ILLINOIS
Natural History Survey
BULLETIN

# A Survey of the Mussels (Unionacea) of the Illinois River: a Polluted Stream

William C. Starrett

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION
URBANA, ILLINOIS

VOLUME 30, ARTICLE 5
FEBRUARY, 1971

**STATE OF ILLINOIS** **DEPARTMENT OF REGISTRATION AND EDUCATION**

**BOARD OF NATURAL RESOURCES AND CONSERVATION**

**WILLIAM H.** ROBINSON, *Chairman;* **THOMAS** PARK, **Ph.D.,** *Biology;* **L. L.** SLOSS, **Ph.D.,** *Geology;* **ROGER ADAMS, Ph.D.,D.Sc.,** *Chemistry;* **ROBERT H. ANDERSON, B.S.C.E.,** *Engineering;* **CHARLES E. OLMSTED,** Ph.D., *Forestry;* **W. L. EVERITT, E.E., Ph.D.,** *Representing the President of the University of Illinois;* **ROGER E.** BEYLER, Ph.D., *Representing the President of Southern Illinois University.*

# NATURAL HISTORY SURVEY DIVISION, Urbana, Illinois

## SCIENTIFIC AND TECHNICAL STAFF

**GEORGE** SPRUGEL, JR., Ph.D., *Chief*

**ALICE P.** CAMPBELL, B.A., *Secretary to the Chief*

### Section of Economic Entomology

**WILLIAM H. LUCKMANN, Ph.D.,** *Entomologist and Head*
**WILLIS N. BRUCE, Ph.D.,** *Entomologist*
**WAYNE L.** HOWE, **Ph.D.,** ***Entomologist***
**STEVENSON** MOORE, III, Ph.D., *Entomologist, Extension*
**HOWARD B.** PETTY, Ph.D., *Entomologist, Extension*
**JAMES E. APPLEBY,** Ph.D., *Associate Entomologist*
**EDWARD J. ARMBRUST,** Ph.D., *Associate Entomologist*
**MARCOS** KOGAN, Ph.D., *Associate Entomologist*
**JOSEPH V. MADDOX, Ph.D.,** *Associate Entomologist*
**RONALD H.** MEYER, Ph.D., *Associate Entomologist*
**ROBERT D. PAUSCH, Ph.D.,** *Associate Entomologist*
**RALPH E.** SECHRIEST, **Ph.D.,** *Associate Entomologist*
**GEORGE L. GODFREY, Ph.D.,** *Assistant Entomologist*
**CLARENCE E.** WHITE, **B.S.,** *Assistant Entomologist*
**KEUN S.** PARK, **M.S.,** *Assistant Chemist*
**SUE E.** WATKINS, *Supervisory Assistant*
**ROSCOE RANDELL, Ph.D.,** *Assistant Professor, Extension*
**DONALD E. KUHLMAN, Ph.D.,** *Instructor, Extension*
**TIM COOLEY,** M.A., *Assistant Specialist, Extension*
**JEAN G.** WILSON, **B.A.,** *Supervisory Assistant*
**KETURAH** REINBOLD, **M.S.,** *Research Assistant*
**JANE ASHLEY,** *Technical Assistant*
**LOWELL** DAVIS, *Technical Assistant*
**NANCY D. DEWITT, B.S.,** *Technical Assistant*
**MARCIA** JANES, **B.S.,** *Technical Assistant*
**LU-PING** KAN, **M.S.,** *Technical Assistant*
**MARIE MONKMAN, M.S.,** *Technical Assistant*
**STEPHEN ROBERTS, B.S.,** *Technical Assistant*
**DOUGLAS K. SELL, B.S.,** *Technical Assistant*

### Section of Faunistic Surveys and Insect Identification

**PHILIP W.** SMITH, **Ph.D.,** *Taxonomist and Head*
**WALLACE E. LABERGE,** Ph.D., *Taxonomist*
**MILTON W. SANDERSON,** Ph.D., *Taxonomist*
**LEWIS J. STANNARD, JR., Ph.D.,** *Taxonomist*
**ROBERT W.** POOLE, **Ph.D.,** *Assistant Taxonomist*
**JOHN D. UNZICKER, Ph.D.,** *Assistant Taxonomist*
**DONALD W. WEBB, M.S.,** *Assistant Taxonomist*
**BERNICE P.** SWEENEY, *Junior Professional Scientist*

### Section of Aquatic Biology

**GEORGE W.** BENNETT, **Ph.D.,** ***Aquatic*** *Biologist and Head*
**D. HOMER** BUCK, **Ph.D.,** *Aquatic Biologist*
**R. WELDON** LARIMORE, **Ph.D.,** *Aquatic Biologist*
**WILLIAM C.** STARRETT, **Ph.D.,** *Aquatic Biologist*
**ROBERT C. HILTIBRAN,** Ph.D., ***Biochemist***
**WILLIAM F. CHILDERS,** Ph.D., *Associate Aquatic Biologist*
**DONALD F. HANSEN,** Ph.D. *Associate Aquatic Biologist*
**RICHARD J. BAUR,** *M.S., Research Assistant*
**DENNIS L. DOOLEY,** *Technical Assistant*
**DONALD W. DUFFORD, M.S.,** *Technical Assistant*
**MARY FRANCES MARTIN,** *Technical Assistant*
**ROBERT F. RANDALL,** Ph.D., *Technical Assistant*
**C. RUSSELL** ROSE, *Field Assistant*
**WARREN U. BRIGHAM,** M.S., *Junior Technical Assistant*

### Section of Botany and Plant Pathology

**J. CEDRIC CARTER,** Ph.D., *Plant Pathologist and Head*
**ROBERT A. EVERS, Ph.D.,** *Botanist*
**JUNIUS L. FORSBERG, Ph.D.,** *Plant Pathologist*
**EUGENE B.** HIMELICK, Ph.D., *Plant Pathologist*
**R. DAN NEELY,** Ph.D., *Plant Pathologist*
*D.* **F. SCHOENEWEISS, Ph.D.,** *Associate Plant Pathologist*
*J.* **LELAND CRANE, Ph.D.,** *Assistant Mycologist*
**WALTER HARTSTIRN, Ph.D.,** *Assistant Plant Pathologist*
**BETTY S. NELSON,** *Technical Assistant*
**GENE E. REID,** *Technical Assistant*

### Section of Wildlife Research

**GLEN C.** SANDERSON, **Ph.D.,** *Wildlife Specialist and Head*
**FRANK C. BELLROSE, B.S.,** *Wildlife Specialist*
**RICHARD** R. GRABER, Ph.D., *Wildlife Specialist*
**HAROLD C.** HANSON, Ph.D., *Wildlife Specialist*
**WILLIAM L. ANDERSON. M.A.,** *Associate Wildlife Specialist*
*W.* **W.** COCHRAN, **JR.,** B.S., *Associate Wildlife Specialist*
**WILLIAM R.** EDWARDS, **M.S.,** *Associate Wildlife Specialist*
**JACK A.** ELLIS, **M.S.,** *Associate Wildlife Specialist*
**RONALD F.** LABISKY, **Ph.D.,** *Associate Wildlife Specialist*
**CHARLES M.** NIXON, **M.S.,** *Associate Wildlife Specialist*
**STANLEY L.** ETTER, **M.S.,** *Assistant Wildlife Specialist*
**ROBERT E. GREENBERG, M.S.,** *Assistant Wildlife Specialist*
**G. BLAIR JOSELYN, M.S.,** *Assistant Wildlife Specialist*
**GEORGE B. ROSE, Ph.D.,** *Assistant Wildlife Specialist*
**DAVID** R. VANCE, **M.S.,** *Assistant Wildlife Specialist*
**RONALD L. WESTEMEIER, B.S.,** *Assistant Wildlife Specialist*
**RONALD E.** DURAN, *Technical Assistant*
**NORMA J. HUBBARD,** *Technical Assistant*
**MARY ANN** KJOS, *Technical Assistant*
**HELEN C.** SCHULTZ, **M.S.,** *Technical Assistant*
**HILDA** WIESENMEYER, *Technical Assistant*
**ELEANORE** WILSON, *Technical Assistant*
**ROBERT** D. CROMPTON, *Field Assistant*
**JAMES W.** SEETS, *Laboratory Assistant*

### Section of Administrative Services

**ROBERT** O. **WATSON, B.S.,** *Administrator and Head*

### Supporting Services

**WILMA G. DILLMAN,** *Property Control and Trust Accounts*
**ROBERT** O. ELLIS, *Assistant for Operations*
**LLOYD E.** HUFFMAN, *Stockroom Manager*
**J. WILLIAM** LUSK, *Mailing and Distribution Services*
**MELVIN E.** SCHWARTZ, *Financial Records*
**JAMES E.** SERGENT, *Greenhouse Superintendent*

### Publications and Public Relations

**OWEN F.** GLISSENDORF, **M.S.,** *Technical Editor*
**ROBERT M.** ZEWADSKI, M.S., *Associate Technical Editor*
**SHIRLEY MCCLELLAN,** *Assistant Technical Editor*
**RICHARD M.** SHEETS, *Technical Illustrator*
**WILMER D.** ZEHR, *Technical Photographer*

### Technical Library

**DORIS F.** DODDS, **B.A., M.S.L.S.,** *Technical Librarian*
**JEAN** ICKES, **B.A., M.S.L.S.,** *Assistant Technical Librarian*

**CONSULTANTS: PARASITOLOGY, NORMAN D.** LEVINE, **Ph.D.,** *Professor of Veterinary Parisitology and Veterinary Research, University of Illinois;* **WILDLIFE RESEARCH, WILLARD D.** KLIMSTRA, **Ph.D.,** *Professor of Zoology and Director of Cooperative Wildlife Research, Southern Illinois University;* **STATISTICS, HORACE W.** NORTON, Ph.D., *Professor of Statistical Design and Analysis, University of Illinois;* **ENTOMOLOGY, GILBERT P.** WALDBAUER, *Ph.D., Associate Professor of Entomology, University of Illinois.*

CONTENTS




*This paper is published by authority of the State of Illinois, IRS Ch. 127, Par. 58.12. It is a contribution from the Section of Aquatic Biology of the Illinois Natural History Survey.*


*Dr. William C. Starrett is an Aquatic Biologist for the Survey.*



(24238-6,500-2-71)

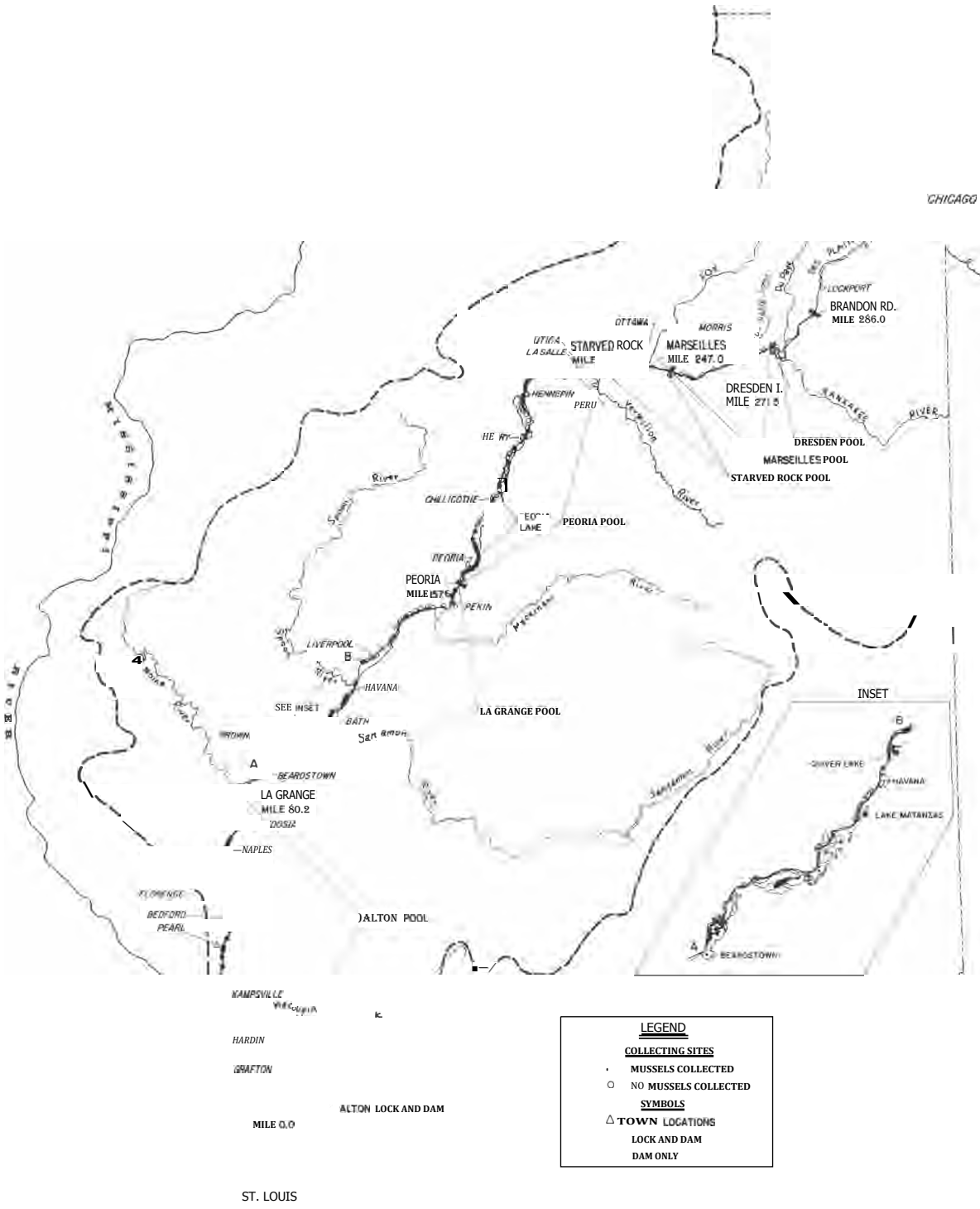



**Fig. 1.—Sites on the Illinois River where attempts were made to collect live mussels in the 1966 survey. T 1966 subfossil mussel collecting sites are not shown.**

# A Survey of the Mussels (Unionacea) of the Illinois River: a Polluted Stream

William C. Starrett

EARLY IN THIS CENTURY Danglade (1914:8) considered the Illinois River the most productive mussel stream per mile in this country. At that time mussel shells were in great demand for use in manufacturing buttons. About 1910 more than 2,600 boats were engaged in mussel fishing on the Illinois River between Peru and Grafton, Illinois (Ibid.) (Fig. 1) . The maximum commercial shell yield from the Illinois River occurred in 1909 and amounted to thousands of tons of good button shells (Ibid.) . Very few statistics are available specifically for the Illinois River; however, to give some indication of the magnitude of the harvest, one shell buyer informed Danglade (1914:16) that in 1911 he bought 600 tons of shells from just two landings in the vicinity of Peoria, Illinois.

Before 1907 most of the mussel fishing on the Illinois River was done by pearl hunters (Danglade 1914:8 & 31). One pearl found in a mussel taken in 1911 from the Illinois River at Chillicothe was valued at $3,000 (Danglade 1914 :15) . After 1906 mussels were taken from the Illinois River primarily for the sale of shells to button-shell buyers, and the pearls and slugs were of secondary consideration.

By 1911 mussels in certain parts of the Illinois River were beginning to be affected by pollution, siltation, and mussel fishing (Forbes & Richardson 1913; Danglade 1914 :48) . The adverse effects of pollution on the fishes and wildlife of the Illinois River during the first half of this century have been discussed by Mills, Starrett, & Bellrose (1966) . After World War II the great increase in the use of plastics in button manufacturing had a further serious effect on the few mussel fishermen remaining along the Illinois River.

About 1962 a renewed interest in mussel fishing on Illinois streams was stimulated by the market demand for Illinois shells by the Japanese pearl-culture industry. Earlier the Japanese had obtained most of their shells from the Tennessee River system, but due to the decline of this natural resource in those waters, the buyers had to look for new sources farther north.

Pearl culturists have found that a calcareous nucleus inserted into the oyster (Pinctada) is the best material to use for a pearl to form around (Cahn 1949:48) . According to Cahn (1949: 49) :

> "As nuclei range in diameter to a maximum of more than six millimeters, the first requirement for their production is a heavy, solid shell. Most nuclei are prepared from the shells of fresh-water mollusks. Unfortunately for the industry, Japan produces no bi-valve with a shell thick enough to produce nuclei of the larger diameters in quantities sufficient to supply the demand. Search for the desired material led to the United States where admirable shell material finally was found in enormous quantities in the Amblema, Quadrula, Pleurobema, and Megalonais species from the Mississippi River and its major tributaries. All have massive shells and were found to yield a high proportion of satisfactory nuclei similar in hardness and specific gravity to the superimposed nacre."

[1] For further information on the pearl industry of the Illinois River and various parts of the world, see Vertrees' (1913) book ***Pearls and Pearling.***

Lopinot (1967:15) mentioned that shells produced in Red China also are suitable for use as nuclei in pearl culture.

As a result of the new Japanese market for shells from Illinois waters, the sales of Illinois mussel fishing licenses rose from 69 in 1961 to 1,279 in 1966 (Lopinot 1967:12 and pers. comm., 18 January 1968). From the larger Illinois streams the best grade of shells for use in pearl culture occurs in the Wabash River, the next in the Illinois River, and the third in the Mississippi River. The 1966 commercial mussel (shells) catch from the Illinois River as reported by the exporters was 1,118.40 tons valued at $109,460.83; for the entire state of Illinois it was 3,557.65 tons valued at $604,307.83 (Lopinot, pers. comm., 5 June 1967) .

Soon after the increase in mussel fishing in the early 1960's, Messrs. William J. Harth and Alvin C. Lopinot of the Illinois Department of Conservation and the author realized that no current information was available concerning the state's mussel fauna and the new mussel fishery. The laws at that time on mussel fishing in Illinois were designed to cope with the old fishery involved in selling shells to the button manufacturers rather than with the new Japanese market requiring large shells of a limited number of species. Studies of mussels were needed on the Wabash, Illinois, and Mississippi rivers. Indiana has since made studies of the mussels of the Wabash River, and these studies should be of benefit to Illinois (Bingham 1968; Meyer 1968) . In 1966 Lopinot (1967) made a general study of the commercial aspects of the new mussel fisheries of the Wabash, Illinois, and Mississippi rivers. The author has been studying the biology and chemistry of the Illinois River and its bottomland lakes relative to pollution for a number of years. Since a considerable amount of old base-line data on the mussels of the Illinois River (Calkins 1874; Kelly 1899; Baker 1906; Forbes & Richardson 1913; Danglade 1914; and Richardson 1928) were available for comparisons with data on the present mussel fauna, the author was interested in expanding his studies to include an investigation of the mussels of that river. Additional funds were made available to him in 1966 and 1967 for such a study by the Bureau of Commercial Fisheries (U.S. Fish and Wildlife Service) and the Illinois Department of Conservation.

