

FINAL REPORT

STATUS SURVEY OF THE WESTERN FANSHELL AND  
THE NEOSHO MUCKET IN OKLAHOMA



PROJECT E - 7

STATE OF OKLAHOMA

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STATE: Oklahoma

PROJECT NUMBER: E - 7

PROJECT TITLE: STATUS SURVEY OF THE WESTERN FANSHELL AND  
THE NEOSHO MUCKET IN OKLAHOMA

### I. Objective:

To determine the distribution and abundance of the freshwater mussels Cyprogenia aberti (Conrad) and Lampsilis rafinesqueana Frierson in Oklahoma.

### ABSTRACT

A survey to determine the status of the freshwater mussels, Cyprogenia aberti (Conrad) and Lampsilis rafinesqueana Frierson, in Oklahoma was completed during August and September, 1989. These species are also known by the common names of Western Fanshell and Neosho Mucket, respectively. The western fanshell is probably extinct in the state. It is known that the species formerly occurred in the Verdigris River in Oklahoma and as a result of this study, was determined that it had also existed in the Caney River. However, no evidence of living or fresh specimens was found in any river system in northeastern Oklahoma. The Neosho mucket has also disappeared from most of its former range within the state and presently only occurs in a segment of the Illinois River system extending from the Lake Frances dam near the Arkansas border to Lake Tenkiller. Protection for this species is recommended.

### II. Introduction:

This report describes efforts to determine the status of two species of freshwater mussels (Mollusca: Bivalvia: Unionidae) in Oklahoma. Both species are generally considered to be rare and have rather limited geographical distributions. Both species may meet the criteria of endangered species and thus it was considered important to gain some information as to their current status. Both species have been recorded in Oklahoma but their current abundance and distribution in the state were unknown. The western fanshell, Cyprogenia aberti (Conrad) was described in 1850 from specimens collected on the rapids of the Verdigris River, Chambers' Ford, Oklahoma (Johnson, 1980). These specimens were collected by Samuel Woodhouse in the survey of the northern Creek boundary in 1849 (Sitgreaves and Woodruff, 1858). According to Johnson and Baker (1973), Chambers' Ford was not located. The species has also been collected in Kansas, Missouri and Arkansas.

The Neosho mucket, Lampsilis rafinesqueana Frierson, was also described from specimens collected in Oklahoma from the Illinois River near Moodys, Cherokee Co. This species has long been confused with a species having an almost identical shell and usually referred to in the literature as Actinonaias ligamentina or

A. carinata. Although the shells of these species are confusing, the soft anatomy is distinct. Lampsilis rafinesqueana females have a mantle flap characteristic of the genus whereas in the genus Actinonaias, females lack mantle flaps. Apparently A. ligamentina does not occur in the Arkansas River system above the Fourche le Fave River in Arkansas (David Stansbery, pers. comm.).

### III. Study Area.

The region included in this study was the tributaries of the Arkansas River in northeastern Oklahoma. These river systems originate in Arkansas, Missouri and Kansas and ultimately enter Oklahoma and flow into the Arkansas river. These include the Illinois River, Spring River, Grand (Neosho) River, Verdigris River and Caney River (See Fig 1).

#### Illinois River

The Illinois River enters Oklahoma at Lake Frances in Adair County and flows generally eastward through northern Adair County and southern Delaware County. It enters northeastern Cherokee County and turns southeast joining the Arkansas River in Sequoyah County. Lake Tenkiller is located on the lower portion of the river, the dam being in Sequoyah County and the lake backing into southern Cherokee County (see Fig. 2). There is a total of 109 miles of the river in Oklahoma (Oklahoma Water Resources Board, 1984).

#### Grand River

The Grand River enters Oklahoma from Kansas, forming the Craig County and Ottawa County boundaries for a short distance and flows southeastward through Ottawa County, joining the Spring River. The Spring River also flows out of Kansas and has a generally south southwest flow before joining the Grand River. The grand enters northern Delaware County, flowing southwestward to northeastern Mayes County, across Mayes County to between northern Cherokee County and Wagoner County southward to the Arkansas River in Muskogee County. There are several lakes within this system. Lake O' The Cherokees dam is located in northeastern Mayes County and backs water completely across Delaware County and leaving only a small portion of free flowing water in the Grand and Spring Rivers in northern Ottawa County. The Elk River flowing out of Missouri also enters the lake in northern Delaware County, but there is no free flowing water in Oklahoma. Lake Hudson is completely within Mayes County. The Fort Gibson Lake dam is in Cherokee County and water is backed up into Mayes County (see Fig. 3). The Grand River flows a total of 164.4 miles in Oklahoma (Oklahoma Water Resources Board, 1984).

#### Verdigris River

The Verdigris River enters Nowata County from Kansas. It flows southward through Nowata and Rogers Counties, southeastward through Wagoner County and enters the Arkansas River in Muskogee County. The dam for Oologah Lake is located in central Rogers County and water backs up into southern Nowata County (see Fig. 4).

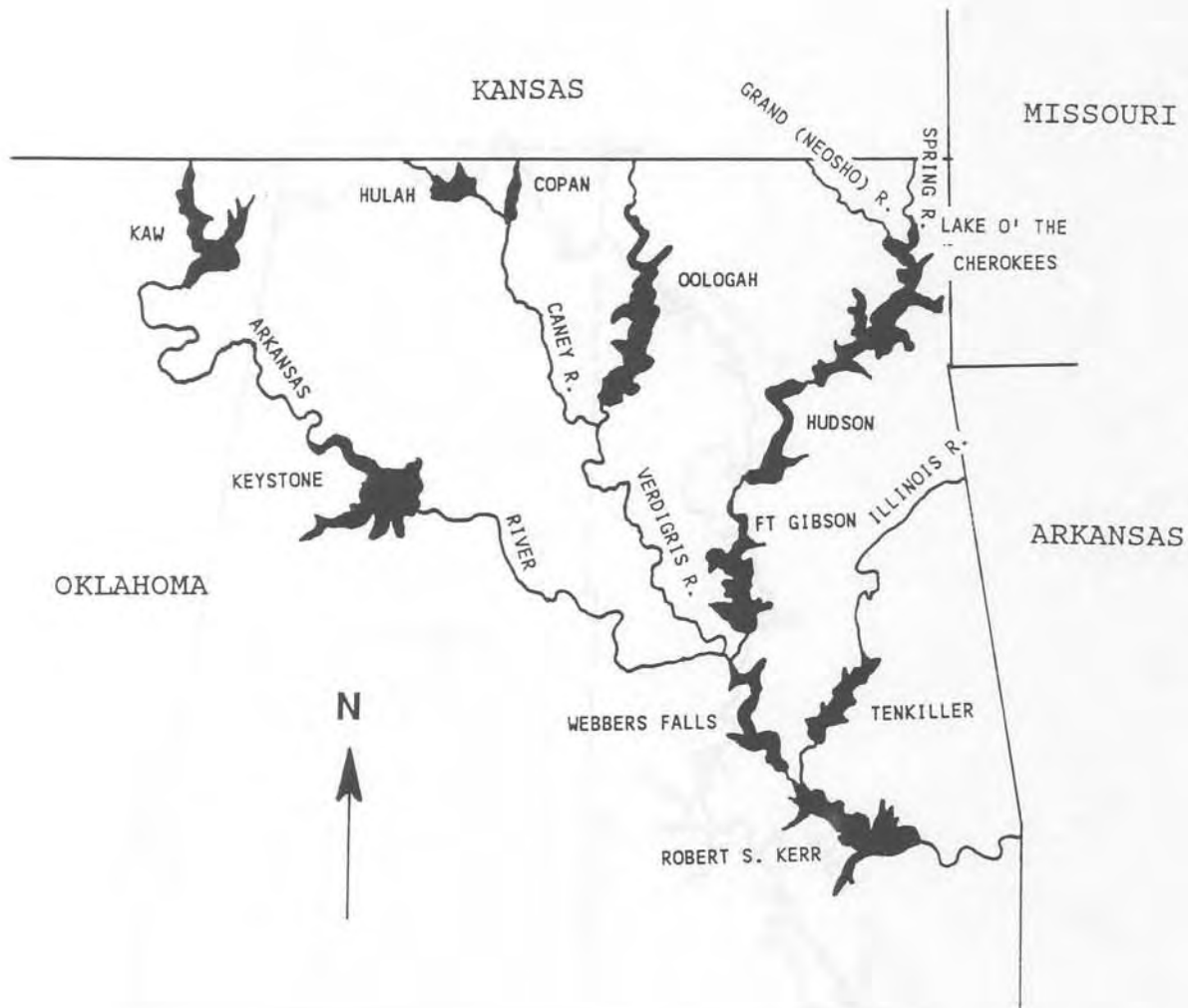


FIGURE 1. General area of study in northeastern Oklahoma.

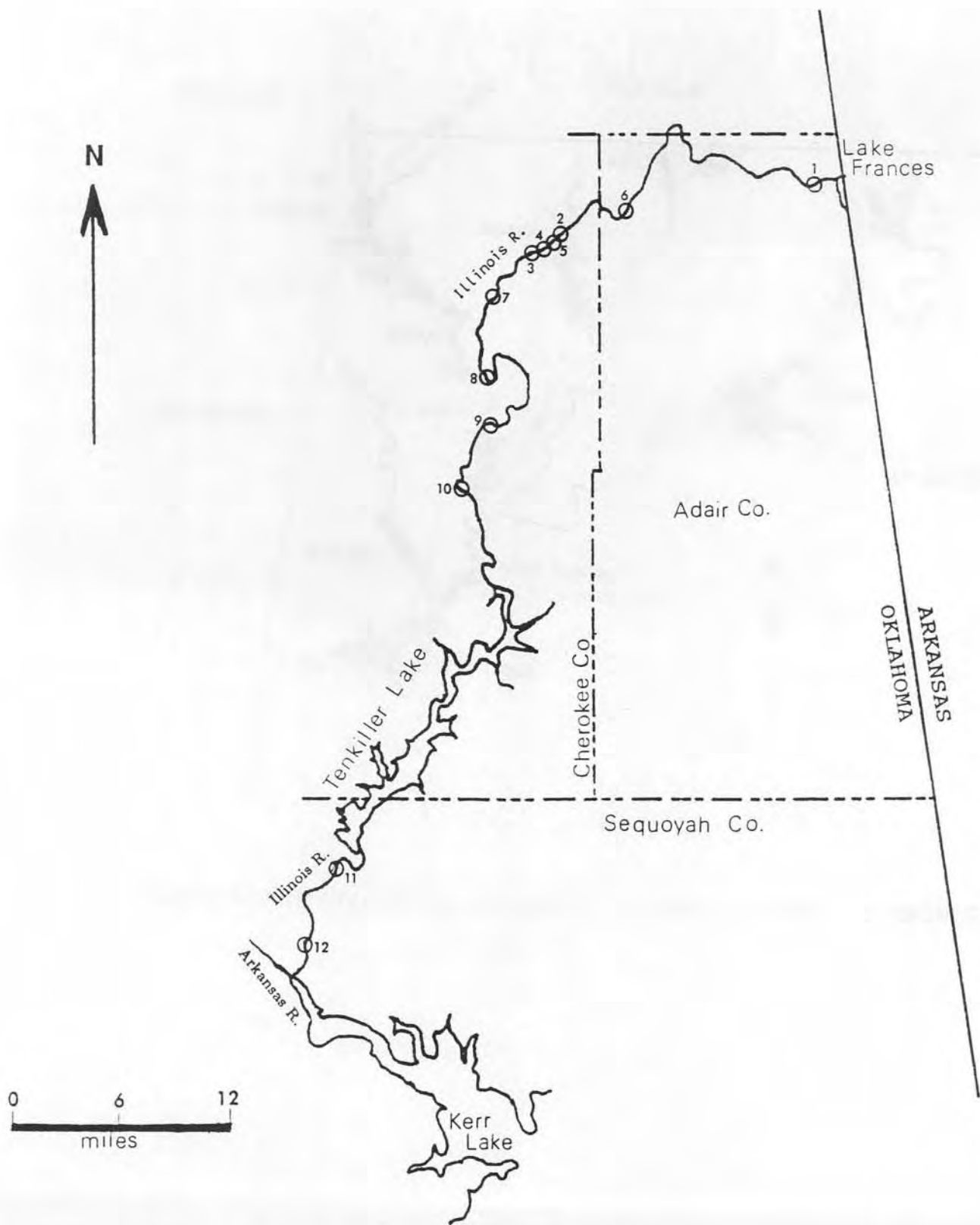


FIGURE 2. Collecting localities on the Illinois River, Oklahoma.

