16), *Actinonaias ligamentina* at three sites (7, 8, and 9), *Amblema plicata* (1 and 13), *Cyclonaias tuberculata* (Rafinesque 1820) (14 and 15) and *Ptychobranchnus fasciolaris* (2 and 3) at two sites each, and *Lampsilis cardium* (4) and *Pleurobema sintoxia* (5) each were dominant at one site.

Species found alive exclusively upstream (*i.e.*, the five most upstream sites) were *Lampsilis fasciola* Rafinesque 1820, *Lasmigona compressa* (I. Lea 1829), and *Villosa iris* (I. Lea 1829). Dead shells of these species however, were found farther downstream. The dominant species in the headwaters were *Ptychobranchnus fasciolaris*, *Amblema plicata*, and *Pleurobema sintoxia*. Species that were present elsewhere but were most common in the headwater section of the river included *Elliptio dilatata* (Rafinesque 1820), *Fusconaia flava* (Rafinesque 1820), and *Pleurobema clava* (Lamarck 1819).

The most common species found in the middle reaches of the Tippecanoe River (sites 6 through 11) were *Quadrula pustulosa*, *Actinonaias ligamentina*, *Pleurobema sintoxia* and *Cyclonaias tuberculata*. Four species found in the upper and middle reaches, *Alasmidonta marginata* Say 1818, *Obovaria subrotunda* (Rafinesque 1820), *Pleurobema clava*, and *Quadrula cylindrica* (Say 1817), were not collected alive at any sites located below Lake Shafer (sites 12 through 16). Seven species were not found alive at any sites above Lake Freeman (site 13): *Anodonta suborbiculata* Say 1831, *Leptodea fragilis* (Rafinesque 1820), *Ligumia recta* (Lamarck 1819), *Potamilus alatus* (Say 1817), *Quadrula metanevra* (Rafinesque, 1820), *Tritogonia verrucosa* (Rafinesque 1820), and *Truncilla truncata* Rafinesque 1820. *Anodonta grandis* Say 1829 and *Lasmigona complanata* (Barnes 1823) were found in low numbers above

TABLE 2. Total list of mussel species (Unionidae) recorded from the Tippecanoe River. L = literature record; M = museum specimen; S = shell only (1987). Status codes: 1 = Federally Endangered; 2 = Proposed Federally Endangered; 3 = Candidate for Federal Listing; 4 = Indiana State Endangered; 5 = Species of Special Concern in Indiana.