The basic purposes of this investigation were to make a survey of the pearly mussel (Mollusca: Pelecypoda: Unionacea) populations of the entire Illinois River in order to formulate a sound basis for managing the mussel resource of this river, and to determine what species and distributional changes had taken place during the past century.

The manuscript was reviewed by Dr. David H. Stansbery of The Ohio State Museum and The Ohio State University and was edited by Robert M. Zewadski of the Illinois Natural History Survey. The first draft of the section in this paper titled "Mussel Fauna of the Illinois River" was read by Dr. Joseph P. E. Morrison of the U.S. National Museum, Dr. Paul W. Parmalee of the Illinois State Museum, and Dr. Henry van der Schalie of the University of Michigan Museum of Zoology.

The project and this publication were financed by a grant-in-aid under P. L. 88-309 (Commercial Fisheries Research and Development Act) from the Bureau of Commercial Fisheries, by the Illinois Department of Conservation, and by the Illinois Natural History Survey.

## ACKNOWLEDGMENTS

I wish to thank Dr. David H. Stansbery of The Ohio State Museum and The Ohio State University for his help in identifying many mussels (naiads) and his advice and suggestions in matters pertaining to the taxonomy of mussels and to the manuscript. Before the project was started, Dr. Paul W. Parmalee of the Illinois State Museum kindly furnished me with a collection of identified mussel shells and records of his Illinois River collections, and made many suggestions on collecting mussels. Dr.

Joseph P. E. Morrison of the U.S. National Museum was very helpful in advising me about the Illinois River shells deposited in the National Museum, furnishing me his personal collection data from the Illinois River, rendering an opinion on several specimens of *Lampsilis* from the river, and giving many suggestions on the taxonomy of mussels. I appreciated receiving the museum records of Illinois River shells and the taxonomic suggestions given to me by Dr. Henry van der Schalie of the University of Michigan Museum of Zoology. I am indebted to Dr. Donald F. Hoffmeister of the University of Illinois Museum of Natural History and Dr. Alan Solem of the Field Museum of Natural History for the courtesies extended me when I visited their museums to examine shells from the Illinois River. Appreciation is expressed to Dr. William J. Clench of the Museum of Comparative Zoology, Harvard University, for furnishing me with the records of Illinois River shells deposited in that museum. I wish to thank Dr. Kenneth Boss, also of the Museum of Comparative Zoology, for sending four lots of Illinois River naiads contained in that museum's collections to Dr. David H. Stansbery for examination.

I wish to express my appreciation to Mr. William J. Harth of the Illinois Department of Conservation for his interest in the study and for making it possible to obtain a grant from the Bureau of Commercial Fisheries. Mr. Alvin C. Lopinot of the Illinois Department of Conservation helped me in many ways on the project and furnished some of the photographs used in this paper. I wish to thank Dr. George W. Bennett of the Illinois Natural History Survey for his many suggestions and for critically reading the manuscript. The administrative assistance received from Miss Maryfran Martin of the Illinois Natural History Survey and Mr. Leslie "Ed" Whitesel of the Bureau of Commercial Fisheries was greatly appreciated.

I wish to express my appreciation for the excellent cooperation and help given me in the field and laboratory by the following employees: Messrs. Gerald Roat (temporary employee), Jerry Griffin (temporary employee), Mike Conklin (temporary employee), Jon Stelter (temporary employee), Webb Moss (temporary employee), and Dennis L. Dooley (Illinois Natural History Survey). The color photographs used in the plates and certain other photographs contained in this paper were taken by Mr. Wilmer D. Zehr, Technical Photographer of the Survey. The color plates were printed by the Edward Hine Company, Peoria, Illinois. Mr. Richard M. Sheets, Technical Illustrator of the Survey, made the map and graphs. For her painstaking assistance in locating hard-to-find references and procuring photocopies, I wish to thank Mrs. Doris F. Dodds, Survey Librarian.

I am especially grateful to Mr. Robert M. Zewadski, Associate Technical Editor of the Survey, for his patience and most helpful suggestions in the editing of this report.

I wish to thank Mr. Allan Poole of the Division of Sanitary Engineering of the Illinois Department of Public Health for furnishing the 1967 data on ammonia nitrogen (N) and total phosphates ($PO_4$) used in this paper. Mr. Edwin Fall, Greater Peoria Sanitary District, kindly furnished information on the treatment of wastes in the Peoria area. Appreciation is expressed to Dr. Willis N. Bruce of the Illinois Natural History Survey for making the organochlorine pesticide determinations on some of the mussels collected in this investigation.

## THE ILLINOIS RIVER

The Illinois River is formed by the confluence of the Kankakee and Des Plaines rivers southwest of Chicago (Fig. 1). Since the completion of the Chicago Sanitary and Ship Canal in 1900 water has been diverted in varying amounts (maximum 10,000 cfs) from Lake Michigan at Chicago (including domestic and industrial water pumped from Lake Michigan and later dumped into the canal as treated and untreated wastes)

through the canal to the Des Plaines River at Lockport and thence into the Illinois River. The Illinois River proper (Fig. 2) is 272.9 miles in length and the entire waterway from Lake Michigan to the mouth of the Illinois River at Grafton (Mississippi River) is 327 miles. The river and its tributaries have a drainage basin of 32,081 square miles (Barrows 1910:1) . The maximum discharge of the Illinois River at Kingston Mines (river mile 145.3) in the water year 1965-1966 was 51,700 cfs, the mean discharge was 16,188 cfs, and the minimum discharge was 3,990 cfs (United States Geological Survey 1967:132) .

> "The Illinois Valley is naturally divided into an upper and a lower part. The upper Illinois, comprising the westward- flowing section from the junction of the Des Plaines and Kankakee to the great bend near Hennepin, is independent of preglacial drainage lines and is excavating a new course, its bed being usually on the rock. The lower Illinois, extending from the great bend to the mouth, occupies the preglacial channel, in which the rock bottom lies nearly 100 feet below the bed of the present stream.
>
> * * *
>
> "The old river channel of the lower Illinois is much too large for the present volume of flow, so that it has been filled up by alluvial deposits forming the present bottom lands. The deposition of material has also been aided by the flat slope of the stream, the fall in the lower 223 miles being only 33 feet" (Hoskins, Ruchhoft, & Williams 1927:4-5)

Formerly, between La Salle and Grafton there were about 400,000 acres of bottomlands subject to overflow by the Illinois River. Some of these overflow lands were in permanent bottomland lakes connected with the river. During the first part of the century nearly 200,000 acres of these bottomlands and lakes were drained and leveed off from the river for agricultural purposes. One of these, Thompson Lake, near Havana in Fulton County, was drained in the early 1920's. The mollusca of this former bottomland lake were studied before 1900 by Strode (1891a and 1891*b*).

Fig. 2.—The Illinois River below Pekin in the La Grange navigation pool at river mile 148.0. Photo by W. D. Zehr.

Presently about 8,000 acres of abandoned drainage districts have been restored as bottomland lakes (type 58) (Hutchinson 1957:123-125). In the current study, mussel collections were made in two of these lakes, Lake Matanzas and Meredosia Lake. The collecting site referred to as Quiver Lake, near Havana in Mason County, is merely a large slough connected with the river.

### River Mile and Bank

The Illinois River is a navigable stream, and the boat channel is well marked with buoys, lights, and markers. These navigational aids are located in detail in the U.S. Army Engineer District, Corps of Engineers, Chicago, Illinois, publication Charts of the Illinois Waterway from Mississippi River at Grafton, Illinois to Lake Michigan at Chicago and Calumet Harbors. In this paper references are made to river miles based on the Corps of Engineers' chart book of the Illinois Waterway. A river mile designation is the exact number of miles upstream from the mouth of the river at Grafton.

The engineering designation of the sides of the river adjacent to the channel is used here and is termed "bank." The bank side is the left bank (LB) or right bank (RB) as viewed from midstream by the observer facing downstream.

### Dams and Navigation Pools

> "Before 1900, low dams were built at Marseilles, Henry, Copperas Creek, La Grange, and Kampsville. Because they were low, their greatest effect on the stream was during periods of low water" (Mills, Starrett, & Bellrose 1966:5).

In the 1930's higher dams with locks for navigation were constructed on the Illinois River to help maintain a 9-foot channel. These locks and dams were built at Dresden Island (24 feet at river mile 271.5), Marseilles (24 feet at river mile 247.0), Starved Rock (19 feet at river mile 231.0), Peoria (11 feet at river mile 157.6), and La Grange (10 feet at river mile 80.2). The lower part of the river is under the influence of the Alton dam on the Mississippi River (Fig. 1) . The waters impounded by these dams are called navigation pools, and throughout this paper references are made to these pools as the geographic locations of the various sections of the river. The lower section of the river is the Alton pool (river miles 0.0-80.2) ; the La Grange pool is between the La Grange dam and the Peoria dam (river miles 80.2-157.6) ; the Peoria pool is between the Peoria dam and the Starved Rock dam (river miles 157.6-231.0) ; the Starved 'Rock pool is between the Starved Rock dam and the Marseilles dam (river miles 231.0-247.0) ; the Marseilles pool is between the Marseilles dam and the Dresden Island dam (river miles 247.0–271.5) ; and the Dresden pool of the Illinois River covers only the lower 1.4 miles of this pool impounded by the Dresden Island dam (river miles 271.5–272.4) ; the remaining upper part of this pool is the Des Plaines River.

### Current Speed

> "The fall in the Illinois River is but slight—an average of .267 of a foot per mile of its total length. Fifty and seven tenths feet of this fall occur in the first forty-two miles of its course, and from Utica to the mouth of the river the total fall is but 31 feet, or an average of .137 of a foot to the mile. The effect of this slight fall is seen in the sluggish current of the Illinois, which ranges from .4 of a mile per hour at the lowest water to 1.737 miles when at twelve feet above low-water mark. The usual rate of flow for ordinary stages varies, however, from 1¼ to 2½ miles per hour" (Forbes & Richardson 1920: xl-xli) .

These records of current speeds were made before 1908. Observations made in the present study reveal that the river is now more sluggish than it was

in the early part of this century. At ordinary river stages the current speed now is only about 0.6 mile per hour. The increase in sluggishness of the river is believed by the author to be a result of the higher dams now on the river and the reduction in diversion of water from Lake Michigan.

In the Alton and La Grange pools (1966) the current ranged from 0.5 to 1.1 miles per hour. During low river stages the current is sometimes not perceptible in the midpart of the La Grange pool (river mile 113.1) . In the extreme lower part of the Peoria pool the river is rather narrow (river miles 157.6-162.8) and the current here in 1966 ranged from 0.4 to 1.1 miles per hour. Between river miles 162.8 and 179.2 the river is 1-2 miles in width and is referred to as Peoria Lake (Lower, Middle, and Upper Peoria lakes) . No current was perceptible in Peoria Lake except at the narrow part of the river connecting Lower and Middle Peoria lakes ("Narrows" at river mile 166.7) where the current was 0.9 mile per hour. In the remainder of the Peoria pool (river miles 179.2-231.0) the river is typical of much of the stream, and the current here ranged from 0.2 to 0.6 mile per hour. Single current determinations were made in 1964 by the author in Starved Rock pool (0.6 mile per hour) and in the Marseilles pool (0.8 mile per hour) .

**Bottom Soils and Turbidity**

Because of the heavy towboat traffic and dredging in the navigation channel, mussel fishing is largely confined to the waters adjacent to the channel. Therefore, we are particularly concerned with the bottom substrates lying between the navigation channel and the shoreline.

> "Soil pollution has been present in Illinois River waters since the recession of the last ice sheet. However, the laying bare of the soil in agricultural operations has greatly increased the problem" (Mills, Starrett, & Bellrose 1966:5) .

In Illinois the sedimentation problem resulting from farming operations increased tremendously in the middle 1930's, as revealed by studies made by Brown, Stall, & De Turk (1947) and the author's personal observations on the Illinois River. This problem came about through the increase in the planting of row crops, particularly soybeans, and the advent of heavy, powered farm equipment. According to the Illinois Cooperative Crop Reporting Service (1965: 58-59) , counties in Illinois partly or wholly drained by the Illinois River in 1964 had 6,220,200 acres planted to corn and 3,466,100 acres in soybeans. In other words, in 1964 about 47 percent of the watershed of the Illinois River in Illinois was in row crops. In 1966, 62 percent of private cropland in this country needed conservation treatment (Stall 1966: 80) .

The increase in the sluggishness of the river, as mentioned above, and the increased planting of row crops on the watershed have, in the author's opinion, made siltation in the past 30 years an important factor adversely affecting the survival of mussels and other organisms in the Illinois River and its bottomland lakes (river miles 0.0-231.0) . A study made in 1950 on Lake Chautauqua, an Illinois River bottomland lake near Havana, revealed that sediment deposits had reduced the storage capacity of the lake by 18.3 percent in 23.8 years (Stall & Melsted 1951:1) .

> "The sediments in Lake Chautauqua are mostly of a fine texture and form a loose, flocculent 'false bottom' (not similar to the type found in bog lakes) over the original lake bottom. A slight disturbance of the 'false bottom' causes particles to become resuspended and so increases the turbidity of the water" (Jackson & Starrett 1959:160) .

The bottom of the river in the Alton, La Grange, and Peoria pools was chiefly hard mud overlaid in numerous areas with fine sediment deposits (soft-mud bottom) similar to the "false bottom" found in Lake Chautauqua. In some sections of the upper La Grange and Peoria pools the silt contained a mixture

of fine sand particles. Very few clean sand or gravel bottoms were observed in the lower three navigation pools. As mentioned earlier, the bottom in the upper two pools (Starved Rock and Marseilles) was primarily rock. In some parts of these two pools the rock was overlaid with mud, sand, and/or gravel.

Turbidity readings (midchannel) made during minimum flow periods by the author are summarized in Table 1. The high turbidities observed in the lower two pools tended to reflect the silted conditions (soft-mud bottom) of the lower river and heavy silt loads brought into this section of the river by the tributary streams. On June 24, 1964, following a flash flood, the Illinois Sanitary Water Board determined the turbidity in one part of the Alton pool to be 2,000 turbidity units.

The author has made numerous observations on the effect a towboat has on turbidity in the various parts of the river. A towboat underway causes a strong current and washing action on the silt bottom ("false bottom") inshore, which resuspends the silt particles, thereby increasing the turbidity. The increase in turbidity is more noticeable in the lower three pools, particularly in the Alton pool, than it is upstream because of differences in bottom types as discussed above. The outrush of the water from shore toward the channel caused by a towboat also temporarily exposes the shallow areas. On November 18, 1964, in the Alton pool at river mile 65.1, the turbidity just prior to the passing of two towboats was 108 units, and within 6 minutes after the tows had passed, the turbidity was 320 units. Sixteen minutes later the turbidity had dropped to 240 units.

Table 1.—Ranges of turbidity (Jackson turbidimeter) during minimum flow periods in the navigation pools of the Illinois River (1963 through 1966)

| Navigation Pool | Range in Jackson Turbidity Units |
|---|---|
| Alton | 36-320 |
| La Grange | 60-220 |
| Peoria | 15-140 |
| Starved Rock | 15-52 |
| Marseilles | 15-47 |
| Dresden | 15-27 |

## Pollution and Water Chemistry

The Illinois River has a long known record of pollution. The pollution of the river has been associated with the growth and expansion on its watershed of human populations, industries, and agriculture. The Illinois River Valley is sometimes referred to as the "Ruhr Valley" of the Midwest because of the tremendous number of industries located along the river.

> "Little concern was shown about changes in, or the changing of, the Illinois River for the first 250 years of its use by white people. Its character seemed to remain about the same, although the greatest flood ever recorded for the river was in the 1840's. Steamboats made their way far up its reaches in the 19th century. Cities sprang up along its shores and, near the headwaters, Chicago began its growth. Events happened rapidly from the last quarter of the 19th century to the present time.
>
> "To give a simple illustration of the development in the river's basin, the population of the counties which are all or in part drained by the Illinois River changed from about a half-million in 1850 to 1,629,738 in 1870. By 1964 this figure had risen to 8,537,900 of a total state population of 10,500,000.
>
> * * *
>
> "The basic reason for the 1900 diversion of Lake Michigan water into the Illinois waterway was to dilute sewage and transport it away from Chicago. Since that time the treatment of sewage in the Chicago area has been greatly improved, but the rich effluent still affects the waters of the waterway below the city (Keup, Ingram, Geckler, &

Horning 1965) . Moreover, the other cities within the Illinois River basin have grown, and make their increasing demands on and contributions to the stream" (Mills, Starrett, & Bellrose 1966:4-5) .

By 1911 the upper section of the Illinois River (Marseilles and Starved Rock pools and the upper section of the Peoria pool) was heavily polluted by untreated domestic and industrial wastes from the Chicago area (Forbes & Richardson 1913) . During and immediately following World War I, pollution became even more severe and critically affected the river downstream as far as Peoria (Purdy 1930:10; Richardson 1928) .

In the past 40 years conditions in the upper section of the river (Marseilles and Starved Rock pools) and Peoria Lake have improved as the result of the treatment of wastes, reduction of flow, and augmentation of pollution laws. In 1922 the population equivalent of domestic and industrial wastes emptied into the river was 6,211,471 (Hoskins, Ruchhoft, & Williams 1927: 25 ) , but by 1960 it had dropped to an equivalent of 2,417,000 people (United States Public Health Service 1963: III-1 ) . However, the beneficial gains in pollution abatement during the past 40 years, reflected by the reduction in BOD (Biochemical Oxygen Demand, Table A-1 ) , that have occurred in spite of increases in human populations and industry on the watershed tend to be offset to a serious degree by the high concentration of ammonia nitrogen originating from treated and untreated effluents and possibly from agricultural fertilizers. In 1967 maximum determinations of ammonia nitrogen (N) ranged from 0.9 ppm in the lower river to 8.2 ppm in the upper Illinois River (Allan Poole, pers. comm., 11 March 1968) . At river mile 274.0 in the Des Plaines River in 1967 the maximum determination of ammonia nitrogen was 26.0 ppm (Ibid.) .