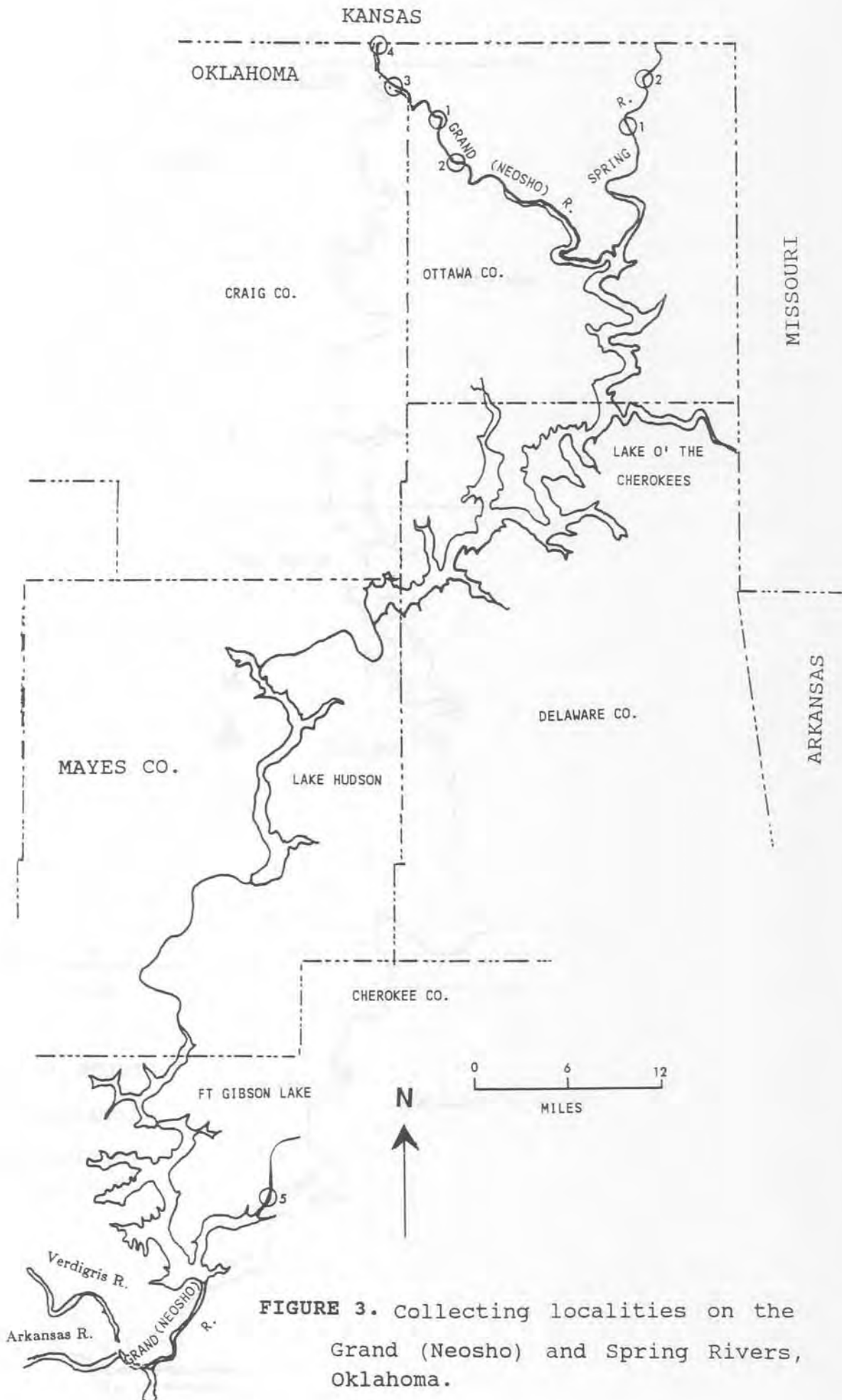
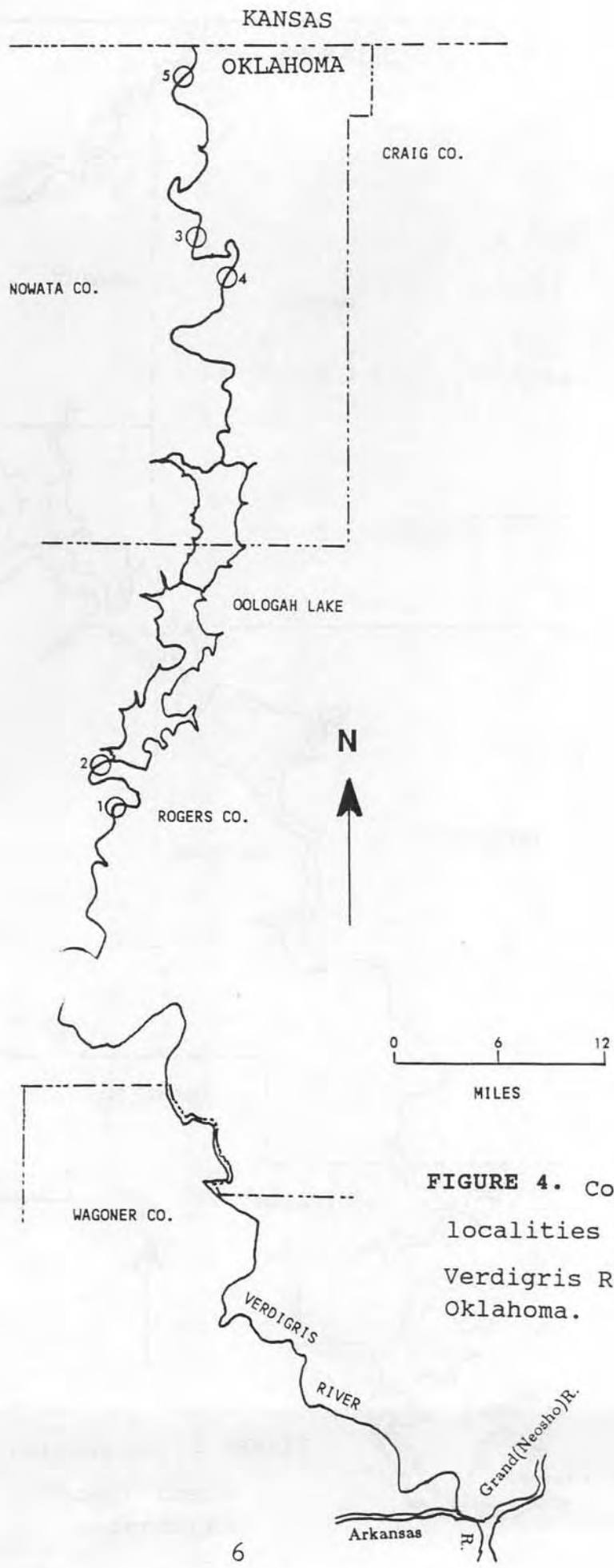


FIGURE 3. Collecting localities on the Grand (Neosho) and Spring Rivers, Oklahoma.



**FIGURE 4.** Collecting localities on the Verdigris River, Oklahoma.

In Oklahoma, the Verdigris River flows a total of 162 miles (Oklahoma Water Resources Board, 1984).

#### Caney River

The Caney River enters northern Osage County from Kansas and flows across the northeastern corner of Osage County. It flows generally south southeastward across Washington County, and through the southwest corner of Rogers County and the northeast corner of Tulsa County. It then re-enters Rogers County and there joins the Verdigris River (see Fig. 5). The Caney River flows a total of 117 miles within Oklahoma (Oklahoma Water Resources Board, 1984).

#### **IV. Methods**

During August and September of 1989, a total of 31 sites within the above named river systems were visited (see Tables 1, 2, 3, 4 and 5). At most of these sites, efforts were made to sample the freshwater mussel populations. Dead shells were collected along the banks to assess the species that have lived in the area and live specimens were collected by wading to obtain information on species currently living in the area and their abundance. At the end of each field collection period, specimens were identified and totaled. Live specimens were returned except in a few instances where live specimens were retained to confirm identifications. Samples of dead shells were retained from each location for later re-examination in the laboratory to confirm identifications.

#### **V. Results**

##### **Cyprogenia aberti**

No living specimens were collected in the state of Oklahoma during the course of this study. One weathered half valve was found at Site 5 on the Caney River, 4.8 miles SE of the Hulah Dam in Osage County, Oklahoma. It is my opinion that Cyprogenia aberti is extinct in Oklahoma.

##### **Lampsilis rafinesqueana**

#### Distribution

Although weathered "fossil" valves of Lampsilis rafinesqueana were found in the Verdigris, Spring, Neosho and Caney Rivers, living specimens and fresh shells were found only in the Illinois River (see Table 1). Live specimens were collected at seven collecting sites along the Illinois River. As few as a single live specimen was collected at Site 6 to as many as 34 were collected at Site 9. Live specimens were collected as far up river as Site 1, about 1 mile down river from the Lake Frances Dam in Adair County, to Site 9, at the Echota Access Area in Cherokee County. Fairly fresh shells were found further down river at Site



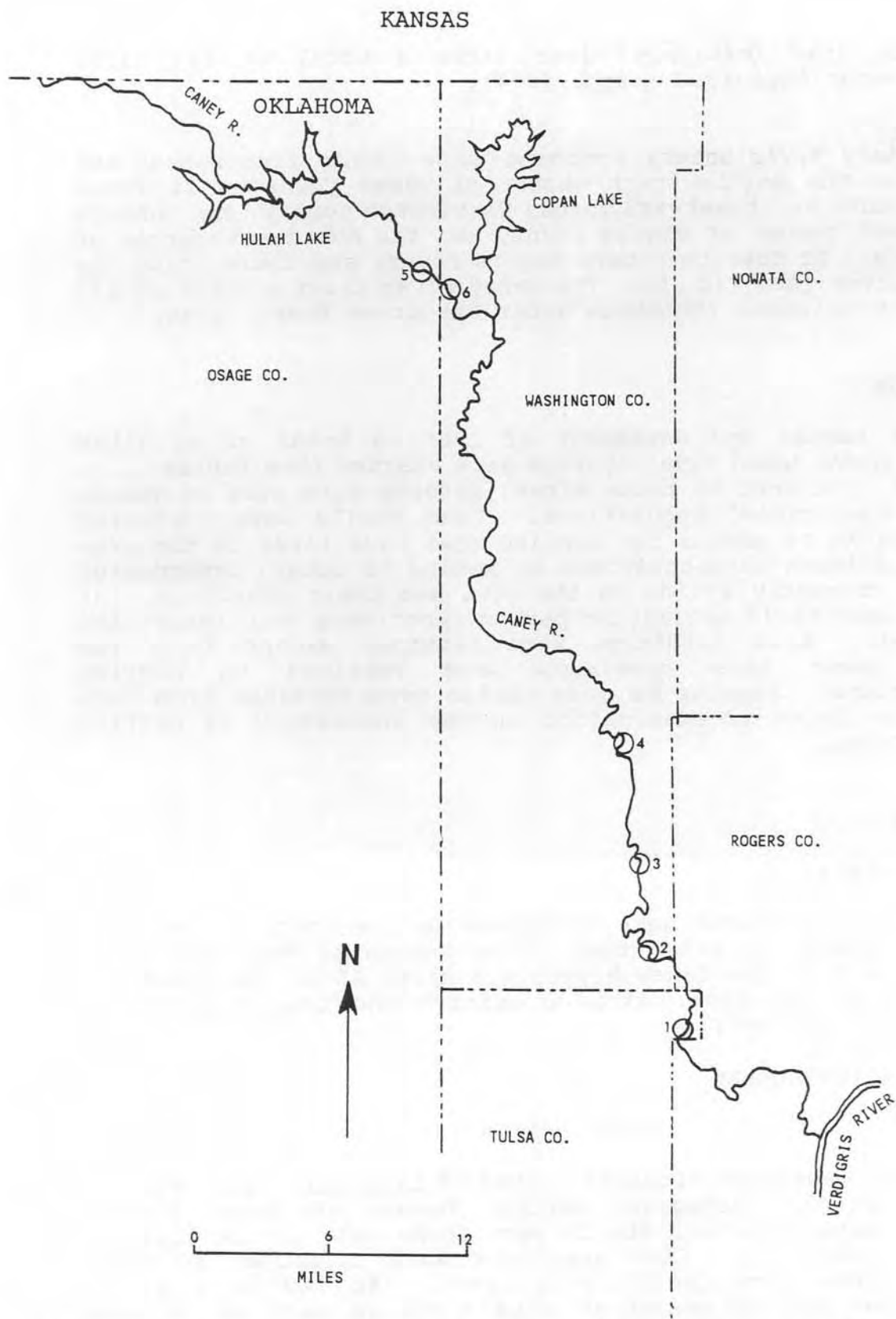


FIGURE 5. Collecting localities on the Caney River, Oklahoma.

TABLE 1. List of Illinois River sampling sites.

Site Number	Locality
1	Ok: Adair Co., about 1 mile down river from Lake Frances Dam, S18-T19N-R26E and S13-T19N-R25E
2	Ok: Cherokee Co., Round Hollow Public Access Area, off State Hwy 10 about 1 mile ENE of Scraper, S26-T19N-R23E
3	Ok: Cherokee Co., Peavine Hollow Public Access Area, about 2.6 miles SE of Scraper off State Hwy 10, S5-T18N-R23E
4	Ok: Cherokee Co., Buck Ford Public Access Area, 1 mile S of Scraper, S33 & 34-T19N-R23E and S3 & 4-T18N-R23E
5	Ok: Cherokee Co., Stunkard Access Area, about 0.7 miles ESE of Scraper off State Hwy 10, S34-T19N-R23E
6	Ok: Adair Co., Hampton's Bridge, 0.8 miles W of Chewey, S19-T19N-R24E
7	Ok: Adair Co., Combs Bridge, 2.5 miles E of Moodys, S13-T18N-R22E
8	Ok: Cherokee Co., No Head Hollow Public Access Area, 1 mile SE of McSpadden Falls on State Hwy 10, S12-T17N-R22E
9	Ok: Cherokee Co., Echota Access Area, S24-T17N-R22E
10	Ok: Cherokee Co., Public Access Area down river from Hwy 51 bridge, S26-T17N-R22E
11	Ok: Sequoyah Co., Below Tenkiller Dam and Power Plant, S22-T13N-R21E
12	Ok: Sequoyah Co., Gore Landing, 1.4 miles SE of Gore off State Hwy 10(US64) S9-T12N-R21E

TABLE 2. List of Spring River sampling sites.