Species	No. Individuals & Rank Order, 1987	% Composition	Status
<b>AMBLEMINEAE</b>			<b>52.3</b>
<i>Quadrula pustulosa</i> (I. Lea 1831)	205 (1)	13.7	
<i>Amblema plicata</i> (Say 1817)	154 (2)	10.3	
<i>Pleurobema sintoxia</i> (Rafinesque 1820)	118 (4)	7.9	
<i>Cyclonaias tuberculata</i> (Rafinesque 1820)	97 (6)	6.5	
<i>Fusconaia flava</i> (Rafinesque 1820)	81 (8)	5.4	
<i>Quadrula quadrula</i> (Rafinesque 1820)	39 (14)	2.6	
<i>Elliptio dilatata</i> (Rafinesque 1820)	36 (15)	2.4	
<i>Pleurobema clava</i> (Lamarck 1819)	19 (18)	1.3	3, 4
<i>Plethobasus cyphus</i> (Rafinesque 1820)	10 (20)	0.7	4
<i>Quadrula cylindrica</i> (Say 1817)	9 (21)	0.6	4
<i>Tritogonia verrucosa</i> (Rafinesque 1820)	7 (23)	0.5	
<i>Quadrula metaneora</i> (Rafinesque 1820)	6 (24)	0.4	
<i>Elliptio crassidens</i> (Lamarck 1819)	M		
<i>Fusconaia subrotunda</i> (I. Lea 1831)	M		4
<i>Pleurobema plenum</i> (I. Lea 1840)	M		1, 4
<i>Pleurobema rubrum</i> (Rafinesque 1820)	M		4
<b>ANODONTINAE</b>			<b>20.3</b>
<i>Lasmigona complanata</i> (Barnes 1823)	84 (7)	5.6	
<i>Anodonta grandis</i> Say 1829	61 (10)	4.1	
<i>Lasmigona costata</i> (Rafinesque 1820)	51 (11)	3.4	
<i>Strophitus undulatus</i> (Say 1817)	48 (12)	3.2	
<i>Alasmidonta marginata</i> Say, 1818	41 (13)	2.7	
<i>Anodonta imbecillis</i> Say 1829	9 (21)	0.6	
<i>Anodonta suborbiculata</i> Say 1831	5 (25)	0.3	
<i>Lasmigona compressa</i> (I. Lea 1829)	4 (30)	0.3	
<i>Anodontoides ferussacianus</i> (I. Lea 1834)	1 (33)	0.1	
<i>Alasmidonta viridis</i> (Rafinesque 1820)	S		
<i>Simpsonaias ambigua</i> (Say 1825)	M		3, 5
<b>LAMPSILINAE</b>			<b>27.4</b>
<i>Ptychobranthus fasciolaris</i> (Rafinesque 1820)	131 (3)	8.7	
<i>Actinonaias ligamentina</i> (Lamarck 1819)	117 (5)	7.8	
<i>Lampsilis cardium</i> Rafinesque 1820	65 (9)	4.3	
<i>Lampsilis siliquoidea</i> (Barnes 1823)	34 (16)	2.3	
<i>Villosa iris</i> (I. Lea 1829)	24 (17)	1.6	
<i>Obovaria subrotunda</i> (Rafinesque 1820)	17 (19)	1.1	
<i>Lampsilis fasciola</i> Rafinesque 1820	5 (25)	0.3	5
<i>Leptodea fragilis</i> (Rafinesque 1820)	5 (25)	0.3	
<i>Potamilus alatus</i> (Say 1817)	5 (25)	0.3	
<i>Truncilla truncata</i> Rafinesque 1820	5 (25)	0.3	
<i>Ligumia recta</i> (Lamarck 1819)	3 (31)	0.2	
<i>Toxolasma lividis</i> (Rafinesque 1831)	2 (32)	0.1	3
<i>Toxolasma parvus</i> (Barnes 1823)	1 (34)	0.1	
<i>Cyprogenia stegaria</i> (Rafinesque 1820)	S		2, 4
<i>Epioblasma obliquata</i> (Rafinesque 1820)	M		1, 4
<i>Epioblasma rangiana</i> (I. Lea 1839)	S		3, 4
<i>Epioblasma triquetra</i> (Rafinesque 1820)	S		4
<i>Hemistena lata</i> (Rafinesque 1820)	M		1
<i>Lampsilis teres</i> (Rafinesque 1820)	L		
<i>Ligumia subrostrata</i> (Say 1831)	M		
<i>Obovaria olivaria</i> (Rafinesque 1820)	M		
<i>Obovaria retusa</i> (Lamarck 1819)	M		1
<i>Truncilla donaciformis</i> (I. Lea 1828)	S		
<i>Villosa fabalis</i> (I. Lea 1831)	S		3, 5

lakes Shafer and Freeman, but were abundant below the spillways of both.

One species, *Amblema plicata*, showed a particularly irregular pattern of distribution. Although it was the second most common species in the survey, *A. plicata* was collected alive at only six sites and could be considered abundant at only two. Almost two thirds (96 of 154) of all individuals of this species collected were taken from a single location (Site 1). *Amblema plicata* was absent (except as weathered shells) from sites 2 through 11, but it was collected alive at all stations sampled below Lake Shafer.

Three species not previously recorded from the Tippecanoe River were collected in 1987. They were *Anodonta suborbiculata*, *Potamilus alatus*, and *Quadrula metanevora*. All were found only in the lower section of the river, below Lake Freeman.

Live specimens of the introduced Asian clam, *Corbicula fluminea* (Müller 1774) were observed at several Tippecanoe River sites during the 1987 survey, but this species was not particularly abundant where found.