Dissolved oxygen now is considerably higher in the upper river and Peoria Lake than it was in the 1911-1928 period (Mills, Starrett, & Bellrose 1966:9) . However, during the past 50 years the dissolved oxygen content of the river below the Peoria-Pekin metropolitan area has decreased. Also the dissolved oxygen content in part of the Peoria pool above Middle Peoria Lake is still critical. The midsummer dissolved oxygen determinations made by the author (Table A-2) and the chemical, radiological, and bacteriological determinations of the Illinois Sanitary Water Board (1967) presented in Table A-1 reflect the pollutional conditions of the river in 1966. The bacterial counts indicate pollution in the entire river in 1966.

The dissolved oxygen was usually relatively high in the upper parts of the navigation pools below the dams, and in midsummer it decreased downstream within the pools (Table A-2) . In several of the pools, especially the Alton pool, where the reoxygenated water is subjected to very few additional domestic and industrial wastes, the dissolved oxygen would be expected to remain relatively high rather than to decline as shown in Table A-2. The continual decline in dissolved oxygen in these pools accompanied with a decrease in BOD is probably related to nitrification oxidation, as was demonstrated by the United States Public Health Service (1963: IX-21) in July of 1962.

In the early 1960's the United States Public Health Service (1963:V-26) determined these amounts of toxic metals in the Illinois River: (i) copper was less than 0.30 ppm; (ii) nickel ranged from 0.01 ppm to 0.25 ppm; (iii) zinc was as high as 0.13 ppm ; and (iv) chromium varied from 0.01 ppm to 0.08 ppm.

Relative to detergents, Sullivan & Evans (1968:198-199) reported that in the Illinois River at Peoria (1.4 miles upstream from the outfall of the Greater Peoria Sanitary District treatment plant) the mean MBAS (methylene blue active substance) dropped from 15.7 tons per day in the 1959-1960 period to 9.0 tons per day in the 1965-1966 period as a result of the conversion from ABS detergents to the more readily biodegradable

The letter A designates that a table is in the Appendix of this paper.

LAS compounds. The author's 1966 ABS determinations from the Illinois River were about one-half of the amounts of his earlier determinations (Table A-2).

According to Verduin (1967: 167–168):

> "The three important sources of phosphorus contribution to our waters are organic matter in sewage, phosphorus-containing detergents, and phosphorus in the runoff and drainage from farmlands, most of which receive heavy applications of phosphate fertilizers."

Mr. Allan Poole (pers. comm., 11 March 1968) informed the author that in 1967 total phosphates ($PO_4$) were as high as 8.3 ppm in the Marseilles pool and 5.7 ppm at Peoria. Sullivan & Hullinger (1969:216) in 1967 determined the mean total phosphorus concentration in Upper and Middle Peoria lakes to be 1.13 ppm, of which orthophosphates represented 75 percent of the total phosphorus; 64 percent of the total phosphorus was in a dissolved state. These authors (1969:215) mentioned that concentrations of total phosphorus in Peoria Lake were 17 to 94 times higher than those found in other bodies of water, according to the literature they reviewed. In the author's opinion treated sewage and industrial effluents (including detergents) were the main sources of phosphorus in the Illinois River. Even though the Illinois River was extremely rich in nutrients, algal blooms in the mainstream were limited by high turbidities and possibly by synergistic effects of toxic metals. When making dissolved oxygen and pH determinations on sunny days, the author found that primary production was quite limited in the mainstream of some parts of the river.

Biological data collected from the Illinois River by the author and his associates have revealed pollutional aspects not disclosed by chemical and bacteriological data (Mills, Starrett, & Bellrose 1966). These pollutional aspects with their effects on the mussels are discussed later in this paper.

### Fishes

Mention of the fishes of the Illinois River is included here because of the fishes' role as hosts for the parasitic, or glochidium, stage of freshwater mussels.

Fig. 3.—An Illinois Natural History Survey crew electrofishing in the La Grange navigation pool of the Illinois River. Photo by Dr. George W. Bennett.

Certain species of mussels require a specific host fish for a short period of time, whereas other species are evidently able to use several kinds of fishes as hosts (Baker 1928:13) . Many changes have occurred in the fish fauna of the river since 1907 and will be discussed in detail in a later paper by Starrett & Smith. Since 1950 the author has been studying the fishes of the Illinois River and its bottomland lakes (Starrett & Fritz 1965) . In this period 101 species of fishes have been collected from the river and its bottomland lakes by the author (Fig. 3) .

## FIELD PROCEDURE

The mussel survey of the Illinois River was conducted from June 9 to October 28, 1966. Most of the collecting was done during the first 3 months of the program. A total of 429 collections was made for live mussels. The collections were made with an exploratory type of crowfoot bar (brail) and a mussel dredge and by wading (hand collecting) between river miles 0.9 and 272.0 (Table 2) . In these collections 4,247 mussels were taken alive (Table A-3) . An additional 20 live mussels were picked up by hand in the Aux Sable River near its mouth at Illinois River mile 268.2 in the Marseilles navigation pool. The shells of all of the live mussels collected in the survey were saved and taken back to the field laboratory of the Illinois Natural History Survey near Havana, Illinois, for identification and storage. (Several live mussels were obtained from commercial mussel fishermen operating in the Peoria pool in 1969, and the records of these shells are included in this paper.)

Upon the completion of a collection, the live mussels were placed in a gunny sack with a tag bearing the collection number. At the end of a day's collecting each collection of live mussels was weighed and steamed. The live mussels were weighed on a Chatillon scale to the nearest 0.01 pound. Each collection of mussels was placed in a steel canner for steaming; a portable two-burner Coleman stove was used in the field as the heat source. After the mussels of an individual collection were steamed, the shells were cleaned and a rubber band was tightly secured around each pair of valves. The cleaned shells of a collection were resacked for storage. The meats and the bottom of the canner were examined for pearls.[1]

A few live mussels from several parts of the river were cleaned with a knife and the fresh meats were wrapped in foil and frozen. Later these meats were checked by the electron capture gas chromatography method for the presence of organochlorine pesticides by Dr. W. N. Bruce of the Illinois Natural History Survey.

A 16-foot, square bow Arkansas Traveller boat powered by a 9½-horsepower outboard motor was used in making the crowfoot bar and mussel dredge collections of live mussels. The speed of the boat was adjusted to compensate for current speed variations in order to fish the mussel collecting devices at a uniform speed. A wooden stanchion was mounted near the bow of the boat and was used for securing the dredge boom and the crowfoot bar line.

A professional mussel fisherman was employed during the first 2 weeks of the program to serve in an advisory capacity to assure proper operation of the collecting devices.

The survey was designed to sample, on a stratified basis, as many different sites in the entire length of the river as was possible with one boat crew in a 3-month period (Table 2) . The sampling sites included known former and existing mussel beds as well as other areas. Former mussel beds were located from reference points given in the literature (Danglade 1914; Forbes & Richardson 1913; and Richardson 1928) , interviews with elderly commercial fishermen, and concentrations of old shells along the shoreline. Since 1964 the author had noted the areas where most of the commercial mussel fishing was being conducted. Those observations, coupled

[1] None of the few dozen small pearls and slugs found during the 1966 survey was of any commercial value.

with interviews with active commercial musel fishermen, enabled us to locate the known productive mussel beds.

The stratified basis of sampling was extended to the remainder of the river by attempting to select as collecting sites those habitats appearing to be the best for mussels. In conducting fish surveys with limited personnel and time on a large river like the Illinois, the author has found that the stratified, or selective, habitat sampling method gives

Table 2.-Illinois River locations by mile numbersa and bottomland lakes where mussel collecting was done in the 1966 survey.

| Alton Pool | | La Grange Pool | | Peoria Pool | | Starved Rock Pool | Marseilles Pool |
|---|---|---|---|---|---|---|---|
| 0.9 | 53.8 | 80.3 | 117.6 | 158.3 | 184.8 | 233.7 | 249.2 |
| 1.0 | 53.9 | 83.0' | 118.4 | 159.4 | 186.4 | 235.3 | 251.0 |
| 5.4 | 54.3 | 86.4 | 121.1 | 159.7 | 188.0 | 236.5 | 251.7 |
| 5.5 | 54.4 | 86.6 | 121.4 | 161.1 | 190.0 | 239.0 | 253.0 |
| 10.3 | 55.7 | 86.8b | 121.9 | 161.2 | 191.5 | 239.9 | 253.5b |
| 10.5 | 56.3 | 87.3 | 122.0 | 161.7 | 191.6 | 240.4' | 256.0 |
| 11.8 | 56.4 | 87.9 | 122.6 | 162.3 | 192.3 | 240.7 | 259.0 |
| 13.0 | 56.6 | 90.2 | QuiverLakeb | 163.0 | 193.1 | 241.0 | 260.2 |
| 13.2 | 57.5 | 91.5 | 125.0 | 164.5 | 193.5 | 241.5 | 262.6 |
| 14.9 | 57.6 | 92.6 | 125.5 | 165.1 | 193.6 | 242.9 | 263.7 |
| 15.0b | 58.0 | 93.4 | 126.4 | 165.2 | 194.1 | 244.3 | 265.5 |
| 19.2 | 58.9 | 93.6 | 126.6 | 165.3 | 196.1" | | 265.7 |
| 19.4 | 60.8 | 94.3b | 128.2 | 166.3 | 196.3b | | 268.2 |
| 20.6 | 62.4 | 95.6 | 129.5 | 166.6 | 197.2 | | 268.7 |
| 21.7 | 62.6 | 95.8 | 129.8b | 167.2" | 198.1 | | 272.0 |
| 24.4 | 63.8 | 96.8 | 130.4 | 167.7 | 199.3 | | |
| 26.0 | 64.4 | 98.0 | 132.0 | 167.9 | 200.4 | | |
| 27.9 | 66.4 | 99.5 | 132.1 | 168.1 | 201.2 | | |
| 28.9 | 66.5 | 100.5 | 135.0 | 168.2 | 202.1 | | |
| 29.0 | 66.6 | 106.6 | 135.5 | 168.3 | 202.8 | | |
| 30.5 | 66.9 | 106.7 | 140.5 | 168.6 | 203.4 | | |
| 30.6 | 68.3 | 106.8 | 140.9 | 168.9 | 204.0 | | |
| 33.2 | 68.6 | 106.9 | 143.0 | 169.3 | 205.0 | | |
| 33.3 | 68.9 | 107.5 | 143.7 | 169.5 | 206.0 | | |
| 35.9 | 69.0 | 108.3 | 145.0 | 170.8 | 208.2 | | |
| 37.3 | 69.4 | 109.0 | 145.7" | 170.9 | 209.4 | | |
| 39.2 | 70.8 | 110.0 | 147.3 | 173.0 | 210.7 | | |
| 39.3 | Meredosia Lakeb | 110.1 | 147.7 | 173.4 | 213.2 | | |
| 40.3 | 72.0 | 112.0 | 147.8 | 174.1 | 213.4 | | |
| 42.3 | 72.9 | 112.1 | 148.2 | 174.9 | 214.0 | | |
| 44.9c | 73.0 | 113.2 | 148.5 | 175.8 | 214.9 | | |
| 45.3 | 73.3 | 113.3 | 149.4 | 177.4 | 217.4 | | |
| 45.9 | 73.7 | 113.7 | 151.1 | 179.7 | 219.4b | | |
| 47.4 | 74.6 | Lake Matanzasb | 153.6 | 180.5 | 219.8 | | |
| 47.5 | 75.8 | 115.3 | 154.4 | 181.0 | 220.7 | | |
| 48.3 | 78.4 | 115.5 | 154.5 | 181.3 | 223.0 | | |
| 51.0 | 78.8 | 116.3 | 156.0b | 182.3 | 224.0 | | |
| 51.2 | 79.8 | 117.0 | 156.4 | 183.5 | 225.8 | | |
| 53.6 | | 117.1 | | 184.1 | 228.3 | | |
| | | | | 184.5b | 229.0 | | |
| | | | | 184.6 | 229.3 | | |

a Miles from the mouth of the Illinois River at Grafton, Illinois. If no footnote reference is given after a river mile number, collections were made only for living mussels.
b Collections were made here for both living mussels and old shells.
Collections were made here only for old shells.
d One collection was made in Aux Sable River near its mouth.

the investigator more assurance of collecting a variety of species in a given locality than by sampling at random. The author believes that a combined series of such collections permits one to use the data with some confidence for comparative purposes with sample series from other parts of the river. For example, in the more polluted navigation pools of the Illinois River the author electrofishes (Fig. 3), on a unit-of-time basis, habitats that he believes should support various species of sunfishes (Centrarchidae) as well as other fishes. He usually takes only a few or none of the more desirable species, whereas in similar habitats of other navigation pools such species may occur abundantly. Such results clearly reflect the effects of pollution on fish life and show the cumulative effects of poor water quality on a stream's ecosystem, which may not be discernible through chemical and bacteriological analyses of the water. The author merely incorporated his fishing sampling techniques into the design of the 1966 mussel survey to determine the effects man has had upon the mussel fauna of the river. Furthermore, this sampling design fitted well into the management aspects of the survey, which were to determine the condition of known mussel beds and to locate new beds that might be of commercial importance.

### Crowfoot Bar

Since 1897 (Smith 1899:294) the crowfoot bar, or brail, has been used widely in the Midwest as a commercial fishing device to collect mussels (Fig. 4). The commercial bar varies from 10 to 17 feet in length and may have as many as 200 hooks, or crowfeet (4-pronged hooks), attached to the bar by short lines or chains. After conversing with several commercial fishermen, the author decided to use a bar much shorter than the commercial bar. The short bar was easier to fish and enabled us to cover greater distances in less time than would have been possible using a commercial bar. Also, the short bar was quite versatile in fishing stumpy and narrow habitats. The short bar used in this study was the exploratory crowfoot bar designed by the Tennessee Shell Company for their fishermen to use in locating new fishing sites in the Midwest. Three

Fig. 4.—Typical crowfoot bar used by commercial mussel fishermen on the Illinois River in 1966. Photo by Alvin C. Lopinot.

of these bars were built for us by the Tennessee Shell Company. The bar was 61.25 inches long, and 44 hooks (0.1 inch in diameter) were suspended from the bar (Fig. 5) .

A nylon towline was secured to either end of the bar, and the bar was fished from the bow of the boat. The boat was run in reverse, and all of the crowfoot bar fishing was done in a downstream direction. The bowman handled the bar and signaled the boat operator when the towline was played out and the bar commenced to fish. Upon noting this signal, the boat operator began timing the fishing with a stop watch. He also recorded on the field sheet the river depths and bottom types observed by the bowman while the bar was fishing (Table 3) . The depths were taken

Fig. 5.—The exploratory crowfoot bar used on the Illinois River in the 1966 mussel survey. Photo by W. D. Zehr.

**Table 3.-Average depths and depth ranges at which mussel** collections were made with **the crowfoot bar and dredge in the Illinois River in the 1966 survey.**

| Navigation Pool | Crowfoot Bar | | Dredge | |
|---|---|---|---|---|
| | Average Depth in Feet | Depth Range in Feet | Average Depth in Feet | Depth Range in Feet |
| Alton | **10.1** | **2.0-22.0** | 9.5 | 1.5-14.0 |
| La Grange | 10.8 | 2.5-18.0 | 8.9 | 2.0-14.0 |
| Peoria | 8.7 | 2.0-20.0 | 7.6 | 3.0-12.0 |
| Starved Rock | 7.9 | 2.0-14.0 | | |
| Marseilles | 9.0 | 1.5-14.5 | | |
| Average Depth | 9.3 | | 8.7 | |

with a lead line, and the bottom types were determined from samples scooped from the bottom with a heavy collecting can mounted on the end of a long pole. According to Coker (1921:46-47) :

> "When a hook enters a shell opening, the mussel closes firmly upon the hook, and in consequence is dragged from the bottom."

In some parts of the river it was necessary to raise the bar about every 200 or 300 feet to remove debris and/or live mussels from the hooks. As soon as the bowman began retrieving the bar or the bar became entangled, the boat operator stopped the timing record. By using a stop watch, it was possible to record the total fishing time expended for a collection, regardless of the number of times it was necessary to raise the bar (Table 4) .

During the survey 322 collections were made with the crowfoot bar and 2,269 live mussels were taken. The first collection made at each selected fishing site (other than wading sites) was done on an exploratory basis with the crowfoot bar. Usually an exploratory collection was made on each side of the river at each sampling station. There were 229 exploratory crowfoot bar collections, and the distances covered in these runs average 1,390 feet (range, 300-5,280 feet) . The water depths fished averaged 9.4 feet (range, 1.5-20 feet) .

In addition to the exploratory fishing, 93 crowfoot bar collections were taken on a semiquantitative basis by fishing the bar over a measured distance of 400 feet. The semiquantitative collections

**Table 4.-Number of mussels caught per** 5 minutes of fishing with **the experimental crowfoot bar over various types of bottoms in** the Illinois River in 1966.

| Bottom Type | Number of Mussels Taken | | |
|---|---|---|---|
| | **Alton Pool** | **La Grange Pool** | **Peoria Pool** |
| **Hard mud** | **11.2** | **2.4** | **0.1** |
| **Soft mud** | **5.7** | **0.7** | **0.1** |
| **Mud-gravel** | 6.4 | **0.0** | 0.2 |
| **Mud-sand** | 6.7 | **0.6** | **1.8** |
| Sand | 3.5 | 0.5 | 0.7 |
| Gravel | 0.0 | 0.0 | 0.5 |
| **Sand-gravel** | **1.4** | 0.2 | 16.5 |

were taken only at the stations where mussels had been taken earlier in the day in exploratory runs. The sampling area was marked off in a downstream direction by laying out 400 feet of nylon line attached at either end to anchored buoys. Small styrofoam floats at 100-foot intervals supported the line. The average depth of the water for all semiquantitative samples was 10.5 feet (range, 4.5-22.0 feet).

Two series of experiments demonstrated that the semiquantitative samples taken with the crowfoot bar were of no value in expressing the number of mussels present in the 400-foot area fished because of the inefficiency of the bar in collecting most of the live mussels present (regardless of size) . The catches and number of crowfoot bar runs made in these two experiments were excluded from the other collections made in the

survey and were not included in this paper.

Since all of the 322 regular crowfoot bar collections were made on a timed basis, the author combined collections from individual sections or navigation pools and expressed the catches as numbers of live mussels caught per 5 minutes of fishing (Tables 4 and A-4—A-8) .