Site Number	Locality
1	Ok: Ottawa Co., Devil's Promenade Bridge, 2.8 miles SE of Quapaw, S5-T28N-R24E
2	Ok: Ottawa Co., Bicentennial Canoe Park, 3.5 miles ENE of Quapaw, S28 & 29-T29N-R24E
3	Kans: Cherokee Co., Baxter Springs, City Park, below dam, S18-T35S-R25E

TABLE 3. List of Neosho River sampling sites.

Site Number	Locality
1	Ok: Craig/Ottawa Co., 4.5 miles NW of Miami at Stepps Ford Bridge, S4, 4, 8 & 9-T28N-R22E
2	Ok: Craig/Ottawa Co., about 3 miles WNW of Miami, S20 & 21-T28N-R22E
3	Ok: Craig/Ottawa Co., about 9.5 miles NW of Miami S27-T29N-R21E
4	Ok: Craig Co./Kans: Cherokee Co. line, 2.9 miles E of US Hwy 59, S16-T29N-R21E
5(Fourteenmile Creek)	Ok: Cherokee Co., 2 miles W of Hulbert on State Hwy 51 S21-T17N-R20E

TABLE 4. List of Verdigris River sampling sites.

Site Number	Locality
1	Ok: Rogers Co., 0.8 miles W of Claremore Mound, S14-T22N-R15E
2	Ok: Rogers Co., below Oologah Dam, S2 & 3-T22N-R15E
3	Ok: Nowata Co., at State Hwy 10, 2.8 miles E of Lenapah, S3-T27N-R16E
4	Ok: Nowata Co., 4 miles N of Childers, Hancock Bridge, S12 & 13-T27N-R16E
5	Ok: Nowata Co., 2 miles SE of South Coffeyville, S16, 20 & 21-T29N-R16E

TABLE 5. List of Caney River sampling sites.

Site Number	Locality
1	Ok: Tulsa Co., Hwy 169 Bridge, S9 & 10-T22N-R14E
2	Ok: Washington Co., S20 & 29-T23N-R14E
3	Ok: Washington Co., Bridge, 4.8 miles E of Ramona, S32-T24N-R14E and S5-T23N-R14E
4	Ok: Washington Co., Bridge 635, S6 & 7-T24N-R14E
5	Ok: Osage Co., 4.8 miles SE of Hulah Dam, S28-T28N-R12E
6	Ok: Washington Co., 4.6 miles NW of Dewey, S2-T27N-R12E and S35-T28N-R12E.

10, at the public access area just below the Hwy 51 bridge in Cherokee County. Below Site 10, it is believed that the influence of Lake Tenkiller prevents a viable population of Lampsilis rafinesqueana from existing. In the section of the Illinois River from the Lake Tenkiller Dam to the Arkansas River, no specimens were found. The water released from Lake Tenkiller is very cold and the flow is highly variable, making it difficult for freshwater mussels of any species to survive. Further down stream, the river again becomes lake-like because of the influence of Kerr Lake and the Arkansas River navigation system.

The results are that there is a population of living Lampsilis rafinesqueana existing in a 55 mile section of the Illinois River above Lake Tenkiller to Lake Frances on the Arkansas border.

#### Abundance

Populations were measured in terms of collecting success at each collection site. Records of both living specimens and dead shells were made at each site. Dead shells were collected at all sites above Tenkiller Lake and living specimens were collected at seven of these sites. Total number of specimens collected per man hour ranged from a minimum of 0.77 at Site 1 to 18.67 at Site 9. If only living specimens were considered then the success ranged from zero at Sites 1, 5 and 10 to 11.33 per man hour at Site 9 (see Table 6). Of the 55 miles of the Illinois River in which living and fresh shells were found, 3.2 miles were sampled. If it were assumed that our sampling techniques were extremely efficient, then with the success of finding living specimens it can be extrapolated that had the entire 55 mile section of the river been sampled, we would have found 1238 individuals. I believe that this would be an estimate of the very minimum number of individuals living in the river. In the later discussion section, it will be argued that the population is somewhat larger.

#### Habitat

Specimens of Lampsilis rafinesqueana collected in the Illinois River were found in primarily two distinct habitats. By far, the greatest concentrations of individuals seemed to be in silty backwater areas. Specimens collected in this habitat tended to be large, darkly stained and having growths of algae on the posterior end of the shell that protruded above the substrate. Smaller specimens were more often collected in swift flowing water over rock or gravel. These individuals tended to be lighter in color and were more likely to show the rays on the shell usually considered typical for the species.

#### Age and Growth

It appears, by counting growth rings, that most of the larger individuals above 100mm in length are from 12 to 15 years of age. The longest and heaviest shells were collected at Site 1 below Lake Frances. This is probably due to the eutrophic conditions of the water in this area coming from the lake. The largest shell

TABLE 6. Collecting success for Lampsilis rafinesqueana at sampling sites.

Site		Total Specimens Collected	Total Specimens Per Man Hour	Live Specimens Collected	Live Specimens Per Man Hour
Illinois R.	1	5	0.77	0	0
	2	29	4.35	18	2.70
	3	10	5.00	4	2.00
	4	9	5.40	7	4.20
	5	3	3.00	0	0
	6	7	2.80	1	0.40
	7	8	4.00	5	2.50
	8	6	4.00	3	2.00
	9	56	18.67	34	11.33
	10	2	0.89	0	0
	11	0	0	0	0
	12	0	0	0	0
Spring R.	1	0	0	0	0
	2	0	0	0	0
	3	1	0.55	0	0
Neosho R.	1	7	0.68	0	0
	2	1	0.35	0	0
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
Verdigris R.	1	0	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	5	2	1.33	0	0
Caney R.	1	0	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	5	2	0.67	0	0
	6	1	0.27	0	0

collected at this site was 149mm in length. This is 16mm longer than specimens collected at any other site on the Illinois River. Size classes of Lampsilis rafinesqueana collected on the Illinois River may be seen in Figure 6.

#### Reproduction

The soft parts of two female Lampsilis rafinesqueana were available for examination. Of these, one 99mm female collected on 8 August 1989 at Site 3 had a very distinct marsupium in the posterior half of the outer gill, but it was devoid of any eggs or glochidia. The other female was 93mm in length and had the marsupium very distended with glochidia. She was also collected on 8 August 1989 but at Site 4. The glochidia were of the typically lampsilid type and were about 0.22mm in length.

## VI. Discussion

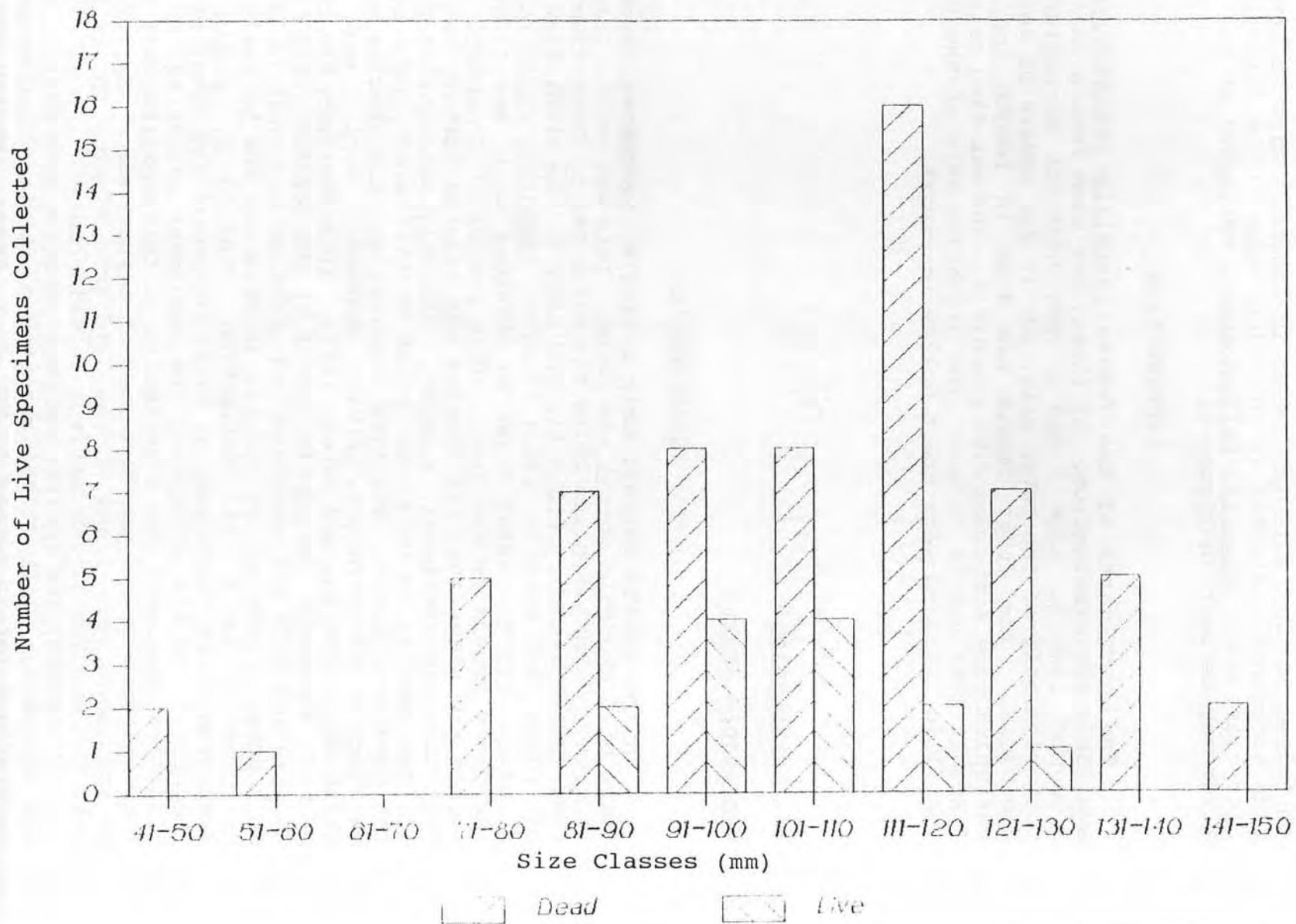
### Cyprogenia aberti

#### Distribution

In the entire survey, only a single, weathered, broken half valve of Cyprogenia aberti was found. This was on the Caney River at Site 5 about 4.8 miles below the Hulah Dam in Osage County. The Caney River was not originally included in the study area, but it was found that Metcalf (1980) reported Lampsilis rafinesqueana as a fossil from the Caney River in Oklahoma so it was thought that the Caney should be examined. This record of C. aberti is a new record and shows that the species has existed further west in the past than was previously thought. The only authenticated records for the species in Oklahoma, prior to this study, have been from the Verdigris River. The type locality for the species is listed as "Rapids of Verdigris River, Chambers' Ford, [not located, Oklahoma]," (Johnson and Baker, 1973). This specimen was collected by S. W. Woodhouse during the survey of the northern Creek Boundary in 1849 and 1850 and described and named by T. Conrad in 1850. The only other report of the species in Oklahoma was by Isely (1925). He reports, in a 1911 collection, finding C. aberti in the Verdigris River "Northwest of Inola (Rogers)" and "East of Catoosa (Rogers)." In his account of the specimens collected, he reports "Two live specimens and five shells of this species were taken in the Verdigris in our ten days work on that stream." In this study, no specimens were found on the Verdigris River. It is presumed that the species is now extinct in Oklahoma.

Otherwise, the species has been reported from Kansas, Missouri and Arkansas. Call (1895) reported a specimen collected in the Verdigris River in Kansas by Mr. J. R. Mead. Murray and Leonard (1962) said that "Cyprogenia aberti is restricted to the Verdigris and Neosho river drainages in Kansas." Schuster (1979) reported

FIGURE 6. Distribution of size classes of Lampsilis rafinesqueana collected in the Illinois River, Oklahoma.



that the species no longer existed in the Verdigris River system and hadn't been "collected from the Verdigris system since R. E. Call's work in the mid- and late 1880's." However, the files of the Kansas Natural Heritage Program show that the species has been found in the Spring River, Fall River and Verdigris River and all of these since 1978.

In Missouri, Cyprogenia aberti has been reported from the southern half of the state. It was reported from the Spring, St. Francis, Black, Current and Meramec rivers (Oesch, 1984).

In Arkansas, specimens from the Caddo and Ouachita rivers were originally described as Unio lamarckiana by Lea in 1852 (Simpson, 1914). Gordon et. al., (1979) listed C. aberti from the White River, Buffalo River, North Fork White River, Black River, Spring River, Little Red River, St. Francis River, Arkansas River, Ouachita River, Saline River and Caddo River.