Six species were found only as shells in the present survey of the Tippecanoe River. Of those, *Alasmidonta viridis* (Rafinesque 1820), *Epioblasma rangiana* (I. Lea 1839) and *Villosa fabalis* (I. Lea 1831) were represented by old or weathered dead shells and are possibly extirpated from the river. Fresh-dead shells of *Cyprogenia stegaria* (Rafinesque 1820), *Epioblasma triquetra* (Rafinesque 1820) and *Truncilla donaciformis* (I. Lea 1828) were collected from at least one site, and these species may still be extant in the drainage.

## DISCUSSION

The 34 species of live mussels collected from the Tippecanoe River during 1987 represent a rich unionid fauna, especially when compared with other tributaries of the Wabash River where recent mussel surveys have been conducted. As based upon historical and recent data, more species are known from the Tippecanoe than from the Vermilion, Embarras, Little Wabash or Eel rivers (Cummings *et al.*, 1988a, 1989; Henschen, 1987; Suloway *et al.*, 1981a). Furthermore, diverse mussel assemblages were found to be distributed more evenly among sites in the Tippecanoe River than in the other recently surveyed Wabash River tributaries. To illustrate this point, the number of species and diversity (Shannon's  $H'$ ) were plotted for the Embarras, Little Wabash, and Tippecanoe rivers (Fig. 2). Although the maximum number of live species collected per site was highest for the Little Wabash River (18 Little Wabash, 17 Tippecanoe, and 16 Embarras), the average number of species per site from the Tippecanoe (12.9) was almost twice that from either the Little Wabash (7.8) or the Embarras (6.2). Maximum diversity ( $H'$ ) per site was only slightly higher from the Tippecanoe, but average diversity was 40% higher than in the Embarras or Little Wabash rivers. This is largely because several sites on both the Little Wabash and the Embarras yielded few or no mussels, whereas mussels were at least moderately abundant at all Tippecanoe River sites (Fig. 2).

A comparison of data from other mussel surveys shows that the fauna of the Tippecanoe River is among the richest in the upper Midwest (Table 3). In fact, species richness is comparable to that reported from similar-sized streams in the Cumberland, Tennessee, and Mobile Bay drainages, from which the greatest diversity of mussels has been documented (Ortmann, 1924; van der Schalie, 1938; Ahlstedt, 1986; Starnes & Bogan, 1988).

Although at present the mussel fauna of the Tippecanoe River appears to be healthy, some degree of habitat degradation in the river is apparent. Judging