Dredge ( Dip Net)

According to Danglade (1914:29-30) :

> "Since the time that the mussel fishery began on this river [Illinois], it was known that Peoria Lake contained large beds of good commercial shells, but until 1911 no very successful method of taking them had been devised, scissor forks, oyster tongs, rakes, and the ordinary mussel bar with crow-foot hooks proving unsatisfactory. The dip net was introduced during the spring of that year and is now used there almost exclusively, as it is simple in construction, inexpensive, and especially suited to soft mud bottoms free from logs and hang-ups, and where there is but little or no current.

* * *

In a general way the dip net consists of a heavy, flattish iron hoop

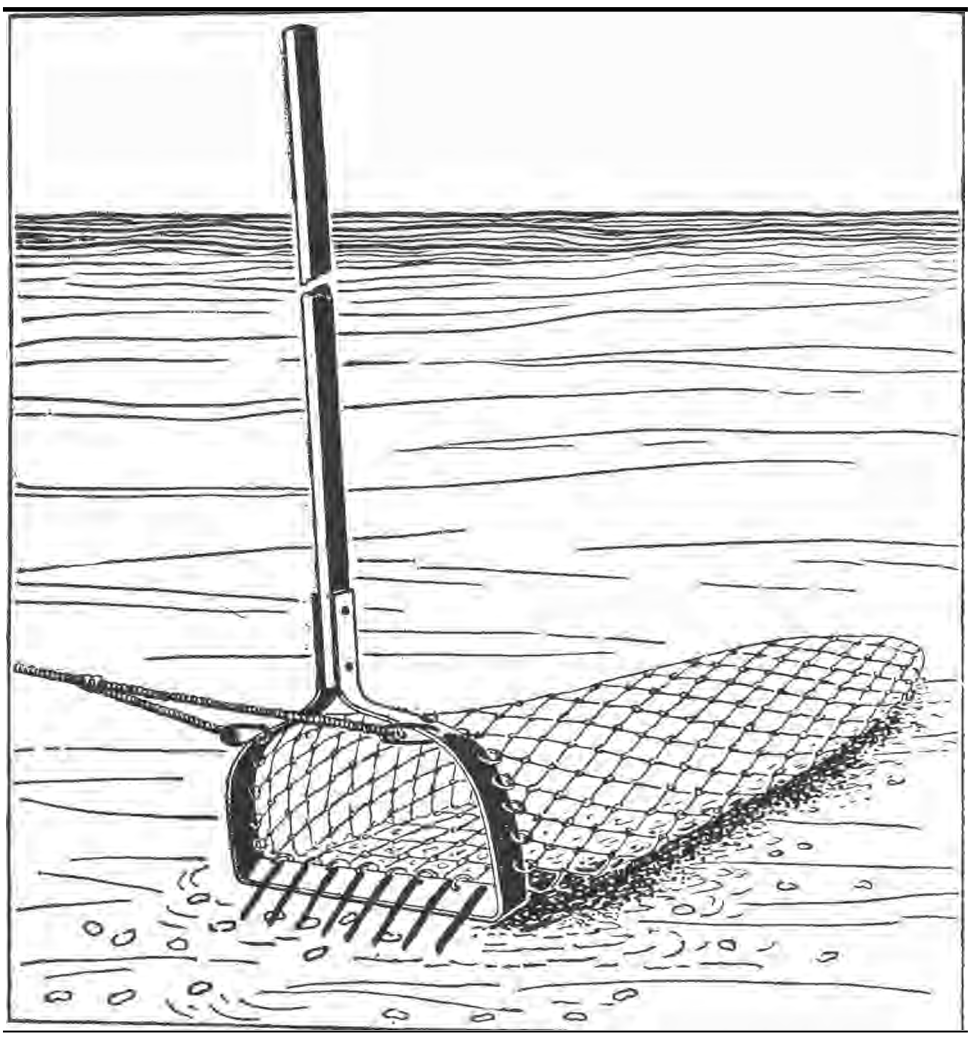


Fig. 6.—Sketch of a dredge fishing for mussels on the bottom of a river (from Danglade 1914:30).

of one piece, bent somewhat triangular in form, with two of its sides curved outward and fastened firmly with bolts to a pole or handle 16 to 20 feet long. The third side or bottom is straight and from 18 to 36 inches in length, and is usually provided with coarse teeth along its edge, which is bent downward. A net of 2-inch mesh, made of small chain or no. 96 trot line with a capacity of a bushel or more, is fastened to the hoop by means of chain links and trails behind it. A short

Fig. 7.—The dredge used in the Illinois River in the 1966 mussel survey. Photo by W. D. Zehr.

rope or bridle attached to the two curved sides of the hoop leads to a single rope secured to the bow of the boat. When the water is rather deep, the boats are fitted with a boom pole extending forward from the bow, and the rope from the bridle is fastened to its end, thus giving greater length of rope and convenience of manipulation. Driven by a gasoline engine of from 4 to 20 horsepower, according to the size and weight of the dip net, the boat draws the apparatus through the water along the bottom" (Fig. 6) .

The dip net, or dredge as it is now called by local fishermen, is still an important commercial mussel fishing device on the Illinois River. The dredge used in the 1966 survey (Fig. 7) was constructed by the Tennessee Shell Company. It was 14.75 inches wide and was attached to a pole 15.0 feet long. The pole was marked off in feet to enable the dredge operator to make water depth readings while fishing (Table 3) . Our dredge was fished as described by Danglade by connecting the bridle of the dredge with a line to a wooden boom temporarily mounted on the bow of the boat (Fig. 8 and Tables A-4—A-8) . The author considered this method of fishing very effective over the predominantly mud or mud-sand bottoms of the lower three navigation pools of the river. The bottom types of the upper river were not suitable for using the dredge.

In the survey 885 live mussels were taken in 74 dredge collections. In making these collections it was found that the dredge could be fished for only a very short distance or length of time (usually less than 1 minute) before it was necessary to raise it and clean out the net. This task was time consuming, since the entire net load of debris and dead shells had to be sorted through for live mussels before the collecting could be continued. This shortcoming of the dredge limited its use for us as an exploratory fishing device. Consequently, only 17 exploratory collections were made with the dredge and these were confined mainly to parts of Peoria Lake where, because of the almost nonexistent current, it was impractical to

Fig. 8.—Lowering the dredge into the Illinois River during the 1966 mussel survey. Note the temporarily mounted boom on the bow of the boat to which the brail line was secured. From a color photo by the author.

fish the crowfoot bar. The average water depth fished in the dredge exploratory collections was 5.4 feet (range, 1.5-12.0 feet) .

The dredge was used primarily for taking 57 quantitative samples of live mussels in the 400-foot marked sampling areas described above. In these collections the dredging was done on the side of the river opposite the 400-foot line fished with the crowfoot bar. The dredge appeared to be efficient in taking most of the live mussels in its path other than specimens less than 1.5 inches long and the mud - burrowing slough sand - shell (Lampsilis anodontoides f. fallaciosa). The average depth fished in the quantitative collections with the dredge was 9.8 feet (range, 5.0-14.0 feet) .

### Wading

Early in the program Dr. Paul W. Parmalee suggested that crowfoot and dredge collections should be supplemented with a series of wading collections to take small-sized mussels and species inhabiting shallow waters.

During the survey 33 different sites were sampled on a time basis by one to five men (usually three) wading in the river and grubbing the bottom with their hands for live mussels (Tables A-4—A-8) . The water depths in the wading collections varied from 0.0 feet to 4.0 feet. In these collections 1,123 live mussels were taken.

### Old Shells

Upon the suggestion of Dr. David H. Stansbery we collected old shells (subfossil) from 21 different locations along the river (Table 2) . The purpose of these collections was to obtain specimens for verification of old records in the literature and information on the distribution of species formerly present in the river.

### Commercial Shells

In the fall of 1966 commercial piles of mussel shells were examined at Meredosia and Kampsville along the Illinois River and at Mt. Carmel, Illinois, along the Wabash River. The shells were selected at random from sorted and culled commercial piles. In this phase of the study 1,937 shells were identified and measured (height to the nearest 0.1 inch) in the field and returned to the piles.

## LABORATORY PROCEDURE

### Live Mussel Shell Collections

Each field collection of shells was processed separately in the laboratory. The shells in each collection were identified, numbered, weighed, and measured; their ages were determined; and they were stored temporarily in plastic bags.

Tentative identifications of the shells were made by the author when each collection was sorted in the laboratory. Later, specimens representing each species taken in the survey together with complete series of certain species were submitted to Dr. David H. Stansbery for identification. As a result, most of the scientific names used here follow the nomenclature suggested by Stansbery (1961, 1962, and 1967) . The nomenclature involving the various species known from the Illinois River is discussed in the next section of this paper.

The English system of weights and measurements was used by the author in this study because an important phase of the investigation dealt with the commercial and management aspects of the river's mussel fishery. However, metric system measurements made by Dr. Stansbery relative to the taxonomy of several species are included.

The shells in a collection were weighed individually by species on a Chatillon scale ( 0.01 pound) .

Shell length and height measurements were made with a Helios dial caliper ( 0.01 inch) . These measurements were made in accordance with Stansbery's definitions (1961 : 10) :

> "LENGTH is the maximum antero-posterior dimension of the shell.
>
> "HEIGHT is the maximum dorso-ventral dimension of the shell meas-

ured at right angles to the length. This dimension does not include the ligament, umbones nor the wing in the alate species, Proptera alata (Say) and Leptodea fragilis (Rafinesque)."

Ages of the mussels were determined by counting the number of annuli on the shells (Stansbery 1961: 12—13). Usually both shells of a pair were used in making an age determination over a transmitted-light chamber. In some instances it was quite difficult to distinguish the true annuli from the false. However, the author believed that even though errors probably were made, the overall average age data for the more abundant species were accurate enough to be of value.

Specimens representing all of the species taken in the survey were deposited in The Ohio State Museum at Columbus, Ohio. Series of specimens of the more common species were deposited in the Field Museum of Natural History at Chicago, Illinois. The catalog numbers (OSM and FMNH) of these specimens have been listed for each species in the next section of this paper under the heading "Live Mussel Records (1966 Survey)." The remaining specimens were stored temporarily at the field laboratory of the Illinois Natural History Survey near Havana.

Estimated standing crops in pounds of live mussels and pounds of commercial shells per acre were calculated from the quantitative dredge collections:

1) Dredge width (1.23 feet) times the distance covered by the dredge in a collection (400 feet) equals the square feet sampled:

$$1.23 \times 400 = 492$$

number of square feet sampled

2) Square feet in an acre (43,560) divided by the number of square feet sampled in a collection equals the portion of an acre sampled:

$$43{,}560 \div 492 = 88.54$$

portion of an acre sampled

3) Live weight or commercial shell weight times the portion of an acre sampled equals the estimated standing crop in pounds per acre. For example,

a) 16.72 pounds equals the live weight of mussels taken in a dredge collection at river mile 1.0

b) $16.72 \times 88.54 = 1{,}480.39$, or 1,480 pounds
estimated standing crop of live mussels in pounds per acre.

### Old Shell Collections

The shells taken in the 1966 "bone" (subfossil) collections were identified by Dr. David H. Stansbery. The river mile numbers where old shells were collected and museum catalog numbers of the specimens deposited in The Ohio State Museum are included in the next section of this paper for each species under the heading "Old Shell Records (1966 Survey)."

### Museum Collections

The author attempted to verify published records of those species previously reported from the Illinois River which were not taken in the 1966 live mussel and old shell collections. Verifications were made by curators at museums or by the author.

Dr. Paul W. Parmalee (pers. comm., 21 November 1966) furnished the author with copies of the accession pages of the Illinois State Museum at Springfield, Illinois, including mussels Dr. Parmalee had collected from the Illinois River in the 1950's. Dr. Henry van der Schalie (pers. comm., 31 August 1967) sent the author information relative to mussel shells from the Illinois River contained in the collections of the University of Michigan Museum of Zoology at Ann Arbor, Michigan. Dr. Joseph P. E. Morrison (pers. comm., 14 July 1967; 27 November 1967; 4 January 1968; 4 June 1968) provided records of mussels he collected from the

Illinois River in 1924 and the 1930's. He also provided information concerning mussels taken from the river by the U.S. Bureau of Fisheries from 1907 to 1916 and by others and now deposited at the U.S. National Museum at Washington, D.C. Dr. William J. Clench (pers. comm., 12 August 1969; 25 November 1969) furnished the author records of the Illinois River mussel shells in the collections of the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts. Several of the shells in this collection were examined for the author by Dr. David H. Stansbery (pers. comm., 20 January 1970; 13 February 1970) . Dr. Stansbery sent the author a list of the Illinois River naiads contained in the collections of The Ohio State Museum at Columbus, Ohio (pers. comm., 22 December 1969) .

Dr. Lowell Getz, while at the University of Connecticut (now at the University of Illinois), presented the author with some of the shells contained in the Benjamin Koons collection from the Illinois River in the 1870's. The author gave several of these shells to Dr. Paul W. Parmalee for deposit in the Illinois State Museum. The remainder of these shells will be presented to the Illinois Natural History Survey at Urbana, Illinois, and The Ohio State Museum.

The author examined mussels from the Illinois River in the collections of the following museums: Field Museum of Natural History at Chicago, Illinois; University of Illinois Museum of Natural History (Frank C. Baker collection) at Urbana, Illinois; and Illinois Natural History Survey at Urbana, Illinois.

Abbreviations of the names of the museum and personal collections consulted during the preparation of this paper are: Benjamin Koons collection (BK), Field Museum of Natural History (FMNH), Illinois Natural History Survey (INHS), Illinois State Museum (ISM) , Museum of Comparative Zoology (MCZ), The Ohio State Museum (OSM), U.S. National Museum (USNM), University of Illinois Museum of Natural History (UIMNH), and University of Michigan Museum of Zoology (UMMZ).

## MUSSEL FAUNA OF THE ILLINOIS RIVER

This section deals with the past and present mussel fauna of the river. Through the years various generic and specific names have been used by different authors for a number of the mussel species found in the Illinois River. Differences in opinions among taxonomists concerning the nomenclature of many of these species still exist and will probably continue to exist until the evidence for solving the many problems is obtained. In this paper the author was more concerned with presenting a synoptic report of the mussel fauna of the river which might be intelligible to current and future workers than with the problems of taxonomy and nomenclature.

Persons desiring to identify mussels from the Illinois River will find Parmalee's (1967) booklet on the mussels of Illinois very helpful. To aid such persons the author has included with the synonymies of most of the species listed below pertinent references to Parmalee's publication and the scientific names used by him. Otherwise, the synonymies include only those names referring to Illinois River records appearing in the literature and personal communications and those found on museum specimens.

For the benefit of those having a serious interest in the Illinois mussel fauna the author has included at the end of the discussion of each species three categories of mussels collected from the Illinois River: (i) "Museum Records," specimens not collected in the 1966 survey; (ii) "Live Mussel Records (1966 Survey)," the Illinois River mile number and river bank and/or the name of the bottomland lake where living specimens were collected in 1966 and their museum catalog numbers (mussels collected alive from the Peoria pool in 1969 were included here and designated as 1969 records) ; and (iii) "Old Shell

Table 5.—Mussel fauna of the Illinois River and its bottomland lakes in the 1870-1900 period, 1906-1912 period, and 1966-1969 period.[a]

| *Kind of Mussel* | *Period* | | |
|---|---|---|---|
| | 1870–1900 | 1906–1912 | 1966–1969[b] |
| *Cumberlandia monodonta* (Spectacle-Case) | Pc | P | A |
| *Fusconaia ebena* (Ebony Shell) | P | P | P |
| *Fusconaia flava f. flava* (Wabash Pig-Toe) | P | P | A |
| *Fusconaia flava f. undata* (Pig-Toe) | P | P | P |
| *Megalonaias gigantea* (Washboard) | P | P | P |
| *Amblema plicata* (Three-Ridge) | P | P | P |
| *Quadrula quadrula* (Maple-Leaf) | P | P | P |
| *Quadrula pustulosa* (Pimple-Back) | P | P | P |
| *Quadrula nodulata* (Warty-Back) | P | P | P |
| *Quadrula melanevra* (Monkey-Face) | P | P | A |
| *Tritogonia verrucosa* (Buckhorn) | P | P | P |
| *Cyclonaias tuberculata* (Purple Warty-Back) | P | P | A |
| *Plethobasus cyphyus* (Bullhead) | P | P | A |
| *Pleurobema coccineum* f. *solida* | P | P | A |
| *Pleurobema pvramidatum* | P | P | A |
| *Elli ptio crassidens* (Elephant's Ear) | P | P | A |
| *Elliptio dilatatus* (Lady-Finger) | P | P | A |
| *Uniomerus tetralasmus* (Pond-Horn) | P | A' | A |
| *Arcidens confragosus* (Rock Pocketbook) | P | P | P |
| *Lasmi gona costata* (Fluted Shell) | P | P | A |
| *Lasmi gona complanata* (White Heel-Splitter) | P | P | P |
| *Anodonta grandis grandis* (Floater) | P | P | P |
| *Anodonta grandis corpulenta* (Floater) | P | P | P |
| *Anodonta imbecillis* (Paper Pond Shell) | P | P | P |
| *Anodonta suborbiculata* (Heel-Splitter) | P | P | P |
| *Alasmidonta calceolus* (Slipper-Shell) | P | A | A |
| *Alasmidonta marginata* (Elk-Toe) | P | A | A |
| *Strophitus undulatus* (Squaw Foot) | P | P | A |
| *Anodontoides ferussacianus* (Cylindrical Paper Shell) | P | P | A |
| *Obliquaria reflexa* (Three-Horned Warty-Back) | P | P | P |
| *Obovaria olivaria* (Hickory-Nut) | P | P | P |
| *Actinonaias ligamentina* (Mucket) | P | P | A |
| *Plagiola lineolata* (Butterfly) | P | P | A |
| *Truncilla truncata* (Deer-Toe) | P | P | P |
| *Truncilla donaciformis* (Fawn's Foot) | P | P | P |
| *Leptodea fragilis* (Fragile Paper Shell) | P | P | P |
| *Proptera alata* (Pink Heel-Splitter) | P | P | P |
| *Proptera capax* (Fat Pocketbook) | P | P | A |
| *Proptera laevissima* (Fragile Heel-Splitter) | P | P | P |
| *Carunculina parva* (Liliput Shell) | P | P | P |
| *Ligumia recta* (Black Sand-Shell) | P | P | A |
| *Villosa iris iris* (Rainbow-Shell) | P | A | A |
| *Lampsilis anodontoides* f. *anodontoides* (Yellow Sand-Shell) | P | P | A |
| *Lampsilis anodontoides I fallaciosa* (Slough Sand-Shell) | P | P | P |
| *Lampsilis radiata luteola* (Fat Mucket) | P | P | P |
| *Lampsilis ventricosa* (Pocketbook) | P | P | A |
| *Lampsilis orbiculata* f. *orbiculata* | P | P | A |
| *Lampsilis orbiculata* f. *hi gginsii* (Higgin's Eye) | P | P | A |
| *Dysnomia triquetra* (Snuffbox) | P | P | A |

[a] Doubtful records of occurrence in the 1870-1912 period: *Marg aritif era margaritif era; Fusconaia subrotunda; Lastena lata; Lasmigona compressa; Obovaria retusa;* and *Leptodea leptodon.* **Recorded from the** Illinois River valley: *Ligumia subrostrata.*

[b] Includes only mussels taken alive in the 1966-1969 study.