For Oklahoma, the significant extralimital distribution records are those from Kansas, because both the Verdigris and Spring river systems eventually enter the state along the northeastern border. Because the species still exists in the Kansas segments of these rivers, and no longer occur in Oklahoma, it must be assumed that conditions in Oklahoma are no longer suitable for them or that at some time since Isely's 1911 collection, there have been one or several extinction events that destroyed the existing population. In all likelihood, the extinction of the species in Oklahoma was the result of human activity (mines, dams, agriculture, sewage, etc.) but natural extremes of climate (cold or drought) cannot be ruled out.

#### Abundance

Since this study produced no evidence of a currently existing population of Cyprogenia aberti in Oklahoma, no statement can be made of its current abundance other than that it is presumed extinct in Oklahoma. However, some conclusions can be made on its past abundance in the state. First of all, the original collection of the species from "Chambers' ford, rapids of Verdigris" was of a single specimen (Sitgreaves and Woodruff, 1858). Since this specimen is apparently lost (Johnson and Baker, 1973 and John S. Tomer pers. comm.) it is not known if this was collected alive, freshly dead or as an old weathered shell. Isely (1925) mentions only "Two live specimens and five shells of this species were taken in the Verdigris in our ten days work on that stream." This indicates that the species was extremely rare by 1911 and if it were formerly more abundant, then was on a severe decline by that time.

#### Habitat

From this study, little can be said of the habitat of C. aberti in Oklahoma. The only shell found on the Caney River several miles below the Lake Hulah dam was not in a habitat favorable to mussels of any species. Only a single live specimen was seen at that locality and that was of Quadrula pustulosa. Shells of 17 species of Unionids were collected at the site and



some were fairly fresh. From observation of the site, it appears that the area of the river is subjected to extreme fluctuations of water levels. Scouring of some areas and shifting silt make a very unsatisfactory habitat for mussels. Isely (1925) reports that the two living specimens collected on the Verdigris River in 1911 "were found in the main channel in water two to three feet deep, with fair current and sand-gravel bottom." This type of habitat was fairly common in all of the rivers sampled during this survey, but no living specimens were found. Schuster (1979) in comments about conditions in Kansas makes the following statement:

"Over the past 100 years the character of the Verdigris River drainage has been greatly changed by the construction of major reservoirs on all three rivers in the system: Elk River (Elk City Reservoir), Fall River (Fall River Reservoir), Verdigris River (Toronto Reservoir). In addition to these, many low water dams have been constructed throughout the system, and bridge and road construction also have had an effect on it. This is in addition to changes in water quality (turbidity, insecticide and pesticide pollution, etc.) due to advanced agrarian techniques. It is little wonder that some species of freshwater mussels have been eliminated."

Similar statements could also be made of conditions in Oklahoma. Siltation due to agricultural development in the state in the last of the Nineteenth Century and early Twentieth Century provided the first severe change in the habitat followed by raw sewage from developing cities and towns. Agricultural chemicals from pesticides and herbicides were primarily post World War II.

### Lampsilis rafinesqueana

#### Distribution

As a result of this survey, it was found that Lampsilis rafinesqueana inhabits the Illinois River from below the Lake Frances dam in Adair County, to, but not including, Lake Tenkiller in Cherokee County. Fresh shells or live specimens were collected throughout this part of the river. I believe that currently, this is the only existing population in Oklahoma. As a result of specimens collected during this study and literature records, it is clear that the species formerly occurred in several other river systems in Oklahoma including the Neosho, Verdigris and Caney rivers and probably the Spring River. Badly weathered "fossil" shells were found at Sites 1 and 2 on the Neosho River, Site 5 on the Verdigris River and Sites 5 and 6 on the Caney River.

The best survey of the study area in the past was by F. B. Isely in 1910-1912 (Isely, 1925). Although he apparently had some confusion of L. rafinesqueana with L. powellii and Actinonaias ligamentina, I believe these can be sorted out and some idea of the former distribution of L. rafinesqueana can be determined. First of all, D. H. Stansbery indicates that he has no evidence of A. ligamentina occurring in the Arkansas River system above the Fourche le Fave River in Arkansas (pers. comm.). In Isely's (1925)

statements about A. ligamentina, which I am inferring to mean L. rafinesqueana, he says "It is by no means so abundant in our area, altho found in good numbers in some of the larger streams." The larger streams of interest to us are the Neosho and Illinois rivers. He also says "the big difference between the mussel fauna of the Neosho and the Verdigris was the absence of L. ligamentina in the latter stream." In his Table 2, he lists Actinonaias ligamentina as occasional from the Neosho River at Miami, Ottawa Co. and at Chetopa, Cherokee Co., and as weathered shells from the Grand River (lower Neosho River) and as rare in Fourteenmile Creek, Cherokee Co. He also lists Lampsilis powellii as occasional from the Neosho River at Chetopa, Cherokee Co. and the Illinois River at Tahlequah, Cherokee Co. His Lampsilis powellii were a tentative identification and were later to be described as a new species by L. S. Frierson as Lampsilis rafinesqueana! Apparently the confusion of "L. ligamentina" and "L. powellii" was actually a separation of the ligamentina-like males and the powellii-like females. It appears that there existed a viable population of L. rafinesqueana in the Neosho River at the time of Isely's survey.

Metcalf (1980) reported collecting a fossil shell of L. rafinesqueana at a site "0.8-1.km downstream from Hulah Reservoir dam." Our collection of apparently fossil shells from the Caney River provide further proof that the species formerly occurred farther west in the past.

Of course, Lampsilis rafinesqueana is not limited to Oklahoma, it is also found in Kansas, Missouri and Arkansas. In Kansas, it has also been confused with Actinonaias ligamentina (also referred to as A. carinata) by some authors. Records from the Kansas Natural Heritage Program indicate that the species has been observed in the Spring, Neosho and Verdigris rivers since 1976. Other authors such as Coker (1919), Murray and Leonard (1962) Branson (1967) and Distler and Bleam (1987) confirm this distribution in Kansas.

In Missouri, Oesch (1984) reports the species from the southwest part of the state in Spring River, Elk River, Center Creek and Shoal Creek. Other authors such as Frierson (1927), Branson (1967) and Johnson (1980) confirm these and include Indian Creek which is a tributary of the Elk River.

The Arkansas distribution is much more confusing and should be studied carefully. Here the confusion between Actinonaias ligamentina and Lampsilis rafinesqueana is much more difficult to sort out. Both species may exist in sympatry. Frierson (1927) in his original description of the species lists the Black River. Gordon, Kraemer and Brown (1979) indicate its occurrence in the Illinois River and Johnson (1980) includes the White and Black Rivers. Landye (1980) list it from the Illinois, Flint and Baron Fork system in Arkansas.

#### Abundance

Although L. rafinesqueana was found throughout the Illinois River from Lake Frances to Lake Tenkiller, it could by no means be considered abundant. Under specific habitat conditions, there were greater concentrations of individuals but these conditions were

widely scattered along the river. Nowhere along the Illinois River were there "mussel beds" where mussels of many species are concentrated in large numbers. All species of mussels found in the Illinois River were found as scattered individuals. Isely (1925) stated that "at Tahlequah the Illinois is not much of a mussel stream." He lists L. rafinesqueana (he refers to it as L. powellii) as "occasional" at Tahlequah, the only site on the Illinois that he sampled. His designation of "occasional" was explained as follows: "Occasional implies the finding of single specimens of a species with some regularity when extensive collecting was done; 3-4 specimens a day might be called occasional." Thus, it seems that populations have apparently not changed significantly since Isely's visit to the Illinois in 1911.

It is interesting to note that of 135 living and dead shells seen along the Illinois River during this investigation, only 3 shells were found that could be considered as juvenile. All of these were collected as dead shells and the smallest of these was 48mm long and appears to be about four years old. This might lead one to consider this to be an aging population with very low reproductive success. This may, in fact, be the case, but, according to Clarke (1986), this early stage of development in freshwater mussels, called a mesoconch, is normally very difficult to find. According to Clarke, the first several years of life are spent in a hypobenthic state, that is, buried completely below the surface of the substrate. He states that the lampsilines are one of the groups that exhibit this phenomenon. Because of this, it is assumed that our population estimate of 1238 is very low, because no living juvenile mussels were collected and taken into account in this estimate.

#### Habitat

Our study found L. rafinesqueana concentrated in silty backwaters and occasionally in rock or gravel with a good current. Isely (1925) in his statements about "Lampsilis ligamentina," which we are assuming to mean L. rafinesqueana in northeastern Oklahoma, says it was found in "stretches of swift water from 1-3 feet deep, flowing over gravel bottom." Oesch (1984) found it "in moderately flowing shallow water in fine to medium gravel."

Apparently the Illinois River has maintained a somewhat pristine condition except for those parts modified by dams. This is apparently not the case in the rivers to the west where L. rafinesqueana formerly existed but no longer occurs. Schuster (1979) makes the following statement about the Verdigris River in Kansas:

"Over the past 100 years the character of the Verdigris River drainage has been greatly changed by the construction of major reservoirs on all three rivers in the system: Elk River (Elk City Reservoir), Fall River (Fall River Reservoir), Verdigris River (Toronto Reservoir). In addition to these, many low water dams have been constructed throughout the system, and bridge and road construction also have had an effect on it. This is in addition to changes in water quality

(turbidity, insecticide and pesticide pollution, etc.) due to advanced agrarian techniques. It is little wonder that some species of freshwater mussels have been eliminated."

This statement can equally be applied to the Spring, Neosho and Caney River systems in Oklahoma. These changes in the characteristics of the rivers and the water are the probable cause for the species absence in these streams today.

## VII. Conclusions and Recommendations

It was found that Cyprogenia aberti (Conrad), commonly known as the western fanshell mussel, is probably extinct in the state of Oklahoma. Thus, at this time, no action on this species in Oklahoma is recommended. If, in the future, some relict population is found within the state, then it should certainly be given protection and efforts should be made to improve its status in the state. Also, if water quality in the river systems in which it has occurred in the past improves, then consideration might be given to reintroducing the species into its former habitat.

For Lampsilis rafinesqueana Frierson, commonly known as the Neosho mucket, its status within Oklahoma is somewhat better. It was not found in and is probably extirpated from the Caney, Verdigris, Neosho and Spring rivers in Oklahoma. However, it is apparently maintaining a population in a 55 mile stretch of the Illinois River from the Lake Frances Dam to Lake Tenkiller. Although the population is seemingly stable, it is not an abundant species and deserves protection. A single event that alters water quality entering Oklahoma from upstream could destroy the Oklahoma population of this mussel. I would highly recommend that this species be classified as endangered in Oklahoma and every effort be made to ensure the continued quality of the Illinois River in the state.

Further studies of L. rafinesqueana should be considered. There is a need to know the fish host(s) and the reproductive season for this species for future management purposes. This would be difficult in the Illinois River where populations are small, but might better be accomplished in other states where higher population densities may exist.

## Acknowledgements

There are a number of individuals whose help and cooperation have made this study possible and enjoyable. First of all, I would like to extend my sincere appreciation to Robert Hall, Joseph Bergmann and John Skeen for their willingness to aid in the field work. I thank David H. Stansbery of The Ohio State University for his help in identification of specimens and comments on systematics and distributions. Discussions with Joseph Bergmann have been enormously helpful in sorting out the confusion when starting this study. Also of great assistance were staff of the University of Science and Arts of Oklahoma, including: Martha Woltz for helping to obtain needed literature; Rosalie Bush for keeping monetary

records; and Jeanne Mather for her help in developing parts of this manuscript.

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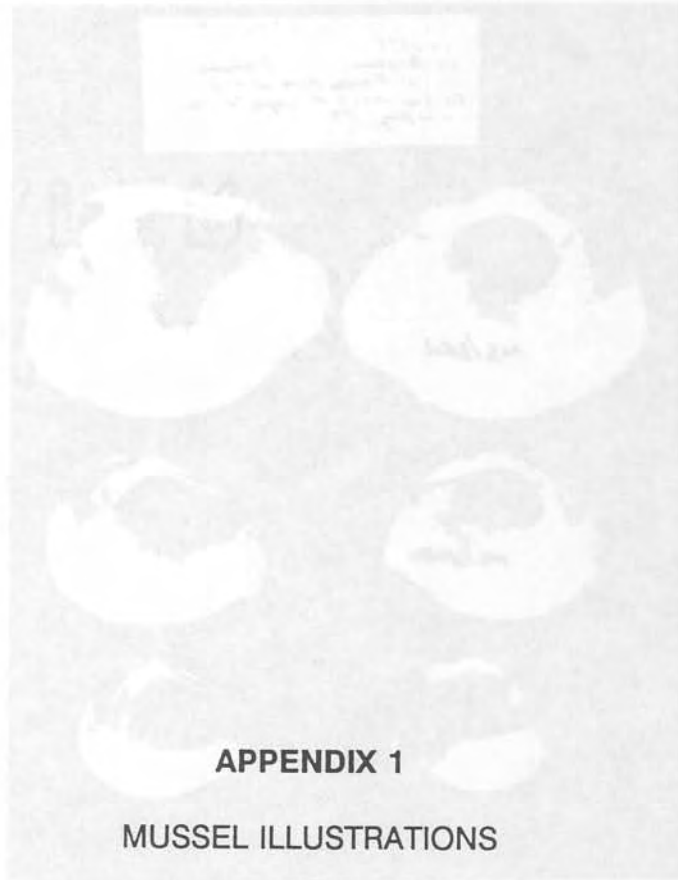
Oesch, R. D. 1984. Missouri naiades: a guide to the mussels of Missouri. Missouri Dept. of Conservation, 270pp.