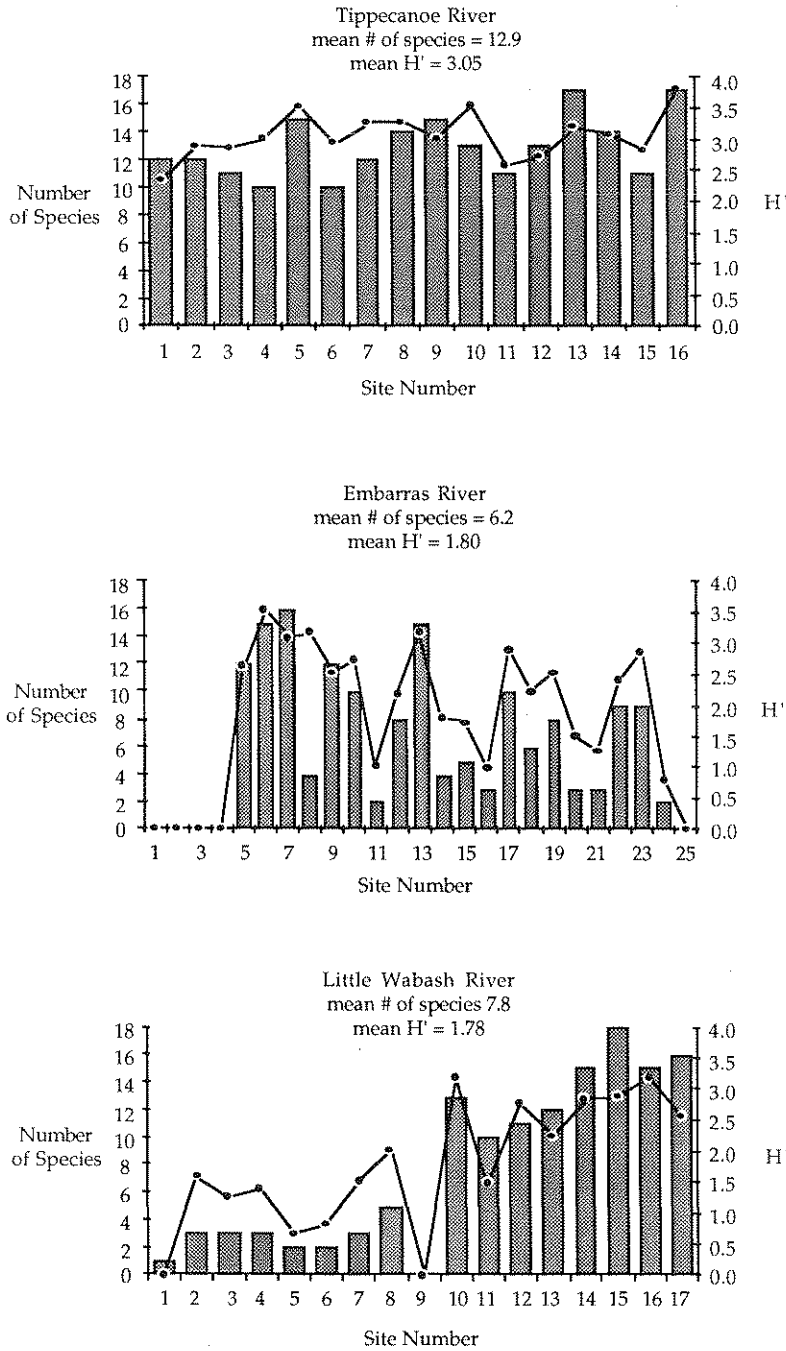


FIG. 2. Number of species (columns) and diversity (Shannon's H') (lines) of unionid mussels collected per site from three tributaries of the Wabash River. Data for the Tippecanoe River are from the present study; data for the Embarras and Little Wabash rivers are from Cummings *et al.*, 1988a and 1989, respectively.

TABLE 3. A comparison of the number of live mussels (Unionidae) collected in midwestern stream surveys (1912-1989).

Stream	Sites	Live spp.	Individuals	Source
Meramec R. Drainage, Mo.	198	42	20,589	Buchanan, 1980
Tippecanoe R., Ind.	16	34	1,499	This study
Lower Osage R., Mo.	23	34	18,038	Grace & Buchanan, 1981
Vermilion R., Ill.	31	30	-	Baker, 1922
Vermilion R., Ill.	28	22	639	Suloway, et al., 1981a
Kankakee R., Ill. & Ind.	43	29	-	Wilson & Clark, 1912
Kankakee R., Ill.	13	20	1,006	Suloway, 1981
Embarras R., Ill.	21	27	876	Cummings, et al., 1988a
Little Wabash R., Ill.	30	26	1,788	Cummings, et al., 1989
Maries R., Mo.	11	26	2,271	Grace & Buchanan, 1981
Clinton R., Mich.	76	26	2,315	Strayer, 1980
Tavern Cr., Mo.	9	24	1,284	Grace & Buchanan, 1981
Kaskaskia R., Ill.	19	23	498	Suloway, et al., 1981b
Little Darby Cr., Ohio	20	22	-	Stein, 1965
Illinois River, Ill.	429	22	4,247	Starrett, 1971
Olentangy R., Ohio	-	21	-	Stein, 1963
Blue R., Ind.	25	15	-	Weilbaker, et al., 1985
Big Indian Cr., Ind.	7	15	-	Taylor, 1982

from the low turbidity and lack of silt deposition, the upstream portion appears to be least affected by habitat modification. Further downstream turbidity increases, and the presence of abundant filamentous algae on rocks in some areas suggests increased organic enrichment. Although mussels were common to abundant in the middle and lower reaches of the Tippecanoe River, mussels were concentrated at some sites, in relatively few "pockets." For example, the majority of mussels from site 8 were found in a small pool along one shore, even though a much larger area of apparently similar habitat was searched.