P designates present; A designates absent.

Records (1966 Survey)," the Illinois River mile where subfossil shells of the species were collected in 1966 and their museum catalog numbers.

Phylum MOLLUSCA
Class PELECYPODA
Order EULAMELLIBRANCHIA
Superfamily UNIONACEA
Family MARGARITIFERIDAE Ortmann, 1911

Margaritifera margaritifera (Linnaeus 1758)

*Margaritana margaritifera* Linné: Baker (1906:76)

Baker (1906:76) reported that Calkins collected this species in the Illinois River. The author was unable to locate a specimen of this species from the Illinois River in the museums he visited or contacted during this study.

This species apparently is restricted largely to soft waters and is usually found in cold, clear, rather rapidly flowing small to medium-sized streams (Ortmann 1919:5; Clarke & Berg 1959:18). According to Clarke & Berg (1959:17) this species has not been collected from central North America. The Illinois River is a large, sluggish, hard-water stream located virtually in the heart of central North America.

On the basis of this evidence the author concluded that Baker's reporting of M. *margaritifera* in the Illinois River was an error and that this species should not be included in the mussel fauna list of the river presented in Table 5.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

Spectacle-Case
Cumberlandia monodonta (Say, 1829)

*Cumberlandia monodonta* (Say): Parmalee (1967:25)

*Margaritana monodonta* Say (=*soleniformis* Lea): Baker (1906:76)

*Margaritana monodonta* (Say): Danglade (1914:10)

The spectacle-case was listed by Baker (1906:76) as having been taken at Havana, Illinois, by State Laboratory personnel. Also Danglade (1914:42) mentioned that he saw several specimens of this species from the Illinois River at the biological laboratory at Havana. A single specimen of the spectacle-case was collected in 1912 by Danglade (Ibid.) from the river at Diamond Island (approximate river mile 24.5) above Hardin. Dr. Joseph P. E. Morrison (pers. comm., 14 July 1967; 27 November 1967) confirmed this record (USNM).

Danglade (1914:42) reported that the spectacle-case was a rare species in the Illinois River in 1912. This species was probably similarly scarce in the Mississippi River where the van der Schalies (1950:456) listed the spectacle-case as occurring so rarely in the mainstream that collecting a specimen was merely a matter of chance.

Neither a living nor a subfossil spectacle-case was taken in the 1966 survey. Nor was this species collected by Parmalee (pers. comm., 29 June 1967) during the 1950's from the Illinois River. It appears that the spectacle-case has disappeared from the river in the past 50 years. Stansbery (1966:29) reported a similar disappearance of this species from the Ohio River.

Museum Records.—Above Hardin, Diamond Island (1912 Danglade) USNM 678486.

Live Mussel Records (1966 Survey). None.

Old Shell Records (1966 Survey).—None.

Family UNIONIDAE (Fleming, 1828) Ortmann, 1911
Subfamily UNIONINAE (Swainson, 1840) Ortmann, 1910

Ebony Shell
Fusconaia ebena (Lea, 1831)
(Plate 3-18)

*Fusconaia ebenus* (Lea): Parmalee (1967:31; 1962:9)

Unio ebenus Lea:
Calkins (1874:42)
Quadrula ebena Lea:
Kelly (1899:401)
Baker ( 1906 : 81 )
Forbes & Richardson (1913:536)
Quadrula ebena (Lea):
Danglade (1914 : 9 )
Fusconaia ebena:
Richardson (1928:457)
Sintoxia antrosa Raf., 1820:
Morrison (pers. comm., 4 January 1968)
Fusconaia antrosa (Raf.) :
FMNH

Danglade (1914:38) considered this species as the most valuable button shell in the United States. He stated that:

> "Although widely distributed throughout the entire river [Illinois], this species is so rare in the upper stretches that often only one or two examples are found in a ton of shells. In the lower third of the river the conditions are better; the number may run as high as 2 or 3 per cent."

In the early 1870's Calkins (1874:42) found the ebony shell occurring abundantly in the river at La Salle County (Starved Rock pool). Baker (1906:81) reported this species from the river at Utica and Havana. In the 1896-1897 period, Kelly (1899:401) examined 23 specimens of ebony shells collected in the Havana area.

In 1912 Forbes & Richardson (1913:536) collected live ebony shells in the river between Chillicothe and Henry. However, in the 1924-1925 period Richardson (1928:457) was unable to find a living specimen of this species in Peoria Lake.

Morrison (pers. comm., 4 January 1968) collected this species in the river at Meredosia in 1930, and in 1955 Parmalee (pers. comm., 21 November 1966) took one live ebony shell at Naples.

Only one living specimen of this species was taken in the 1966 survey. This mussel was collected near the mouth of the river with the crowfoot bar on a hard bottom in 9.0 feet of water. The height of the specimen was 2.8 inches, and it was determined to be 14 years old. This species was not found in the Illinois River commercial shell piles examined in 1966.

Formerly, the ebony shell was a fairly abundant mussel in the Illinois River as evidenced by the records presented here. Today it is rare and apparently occurs only in the lower part of the river (Alton pool). This virtual disappearance of the ebony shell from the Illinois River during the past 50 years probably was related to siltation and pollution rather than to any change in the fish population. The known fish host for this mussel (Baker 1928:67), the skipjack herring, Alosa chrysochloris (Rafinesque), has always been considered an uncommon species in the Illinois River (Forbes & Richardson 1920: 49; Starrett & Smith unpublished).

Museum Records.—Chillicothe (1907 Freeland & Williams) USNM 676962; Havana area (pre-1900 Strode) FMNH 9220 and 50574, (1894) UIMNH 22179, and (1909) INHS; Meredosia (1907 F & W) USNM 676951 and (1930 Morrison) USNM 678633; Naples (1955 Parmalee) ISM 1122; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678555; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678556; and Illinois River without locality (pre-1943 Webb Coll.) FMNH 22845.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB). OSM 18013.

Old Shell Records (1966 Survey).—River mile 15.0, 44.9, 66.0-66.4, 75.8, 86.6, 94.3, 106.8, 129.8, 145.7, 156.0, 196.3, 198.1, and 219.4. OSM 18194, 18207, 18251, 18276, 18289, 18311, 18327, 18357, 18441, and 18452.

Fusconaia subrotunda (Lea, 1831)

Fusconaia subrotunda (Lea) :
Parmalee (1967:87)
Quadrula subrotunda Lea:
Baker (1906:81)

Baker (1906:81) stated that F. subrotunda was reported from the Illinois

River by Call. The author was unable to locate a specimen of this species taken from the Illinois River. According to Simpson (1914:893) this species occurred in the Ohio, Cumberland, and Tennessee river systems. Parmalee (pers. comm., 29 June 1967) informed the author that:

> "I have never collected this in the Illinois River or in any river in the state, for that matter. Apparently this species is confined to the Ohio River and its tributaries and if it still occurs there today, it would be rare."

Van der Schalie (pers. comm., 31 August 1967) considered the Illinois River out of the range for this species. Morrison (pers. comm., 27 November 1967) mentioned that any records of this species from the Illinois River were probably misidentified (flatter) specimens of F. ebena.

On the basis of the evidence the author has excluded this species from his mussel fauna list of the Illinois River (Table 5).

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Fusconaia flava Complex

A series of specimens belonging to the Fusconaia flava complex collected from the river in the 1966 survey was submitted to Dr. David Stansbery for examination. The comments and analysis made by Dr. Stansbery (pers. comm., 12 July 1967) concerning this complex and the Illinois River material were:

> "A total of 29 specimens of this form constitute our holdings of this species from the Illinois River. All but a single specimen were collected by Dr. William Starrett in 1966 and these latter specimens comprise 14 separate lots. These lots extend from Illinois River mile 1 to Ill. Riv. mi. 169.3.
>
> "Each specimen was measured as to length, height, and width. A vernier caliper was used and each dimension rounded off to the nearest millimeter. From these data were calculated the height index $\left(\frac{H}{L} \times 100\right)$, width index $\left(\frac{T}{L} \times 100\right)$, and transverse index $\left(\frac{W}{L} \times 100\right)$. It was the width index which Ortmann (1918, 1919, & 1920) used to differentiate the headwater forms from the downstream forms in a number of other species.
>
> "In order to work with this complex in Lake Erie (some years ago) I compared these same proportions of the holotypes of each of the described names in this complex. I found that (Stansbery 1960:104) there was a gradual gradation in both height and width indices from the very compressed flava Rafinesque, 1820, through rubiginosa Lea, 1829; parvula Grier, 1918; trigonus Lea, 1831; undatus Barnes, 1823; to wagneri Baker, 1928. The latter is the very high, very wide extreme found (then) in Lake Pepin of the Mississippi River. While I dislike to disagree with a worker of Baker's stature I must, in all honesty, confess that my concept of this group does not concur with his. I cannot separate any of the above described forms into species distinct from the first described — flava Rafinesque, 1820.
>
> "Since receiving this fine set of material from the Illinois River I have once again gone over my original measurements and calculations as well as the extensive material which has accumulated here at the Ohio State Museum in the interim. All of this has served only to convince me that the concept I arrived at in 1960 is the correct one. Had Baker had at his disposal the material we have for study today I

believe he would concur with the following arrangement.

| | Width Index |
|---|---|
| Fusconaia flava forma flava (Raf., 1820) | Up to 54* |
| Fusconaia flava forma undata (Barnes, 1823) | 55* and over |

* see Ortmann 1 920 :282

"The names *flava* Raf. and *undata* Barnes are used above since they are conspecific and represent the earliest names applied to the compressed and swollen forms, respectively. Ortmann in some instances used a third designation for intermediate specimens. If for any reason this becomes desirable, the form trigona Lea lies intermediate between the extremes of this complex. Wherever I have had the opportunity to study all the F. flava forms within a single stream system it has proved to be a cline from F. f. flava in the headwaters to F. f. undata downstream.

"Whether the differences observed between the headwaters and the big rivers are principally genetic or environmental is not presently known and constitute a different, though not less interesting, problem.

"This brings us to the question of the identification of the Illinois River Fusconaia flava specimens. The width indices of the 29 specimens studied varied from a low of 57 to a high of 75 thus placing all of them in the form undata. A larger sample might well produce some form flava specimens and it's almost certain that collecting in the tributaries would do so. The mean width index for all 29 specimens was 66. This means that Fusconaia flava of the Illinois River proper groups with those forms found in the Mississippi River below Minneapolis, the lower Ohio River, lower Wabash River, and the lower White, Black, and St. Francis Rivers of Arkansas. There are a few records of this form of F. flava for the lower Cumberland and Tennessee Rivers (in Kentucky) but neither this form nor the compressed flava seem to have been able to invade the Cumberland Plateau or southern Appalachians. Related forms are present in the Gulf Coast rivers of the coastal plain from the Alabama River west to at least the Sabine River of Texas but apparently represent different species."

As Stansbery mentions, he was unable to separate the forms of flava discussed here into distinct species. However, van der Schalie (pers. comm., 31 August 1967) considered flava and undata to be separate species unless they were proved to be dines. Morrison (pers. comm., 27 November 1967) also treated flava and lateralis (undata) as separate species. The author has followed Stansbery's opinion relative to the F. flava complex and believes that the synonymies included below for each form will enable the reader to comprehend the form or species discussed, regardless of his opinion concerning this complex.

### Wabash Pig-Toe

### Fusconaia flava forma flava (Rafinesque, 1820)

Fusconaia *flava* (Raf.) :
Parmalee (1967:31)
FMNH
MCZ
Unio rubiginosus Lea:
Calkins (1874:44)
Quadrula rubiginosa Lea:
Kelly (1899:401)
Quadrula rubiginosa (Lea):
Danglade (1914:9)
Quadrula *rubiginosa* Lea ( flava Conrad) :
Baker (1906:80)

This headwaters and creek form of Fusconaia flava was not collected from the Illinois River in the 1966 survey. During the 1966 survey a living specimen of the creek form flava was taken in the Aux Sable River, a tributary

stream of the upper Illinois River (OSM 17342).

Calkins (1874:44) considered rubiginosus an abundant species in the Illinois (Starved Rock pool) and Fox rivers. Downstream from Starved Rock at Peru several specimens of F. flava were collected from the Illinois (pre-1910) and later deposited in the Museum of Comparative Zoology. Dr. Stansbery (pers. comm., 20 January 1970) examined these museum specimens for the author and informed him that:

> "The F. flava I would term form flava Raf. but have the suggestion of the form trigona Lea which is one of several inter - connecting forms between flava Raf. and *undata* Barnes. They do not, however, have the outline, width index, high beaks or sulcus typical of undata Barnes."

Kelly (1899:401) indicated that in the 1896-1897 period he checked for parasites one specimen of this form from the river at Havana. Also Baker (1906: 80) reported that rubiginosa was taken at Havana (no mention of stream) by State Laboratory personnel. The author examined in the collections of the Field Museum of Natural History a shell collected at Havana (no mention of stream) in 1895 which he considered to be form flava. The Illinois River flows past the west side of Havana, but directly across from Havana, Spoon River empties into the Illinois. The author conjectured that this shell was collected either in or near the mouth of Spoon River.

Danglade (1914:39) considered rubiginosa rare in the Illinois River, and the only examples of this mussel found in his survey were taken from Peoria Lake. Stansbery mentioned above that a larger sample in 1966 of F. flava f. undata from the river might have produced some specimens of the form flava and possibly Danglade's (Ibid.) records of this form (rubiginosa) were a result of examining large collections of specimens belonging to this complex. The tributary streams emptying into Peoria Lake were all temporary or intermittent creeks and were not typical streams where the form flava might be expected to occur. In the author's opinion the records cited above of form flava (*rubiginosus* and rubiginosa) occurring in the Illinois, other than Peoria Lake, were based on specimens collected at or near the mouths of tributary streams.

The host fish of this form is not known.

Museum Records.—Peru (pre-1910) MCZ 269572; and Havana, no stream mentioned (1895 Hay) FMNH 14898.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Pig-Toe
### Fusconaia flava forma undata
### (Barnes, 1823)
### (Plate 3-14)

Fusconaia undata (Barnes):
Parmalee (1967:32)
Richardson (1928:457)
Unio trigonus Lea:
Calkins (1874:45)
Quadrula trigona Lea:
Kelly (1899:401)
Forbes & Richardson (1913:533)
Quadrula trigona (Lea):
Danglade (1914:9)
Quadrula undata (Barnes):
Danglade (1914:39)
Fusconaia undata undata Barnes:
FMNH
Fusconaia undata wagneri (Baker):
FMNH
Fusconaia undata:
Richardson (1928:457)
Sintoxia lateralis Raf., 1820:
Morrison (pers. comm., 4 January 1968)

Danglade (1914:39) considered this form the most abundant of the "pig-toe" group in the Illinois River and stated that:

> "Some beds, depending upon the parts worked, gave the following percentages: Chillicothe, 7; Pekin, 3; Florence, 9; and Hardin, 2."

In the 1966 survey 46 live specimens of this form were taken between river

miles 1.0 and 170.9 (Table A-3). The pig-toe constituted 1.1 percent of the live mussels taken in the survey and ranked 11th in abundance in the 1966 collections (Tables 6 and 7) . The average height of these shells was 1.9 inches. Most of these shells were between 8 and 12 years of age (Table A-9). No pig-toe taken in the survey or examined in the Illinois River commercial piles was over 2.4 inches in height (minimum commercial height 2.5 inches). The small size and scarcity of this form in the Illinois River in 1966 virtually eliminated it as a commercial shell.

Formerly the pig-toe was distributed throughout most of the river, as indicated in the museum records and by subfossil shells found in 1966. In the 1966 survey neither a living nor an old shell of this form was taken in the Starved Rock navigation pool; however, Calkins (1874:45) reported it from this pool in La Salle County.

In the present study 26 live specimens were taken in the Alton pool and 19 specimens from the lower part of the Peoria pool. Only a single live pig-toe was collected in the La Grange pool (between Alton and Peoria pools) . In the 1896-1897 period Kelly (1899:401) took 22 pig-toes from the river at Havana in the La Grange pool. In 1912 Forbes & Richardson (1913:533 & 536) collected pig-toes between Hennepin and Chillicothe. However, in the 1924-1925 period Richardson (1928:457) did not take this form above the lower end of Upper Peoria Lake. This was approximately the same upstream location (river mile 170.9) where live pig-toes dropped out of the 1966 survey collections.