Oklahoma Water Resources Board. 1984. Oklahoma's Water Atlas. Pub. 120, 186pp.

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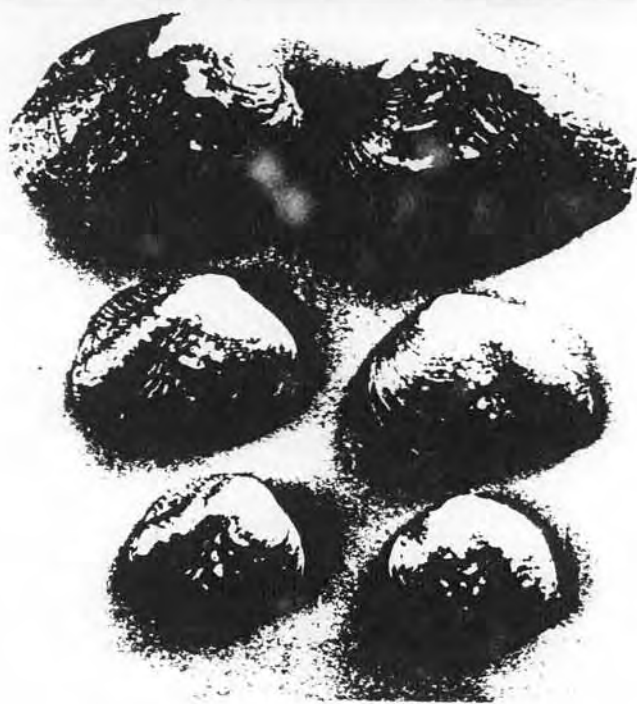
Simpson, C. T. 1914. A descriptive catalogue of the naiades or pearly fresh-water mussels. Bryant Walker, Detroit, Michigan. 1540pp.

Sitgreaves, L. and I. C. Woodruff. 1858. Reports of Captains Sitgreaves and Woodruff of the survey of the Creek Indian boundary line. House Exec. Doc. Vol. 12, Doc. 104, 32pp.



Specimens of *Syrnoides sparti* of various size classes from the  
Franklin River in Missouri.

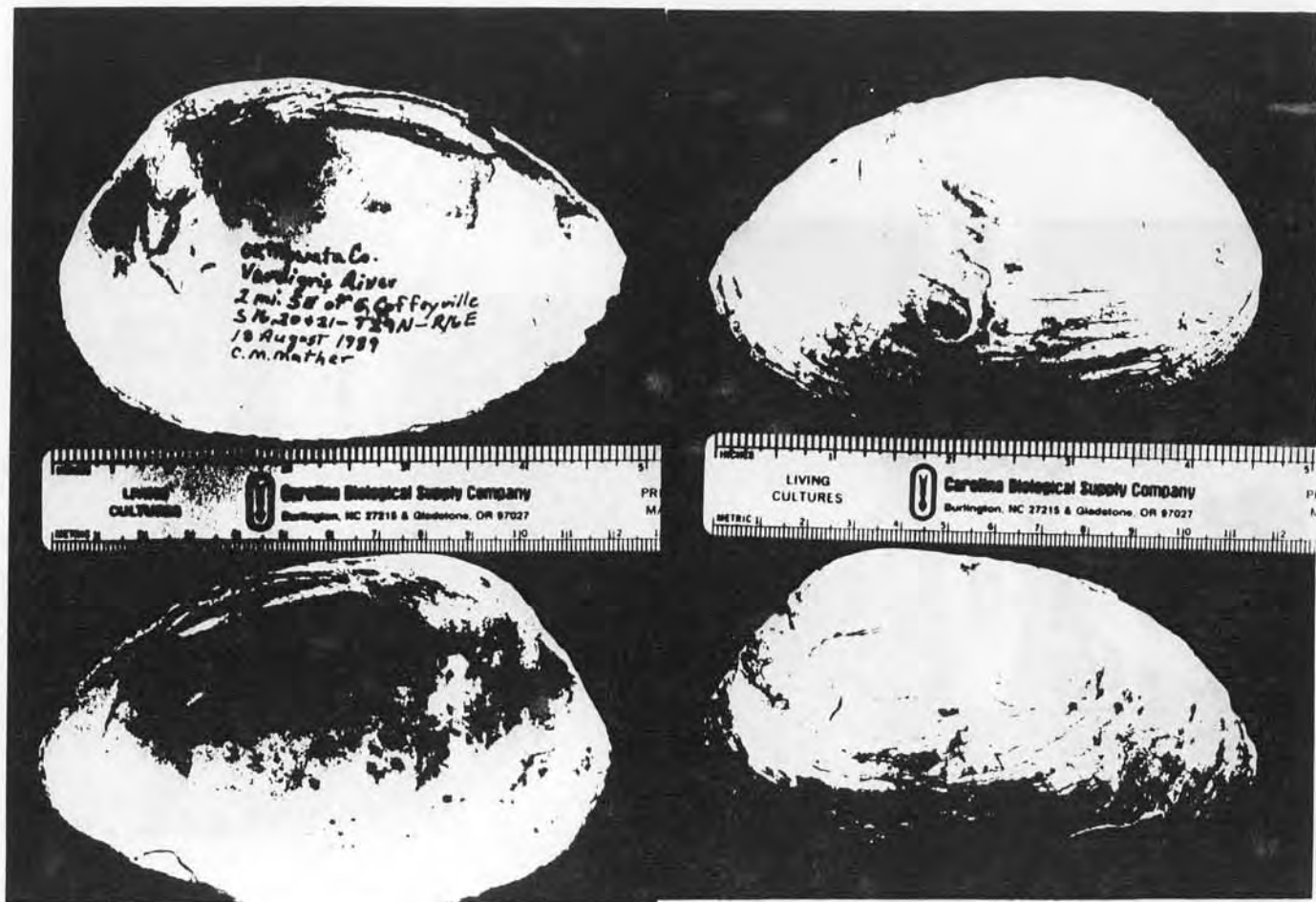




Specimens of *Cyprogenia aberti* of various size classes from the St. Francis River in Missouri.

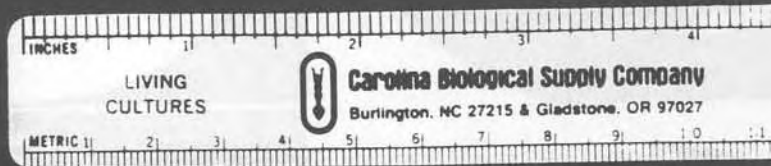


Specimens of Cyprogenia aberti from the Caddo River in Arkansas.



Badly weathered, "fossil" specimen of *Lampsilis rafinesqueana* collected during this survey on the Verdigris River, Nowata County, Oklahoma.

OK: Adair Co.,  
Illinois River at Hampton's Bridge  
0.8 mi. W. of Chewey  
S19-T19N-R24E  
9 August 1989  
C.M. Mather, Robert Hall + John Skeen



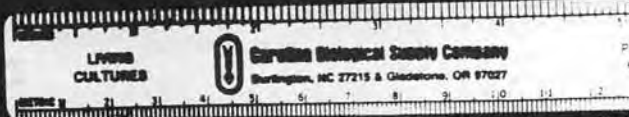
Fresh juvenile shell of Lampsilis rafinesqueana collected during this survey on the Illinois River, Adair County, Oklahoma.



Carolina Biological Supply Company

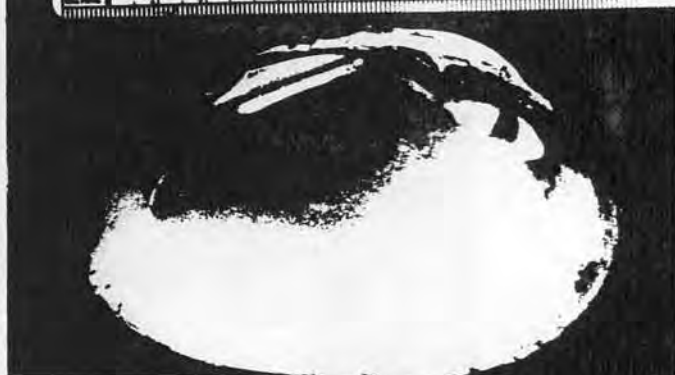


Cherokee Co  
River, Public Access  
524-771N-R22 E  
7 August 1989  
C.M. Mather, John Skene, Robert Hall



LIVING CULTURES

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Cherokee Co  
River, Public Access  
524-771N-R22 E  
7 August 1989  
C.M. Mather, John Skene, Robert Hall

LIVING CULTURES  
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Fresh adult shells of Lampsilis rafinesqueana collected during this study on the Illinois River, Cherokee County, Oklahoma. Male in top four photos and female in the bottom four photos.



Badly weathered, broken, "fossil" specimen of Cyprogenia aberti collected during this survey on the Caney River, Osage County, Oklahoma.



1. "The Great Migration" - a book by James H. Hogue, published in 1967. It is a historical novel about the migration of African Americans from the South to the North during the early 20th century.





### CYPROGENIA ABERTI LITERATURE

Branson, Branley A. 1966. Unionid records from Kansas, Arkansas and Louisiana. *Sterkiana*. 23:7-8.

Indicates that three (3) specimens of Cyprogenia aberti were collected "Spring River, 14 miles south, 2 miles east of Pittsburg, Cherokee Co., Kansas; 3 November 1963."  
States "This species has not been reported in southern Kansas since 1906 and this is the only record for the southeastern part of the state."

Branson, Branley Allan. 1984. The mussels (Unionaceae:Bivalvia) of Oklahoma--Part 3: Lampsilini. *Proc. Okla. Acad. Sci.* 64:20-36.

"Verdigris River"

"Synonyms include Unio aberti Conrad 1850, U. lamarkianus Lea 1852 and U. popnoi Call 1855."

Photo, Fig. 3, p. 29.

Buchanan, Alan C. 1980. Mussels (Naiades) of the Meramec River Basin, Missouri. Aquatic Series No. 17, Missouri Dept. Conservation, 68pp.

"C. aberti was not found in the Meramec Basin during this study. It has been found only at two sites in the Meramec River in the past, and is very uncommon (Oesch in press). Early in this century, Utterback (1915) found C. aberti in the White, Black, Neosho and St. Francis rivers. More recently, it has been reported from the St. Francis, Current, Black, Spring and Castor rivers (Oesch in press) and from the Little Black River (Buchanan 1979b). In North America, C. aberti has been reported from southeastern Kansas, southern Missouri, eastern Oklahoma and Arkansas (Burch 1973)."

"Habitat: It is usually found on mud or rock and gravel bottoms in Kansas (Murray and Leonard 1962). Buchanan (1979b) found C. aberti in sand and gravel substrate in slow (less than 0.2 ft./sec. surface to bottom) to moderate (1.4ft./sec. at bottom) current in 3 inches to 18 inches of water."

"Relative abundance: No living C. aberti were found in the Meramec River Basin. Based on published literature this species is very uncommon in Missouri and throughout most of its range."

"Breeding season: Unknown."

"Fish host: Unknown."

"Status: Rare in Missouri (Missouri Department of Conservation 1977). Listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (United States Department of the Interior, Fish and Wildlife Service 1978).

Burch, J. B. 1975. Freshwater Unionacean clams (Mollusca: Pelecypoda) of North America. Revised edition. Malacological Publications, 204pp.

p. 22. Lists from Kansas, Missouri, Oklahoma and Arkansas.  
p. 94. Illustration 152.

Call, R. Ellsworth, 1895. A study of the Unionidae of Arkansas, with incidental reference to their distribution in the Mississippi Valley. Trans. Acad. Sci. of St. Louis 5(7):1-65.

"This form was described by Lea from the Caddo river, under the name of Unio lakmarckianus, the specimens of which were submitted to him by Dr. Byrd Powell. Additional examples were submitted by Dr. Hale who collected them in the Ouachita river, near the Hot Springs. The specimen figured by Doctor Lea is a young one and is by no means a fair illustration of the shell. In the description of the species he mentions the numerous small nodules found over its surface but the figure shows the shell as smooth. The very young shells are nearly as triangular as the well known Unio elegans Lea."

"In 1885 the writer, without then having access to the complete bibliography of the species, and misled by the great size of the specimens submitted to him, described the form as new, giving it the name of its Kansas discoverer. Later the error was discovered by him and the facts fully stated.\* In this last named paper the remarkable character of the ctenidium was made known and illustrated from specimens collected in the Verdigris river, Kansas, by Mr. J. R. Mead."

"This species has thus far been only found in the Arkansas and Red river drainage basins. It has not occurred to us in our collecting in the State."

Federal Register. 1989. Part IV: Department of the Interior, Fish and Wildlife Service. 50 CFR Part 17. January 6, 1989. Endangered and Threatened Wildlife and Plants; Animal Notice of Review

p. 578. Lists Western fanshell (= western fan-shell pearly mussel) Cyprogenia aberti (Conrad, 1850) from AR, KS, MO, OK as category 2.

p. 554 "Category 2 comprises taxa for which information now in possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threat are not currently available to support proposed rules. The Service emphasizes that these taxa are not being proposed for listing by this notice, and that there are not specific plans for such proposals unless additional information becomes available. Further biological research and field study may be needed to ascertain the status of taxa in this category, and it is likely that many will be found not to warrant listing. The Service hopes that this notice will encourage investigation of the status and vulnerability of these taxa,

and consideration of them in the course of environmental planning."