In the lower reaches of the Tippecanoe, artificial impoundments (Lake Shafer and Lake Freeman) reduce the quantity of mussel habitat. The destruction of riffles, fluctuations in water level, and other factors resulting from artificial impoundment have been observed by several authors to be detrimental to mussels (e.g., Suloway *et al.* 1981b). Sites located directly below the dams forming these impoundments supported large mussel populations, but these tended to be highly localized in a few pools. Riffles in these areas supported very few mussels, possibly because they are intermittently exposed when little water is released from the reservoirs. Also, the most abundant species below the dams (e.g., *Anodonta grandis*, *Lasmigona complanata*, and *Quadrula quadrula* (Rafinesque 1820), as well as two of the species newly reported from the Tippecanoe River (*Anodonta suborbiculata* and *Potamilus alatus*) are among those that tend to be more tolerant of conditions (e.g., slow current, soft substrates, etc.), associated with impoundment (Klippel & Parmalee, 1979).

Data from this survey, the literature, and museum collections were combined to yield a total of 51 species reported from the Tippecanoe River (Table 2). Among these are several species considered rare by various state and federal agencies.



Four species are presently listed as federally endangered, one has been proposed for endangered status, five are candidates for listing (Category 2), ten are endangered in Indiana (some of which are also federally listed or candidates), and three are species of special concern in the state (USFWS, 1989a,b,c,d,e; IDNR, 1988). A brief discussion of the historical and present occurrence of these 15 species in the Tippecanoe River follows.

#### FEDERALLY ENDANGERED SPECIES

*Epioblasma obliquata* (Rafinesque 1820). **Catspaw.** Wilson & Clark (1912) reported the catspaw [as *Truncilla sulcata* (Lea)] from Tippecanoe Lake, but provided no comments on its abundance. Goodrich & van der Schalie (1944) considered *E. obliquata* to be rare in Indiana and cited records from the Ohio, Wabash, White, and Maumee rivers. No shells or live individuals of *E. obliquata* were found during the present study; however, a weathered shell was collected at the U.S. Route 35 bridge in Pulaski County during the summer of 1987 (OSUM #29779). The catspaw is most likely extirpated from the Tippecanoe River proper, but its status in the lake region is unknown.

*Hemistena lata* (Rafinesque 1820). **Cracking pearly mussel.** Extirpated from nearly all of its former range, it still survives in the Elk, Powell, and Clinch rivers in Tennessee (Stansbery, 1970; Bogan & Parmalee, 1983; Ahlstedt, 1986). It was last found in the Green River in Kentucky in the 1960's. Reported as rare in the Wabash in the last century (Call, 1900), *H. lata* was listed from the Tippecanoe River by Daniels (1903), and the specimens were deposited in the Mollusk Collection of the University of Michigan Museum of Zoology (UMMZ #107882). Goodrich and van der Schalie (1944) reported this species from the Wabash and Tippecanoe rivers but stated that it was rare throughout its range. No specimens of *H. lata* were found during the present study, and it most likely is extirpated from the drainage.

*Obovaria retusa* (Lamarck 1819). **Ring pink.** Two specimens of *Obovaria retusa* collected by L.E. Daniels from the Tippecanoe River were found in the Mollusk Collection at the University of Michigan Museum of Zoology (UMMZ #105700). This species was not reported from the Tippecanoe River in the papers published by Daniels (1903, 1914) on the Mollusca of Indiana. No individuals were found in the Tippecanoe River in 1987, but weathered shells were taken in the Wabash River near the mouth of the Tippecanoe in 1988 (Cummings, *et al.*, 1988b).

*Pleurobema plenum* (I. Lea 1840). **Rough pigtoe.** Listed by Daniels (1903) from the Tippecanoe River in Carroll County, *P. plenum* was not found in the river in 1987. This species has not been collected in Indiana in over 50 years and is probably extirpated from the state. The only remaining populations are in the Clinch, lower Tennessee, and Green rivers (Clarke, 1983).

#### PROPOSED FEDERALLY ENDANGERED SPECIES

*Cyprogenia stegaria* (Rafinesque 1820). **Fanshell.** This species was reported by Call (1900) to be abundant in the Wabash River. Goodrich & van der Schalie (1944) listed the fanshell as a large river species, confined to the Ohio, Wabash, and White rivers in Indiana. Three valves of *C. stegaria* were found in the lower Tippecanoe during 1987, at sites 15 and 16. Although no live specimens were found, one of the shells was in good condition and probably represented a recently dead individual. This species may still occur in the lower Tippecanoe River.