According to Baker (1928:61) the white crappie, Pomoxis annularis Rafinesque, and black crappie, Pomoxis nigromaculatus (Lesueur), were believed to be the host fishes for the glochidia of the pig-toe. Both of these species, particularly the black crappie, were common

Table 6.—Rankings of the relative abundance of kinds of live mussels taken in the 1966 survey of the Illinois River and its bottomland lakes, based on the number of specimens collected.a

| Kind of Mussel | Alton Pool Rank | La Grange Pool Rank | Peoria Pool Rank | Entire River Rank |
|---|---|---|---|---|
| A. plicata (Three-Ridge) | 1 | 1 | 1 | 1 |
| Q. pustulosa (Pimple-Back) | 2 | 7 | | 2 |
| Q. quadrula (Maple-Leaf) | 3 | 2 | 3 | 3 |
| M. gigantea (Washboard) | 4 | 4 | 10 | 4 |
| A. g. corpulenta (Floater) | 8 | 3 | 2 | 5 |
| A. confragosus (Rock Pocketbook) | 6 | 6 | 10 | 6 |
| Q. nodulata (Warty-Back) | 5 | 10 | | 7 |
| L. fragilis (Fragile Paper Shell) | 9 | 5 | 7 | 8 |
| L. a. f. fallaciosa (Slough Sand-Shell) | 10 | 9 | 5 | 9 |
| 0. reflexa (Three-Horned Warty-Back) | 7 | 12 | | 10 |
| F. f. f. undata (Pig-Toe) | 11 | 12 | 4 | 11 |
| P. laevissima (Fragile Heel-Splitter) | 12 | 8 | 6 | 12 |
| P. alata (Pink Heel-Splitter) | 13 | 12 | 8 | 13 |
| L. complanata (White Heel-Splitter) | 15 | 10 | 8 | 14 |
| T. truncata (Deer-Toe) | 14 | 11 | | 15 |
| L. r. luteola (Fat Mucket) | . .b | 11 | 7 | 16 |
| A. imbecillis (Paper Pond Shell) | 16 | 11 | 10 | 17 |
| A. g. grandis (Floater) | | 11 | 9 | 18 |
| F. ebena (Ebony Shell) | 17 | | | 19 |
| A. suborbiculata (Heel-Splitter) | . | 12 | | 19 |
| 0. olivaria (Hickory-Nut) | 17 | | | 19 |
| T. donaciformis (Fawn's Foot) | 17 | | | 19 |
| C. parva (Liliput Shell) | 17 | | | 19 |

a 1969 data are not included in this table.
b Mussel was not collected.

Table 7.-Rankings of the relative abundance of kinds of live mussels taken in the 1966 survey of the Illinois River and its bottomland lakes, based on the percentage of collections in which a kind of mussel occurred."

| Kind of Mussel | Alton Pool | | La Grange Pool | | Peoria Pool | | Entire River | |
|---|---|---|---|---|---|---|---|---|
| | Percent of Collections in Which Mussel Occurred | Rank | Percent of Collections in Which Mussel Occurred | Rank | Percent of Collections in Which Mussel Occurred | Rank | Percent of Collections in Which Mussel Occurred | Rank |
| A. plicata (Three-Ridge) | 78.4 | 1 | 40.8 | 1 | 39.5 | 1 | 54.4 | 1 |
| Q. quadrula (Maple-Leaf) | 56.8 | 3 | 31.5 | 2 | 10.9 | 4 | 34.8 | 2 |
| Q. pustulosa (Pimple-Back) | 59.5 | 2 | 6.[illegible] | 7 | 0.0 | | 24.2 | 3 |
| M. gigantea (Washboard) | 43.9 | 4 | 10.8 | 4 | 0.8 | 10 | 20.2 | 4 |
| A. g. corpulenta (Floater) | 8.1 | 7 | 10.0 | 5 | 20.2 | 2 | 12.3 | 5 |
| L. fragilis (Fragile Paper Shell) | 16.9 | 6 | 12.3 | 3 | 4.2 | 6 | 11.6 | 6 |
| A. confragosus (Rock Pocketbook) | 20.9 | 5 | 7.7 | 6 | 0.8 | 10 | 10.6 | 7 |
| Q. nodulata (Warty-Back) | 20.9 | 5 | 3.8 | 9 | 0.0 | | 9.1 | 8 |
| L. a. f.fallaciosa (Slough Sand-Shell) | 6.8 | 8 | 4.6 | 8 | 11.8 | 3 | 7.6 | 9 |
| F. f. f. undata (Pig-Toe) | 8.1 | 7 | 0.8 | 11 | 10.9 | 4 | 6.5 | 10 |
| O. reflexa (Three-Horned Warty-Back) | 16.9 | 6 | 0.8 | 11 | 0.0 | .. | 6.5 | 10 |
| P. laevissima (Fragile Heel-Splitter) | 4.1 | 10 | 4.6 | 8 | 5.0 | 5 | 4.5 | 11 |
| L. complanata (White Heel-Splitter) | 2.7 | 11 | 3.8 | 9 | 2.5 | 8 | 3.0 | 12 |
| P. alata (Pink Heel-Splitter) | 5.4 | 9 | 0.8 | 11 | 2.5 | 8 | 3.0 | 12 |
| T. truncata (Deer-Toe) | 4.1 | 10 | 1.5 | 10 | 0.0 | .. | 2.0 | 13 |
| L. r. luteola (Fat Mucket) | 0.0 | .. | 1.5 | 10 | 3.4 | 7 | 1.5 | 14 |
| A. g. grandis (Floater) | 0.0 | .. | 1.5 | 10 | 1.7 | 9 | 1.0 | 15 |
| A. imbecillis (Paper Pond Shell) | 1.4 | 12 | 0.8 | 11 | 0.8 | 10 | 1.0 | 15 |
| F. ebena (Ebony Shell) | 0.7 | 13 | 0.0 | .. | 0.0 | .. | 0.3 | 16 |
| A. suborbiculata (Heel-Splitter) | 0.0 | .. | 0.8 | 11 | 0.0 | .. | 0.3 | 16 |
| O. olivaria (Hickory-Nut) | 0.7 | 13 | 0.0 | .. | 0.0 | | 0.3 | 16 |
| T. donaciformis (Fawn's Foot) | 0.7 | 13 | 0.0 | .. | 0.0 | | 0.3 | 16 |
| C. parva (Liliput Shell) | 0.7 | 13 | 0.0 | .. | 0.0 | | 0.3 | 16 |

[a] 1969 data are not included in this table.

in some years (1957-1967) in the Illinois River from its mouth to the Starved Rock dam and uncommon in the Starved Rock and Marseilles pools (Starrett unpublished). The decrease in abundance and distribution of the pig-toe in the Illinois River during this century probably was a result of pollution. Also, pollution has affected the fish hosts of the pig-toe, particularly in the upper two navigation pools of the river.

Museum Records.-Peru (pre-1943 Webb Coll.) FMNH 22829; Spring Valley (1924 Morrison) USNM 678631 (dead) ; Chillicothe (1907 Freeland & Williams) USNM 677037; Peoria (pre-1943 Webb Coll.) FMNH 22824; Pekin (1907) FMNH 11216; 3 miles SE of Banner (1953 Parmalee) ISM 220 (dead) ; Quiver Lake (1955 Parmalee) ISM 1049; Havana (1894 Baker) UIMNH 22171; Beardstown (1907 F & W) USNM 676954; Meredosia (1907 F & W) USNM 677026 and (1930 Morrison) USNM 678632 (dead) ; Naples (1955 Parmalee) ISM 1123; Valley City (1909 Freeland) USNM 678591; Pearl (1965 Parmalee) ISM 3310-3311; 1 mile below Hardin (1907) USNM 678554; and Illinois River without locality FMNH 57524 and (1870's) BK.

Live Mussel Records (1966 Survey) .-River mile 1.0 (LB), 10.5 (RB), 14.9-15.1 (RB), 28.9-29.1 (RB), 48.3 (RB), 51.0-51.3 (RB), 51.2 (LB), 66.0-66.4 (LB), 73.0 (RB), 75.8 (RB), 154.4-154.5 (RB), 162.3 (LB), 166.6 (LB), 167.2 (LB), 167.2 (RB), 167.7 (LB),

168.1-168.5 (RB), 168.6 (LB), 169.3 (RB), and 170.9 (RB). OSM 17344, 17697, 17698 (2), 17699, 17713, 17714 (6), 17728 (5), 17729 (2), 17731 (3), 17732, 17735, 17736 (2), 17737, and 17738; FMNH 156957 (3) and 156966.

Old Shell Records (1966 Survey).—River mile 44.9, 66.0-66.4, 75.8, 94.3, 106.8, 129.8, 145.7, 156.0, 184.5, 196.1, 196.3-198.1, 219.4, 253.5-256.5. OSM 18193, 18277, 18288, 18310, 18326, 18356, 18381, 18429, 18440, 18451, and 18476.

Washboard
Megalonaias gigantea (Barnes, 1823)
(Plate 1-4)

Megalonaias gigantea (Barnes):
Parmalee (1967:33; 1962:9)
Richardson (1928:457)
MCZ
Quadrula multiplicata Lea:
Kelly (1899:401)
Quadrula heros Say (=*multiplicata* Lea):
Baker (1906:78)
Forbes & Richardson (1913:533)
Quadrula heros (Say):
Danglade (1914:10)
Amblema (Megalonaias) gigantea gigantea (Barnes):
FMNH
Megalonaias gigantea Barnes:
Morrison (pers. comm., 4 January 1968)

Danglade (1914:40) considered the washboard the best button shell found in the Illinois River. In 1966 this species was the second most important shell taken from the Illinois River for use in the Japanese pearl-culture industry. The washboard ranked fourth in abundance in the 1966 survey collections (Tables 6 and 7) and constituted 4.9 percent of the live shells taken (Table A-3). Most of the washboards collected were over 2.5 inches in height (Table A-10) and 70.5 percent of them were between 11 and 18 years of age (Table A-11).

In 1912 the washboard was an abundant shell in various parts of the river between Spring Valley (river mile 218.5) and its mouth (Danglade 1914:13-24; Richardson 1928:457). Baker (1906: 78) stated that this species had been taken from the river at Ottawa (river mile 239.5) and Utica (river mile 229.6). These citations from the literature together with the museum and subfossil shell records indicated that the washboard formerly was distributed throughout the river upstream as far as Ottawa. No record was located relative to the occurrence of the washboard in the Marseilles pool.

In the 1966 survey 207 live washboards were collected between river miles 0.9 and 196.1 (near Henry); however, 88.4 percent of these specimens were taken from the Alton pool between river miles 0.9 and 79.8 (Tables 8 and A-3). In the river proper no live washboard was taken between river miles 110.5 (9 miles below Havana) and 196.1. However, in 1969 a few live specimens were taken by commercial fishermen just below Peoria Lake and in Peoria Lake. At river mile 196.1 a single live washboard was collected by wading. Just above Havana at Quiver Lake two specimens were taken alive, one with the crowfoot bar and the other by wading.

In the 1896-1897 period Kelly (1899: 401) examined 26 washboards collected from the river at Havana. Danglade (1914:18) found in 1912 that washboards predominated the commercial shell catch at Havana. In 1912 Forbes & Richardson (1913:533 & 536) took 11 washboards at Hennepin (river mile 207.4), and they found this species to be one of the most abundant living mussels between Henry and Chillicothe (river mile 180.4, just above the upper end of Peoria Lake). In that same year Danglade (1914:16-17) collected washboards and checked commercial shell piles containing this species from Peoria Lake. Richardson (1928:456–457) did not find a live washboard in Peoria Lake during his 1924-1925 survey. He stated that only the hardier species of mussels had been able to survive the destructive pollution period of 1917-1920 in the upper river. Evidently pollution has now virtually restricted the washboard to the lower river proper from

Table 8.-Catches of washboards (**Megalonaias gigantea**) per 5 minutes of fishing with the crowfoot bar in the Illinois River proper in the 1966 survey.

| River Mile | *Number* Caught Per 5 Minutes of Fishing |
|---|---|
| 0.9- 5.5 | 3.1 |
| 10.5- 15.1 | 0.3 |
| 19.2- 29.0 | 1.1 |
| 30.5- 39.2 | 0.7 |
| 40.3- 48.3 | 0.5 |
| 51.0- 58.9 | 1.2 |
| 60.8- 69.4 | 0.4 |
| 70.8- 79.8 | 0.1 |
| 80.3- 87.9 | 0.2 |
| 90.2-100.5 | 0.1 |
| 106.6-114.0 | 0.1 |
| 115.3-272.0* | 0.0 |

*In this entire stretch of the river only one washboard was taken by wading at river mile 196.1. However, live specimens were taken in Bath Chute (river miles 106.8-113.3) and Quiver Lake (river miles 122.2-122.8). In 1969 live specimens were taken in the vicinity of Peoria.

below Havana to its mouth. The single specimen taken in the 1966 survey near Henry was apparently accidental. The largest estimated standing crop calculated for washboards in 1966 was 752 pounds (shell weight) per acre at river mile 51.2 (RB) in the Alton pool.

It was doubtful if a lack or scarcity of host fishes was a factor in the present limited distribution of the washboard in the river. All of the five known host fishes (Baker 1928:72) for the washboard occurred in the river in the 1960's. The gizzard shad, Dorosoma cepedianum (Lesueur), usually was abundant in the river from its mouth to Chillicothe, and in most years the author found that this fish occurred throughout much of the river. The white bass, Morone chrysops (Rafinesque), was sporadic in abundance; however, for several years the author collected this species at most of his fishing stations in the river. This host fish is known to have a tendency to migrate in the river and its bottomland lakes (Starrett & Fritz 1965:70-71) and would have been capable of disseminating the washboard throughout its original range provided the environment had been suitable for the fish and the mussel. The dogfish, Amia calva Linnaeus, was no longer common in the river, and the flathead catfish, Pylodictis olivaris (Rafinesque), was confined largely to the lower two navigation pools. As mentioned earlier, the white crappie was present in large enough numbers to have served as a host fish between the mouth of the river and Starved Rock dam.

Museum Records.-Chillicothe (1907 Freeland & Williams) USNM 677040; Peoria Narrows (1924) INHS (dead); between Peoria and Pekin (1908 F & W) USNM 677045; between Pekin and Havana (1908 F & W) USNM 678602; Quiver Lake (1955 Parmalee) ISM 1036-1037; Havana (1894 Baker) UIMNH 22173, FMNH 67963, and (1912) INHS a-22; Frederick (pre-1943 Webb Coll.) FMNH 22486; Beardstown (pre-1910) MCZ; Meredosia (1930 Morrison) USNM 678649, (pre-1910) MCZ, and (1955 Parmalee) ISM 1361-1365; Naples (1955 Parmalee) ISM 1086-1093; Pearl (1955 Parmalee) ISM 3297-3298; 1 mile N of Hardin (1956 Parmalee) ISM 2202 (dead); 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678565; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678566; 2 miles above Grafton (1907 Bartsch stat. 111) USNM 678567; Grafton (1909 Freeland) USNM 678603; and Illinois River without locality (1898) FMNH 50553.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB), 5.4-5.5 (RB), 10.5 (RB), 11.8-12.1 (LB), 14.9-15.1 (RB), 19.4 (RB), 21.7-22.0 (RB), 24.2-24.4 (LB), 27.9 (LB), 28.9-29.1 (RB), 30.5-30.8 (RB), 33.2-33.5 (RB), 39.1-39.3 (RB), 40.3-40.5 (RB), 42.2-42.3 (LB), 47.4-47.7 (LB), 48.3 (RB), 51.0-51.3 (RB), 51.2 (LB), 53.6 (LB), 53.8 (LB), 54.3 (LB), 54.4 (RB), 56.3 (LB), 57.5-57.7 (LB), 57.6 (RB), 58.0 (RB), 58.9 (RB), 60.8 (RB), 62.6 (LB), 64.4 (LB), 66.0-66.4 (LB), 66.6 (LB), 68.6 (RB), 68.9 (RB), 69.0 (RB), 69.4

(RB), 72.9 (RB), 73.0 (RB), 79.8 (RB), 86.6 **(LB)**, 86.8 **(LB)**, 93.6 **(LB)**, 96.8 (RB), 106.0-106.9 **(LB)**, 108.8-109.0 (RB), 110.0 (RB) , 110.1 **(LB)**, 110.5 (RB), Quiver Lake, and 196.1 **(LB)**. OSM 17705-17707 and 17709; FMNH 156700 (3), 156987 (4), 156999 (10), 157005 (4), 157008 (9), and 157009 (4). (1969) : 162.3 **(LB)**. OSM 22274.

Old Shell Records (1966 Survey).—River mile 66.0-66.4, 75.8, 86.6-86.8, 106.8, Quiver Lake, 129.8, 145.7, 156.0, 184.5, 196.1, 219.4. OSM 18219, 18253, 18270, 18290, 18301, 18312, 18329, 18359, 18382, 18431, and 18454.

### Three-Ridge (Blue-Point)
### Amblema plicata (Say, 1817)
### (Plate 1-3)

Amblema peruviana (Lamarck) :
Parmalee (1967:27; 1962:9)
MCZ

*Amblema* costata:
Parmalee (pers. comm., 21 November 1966)
MCZ

Quadrula plicata Say:
Kelly (1899:401)
Baker (1906:78)
Forbes & Richardson (1913:529)

Unio undulatus Barnes:
Calkins (1874 : 45) [1]

Quadrula plicata (Say) :
Danglade (1914:10)

Quadrula undulata Barnes:
Baker (1906:78)

Quadrula undulata (Barnes) :
Danglade (1914:10)

*Amblema* rariplicata:
Richardson (1928:456)
Parmalee (pers. comm., 21 November 1966)

Amblema (Amblema) plicata plicata (Say) :
FMNH

Amblema (Amblema) plicata costata Raf.:
FMNH

Amblema plicata Say, 1817 (form *rariplicata* Lam., 1819 included) :
Morrison (pers. comm., 4 January 1968)

Amblema plicata:
OSM

According to Parmalee (1967:26) :

> "Some authors (for example F. C. Baker, 1928) have recognized three distinct species of Amblema: A. costata which is associated with a headwaters or small stream environment; A. rariplicata, a species of medium-sized rivers, or of downstream sections of large rivers such as the Illinois and differing from the former in the shell being somewhat more elongated and inflated; and A. peruviana, the large river species showing an even greater degree of inflation of the shell and umbones. On the other hand, some authorities recognize only one species, and the others are considered simply as forms or variants resulting from differences in size and depth of rivers in which they occur. Again, depending upon the author consulted, the names Crenodonta peruviana or Amblema plicata are used."

A series of specimens of the genus Amblema collected in 1966 from the Illinois River was identified by Dr. David Stansbery as Amblema plicata f. *plicata* (Say, 1817) . Concerning this complex Stansbery (pers. comm., 1 December 1967) stated:

> "The only type material of Unio plicata Say, 1817, that I could locate was at the Philadelphia Academy. . . . It is obviously a Lake Erie specimen as labeled, fits the description by Say, and has all the characteristics of Unio peruviana Lamarck, 1819, except size. This latter is to be expected since all the true

[1] Baker (1928:69) *lists Unio undulatus* Barnes under *Megalonaias gigantea* (Barnes). Call's (1900: 445–446) description and Plate 13 of *U. undulatus* Barnes fit that of *Amblema plicata* (Say). Likewise, Goodrich & van der Schalie (1944:306) refer to Call's Plate 13 as *Amblema costata* Rafinesque. According to Stansbery (pers. comm., 31 July 1968): "A careful examination of Barnes' plate of the holotype of *Unio undulatus* proves it to be an eroded specimen of *Megalonaias gigantea.*" The author was of the opinion that Calkins (1874:45), like Call, was referring to *U. undulatus* as *A. plicata* rather than *M. gigantea.*

stream species found in Lake Erie are, without exception, stunted.