Frierson, L. S. 1927. A classified and annotated check list of the North American naiades. Baylor University Press, Waco, Tx. 1-111.

Says about Cyprogenia stegaria, C. stegaria-pusilla and C. aberti: "The shells listed above almost merge into one unbroken chain in the state of Arkansas."

Gordon, Mark E. 1980. Recent Mollusca of Arkansas with annotations to systematics and zoogeography. Ark. Acad. Sci. Proc. 34:58-62.

Lists Cyprogenia aberti (Conrad) as an Arkansas species and indicates that it is an "Endemic Interior Highlands species."

Gordon, Mark E. 1982. Mollusca of the White River, Arkansas and Missouri. The Southwestern Naturalist 27(3):347-352.

Lists Cyprogenia aberti from three (3) localities on the White River.

1. "White River above Lake Sequoyah to the origin, Washington and Madison Cos."
2. "Below Beaver Reservoir dam, Busch, Carrol Co." (relic shells only)
3. "Newport, Jackson Co."

Gordon, Mark E. and Arthur V. Brown. 1980. Significant additions to the Molluscan fauna of the Illinois River, Arkansas. Ark. Acad. Sci. Proc. 34:113-114.

Indicates that Cyprogenia aberti is generally distributed in the Interior Highlands and into Oklahoma and Kansas. Throughout the Spring River System. "For these reasons, it is highly probable that C. aberti is present in the Illinois River, although it may occur only downstream in Oklahoma."

Gordon, M. E., A. V. Brown and L. Russert Kraemer. 1979. Mollusca of the Illinois River, Arkansas. Ark. Acad. Sci. Proc. 33:35-37.

Indicates that Cyprogenia aberti was not found in the Illinois River, but does occur in drainages adjacent to the Illinois.

Gordon, M. E., L. Russert Kraemer, and A. V. Brown. 1979. Unionaceae of Arkansas: Historical review, checklist, and observations on distributional patterns. Bull. Am. Malacological Union, Inc., 1979:31-37.

"Endemic Interior Highland species."

Listed C. aberti from the following rivers: White River, Buffalo River, North Fork White River, Black River, Spring River, Little Red River, St. Francis River, Arkansas River, Ouachita River, Saline River and Caddo River.

Isely, Frederick B. 1925. The fresh-water mussel fauna of eastern Oklahoma. Proc. Okla. Acad. Sci. 1924, 4:43-118.

Table 2. Lists Cyprogenia aberti from the Verdigris River "Northwest of Inola (Rogers)" and "East of Catoosa (Rogers)" p. 71. Lists 5 specimens of "Cypreginia [sic] aberti" as randomly collected specimens.

p. 103. "34. Cyprogenia aberti (Conrad).--Two live specimens and five shells of this species were taken in the Verdigris in our ten days work on that stream. The specimens taken were found in the main channel in water two to three feet deep, with fair current and sand-gravel bottom."

Johnson, Richard I. 1980. Zoogeography of North American Unionacea (Mollusca: Bivalvia) north of the maximum Pleistocene glaciation. Bull. Mus. Comp. Zool. 149(2):77-189.

Length 80mm, Height 75mm, Width 44mm, Fall River, Wilson Co., Kansas. Paratype of Unio popenoi.

Length 48mm, height 41mm, width 26mm, Ouachita River, Arkadelphia, Clark Co., Arkansas.

"Habitat. Reported from Kansas as living in rocky, gravel or soft mud substrates."

"Remarks. Cyprogenia aberti (Conrad) of the Ozarkian Region is readily distinguishable from all other unionids there by the peculiar, mottled color of the periostracum; its generally compressed, oval or rhomboidal shell; and by the subvertical wrinkles or nodules which occur at least on the upper part of the disk. While most specimens of aberti are oval or rhomboidal, some specimens become rounded triangular, much resembling C. stegaria of the Cumberlandian and Ohioan regions. Call (1895: 20) in a collection made in the St. Francis River, Wittsburg, Cross Co., Arkansas, noted that many of the young appeared to be aberti, but that, "the triangular outline is lost with age and the circular form becomes more and more marked." This lot, MCZ 5492, now consists of only two adult specimens. He also mentioned specimens from the Saline River of the Black River system, now lost. He regarded both of these lots as being irroratus = stegaria. Frierson (1927: 66) mentioned that stegaria and aberti "almost merge into one unbroken chain in the state of Arkansas." Having studied virtually all of the available material, it is admitted that occasional specimens of both aberti and stegaria closely resemble one another, but the shell of the former species always has a much narrower, and more compressed posterior slope."

"Range. Found only in the Ozarkian Region: below the Ozark Crest in the Black, Arkansas, White, and St. Francis river systems; and above it in the Meramec River system."

"Abundance. Formerly abundant in the Fall River, Kansas. Murray and Leonard (1962: 107) claimed that this species has not been collected in Kansas since 1906. Collected in some numbers by the Harvard-Ohio State Museum Expedition, 1965, in the Ouachita River, of the Black River system, near Pencil

Bluff, Montgomery Co., Arkansas."

"Arkansas River System, Verdigris River Drainage. Kansas: Fall River, 3.5 mi. S Fredonia, Wilson Co. (MZUM); Verdigris River (MCZ). Oklahoma: Verdigris River, Oologah (USNM), Catoosa, NW Inola (both Isely), all Rogers Co. Verdigris River, Chambers Ford (not located) (Conrad)."

Photo p. 187, fig. 3, St. Francis River, Wittsburg, Cross Co., Arkansas. MCZ 5492.

Johnson, Richard I. and H. Burrington Baker. 1973. The types of Unionacea (Mollusca: Bivalvia) in the Academy of Natural Sciences of Philadelphia. Proc. Acad. Nat. Sci. Phila. 125(9):145-186.

"aberti Conrad, Unio: 1850, PANSP, 5: 10 (Rapids of Verdigris River, Chambers Ford [not located, Oklahoma] Arkansas [River drainage]); 1854, JANSP (2) 2: 295, pl. 26, fig. 1. Figured type not located; larger specimen ANSP 41133 from Phillips, but there is no evidence that it is a type."

Kansas Natural Heritage Program files. County-of-Distribution Map.

Lists Cyprogenia aberti from the Spring River and Verdigris River systems.

Murray, Harold D. and A. Byron Leonard. 1962. Handbook of Unionid Mussels in Kansas. Univ. Kans. Mus. Nat. Hist., Misc. Pub. 28. 184pp.

"Type Locality: Verdigris River, Arkansas"

"Limited in range to the southeastern portion of Kansas, southern Missouri, eastern Oklahoma, and Arkansas."

"Cyprogenia aberti is restricted to the Verdigris and Neosho river drainages in Kansas."

"The westernmost record for C. aberti in Kansas is somewhere on the Neosho River, Lyon County."

"The bottom conditions of Kansas rivers from which C. aberti has been reported are rock, gravel, and soft mud."

"If C. aberti presently occurs in the southern drainages, it is rare. No specimens have been recovered since 1906. The largest C. aberti reported for Kansas measures approximately 3 5/8 inches long."

Illustration, p. 106. "Cyprogenia aberti (Conrad), no. 3180; from Neosho River, Lyon Co., Kansas."

Remarks(CMM): Obviously, "Arkansas" as the Type Locality should read "Oklahoma."

Oesch, Ronald D. 1984. Missouri Naiades: A guide to the mussels of Missouri. Missouri Dept. of Conservation, 270pp.

p. 4. Comments on Utterback's (1915) comments "on the Indians' preference for Cyprogenia aberti over other available mussels"

p. 144. "The western fan-shell has limited distribution in Missouri. It is found south of the Missouri River in six rivers of the eastern and southern part of the state and in the Spring River near the Kansas-Missouri line. Locally abundant populations occur in both the St. Francis and the Black rivers on the east side of the state and in the Spring River in the west. It is rare in the Current and Meramec rivers. This naiad does well in shallow water with mixed gravel and mud bottom."

"Cyprogenia aberti was listed as endangered in Missouri, Nordstrom et. al. (1977:17), and in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (U.S. Dept. Int., Fish and Wildlife Serv., 1978)."

"C. aberti and the closely related species C. irrorata (Lea, 1828) or C. stegaria (Raf., 1820) apparently have been separated geographically in recent time. C. aberti is known only from sites west of the Mississippi River. Stansbery (pers. comm., February 1975) says of C. aberti: "This is a riffle species restricted to the high-gradient streams west of the Mississippi and largely restricted to Missouri and Arkansas with records from Kansas and Oklahoma." C. irrorata is known only from the Ohio River basin. Neither seem to have been found in the mainstream of the Mississippi River, Stansbery (pers. comm., February 21, 1979)."

"The fish host is not known."

Illustration

Schuster, Guenter A. 1979. Notes on the freshwater mussel fauna of the Verdigris River system in Kansas. Trans. Kans. Acad. Sci. 82(1):11-24.

p. 23. "Over the past 100 years the character of the Verdigris River drainage has been greatly changed by the construction of major reservoirs on all three rivers in the system: Elk River (Elk City Reservoir), Fall River (Fall River Reservoir), Verdigris River (Toronto Reservoir). In addition to these, many low water dams have been constructed throughout the system, and bridge and road construction also have had an effect on it. This is in addition to changes in water quality (turbidity, insecticide and pesticide pollution, etc.) due to advanced agrarian techniques. It is little wonder that some species of freshwater mussels have been eliminated. In optimistic terms, it is indeed fortunate that only five species known to have occurred in the Verdigris drainage have succumbed. These species include Quadrula cylindrica, Elliptio dilatatus, Cyprogenia aberti, Actinonaias carinata, Proptera laevissima. None of these species have been collected from the Verdigris system since R. E. Call's work in the mid- and late 1880's."

Shepard, William D. and Alan P. Covich. 1982. The Unionid fauna of Ft. Gibson Reservoir and the Grand (Neosho) River in Oklahoma: Comments on a proposed increase in water level. The Southwestern Naturalist 27(3):359-361.

Did not report Cyprogenia aberti from any sampling sites.

Simpson, Charles Torrey. 1900. Synopsis of the naiades, or pearly fresh-water mussels. Proc. U. S. Nat. Mus. 22:501-1044.

Unio aberti Conrad, Pr. Ac. N. Sci. Phila., V, 1850, p. 10; VI, 1853, p. 244; Jl. Ac. N. Sci. Phila., 1854, p. 295, pl. xxvi, fig. 1.-- B. H. Wright, Check List, 1888.

Margaron (Unio) aberti Lea, Syn. 1870, p.34.

Unio lamarckianus Lea, Tr. Am. Phil. Sci., X, 1852, p. 266, pl. xvii, fig. 20; Obs., V, 1852, p.22, pl. xvii, fig. 20.-- H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 496.--

Sowerby, Conch. Icon., XVI, 1868, pl. xcii, fig. 498.--Paetel, Conch. Sam., III, 1890, p. 156.

Margaron (Unio) lamarckianus Lea, Syn., 1852, p. 23.

Unio popenoi Call, Bull. Washb. Coll., I, 1885, p.49, pl. II.

Kansas; Missouri; Indian Territory; Arkansas.

Simpson, Charles Torrey, 1914. A Descriptive Catalogue of the Naiades or Pearly Fresh-Water Mussels. Bryant Walker, Detroit, Michigan. 1540pp.

Type locality, Verdigris River, Ark.

Remarks(CMM): Obviously the type locality is Verdigris River, Oklahoma.

Sitgreaves, Lorenzo, and I. C. Woodruff. 1858. Reports of Captains Sitgreaves and Woodruff of the survey of the Creek Indian boundary line. House Exec. Doc. Vol. 12, Doc. 104, pp. 1-32(map).

Lists Unio Aberti (1 specimen) in a list of shells collected in the survey of the Creek Indian boundary line.

Stansbery, David H. 1970. Eastern freshwater mollusks (I) The Mississippi and St. Lawrence River Systems. American Malacological Union Symposium on Rare and Endangered Mollusks. Malacologica, 10(1):9-22.

"Cyprogenia aberti (Conrad, 1850)."

"The range of this species has apparently been reduced to the Black and Ouachita Rivers of Arkansas."

Stansbery, David H. 1971. Rare and endangered freshwater mollusks in eastern United States. In: Rare & Endangered Mollusks (Naiads) of the U. S. (S. E. Jorgensen and R. W. Sharp, Eds.), 5-18.

Lists Cyprogenia aberti (Conrad, 1850) listed as endangered. Previously listed by Stansbery (1970).

Turgeon, Donna D. et. al. 1988. Common and Scientific names of aquatic invertebrates from the United States and Canada: Mollusks. American Fisheries Society Special Publication 16.

Lists Cyprogenia aberti (Conrad, 1850) as "western fanshell"

Utterback, William I. 1915-1916. The Naiades of Missouri. The Amer. Midland Naturalist 4:41-53,97-152,182-204,244-273 (1915); 311-327,339-354,387-400,432-464 (1916); pls. 1-27.