## FEDERAL CANDIDATE SPECIES (Category 2, USFWS)

*Epioblasma rangiana* (I. Lea 1839). Northern riffleshell. Call (1894; 1896; 1897) reported this species from Indiana with *E. torulosa rangiana* occurring in headwater streams and *E. torulosa torulosa* occurring in the Wabash River proper. Daniels (1903) listed the Tippecanoe River as a locality for *E. torulosa rangiana*. During the 1987 survey, weathered valves of *E. rangiana* were collected from nine of the 16 sites sampled. Although all of the specimens appeared to have been dead for some time, many had the periostracum intact, suggesting the possibility that this species still occurs in the drainage.

The members of the *Epioblasma torulosa* species complex found in the Interior Basin have been variously lumped (Johnson, 1978), split (Frierson, 1927), treated as varieties (Simpson, 1900) or subspecies (Stansbery, 1971). A comparison of specimens from the Tippecanoe with those from the Wabash River near the confluence of the two rivers shows a distinct separation of the two phenotypes in the drainage. No intergrades, clines or intermediate forms were found and shells of both were found syntopically in the Wabash. Although a comprehensive study of this complex should be done to clarify the ranges of the species, examination of the material from the upper Wabash River drainage supports the elevation of *rangiana* to specific rank.

*Pleurobema clava* (Lamarck 1819). Clubshell. Reported from the Tippecanoe River by Daniels (1903), the clubshell was listed as widely scattered in the smaller streams of Indiana (Call, 1900; Goodrich & van der Schalie, 1944). Nineteen living *P. clava* were found at four sites during the present survey, and shells were found at seven additional localities. *Pleurobema clava* ranked 18th in abundance of the 34 species collected alive and was the fourth most common species collected at Site 3 (Table 2). The clubshell was found in water 15 to 60 cm deep, in a substrate of sand or mixed sand and gravel. This formerly common and widespread species has disappeared from much of its former range (Stansbery, 1970) and is probably extirpated in neighboring Illinois (Parmalee, 1967; Suloway *et al.*, 1981a). The population in the Tippecanoe River is one of the last remaining in the upper Midwest and should be protected and closely monitored to ensure its survival.

*Simpsonaias ambigua* (Say 1825). Salamander mussel. The salamander mussel is known from the Ohio, Mississippi, Cumberland, and Great Lakes drainages (Clarke, 1985). In Indiana, *S. ambigua* has been reported from both the Wabash and Great Lakes drainages, including the Tippecanoe River (*op. cit.*). It was considered rare by Stansbery (1970), but he noted that, due to its precise habitat requirements and very localized distribution, its rarity may be "more apparent than real." It has not been collected alive in Illinois for over 50 years and is listed as endangered there (IDOC, 1989). This species was not collected in the Tippecanoe River during 1987 and may be extirpated from the drainage. However, because of its small size, it may have been overlooked. Careful exploration of the specific habitat of *S. ambigua* (particularly pockets of sand and silt under large flat rocks or bedrock ledges) has resulted in discovering populations at several localities in Wisconsin (David Heath, Wisconsin Department of Natural Resources, pers. comm.).

*Toxolasma lividus* (Rafinesque 1831). Purple lilliput. Shells of the purple lilliput were found throughout the Tippecanoe River, but it was taken live only at sites 1 and 16. Given the small size of this mussel and the presence of recently dead shells at many of the sites, it may be more widespread in the river than our collections indicate. More intensive collecting and employment of more efficient

sampling methods (*i.e.*, substrate vacuum or sieves) would be required to determine the status of this species in the Tippecanoe River. This species was collected in the headwater lakes of the drainage by previous workers (Call, 1896; Daniels, 1903), and an investigation of those lakes is warranted.