"Since Unio plicata Say, 1817, was the first plicate naiad described from North America the name has priority. Since the smaller individuals of this complex from the Mississippi River, Ohio River, and Illinois River cannot be distinguished from these Lake Erie specimens (except for size) I conclude that U. peruviana Lamarck, 1819, and U. rariplicata Lamarck, 1819, are the same species and hence synonyms of U. plicata Say, 1817.

"All of the forms of this complex in the Ohio River drainage & Great Lakes drainage are abundantly connected by intermediates. None is clear cut — they all 'run together.' Therefore there can be but one species. The earliest name is U. *plicata* Say, 1817, as I indicated in 1961 (1961:3, 4, & 7).

"In spite of the fact that all forms in the drainage concerned are connected by intermediates there are extremes. These extremes are the compressed form costata Raf., 1820, found in the headwaters and the inflated form *plicata* Say, 1817, found in the big rivers (and in river-lakes such as Lake Erie) . Lake Erie is in so many ways a big river with a few peculiarities of its own. Our Lake Erie A. plicata specimens include many form *plicata*, some form costata, and intermediates of every description but all somewhat stunted. No extremes of form costata have been taken, to my knowledge, from Lake Erie.

"The compressed costata form of A. plicata is not geographically definable . . . . It is related only to habitat—to the headwaters. We do not know whether it is genetically different from the swollen *plicata* form or not. Hence, it is not definable as a subspecies. It is recognizable as a form . . . .

"If we recognize forms, since costata Raf., 1820, is the first name given to the headwater form, Amblema plicata form costata Raf., 1820, should be used. Since the type is the swollen form, Amblema plicata form *plicata* (Say, 1817) , should be used for it."

The author checked two specimens taken before 1918 at Havana in the collections of the Field Museum of Natural History (FMNH 68177) , and these specimens were compressed much as is the form costata. Otherwise, all of the specimens from the river examined by the author were the swollen form *plicata*.

In 1966 the three-ridge was the most abundant mussel in the Illinois River and made up 62.4 percent of the live mussels taken in the 1966 survey (Tables 6, 7, and A-3) . It was also the most important mussel taken commercially and formed 74.8 percent of the shells examined in the sorted commercial shell piles along the river (Alton pool) . In the 1966 survey live mussels of all species were collected only in the three lower navigation pools, and in these pools the three-ridge accounted for the following percentages of live mussels taken: 56.9 percent in the Alton pool, 61.4 percent in the La Grange pool, and 81.2 percent in the Peoria pool. Of the 2,650 live three-ridges collected in 1966, 85.7 percent were 2.0-3.0 inches in height (Table A-12) and 87.5 percent were 7-15 years of age (Table A-13) . The largest estimated standing crop of live mussels in the 1966 survey was 3,508 pounds (shell weight) per acre of three-ridges at river mile 162.3 (LB) just below the lower end of Peoria Lake.

The three-ridge was one of the more pollution-tolerant species of mussels found in the study, which probably accounts for its wide distribution and abundance in the river. In the upper sections of the La Grange pool (river miles 140.5-156.6) and Peoria pool (river miles 174.9—229.3) the three-ridge was found in small numbers but was one of the few species able to survive in those areas of the river (Table A-3) . Severe pollution conditions existed in the river upstream from Peoria between 1917 and 1920, and Richardson (1928 : 456) mentioned that the three-ridge was the only one of the

16 species of mussels found in Peoria Lake in the 1924-1925 period that occurred in more than very scanty numbers. The aspects of pollution affecting the three-ridge and other mussels are discussed further in the next section of this paper.

In the 1966 survey subfossil three-ridge shells were taken upstream as far as river miles 253.5-256.5 in the Marseilles pool. Calkins (1874:45) collected undulatus from the river in La Salle County, Baker (1906:78) reported that undulata was taken by Handwerk at Starved Rock, and an Ohio State Museum specimen was collected there in the 1800's. In 1912 Forbes & Richardson (1913:528) took live three-ridges as far upstream as Starved Rock. Danglade (1914:13-25) found the three-ridge (blue-point and three-ridge combined) to be the most abundant mussel at the majority of his stations on the river between Henry and Grafton in 1912.

Baker (1928:74-75) reported that crappies were host fishes for the glochidia of the three-ridge. Recently in the laboratory Stein (1968:46) successfully recovered metamorphosed juveniles of A. plicata from infections of the yellow perch, Perca flavescens (Mitchill); rock bass, Ambloplites rupestris (Rafinesque); green sunfish, Lepomis cyanellus Rafinesque; bluegill, Lepomis macrochirus Rafinesque; and pumpkinseed, Lepomis gibbosus (Linnaeus). She was unable to infect several species of minnows, catfishes, and gars with glochidia of this mussel. The bluegill, green sunfish, and both species of crappies were all common fishes in the Illinois River during the 1960's.

Museum Records.—Starved Rock (pre-1900) OSM 10068; Peru (pre-1910) MCZ; Peoria (1931 Morrison) USNM 678634; between Peoria and Pekin (1908 Freeland & Williams) USNM 678594; Pekin (1907 F & W) FMNH 11206; 3 miles SE of Banner (1953 Parmalee) ISM 111 (dead); between Pekin and Havana (1908 F & W) USNM 678595; Liverpool (1957 Parmalee) ISM 2260; 2 miles N of Havana (1955 Parmalee) ISM 1008-1015; Havana (1909 Freeland) USNM 677769, (1894 Baker) UIMNH 22149, (1909) INHS, and (pre-1918 Hand Coll.) FMNH 68177; Frederick (pre-1943 Webb Coll.) FMNH 20216; 2 miles N of Beardstown (1959 Parmalee) ISM 2868; Beardstown (pre-1943 Webb Coll.) FMNH 22533 and (pre-191.0) MCZ; Meredosia (1907 F & W) USNM 6 7 7 03 6, (1930 Morrison) USNM 678635-678636, (1932 Morrison) USNM 678637, (pre-1910) MCZ, and (1955 Parmalee) ISM 1407-1412; Naples (1912 Danglade) USNM 678596 and (1955 Parmalee) ISM 1112-1117; Valley City (1909 Freeland) USNM 677766; Florence (Freeland) USNM 678592; Montezuma (shell pile) USNM 678593; Pearl (1909 F & W) USNM 677770 and (1965 Parmalee) ISM 3312; 1 mile N of Hardin (1956 Parmalee) ISM 2203 (dead); Hardin (1907 F & W) USNM 676943; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678557; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678558; 2 miles above Grafton (1907 Bartsch stat. 111) USNM 678559; and Illinois River without locality (pre-1900) OSM 23993 (dead).

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 **(LB)**, 5.4-5.5 (RB), 10.3-10.5 (RB), 11.8-12.1 **(LB)**, 13.0 (RB), 13.2-13.5 **(LB)**, 14.9-15.1 (RB), 19.2-19.4 (RB), 20.6-20.8 **(LB)**, 21.7-22.0 (RB), 24.2-24.4 **(LB)**, 25.8-26.0 **(LB)**, 27.9 **(LB)**, 28.9-29.1 (RB), 30.5-30.8 (RB), 33.2-33.5 (RB), 35.9-36.1 **(LB)**, 36.1-36.3 (RB), 37.3-37.6 (RB), 39.1-39.3 (RB), 40.3-40.5 (RB), 40.5-40.7 **(LB)**, 42.2-42.3 **(LB)**, 42.3 (RB), 45.3-45.9 **(LB)**, 47.4-47.7 **(LB)**, 48.3 (RB), 51.0-51.3 (RB), 51.2 **(LB)**, 53.6 **(LB)**, 53.8 **(LB)**, 54.3 (RB), 54.4 (RB), 56.3 **(LB)**, 56.6 **(LB)**, 57.5-57.7 **(LB)**, 57.6 (RB), 58.0 (RB), 58.9 (RB), 60.8 (RB), 60.8 **(LB)**, 62.4 (RB), 62.6 (RB), 62.6 **(LB)**, 63.8 **(LB)**, 64.4 **(LB)**, 64.4 (RB), 66.0-66.6 **(LB)**, 66.9 (RB), 68.3 (RB), 68.3 **(LB)**, 68.6 (RB), 68.9 (RB), 68.9 **(LB)**, 69.0 (RB), 69.4 (RB), 72.0 **(LB)**, 72.9 (RB), 73.0 (RB), 73.7 (RB), 73.7 **(LB)**, 74.6 (RB), 75.8 (RB), 79.8 (RB), 79.8 **(LB)**, 86.4 **(LB)**, 86.6 **(LB)**, 86.8 **(LB)**, 87.3 (RB), 87.9 **(LB)**, 93.4-93.6 **(LB)**, 95.6 (RB), 95.8 **(LB)**, 96.8 (RB), 98.0 **(LB)**, 99.0-99.5 (RB), 100.0-

100.5 (LB), 106.0-106.9 (LB), 108.2-108.3 (RB), 108.8-109.0 (RB), 110.0 (RB), 110.0-110.2 (LB), 110.5 (LB), 112.1-112.5 (RB), 113.2-114.0 (LB), 115.3 (RB), 121.9-122.0 (LB), 122.2 Quiver Lake (LB), 122.8 Quiver Lake (LB), 129.8-130.4 (RB), 132.1 (RB), 135.0 (RB), 145.7 (RB), 148.5 (LB), 154.3-154.5 (RB), 155.9-156.4 (RB), 156.4-156.6 (LB), 159.4 (LB), 161.1-161.3 (LB), 161.2 (RB), 161.7-161.8 (LB), 162.3 (LB), 163.0 (LB), 164.4-165.1 (LB), 164.5-164.9 (RB), 165.2 (RB), 165.3 (LB), 166.3 (LB), 166.6 (LB), 167.2 (RB), 167.2 (LB), 167.5-167.7 (LB), 168.1-168.3 (LB), 168.1-168.5 (RB), 168.6 (LB), 169.3 (RB), 169.5 (LB), 170.8-171.8 (RB), 173.0 (RB), 174.1-174.9 (RB), 174.1 (LB), 184.5 (RB), 184.6 (RB), 184.8 (RB), 191.5 (LB), 196.1 (LB), 205.0 (RB), and 228.3 (RB). OSM 17711, 17720, 17742, 17747, 17749, 18126 (6), 18127 (5), 18128 (4), 18130 (4), 18131 (4), 18132 (3), 18133 (3), 18135 (3), 18136 (4), 18138 (4), 18139 (4), 18140 (4), 18141 (4), 18142 (4), 18143 (3), 18144 (3), 18145 (4), 18146 (2), 18147 (4), 18148 (2), 18149 (2), 18150 (2), 18151 (3), 18152 (3), 18153, 18154 (4), 18155 (4), 18156 (5), 18157 (5), and 18158; FMNH 156952 (5), 156954 (4), 156955 (3), 156958 (14), 156959 (26), 156972 (10), 156975 (3), and 156977 (7).

Old Shell Records (1966 Survey).—River mile 66.0-66.4, 75.8, 86.6-86.8, 94.3, 106.8, 145.7, 156.0, 184.5, 196.1, 196.3-198.1, 219.4, and 253.5-256.5. OSM 18218, 18252, 18269, 18278, 18291, 18328, 18358, 18430, 18442, 18453, and 18477.

**Maple-Leaf**

**Quadrula quadrula** (Rafinesque, 1820)
(Plate 1-6)

*Quadrula quadrula* Raf.:
Parmalee (1967:43; 1962:9)
Richardson (1928:457)
Morrison (pers. comm., 4 January 1968)
MCZ

*Quadrula asperrima* Lea:
Kelly (1899:401)
Forbes & Richardson (1913:533)

*Quadrula lachrymosa* Lea (= *quadrula* Say, *asperrimus* Lea):
Baker (1906:79)

*Quadrula lachrymosa* (Lea):
Danglade (1914:10)

*Quadrula fragosa* Conrad:
Baker (1906:79)

*Quadrula fragosa* (Con.):
Danglade (1914:9)

*Quadrula (Quadrula) quadrula quadrula* (Raf.):
FMNH

Baker (1906:79) and Danglade (1914:9 & 10) included both *Quadrula fragosa* and *Quadrula lachrymosa* as occurring in the Illinois River. Relative to the occurrence of *fragosa* in the Illinois River Danglade (1914:40) stated:

> "Rare; an example was found in Peoria Lake, but it does not agree exactly with *fragosa* as we found it in the Cumberland River, near Clarksville, Tenn."

At a later date Baker (1928:89) wrote:

> "*Fragosa* appears rare in Wisconsin and Illinois . . . . The nearest approach in Illinois is found among specimens from Spoon River."

A large series of maple-leafs collected in the 1966 survey was studied by Dr. Stansbery, and he identified them as *Quadrula quadrula.* However, he did mention (pers. comm., 26 September 1967) that the specimens had suggestions of the *fragosa* (Conrad) description but that they were not distinguishable from his museum specimens of *Q. quadrula* from the Ohio River proper (type locale). Specimens from the Illinois River examined by the author were likewise *Q. quadrula,* Including several museum specimens labeled *fragosa.* In this paper the author has treated the Illinois River *fragosa* records in the literature as being *Q. quadrula.*

In the 1966 survey the maple-leaf comprised 9.2 percent of the live mussels taken and ranked third in abundance (Tables 6 and 7). Because of its small size, this species was of little importance in satisfying the commercial demand in 1966. Of the 390 live specimens collected in the survey, 86.9 percent were 7-13 years of age (Table A-14) and 85.1 per-

cent ranged from 1.7 to 2.5 inches in height (Table A-15).

The maple-leaf was more abundant in collections made in the Alton pool than those made in the La Grange and Peoria pools (Table A-3). In the Alton pool at river mile 72.9 (RB) a standing crop of 303 pounds per acre (shell weight) of live maple-leafs was estimated. Live specimens of this species were taken between river miles 0.9 and 210.7 (Table A-3). In the upper part of the La Grange pool (river miles 140.5-156.6), considered by the author as poor mussel habitat because of pollution, a series of eight live maple-leafs was taken. However, in the Peoria pool no live maple-leaf was collected between river mile 167.7 (lower end of Middle Peoria Lake) and mile 210.7 (between Hennepin and Spring Valley). At mile 210.7 a single live maple-leaf was taken. In the entire upper part of the Peoria pool (river miles 174.9-229.3) only 38 live mussels of all species were collected in 1966. The paucity of mussels in this part of the river was thought by the author to have been caused by pollution. As mentioned earlier, no live mussel was taken above mile 229.3. The presence of maple-leafs in the upper part of the La Grange pool indicated that this species was somewhat tolerant of pollution, but the virtual absence of the species above river mile 167.7 tended to contradict this opinion. Possibly the host fish of the maple-leaf was either scarce or absent in the upper section of the Peoria pool; however, the author was unable to ascertain the host species of this mussel (Coker 1921:23; Baker 1928:86).

At the Field Museum of Natural History the author examined a maple-leaf taken from the river at Ottawa (Starved Rock pool). Richardson (1928:456-457) stated that in 1912 the maple-leaf occurred upstream as far as Spring Valley (river mile 218.5). In 1912 Danglade (1914:40) did not consider the maple-leaf common but mentioned that it occurred in small numbers in most of the mussel beds in the river. Since Danglade's study of the river many species of mussels have disappeared or decreased in abundance. As a result of these changes, in 1966 the maple-leaf was relatively one of the most abundant species present, particularly in the Alton pool. The maple-leaf was limited in its distribution in 1966 (with the exception of the single record upstream at river mile 210.7) from Middle Peoria Lake to Grafton, whereas formerly it ranged from Ottawa to Grafton.

Museum Records.—Ottawa FMNH 22686; La Salle (pre-1910) MCZ; Peru (pre-1910) MCZ; Lake Senachwine (1934) INHS; Peoria Narrows (1924) INHS H-4; Peoria (1912 Danglade) USNM 678597; Quiver Lake (1955 Parmalee) ISM 1016-1021; Havana (1894 Baker) UIMNH 22177, (1895 Hay) FMNH 14131, and (1912) INHS a-102; 2 miles N of Beardstown (1959 Parmalee) ISM 2866-2867; Beardstown (pre-1910) MCZ; Meredosia (1930 Morrison) USNM 678638-678639, (1932 Morrison) USNM 678640, (pre-1910) MCZ, and (1955 Parmalee) ISM 1394-1400; Naples (1955 Parmalee) ISM 1140-1144; and Pearl (1965 Parmalee) ISM 3305-3307.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB), 5.4-5.5 (RB), 10.3-10.5 (RB), 13.2-13.5 (LB), 14.9-15.1 (RB), 19.2-19.4 (RB), 24.2-24.4 (LB), 25.8-26.0 (LB), 27.9 (LB), 29.0 (RB), 30.5-30.8 (RB), 33.2-33.5 (RB), 37.3-37.6 (RB), 39.1-39.3 (RB), 39.2 (LB), 40.3-40.5 (RB), 42.2-42.3 (LB), 45.3 (LB), 45.4-45.9 (LB), 48.3 (RB), 51.0-51.3 (RB), 51.2 (LB), 53.8 (LB), 54.3-54.4 (RB), 56.3 (LB), 57.5-57.7 (LB), 57.6 (RB), 58.0 (RB), 58.9 (RB), 62.4 (RB), 62.6 (RB), 63.8 (LB), 64.4 (LB), 64.4 (RB), 66.0-66.4 (LB), 66.5 (LB), 66.6 (LB), 66.9 (RB), 68.3 (RB), 68.6 (RB), 68.9 (RB), 69.0 (RB), 72.9 (RB), 73.0 (RB), 73.7 (RB), 73.7 (LB), 74.6 (RB), 75.8 (RB), 79.8 (RB), 86.4 (LB), 86.6 (LB), 86.8 (LB), 87.9 (LB), 91.5 (RB), 93.4-93.6 (LB), 95.8 (LB), 98.0 (LB), 99.0-99.5 (RB), 100.0-100.5 (LB), 106.0-106.9 (LB), 110.0 (RB), 110.0-110.2 (LB), 110.5 (LB), 110.5 (RB), 113.2-114.0 (LB), 115.3 (RB), 118.4 (RB), 121.9-122.0 (LB), 122.2 Quiver Lake (LB), 122.8 Quiver

Lake (LB), 125.5 (RB), 129.8-130.4 (RB), 132.1 (RB), 135.0 (RB), 154.3-154.5 (RB), 155.7-156.0 (LB), 161.1-161.3 (LB), 161.7-161.8 (LB), 162.3 (LB), 166.3 (LB), 167.2 (RB), 167.2 (LB), 167.5-167.7 (LB), and 210.7 (RB). OSM 17354, 17355 (7), 17356 (11), 17357, 17358 (3), 17359, 17360, 17361 (7), 17362 (2), 17363 (4), 17364-17368, 17369, (6), 17370 (4), 17371 (3), 17372 (7), 17373 (6), 17374 (3), 17375, 17376 (3), 17377 (4), 17378 (5), 17379, 17380 (2), 17381 (4), 17382 (2), 17383 (2), 17384 (2), 17385 (11), 17386 (2), 17387 (2), 17388 (3), 17389 (16), 17390, 17391, 17392 (7), 17393 (3), 17394 (9), 17395 (5), 17396 (3), 17397 (4), 17398 (26), 17399 (21), 17400 (3), 17401 (5), 17402 (6), 17403, 17404 (8), 17405 (3), 17406 (5), 17407, 17408 (4), 17409, 17410, 17411 (4), 17412 (6), 17413 (2), 17414 (5), 17415 (19), and 17416 (7); FMNH 156950 (7), 156953 (14), 156956 (5), 156965 (5), and 156970 (10).