"Young Fan-Tail"

Describes animal and shell characters

male 42 x 32 x 16.5 (St. Francis R., Greenville)

female 40 x 32 x 16.0 (White R., Hollister)

male 37 x 30 x 14.5 (White R., Hollister)

female 30 x 22 x 11.0 (White R., Hollister)

C. Aberti is a rather common little shell in the White, Black and Neosho basins of this State. It is distinguished from C. irrorata by not being so rounded, nor so solid, rugose and ridged parallel to growth lines. It is not to say a variable shell, yet the writer has noted some with such a truncated posterior end as to suggest an approach to irrorata, or is probably the C. Aberti lamarckiana (Lea) reported for the Black River, Missouri. Specimens taken from Indian mounds in Southwest Missouri show great preservation although deposited some centuries ago. As they were placed in these graves for "food" to the departed spirit" (as was the burial custom of the aborigines) in greater quantities than other mussel shells it is evident that this species was prized above all others for its food qualities. It can be determined that the live mussels were deposited since dried muscular tissue is still adhering to the muscle scars."

Cyprogenia Aberti lamarckiana (Lea)

"This sub-species is simply listed for this State through a report of it by Mr. Elwood Pleas to the U. S. National Museum, where it is now on exhibit under the number, 124,630--and also through a recent report of it for the Black River, Popular Bluff, Missouri, by Mr. Walker who has received it in this same collection of Mr. Pleas, a part of which lot was sent to the Washington Musseum. No data is at hand for illustration or description."





LITERATURE - LAMPSILIS RAFINESQUEANA

Brannon, Stanley A. 1966. Unpublished records from Kansas, Texas, and Louisiana. *Transactions* 12(1):1-6.

Additional specimens reported from two localities in Kansas: King River, 1 mile north of Marble and White River, 1 mile east of Tiptonville.

Remarks(CMN): Either one or both of these localities actually represent *Lampsilis rafinesqueana*.

Brannon, Stanley A. 1967. A partial biological survey of the King River drainage in Kansas, Oklahoma and Missouri. Part I: an annotated atlas, basic biological data, and collection records. Kansas State University, Manhattan, Kansas. 1967-1971. 411-412-191.

Additional material (part) "restricted to Spring River, Small Creek and their larger tributaries." Four small sand-gravel bars, but several specimens were taken from layers in bedrock. Apparently *Lampsilis rafinesqueana* "allition".

APPENDIX 3

LAMPSILIS RAFINESQUEANA LITERATURE

Brannon, Stanley A. 1970. Distribution records and remarks for some Arkansas, Missouri and Kansas mollusks. *Transactions* 12(1):186-191.

Lists *Lampsilis rafinesqueana* from the St. Louis area, Springfield, Missouri.

Remarks(CMN): This could represent *L. rafinesqueana*.

Brannon, Stanley A. 1973. Significant Missouri mollusks. Oklahoma. *The Mollusks*. 57(1):8-10.

Reports *Lampsilis rafinesqueana* (Garrison) from Great Lake 1966. O' the Chesapeake. Delaware Co., Oklahoma. 1967-1968.

Remarks(CMN): I question this locality because the locality also listed in this publication (B) is the Illinois River. It east of Tiptonville, Missouri. OK. He does not list either *Lampsilis* or *L. rafinesqueana* from the Illinois River. Check accession number 13470 at the National Museum.

Brannon, Stanley A. 1984. The Missouri Mollusks. *Transactions* 12(1):1-6. Oklahoma--Part 1: *Lampsilis*. Proc. Okla. Acad. Sci. 1984, 1985.

LITERATURE - LAMPSILIS RAFINESQUEANA

Branson, Branley A. 1966. Unionid records from Kansas, Arkansas and Louisiana. *Sterkiana* (23):7-8.

Actinonaias carinata reported from two localities in Arkansas: Kings Rkiver, 1 mile north of Marble and White River, 10 miles east of Fayetteville.

Remarks(CMM): Either one or both of these records may actually represent Lampsilis rafinesqueana.

Branson, Branley A. 1967. A partial biological survey of the Spring River drainage in Kansas, Oklahoma and Missouri. Part I, Collecting sites, basic limnological data, and mollusks. *Trans. Kans. Acad. Sci.*, 69(3-4):242-293.

Actinonaias carinata (Barnes) "Restricted to Spring River, Shoal Creek and their clearer tributaries. Found mostly on sand-gravel bars, but several specimens were taken from fissures in bedrock. Apparently intolerant of pollution and siltation."

Shoal Creek, Kansas  
Shoal Creek, Missouri  
Spring River, Missouri  
Spring River, Kansas

Remarks(CMM): This is obviously Lampsilis rafinesqueana.

Branson, Branley A. 1970. Distribution records and annotations for some Arkansas, Missouri and Kansas Mollusks. *Trans. Kans. Acad. Sci.* 72(3):386-393.

Lists Actinonaias carinata from the St. James River, Springfield, Missouri.

Remarks(CMM): This could represent L. rafinesqueana.

Branson, Branley A. 1973. Significant Pelecypod Records from Oklahoma. *The Nautilus*. 87(1):8-10.

Reports Actinonaias carinata (Barnes) from Grand Lake (Lake O' the Cherokees) , Delaware Co., Oklahoma, 16 May 1960.

Remarks(CMM): I question this locality, because the previous site listed in this publication (B) is the Illinois River, 5 M east of Tahlequah, Cherokee Co., Ok. He does not list either Actinonaias or L. rafinesqueana from the Illinois River site! Check Accession Number 23470 at U.S. National Museum.

Branson, Branley Allan. 1984. The Mussels (Unionaceae: Bivalvia) of Oklahoma--Part 3: Lalmpsilini. *Proc. Okla. Acad. Sci.* 64:20-36.

Lists Lampsilis rafinesqueana (Frierson 1927) Oklahoma distribution as: Big Caney River; Verdigris River and Illinois River; Illinois River at Moodys, Cherokee County (type locality)

"In the Ozarkian region, this species is easily confused with Actinonaias ligamentina, although the latter species is more obviously rayed. The presence of mantle flaps is the key diagnostic feature between the two species. Actinonaias rafinesqueana (Frierson 1927) is a synonym." (p 27)

Illustration as Fig. 25, p 35. from Spring River, Cherokee Co., Kans. at Hwy K-96.

Lists Actinonaias ligamentina (Lamarck 1819) as being from: Kiamichi, Little, Neosho, Poteau rivers and Fourteenmile Creek; Kiamichi River and Glover River; Neosho and Mountain Fork rivers and Little River.

Remarks (CMM): The Neosho River and Fourteenmile Creek records are undoubtedly L. rafinesqueana.

Burch, J. B. 1975. Freshwater Unionacean clams (Mollusca: Pelecypoda) of North America, Revised Ed. Malacological Publications 204pp.

Does not list L. rafinesqueana

Distler, D. A. and D. Bleam. 1987. Records of two invertebrate species in Kansas. Abstracts: 119th Annual Meeting, Kans. Acad. Sci. 6:13.

Reports Lampsilis rafinesqueana from the Spring River at K-96 Hwy., Cherokee Co. (T33S, R25E, Sec. 11) by Charles Cope, 24 July 1984.

Federal Register, Part IV, Department of the Interior, Fish and Wildlife Service 50 CFR Part 17, Endangered and Threatened Wildlife and Plants; Animal Notice of Review. Friday, January 6, 1989.

p. 579, lists "Neosho mucket (=Neosho pearly mussel) Lampsilis rafinesqueana Frierson, 1927" as being in Ark, Kans, Mo, & Ok and as being in Category 2.

p. 554, "Category 2 comprises taxa for which information now in possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threat are not currently available to support proposed rules. The Service emphasizes that these taxa are not being proposed for listing by this notice, and that there are not specific plans for such proposals unless additional information becomes available. Further biological research and field study may be needed to ascertain the status of taxa in this category, and it is likely that many will be found not to warrant listing. The Service hopes that this notice will encourage investigation of the status and vulnerability of these taxa,

and consideration of them in the course of environmental planning."

Frierson, L. S. 1927. A classified and annotated check list of the North American Naiades. Baylor Univ. Press, Waco, Texas. 111pp.

"Lampsilis rafinesqueana, New Species."

"Shell dimorphic; the male is elliptical, rather transversely so; rounded before, biangulate behind, the double point about midway the altitude. Dorsal and basal margin about equally arched."

"Post ridge rounded, disc having its greatest inflation half-way its length, and the upper third of altitude."

"The female is ovate, the posterior widely expanded, fanshaped."

"Nacre white, prismatic layer wide."

"The epidermis is olive-yellow to dark brown, rayed all over with chain like rays, rather indistinct usually."

"Teeth double in the left, single in the right valve."

"Lateral rather short, distinct from the cardinal, interdentum rounded."

"Length of male 93; Diameter 38; Altitude 57mm."

"Female, length 86; Diameter 35; Altitude 60mm."

"The individuals whose dimensions are given came from Moodys, Oklahoma."

"Another showing much resemblance to the Lampsilis pectorosa is from the Black River, Arkansas and another (male) from Indian creek, McDonald County, Missouri, bears a close resemblance to the biangulata Lea."

"This species is distinctly the western analogue of the Lampsilis pectorosa Conrad, of the Tennessee drainage, the females being more fan shaped behind."

"Specimens have been sent out from Moodys, as Unio powelli Lea."

Remarks(CMM): This is the original description of the species.

Frierson, L. S. 1928. Illustrations of Unionidae. The Nautilus 41:138-139, pls. 1-3.

"Lampsilis rafinesqueana Frierson, pl. 1, fig. 1 (female), 2 (male). The type of this fine species is from Moodys, Oklahoma; others are from the Black River, Ark., and Indian Creek, McDonald Co., Mo. It is the western analogue of L. pectorosa (Con.), of the Tennessee drainage."

Gordon, Mark E. 1980. Recent Mollusca of Arkansas with annotations to systematics and zoogeography. Ark. Acad. Sci. Proc. 34:58-62.

Lists Lampsilis rafinesqueana Frierson as "Endemic Interior Highlands species restricted to; the Ozark Plateaus and some adjacent areas."

Gordon, Mark E. 1982. Mollusca of the White River, Arkansas and Missouri. Southwestern Nat. 27(3):347-352.

List Actinonaias carinata from the White River in Arkansas.

Remarks(CMM): This could be Lampsilis rafinesqueana.

Gordon, Mark E. and Arthur V. Brown. 1980. Significant additions to the molluscan fauna of the Illinois River, Arkansas. Ark. Acad. Sci. Proc. 34:113-114.

"Likewise, L. rafinesqueana Frierson occurs throughout the west slope drainages (Table 1) but not in the White River." Lists Lampsilis rafinesqueana from the Illinois, Elk and Spring rivers.

Also indicates that Actinonaias carinata occurs in the Illinois, Elk and Spring rivers.

Remarks(CMM): I believe that the A. carinata records for the Illinois, Elk and Spring rivers are in error. I believe that these are based upon male L. rafinesqueana that appear like A. carinata.

Gordon, M. E., A. V. Brown and L. Russert Kraemer. 1979. Mollusca of the Illinois River, Arkansas. Ark. Acad. Sci. Proc. 33:35-37.

Lists Actinonaias carinata as a "Commonly encountered species" "Lampsilis rafinesqueana Frierson. . . . Neosho mucket The shell of this species is very easy to confuse with Actinonaias carinata; however, Oesch (pers. comm.) states that it possesses a mantle flap similar to that of L. ovata ventricosa."

"The Elk River fauna in Missouri, a tributary of the Neosho River, includes F. oxarkensis and L. rafinesqueana, the latter being apparently endemic to the Illinois and Neosho rivers drainages. These rivers are within 16 km of the Illinois. Frog Bayou, to the south, apparently holds none of these species (pers. data)."

Gordon, Mark E. and John L. Harris. 1985. Distribution of Lampsilis powelli (Lea) (Bivalvia: Unionacea). The Nautilus 99(4):142-144.

In reference to Isely's (1925) comments on p. 111: "Lampsilis rafinesqueana Frierson (1927) was described from these Illinois River, Oklahoma, specimens. The holotype (female) and a male from the Elk River, McDonald County, Missouri (probably the "L. powelli" in Utterback, 1916) were illustrated in Frierson (1928). Call's (1887) and Scammon's (1906) descriptions for their L. powelli specimens are readily identifiable as L. rafinesqueana (confirmed by examination of Call's voucher, MCZ 5550). The distinctive raying of the latter species may be obscured or obliterated in older

specimens and the shell, particularly males, may be easily confused with A. ligamentina."

Gordon, Mark E. and Louise Russert Kraemer. 1984. Lampsilis reeveiana and Lampsilis streckeri (Bivalvia: Unionacea): Some clarification. Malacological Review, 17:99-100.

In discussing Lampsilis reeveiana: "It is not present in the west slope drainages of the Illinois River or tributaries of the Neosho River (Gordon & Brown, 1981), although it appears to be replaced in these streams by L. rafinesqueana Frierson."

Gordon, M. E., L. Russert Kraemer and A. V. Brown. 1979. Unionaceae of Arkansas: Historical review, checklist, and observations on distributional patterns. Bull. Am. Malacological Union, Inc., 1979:31-37.

Lists L. rafinesqueana as "Endemic Interior Highlands species restricted to Ozark Plateaus." Lists it only from the Illinois River in Arkansas.