*Villosa fabalis* (I. Lea 1831). **Rayed bean.** Call (1900) considered *Villosa fabalis* to be common in the Wabash River and Tippecanoe Lake, and Daniels (1903) reported it from the Tippecanoe River. Only weathered dead shells of this species were found in 1987, at sites 5, 10, and 15. Because of its small size, it is uncertain whether this species was simply overlooked or if it no longer occurs in the river. As with the previous species, a more intensive search may reveal the presence of live *V. fabalis* in the Tippecanoe River. Reported from Lake Maxinkuckee (Evermann & Clark, 1920), *V. fabalis* still may be found in the natural lakes in the upper part of the drainage. Listed as endangered in Illinois, additional sampling in the glacial lakes of Northern Indiana will be required to determine its status in that state.

#### INDIANA STATE ENDANGERED SPECIES

*Epioblasma triquetra* (Rafinesque 1820). **Snuffbox.** The snuffbox was reported by Call (1900) as abundant in the Wabash River. Daniels (1903) listed the Tippecanoe and Wabash rivers, among others, as localities for this species in Indiana. Goodrich & van der Schalie (1944) noted that *E. triquetra* was usually found in medium to large rivers (including the Wabash) but seldom was present in large numbers. In 1987, only weathered shells of this species were found at sites 12 and 16.

*Fusconaia subrotunda* (I. Lea 1831). **Long-solid.** Although reported from the Tippecanoe River by Daniels (1903), no evidence of this species was found in the river in 1987. As with *Pleurobema plenum*, the long-solid has not been found in the Wabash River drainage in many years and is most likely extirpated.

*Plethobasus cyphus* (Rafinesque 1820). **Sheepnose.** Call (1900) reported the sheepnose as common in the deeper waters of the Wabash River in Indiana, but Goodrich & van der Schalie (1944) considered it rare in the state. Daniels (1903) reported *P. cyphus* from the Tippecanoe River. A total of ten live individuals of this species was found at six sites in 1987. It was most common in the mid-portion of the river (sites 5 through 10) and was absent from all sites downstream of the reservoirs. *Plethobasus cyphus* is listed as endangered in Missouri (Wilson, 1984) and Illinois (IDOC, 1989). The Tippecanoe population may be the largest in the upper Wabash River drainage and warrants protection.

*Quadrula cylindrica* (Say 1817). **Rabbitsfoot.** Reported to be common in the Wabash and Tippecanoe rivers (Call, 1900; Daniels, 1903), a total of nine live *Q. cylindrica* was found in 1987 at sites 9, 10, and 11. Shells were found at sites 6, 8, 15, and 16. This once wide-ranging species has been nearly extirpated in Illinois and other states (Parmalee, 1967; Stansbery, 1970; Suloway *et al.*, 1981a; Wilson, 1984) and should be given consideration for federal listing as threatened.

*Pleurobema rubrum* (Rafinesque 1820). **Pyramid pigtoe.** Although not considered by the U.S. Fish and Wildlife Service as meeting the Endangered Species Act's legal definition of a species (USFWS, 1989b, Federal Category 3B), *Pleurobema rubrum*, was shown by Stansbery (1983) to be distinct from other congeneric species of *Pleurobema*. Reported from the Tippecanoe River by Daniels (1903), no evidence of this species was found during the present survey. However, one valve was collected from the Tippecanoe River at Delong, Fulton County, on 7 September 1985 (INHS #2179), and two valves were found at U.S. Route 35 in

Winemac, Pulaski County, on 20 September 1987 (INHS #4708). In both lots the shells are old and weathered and it appears that this species is extirpated from the Tippecanoe River.

#### INDIANA SPECIES OF SPECIAL CONCERN

*Lampsilis fasciola* Rafinesque 1820. Wavy-rayed lampmussel. Reported by Daniels (1903) from the Tippecanoe River, *L. fasciola* was found at three sites in the upper third of the river in 1987. The wavy-rayed lampmussel was not collected in a recent survey of the adjacent Eel River (Henschen, 1987) and is endangered in Illinois (IDOC, 1989). Further surveys will be needed to ascertain its status in the remainder of the Wabash River drainage.

The Tippecanoe River supports an abundant and diverse unionid fauna, including many rare species. The preservation of the North American mussel fauna depends upon protecting the Tippecanoe River and others like it from further habitat degradation. Few streams remaining in the upper Midwest support such a large number of living mussel species and serious consideration should be given to designating this river as a mussel sanctuary or preserve to provide protection for this rapidly declining fauna.

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