Isely, Frederick B. 1925. The fresh-water mussel fauna of eastern Oklahoma. Proc. Okla. Acad. Sci. 1924, 4:43-118.

p.110-111, "Lampsilis ligamentina (Lamarck), Actinonaiia carinata (Barnes).--Mucket. This is one of the best known and most productive of commercial species. In some Indiana and Iowa streams half of the commercial catch will consist of muckets. It is by no means so abundant in our area, altho found in good numbers in some of the larger streams as the Neosho, Poteau, and Illinois. As I have already suggested the big difference between the mussel fauna of the Neosho and the Verdigris was the absence of L. ligamentina in the latter stream. The habitat in which L. ligamentina was found dominant may be described as: stretches of swift water from 1-3 feet deep, flowing over gravel bottom, Lefevre and Curtis (1910) have shown this to be a rapid growing species. It is one of the species especially being used for the work of artificial propagation."

p.111, "Lampsilis ligamentina gibba (Simpson), Actinonaiia carinata gibba.--Most of the examples close to L. ligamentina, found in the Kiamichi and Little River were referred to variety gibba. They were short and rather truncated posteriorly, otherwise like the typical species. In-fact they seemed to be dwarfed specimens like all other of the Kiamichi species, except pustulosa. In habits and distribution they were the same as the regular species. The Kiamichi gibba sometimes has the nacre pink."

p. 111, "Lampsilis powellii (Lea).--Mr. Hill reports this species from the Illinois and has sent me a number of specimens. Frierson suggests that Hill's specimens are either powellii or an undescribed species; he also places some of

them near *L. ligamentina* examples of the Neosho as probably *powellii*."

Table 2, lists *L. ligamentina* as occasional from:

Neosho R. at Miami, Ottawa Co.  
Neosho R. at Chetopa, Cherokee Co.  
Poteau R. at Poteau, LeFlore Co.

Lists *L. ligamentina* as weathered shells only from:  
Grand R.

Lists *L. ligamentina* as rare from:  
Fourteenmile Creek, Cherokee Co.

Lists *L. powellii* as occasional from:  
Neosho R. at Chetopa, Cherokee Co.  
Illinois R. at Tahlequah, Cherokee Co.

p. 75, indicates that a total of 32 specimens of *L. ligamentina* were collected in the Neosho R. at Chetopa, Cherokee Co.

p. 72, "The Neosho may be described as a clear water stream of good size, with a gravel-sand-mud bottom or pure mixtures of the above materials in the various portions of the stream. The heavy coarse gravel of the lower Grand is not found in the Neosho. This heavy gravel is probably derived from Spring River and the other smaller eastern tributaries of the Grand." (1911-1912)

p. 67, "at Tahlequah the Illinois is not much of a mussel stream." also lists *L. powellii* as being sent to him by Thos. S. Hill from Moodys, Ok

p. 64, lists one specimen of *L. ligamentina* from "a broad side channel about a mile up the creek. The bottom of this side channel was a mixture of mud, gravel, and sand."

p.63, "No living mussels were found in the lower Grand even in the side channels. Badly weathered shells were common on the gravel bars and as the river has a very strong current it is thought possible that some shells may have been carried down from farther up stream. Several people told us that, a number of years back, mussels were common in certain areas of the lower Grand, but that in recent years all mussels had died. Of the shells found *Q. undulata*, *Q. heros*, and *L. ligamentina* were the most abundant." 1911

Remarks(CMM): The records of *L. ligamentina* from the Neosho, Grand and Illinois Rivers are certainly *L. rafinesqueana*. All records of *L. powellii* are also *L. rafinesqueana* as Frierson had not described the species as of the time the collections were made, or at the time of publication. I suspect that the confusion of "*L. ligamentina*" and "*L. powellii*" was actually a separation of the *ligamentina*-like males and the *powellii*-like females.



Johnson, Richard I. 1972. Illustrations of all of the mollusks described by Loraine Screven Frierson. Occ. Papers on Mollusks, MCZ, 3(41):137-173.

"rafinesqueana Lampsilis Plate 28, fig. 5  
Plate 29, fig. 1  
1927, Check List, p. 69 (Mud Creek) Moodys (10 mi. N Tahlequah, Cherokee Co.), Oklahoma). Holotype MZUM 87576, figured by Frierson, 1928, Nautilus, 41:138, pl. 1, figs. 1, 2; paratype ANSP 145238."

Johnson, Richard I. 1980. Zoogeography of North American Unionacea (Mollusca: Bivalvia) North of the Maximum Pleistocene Glaciation. Bull. Mus. Comp. Zool. 149(2):77-189.

Actinonaias rafinesqueana (Frierson). Lists:  
104mm(length) 62mm(height) 35mm(width) White River, Cotter, Baxter Co., Arkansas. Male.

86mm(length) 60mm(height) 35mm(width) Illinois River, Moodys, Cherokee Co., Oklahoma. Holotype. Female.

p. 120-121. Map, plate 8B, illustration plate 11.

"In the Ozarkian Region, rafinesqueana can be confused with A. ligamentina (Lamarck), but the latter has a much heavier shell, a stronger posterior ridge, is more heavily rayed, and usually has a more greenish or brownish periostracum. A. rafinesqueana has also been confused with Lampsilis powelli (Lea), but the latter shell is proportionally longer, brighter yellow, and is without rays. Found only in the Ozarkian Region, below the Ozark Crest, in the upper Arkansas and White river systems."

"Verdigris River Drainage. Oklahoma: Verdigris River (Gordon, pers. comm.)."

"Neosho River Drainage. Missouri: Spring River (Jasper Co.); Elk River, (McDonald Co.) (both Nordstrom et al. 1977: 19); Indian Creek (of Elk River); McDonald Co. (figured allotype, MZUM(lost))."

"Illinois River Drainage. Oklahoma: (Illinois River), Moodys, Cherokee Co. (Holotype MZUM 87576; paratypes MZUM 90665; paratype ANSP 145238)."

"White River Drainage. Arkansas: White River, Monte Ne, Benton Co.; White River, Cotter, Baxter Co. (both MCZ)."

Black River Drainage. Arkansas: Black River (MZUM).

Kansas Natural Heritage Program files. County-of-Distribution Maps.

Shows locations on the Spring River, Neosho River and Verdigris Rivers in SE Kansas. Lists localities and dates of last observation. Not published data.

Landye, J. Jerry. 1980. Status of rare, endangered and/or threatened molluscan species of Texas and Oklahoma. Report to U. S. Fish and Wildlife Service, Region II. 12pp.

"Northeastern Oklahoma is typified by the presence of the Ozarkian Plateau which enters from Arkansas and Missouri. One of the major drainage systems of this area is the Illinois River system. Lampsilis rafinesqueana occurs in this system and its limited distribution in Arkansas and Oklahoma should be considered threatened. Problems of the anerobic reservoir, Lake Frances highlight the problems of the system." (p. 6)

"Lampsilis rafinesqueana has been found in the Illinois, Flint, and Baron Fork system in Arkansas and Oklahoma (Gordon, Kraemer, and Brown, 1980). Its limited distribution with the Illinois River system makes it a good candidate for threatened status. Its occurrence in Oklahoma is extremely limited. Marc (sic) Gordon's thesis work at the University of Arkansas involved this species." (p. 7)

Remarks(CMM): Gordon, Kraemer, and Brown, 1980, did NOT mention it in the Flint and Baron Fork rivers!

Mensingher, Gary C. 1972. Commercial harvest of mussels in Oklahoma 1966-1971. Proc. Okla. Acad. Sci. 52:150-152.

Indicates that "Muckets" were harvested in the Kiamichi River in Oklahoma, but harvests from the Verdigris River in 1967, 1969 and 1970 did not include "Muckets."

Metcalf, Artie L. 1980. Unionacean Mussels, Past and Present, from six streams in Kansas and Oklahoma. Trans. Kans. Acad. Sci. 83(1):1-19.

Lampsilis rafinesqueana reported from three sites on the Big Caney River. Fossil: 3.55km NW Hewins, immediately below Osro Falls. SW1/4, SE1/4, Sec. 29, T.34S, R. 9 E. (1974-1978). Weathered: 5.8km WNW Elgin at Fletchers Ford, near Wilson Cemetery. NW1/4, SW1/4, Sec. 8, T. 35 S, R. 10 E. (1969, 1974-1978). and 0.8-1.0km downstream from Hulah Reservoir dam. NW1/4m NW1/4, Sec. 12, T. 28N, R. 11 E. (1975-1978). p. 8. "Lampsilis rafinesqueana Frierson. Specimens of this species were identified by David Stansbery, Ohio State University. This species has sometimes been ascribed to Actinonaias carinata (Barnes) or to A. ligamentina (Lamarck). Only weathered valves and fossils of this species were found and only on Big Caney River at Locs. C-7 and C-9 (and elsewhere near these stations). The species now seems extinct in Big Caney River. Schuster did not find it in his survey of the upper Verdigris system (1979:23) and deemed it to be extirpated there."

Murray, Harold D. and A. Byron Leonard. 1962. Handbook of Unionid Mussels in Kansas. Univ. Kans. Mus. Nat. Hist. Misc. Pub. 28, 184pp.

Page 108-111. Lists Actinonaias carinata carinata (Barnes). The illustration appears to be Lampsilis rafinesqueana Frierson, 1927. Gives Kansas distribution as "restricted to southeastern Kansas. Scammon (1906, p 291) reported it as uncommon in the Kansas and Wakarusa rivers and common in the Marais des Cygnes River. In 1919 it occurred in the Neosho River as far north as Emporia (Coker, 1919, p 28). Recent investigations in these same areas indicate that the "mucket mussel" is presently found only in the Neosho and Spring rivers. It probably ranges no farther north than the western edge of Allen County. The westernmost records for A. c. carinata in Kansas are: Neosho River, Emporia, Lyon County; Fall River, Eureka, Greenwood County (specimen not seen)."

Remarks(CMM): All of these SE Kansas records are probably L. rafinesqueana.

Oesch, Ronald D. 1984. Missouri Naiades: A Guide to the Mussels of Missouri. Missouri Dept. of Conservation, 270pp.

"Comments: The Neosho mucket is another of the rare naiades of the state. In modern times it has been found in only four rivers in southwestern Missouri--the Spring River, where it is most abundant, Center Creek, Shoal Creek and the Elk River. This mussel was not listed in the 1974 edition, Nordstrom, et. al. (1977:19). At the time of the first publication its continued existence in the state had not been confirmed. Nothing has been published about the ecology of this species prior to this report. It is the author's observation that it will typically be found in moderately flowing shallow water in fine to medium gravel. This shell is easily confused with Actinonaias ligamentina carinata. However, the green chevron shapes usually seen on the shell of the Neosho mucket will provide positive identification. Internally, the mantle flaps of the female place this species in the genus Lampsilis and identify it from Actinonaias ligamentina carinata. One female was observed in the rotated (head stand) position with mantle flaps waving in September."

Schuster, Guenter A. 1979. Notes on the freshwater mussel fauna of the Verdigris River system in Kansas. Trans. Kans. Acad. Sci. 82(1):11-24.

p. 23. "Over the past 100 years the character of the Verdigris River drainage has been greatly changed by the construction of major reservoirs on all three rivers in the system: Elk River (Elk City Reservoir), Fall River (Fall River Reservoir), Verdigris River (Toronto Reservoir). In addition

to these, many low water dams have been constructed throughout the system, and bridge and road construction also have had an effect on it. This is in addition to changes in water quality (turbidity, insecticide and pesticide pollution, etc.) due to advanced agrarian techniques. It is little wonder that some species of freshwater mussels have been eliminated. In optimistic terms, it is indeed fortunate that only five species known to have occurred in the Verdigris drainage have succumbed. These species include Quadrula cylindrica, Elliptio dilatatus, Cyprogenia aberti, Actinonaias carinata, Proptera laevis. None of these species have been collected from the Verdigris system since R. E. Call's work in the mid- and late 1880's."

Remarks(CMM): It is presumed that the Actinonaias carinata listed here as probably extinct in the system is most likely Lampsilis rafinesqueana.

Schuster, Guenter A. and Mark B. DuBois 1979. Additional new records of freshwater mussels (Bivalvia: Unionidae) from Kansas. Tech. Publ. State Biol. Surv. Kansas 8:1-11.

Lists Actinonaias ligamentina from the Marais des Cygnes, Franklin Co. and the Neosho, Coffey and Labette Co.

Remarks(CMM): Any or all of these records may actually represent Lampsilis rafinesqueana.

Shepard, William D. and Alan P. Covich. 1982. The Unionid fauna of Ft. Gibson Reservoir and the Grand (Neosho) River in Oklahoma: Comments on a proposed increase in water level. Southwestern Nat. 27(3):359-361.

Did not report either Actinonaias carinata or Lampsilis rafinesqueana from neither Ft. Gibson Reservoir nor the Grand (Neosho) River.

Stansbery, David H. 1971. Rare and endangered freshwater mollusks in eastern United States. In: Rare & Endangered Mollusks (Naiads) of the U. S., S. E. Jorgensen and R. W. Sharp, Eds. U.S. Fish and Wildlife Service, p.5-18.

p. 15. First listing of Lampsilis rafinesqueana as rare and endangered.

Turgeon, Donna D, et. al. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. American Fisheries Society Special Publication 16.

Lists Lampsilis rafinesqueana Frierson, 1927 as the "Neosho mucket."

Valentine, B. D. and D. H. Stansbery. 1971. An introduction to the naiads of the Lake Texoma region, Oklahoma, with notes on the Red River fauna (Mollusca: Unionidae). *Sterkiana*, 42:1-40.

Remarks(CMM): Only mentions Lampsilis rafinesqueana.