Old Shell Records (1966 Survey).-River mile 44.9, 66.0-66.4, 75.8, 83.0, 94.3, 106.8, Quiver Lake, 129.8, 156.0, 196.3-198.1. OSM 18195, 18264, 18280, 18292, 18302, and 18443.

### Pimple-Back (Warty-Back)
### Quadrula pustulosa (Lea, 1831)
### (Plate 1-5)

Quadrula pustulosa (Lea):
- Parmalee (1967:40; 1962:9)
- Forbes & Richardson (1913:531)
- Danglade (1914:9)
- Coker (1921:23)
- Richardson (1928:457)
- OSM

Unio pustulosus Lea:
- Calkins (1874:44)

Quadrula pustulosa Lea:
- Kelly (1899:401)
- MCZ

Quadrula pustulosa Lea (= dorfeuilliana Lea, schookraftensis Lea):
- Baker (1906:79-80)

Quadrula (Pustulosa) pustulosa pustulosa (Lea):
- FMNH

Quadrula bullata Raf., 1820:
- Morrison (pers. comm., 4 January 1968)

The pimple-back was the second most abundant mussel taken in the 1966 survey (Tables 6 and 7) and it constituted 10.0 percent of all live mussels collected (Table A-3). Even though this species ranked second in abundance, its distribution was limited in 1966. In the river proper live pimple-backs were taken only between river miles 0.9 and 113.7 (about 6 miles below Havana, Table A-3). Three live specimens were collected in Quiver Lake, just above Havana. In 1969 the author obtained from a commercial mussel fisherman a live specimen of this species taken just below Peoria Lake at river mile 162.3. Most of the pimple-backs were taken in the Alton pool where they made up 14.7 percent of the catch and ranked second in abundance. The highest estimated standing crop of live pimple-backs in the Alton pool was 127 pounds per acre (shell weight) at river mile 42.3 (LB). In the La Grange pool the pimple-back ranked seventh in abundance and constituted 2.2 percent of the catch.

Coker (1921:23) mentioned that the pimple-back seldom attained a length of more than 2.5 inches. This was true for this species in the Illinois River in 1966, since only 3.5 percent of the 426 live pimple-backs taken were over 2.5 inches in length. All of these specimens were less than 2.5 inches in height (Table A-16) and 90.8 percent of them were between 6 and 12 years of age (Table A-17). The Japanese market demanded pimple-backs of 2.5 inches or more in height. The pimple-backs noted in the sorted commercial piles along the river were nearly all below the desired commercial size. Therefore, this species from the Illinois River was of little or no value for the Japanese market.

Concerning the button industry, where size was of less importance than in the pearl-culture industry, Coker (1921:23) considered the pimple-back one of the best mussels occurring in the Illinois River. Danglade (1914:40) found in 1912 that:

> "The *pustulosa*, or warty-back, is a very common shell in the Illinois, certain very productive beds yielding a large per cent of the output."

He was referring to the use of the pimple-back in the button industry.

In the 1966 survey subfossil shells of the pimple-back were taken at various locations along the river including the

Marseilles pool. Calkins (1874:44) collected this species from the river in La Salle County (Starved Rock pool). In 1912 Forbes & Richardson (1913:531) found that owing to pollution at Spring Valley (river mile 218.5) all of the mussels they collected were dead except one pimple-back. Danglade (1914:37) listed the pimple-back as occurring in the river in 1912 at all of his stations between Henry and Grafton. In the 1924-1925 period Richardson (1928:457) collected the pimple-back in Lower Peoria Lake.

Formerly the pimple-back was distributed throughout much of the river proper, but in 1966 it was limited chiefly to the lower part of the river. The present limited distribution of the pimple-back was probably the result of pollution.

According to Baker (1928:92) the channel catfish, Ictalurus punctatus (Rafinesque), was the known host fish for the pimple-back. The author has collected channel catfish in all five navigation pools. However, it occurred much more abundantly in the Alton and La Grange pools than in the upper three pools. Apparently the potentiality has existed for distributing young pimple-backs by the channel catfish throughout the entire La Grange pool and the lower part of the Peoria pool, but the species has been unable to reestablish itself because of unsuitable environmental conditions in this part of the river, except in the lower part of the La Grange pool and in the vicinity of Peoria.

Museum Records.—Peru (pre-1910) MCZ; Utica (Baker) FMNH 68035; Peoria (1870's) BK; between Pekin and Havana USNM 677043; Quiver Lake (1955 Parmalee) ISM 1002-1007; Havana (1894 Baker) UIMNH 22182, (1895 Hay) FMNH 14129, (1912) INHS a-107, (pre-1917 Zetek) FMNH 67964; Meredosia (1930 Morrison) USNM 678641-678642, (1932 Morrison) USNM 678643, and (1955 Parmalee) ISM 1404-1405; Naples (1955 Parmalee) ISM 1130-1135; Pearl (1965 Parmalee) ISM 3308-3309; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678560; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678561; and Illinois River without locality (pre-1900) OSM 10092.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB), 10.5 (RB), 11.8-12.1 (LB), 13.0 (RB), 13.2-13.5 (LB), 14.9-15.1 (RB), 19.2-19.4 (RB), 20.6-20.8 (LB), 24.2-24.4 (LB), 29.0 (RB), 30.5-30.8 (RB), 33.2-33.5 (RB), 37.3-37.6 (RB), 39.1-39.3 (RB), 39.2 (LB), 40.3-40.5 (RB), 42.2-42.3 (LB), 45.3 (RB), 45.3 (LB), 45.4-45.9 (LB), 47.4-47.7 (LB), 48.3 (RB), 51.0-51.3 (RB), 51.2 (LB), 53.6 (LB), 53.8 (LB), 54.3 (RB), 54.4 (RB), 56.3 (LB), 57.5-57.7 (LB), 58.0 (RB), 58.9 (RB), 60.8 (RB), 62.4 (RB), 62.6 (RB), 62.6 (LB), 63.8 (LB), 64.4 (LB), 66.0-66.6 (LB), 66.9 (RB), 68.3 (RB), 68.6 (RB), 68.9 (LB), 69.0 (RB), 72.9 (RB), 73.0 (RB), 74.6 (RB), 75.8 (RB), 79.8 (RB), 79.8 (LB), 98.0 (LB), 106.0-106.9 (LB), 110.0 (RB), 113.7 (LB), and Quiver Lake. OSM 17345, 18129 (2), 18134, 18137 (3); FMNH 156970 (2), 156982 (7), 156983 (5), 157002 (13), and 157004 (5). (1969): 162.3 (LB). OSM 22276.

Old Shell Records (1966 Survey).—River mile 44.9, Meredosia Lake, 66.0-66.4, 75.8, 94.3, 106.8, Quiver Lake, 129.8, 145.7, 156.0, 196.1, 196.3-198.1, 219.4, and 253.5-256.5. OSM 18196, 18254, 18262, 18281, 18293, 18303, 18313, 18330, 18360, 18432, 18444, 18455, and 18478.

### Warty-Back
### Quadrula nodulata (Rafinesque, 1820)
### (Plate 2-7)

Quadrula nodulata (Raf.):
Parmalee (1967:39; 1962:9)
Quadrula nodulata Raf., 1820:
Morrison (pers. comm., 4 January 1968)
Unio pustulatus Lea:
Calkins (1874:44)
Quadrula pustulata Lea:
Kelly (1899:401)
Baker (1906:80)
Quadrula pustulata (Lea):
Danglade (1914:9)
Quadrula (Pustulosa) nodulata (Raf.):
FMNH

The warty-back ranked seventh in abundance (Tables 6 and 7) and accounted for 1.6 percent of the live mussels taken in the 1966 survey (Table A-3). Sixty-eight live warty-backs were collected between river miles 0.9 and

95.8 (below Browning). However, 92.6 percent of these specimens were taken in the Alton pool, and in that pool the species ranked fifth in abundance. The warty-backs collected in the survey ranged from 5 to 14 years in age (Table A-18). No specimen of this species taken in the 1966 Illinois River collections exceeded 2.0 inches in height, and the warty-back was therefore too small to have any value for the pearl-culture industry. According to Danglade (1914: 39), in 1912 the warty-back was usually classed with the pimple-back (Q. *pustulosa*) but was of lesser quality for use in the button industry.

Calkins (1874:44) reported collecting this species from the river in La Salle County (Starved Rock pool). Forbes & Richardson (1913) did not collect the warty-back in their 1912 survey between Morris and Chillicothe. However, in 1966 a subfossil shell of this species was taken from that section of the river at river mile 196.1 (Henry). Danglade (1914:39) stated that the warty-back was distributed generally throughout the river but occurred in very small numbers. However, in his 1912 survey (Danglade 1914:37) he did not record taking this species any farther upstream than Havana. In the period of 1896-1897, Kelly (1899:401) examined 20 warty-backs collected at Havana. The museum records of this species listed below were limited to specimens from the lower river. Likewise, the subfossil shells of the warty-back taken in 1966 were all confined to the lower river except for the one record at river mile 196.1. Apparently this species was not common in the Illinois River above Havana even before 1913, and it seems to have been eliminated from the middle and upper river by pollution before 1920.

Possible fish hosts for the warty-back listed by Baker (1928:96) were the white crappie; black crappie; largemouth bass, Micro pterus salmoides (Lacépède); and bluegill. All of these fish species occurred in the river.

Museum Records.—Havana (pre-1900 Strode) FMNH 50478, (1894 Baker) UIMNH 22178, and (1895 Hay) FMNH 14130; Meredosia (1930 Morrison) USNM 678644-678645, (1932 Morrison) USNM 678646, and (1955 Parmalee) ISM 1401-1403; Naples (1955 Parmalee) ISM 1136-1139; Pearl (1965 Parmalee) ISM 3304; and 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678562.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB), 11.8-12.1 (LB), 13.0 (RB), 21.7-22.0 (RB), 33.2-33.5 (RB), 37.3-37.6 (RB), 39.1-39.3 (RB), 40.5-40.7 (LB), 42.3 (LB), 45.3 (RB), 45.3 (LB), 45.4-45.9 (LB), 47.4-47.7 (LB), 54.3 (RB), 62.4 (RB), 64.4 (LB), 66.0-66.4 (LB), 66.5 (LB), 66.9 (RB), 73.0 (RB), 73.7 (LB), 74.6 (RB), 75.8 (RB), 86.6-86.8 (RB), 86.8 (LB), 95.8 (LB). OSM 17338, 17339 (2), 17340 (3), 17341, 17346 (14), 17348 (9), 17349, 17350, 17351 (3), 17352, and 17353; FMNH 156947 (4), 156948, and 156992 (2).

Old Shell Records (1966 Survey).—River mile 44.9, 75.8, 83.0, 86.6-86.8, and 196.1. OSM 18197, 18265, 18271, and 18433.

### Monkey-Face

Quadrula metanevra (Rafinesque, 1820)

Quadrula metanevra (Raf.):
Parmalee (1967:39; 1962:9)
Danglade (1914:10)

Unio metanevrus Raf.:
Calkins (1874:43)

Quadrula metanevra Raf.:
Kelly (1899:401)
Baker (1906:79)
MCZ

Quadrula metanevra wardii Lea:
Baker (1906:79)

Quadrula (Orthonymus) *metanevra* (Raf.):
FMNH

Danglade (1914:40) considered the monkey-face a rare species in the Illinois River. In his 1912 survey (1914:37) he took a few specimens at Peoria Lake, Bath, the old La Grange locks, Meredosia, Bedford, Pearl, and Grafton (possibly the Mississippi River). In 1874 Calkins (1874:43) reported that the monkey-face occurred abundantly in the upper river (Starved Rock pool). In the early 1930's Morrison (pers. comm., 27 November 1967) did not collect a live specimen of this species at Meredosia. Likewise, Parmalee (pers. comm., 21 November 1966) did not take a live monkey-face in his collections in the

lower river in the 1950's. However, he did collect subfossil shells of this species at Naples and Meredosia. No live specimen of this species was taken in our 1966 survey, but a few subfossil shells were found between river miles 94.3 and 219.4.

Baker (1928:99) stated that:

> "Metanevra is a species of both large and small rivers where it lives in the channel on a gravel bottom in deep water, where there is a good current . . . . Rare on a mud bottom."

The scarcity of the monkey-face in the middle and lower parts of the river, even before 1913, probably was related to the scarcity of gravel bottoms in that section of the river. The upper river, before dams were constructed and pollution became severe, may have provided a more suitable environment for this species than the middle and lower river.

The bluegill and the sauger, Stizostedion canadense (Smith), were reported by Baker (1928:99) as the host fishes for the monkey-face. The bluegill was a common fish in the lower three pools of the river, but the sauger was uncommon.

Museum Records. — Starved Rock (pre-1904 Conrad) FMNH 68124; La Salle (pre-1910) MCZ; and Havana INHS.

Live Mussel Records (1966 Survey). — None.

Old Shell Records (1966 Survey). — River mile 94.3, 145.7, 156.0, and 219.4. OSM 18279, 18331, 18361, and 18456.

Buckhorn (Pistol-Grip)

Tritogonia verrucosa (Rafinesque, 1820)

Tritogonia verrucosa (Barnes):
Parmalee (1967:43; 1962:9)

Unio tuberculatus Barnes:
Calkins (1874:45)

Tritogonia tuberculata Barnes:
Baker (1906:70)
Forbes & Richardson (1913:531)
Richardson (1928:458)
MCZ

Tritogonia tuberculata (Barnes):
Danglade (1914 : 10)

Tritogonia verrucosa Raf., 1820:
Morrison (pers. comm., 4 January 1968)
MCZ

Tritogonia verrucosa verrucosa (Raf.):
FMNH

In 1912 Danglade (1914:43) considered the buckhorn widely distributed but comparatively rare in the Illinois River. Calkins (1874:45) found in the early 1870's that this species occurred abundantly in the upper river (Starved Rock pool). Danglade (1914:37) reported taking the buckhorn at most of his stations on the river between Henry and Grafton. In 1912 Forbes & Richardson (1913:531-537) did not take the buckhorn in their collections at Hennepin but did collect it in the Illinois River opposite Lake Depue and in the river between Henry and Chillicothe. This species was not taken in Peoria Lake in the 1924-1925 period by Richardson (1928:457-458). In 1930 Morrison (pers. comm., 4 January 1968) collected live buckhorns from the river at Meredosia. Twenty-five years later Parmalee (pers. comm., 21 November 1966) also took live specimens of this species at Meredosia; however, he did not take a live buckhorn at any of his other collecting stations in the river in the 1950's. No live specimen of this species was collected from the river in the 1966 survey; however, two buckhorns were taken alive in 1969 by a commercial mussel fisherman from the river at Peoria just below Peoria Lake. This species possibly still occurs in the Alton pool, as indicated by Parmalee's 1955 record at Meredosia.

Apparently the buckhorn had disappeared from the river above Peoria before 1924 (Richardson 1928:457-458) as a result of pollution and is now rare in the lower part of the Peoria pool and possibly in the Alton pool. The museum and old shell records and literature citations presented here indicated that the buckhorn formerly occurred in all of the navigation pools of the river.

The host fish of the buckhorn is not known.

Museum Records.—Peru (pre-1910) MCZ; Peoria (1870's) BK and (1878) INHS; between Pekin and Havana (1907 Freeland & Williams) USNM 678598; Havana (1894 Baker) UIMNH 22176, (1895 Hay) FMNH 8342, and (1910 Zetek) FMNH 59188 and 68172; Grand Point (possibly Grand Island near Bath) (Freeland) USNM 678599;

Meredosia (pre-1910) MCZ, (1930 Morrison) USNM 678647-678648, and (1955 Parmalee) ISM 1419-1420; and Naples (1955 Parmalee) ISM 1094-1095 (dead).

Live Mussel Records (1966 Survey).—None. (1969): River mile 162.3 (LB). OSM 22275.

Old Shell Records (1966 Survey).—River mile 44.9, 106.8, 145.7, 156.0, 219.4, and 253.5-256.5. OSM 18198, 18294, 18332, 18362, 18457, and 18480.

### Purple Warty-Back
### Cyclonaias tuberculata (Rafinesque, 1820)

Cyclonaias tuberculata Raf.:
Parmalee (1967:27; 1962:9)
Unio verrucosus Barnes:
Calkins (1874:46)
Quadrula tuberculata Bar.:
Kelly (1899:401)
Quadrula granifera Lea:
Kelly (1899:401)
Baker (1906:82)
Quadrula tuberculata Raf. (= verrucosa Barnes):
Baker (1906:81-82)
Quadrula granifera (Lea):
Danglade (1914:9)
Quadrula tuberculata (Raf.):
Danglade (1914:9)
Cyclonaias tuberculata granifera (Lea):
Baker (1928:107)
Rotundaria tuberculata Raf., 1820:
Morrison (pers. comm., 4 January 1968)

Danglade (1914:38) listed two species of purple warty-backs (Q. granifera and Q. tuberculata) as occurring in the Illinois River in 1912. Regarding granifera he stated (Ibid.) that:

> "This is a rather rare shell in the Illinois, although a few examples were found in the upper half of the shell-producing portion of the river at Chillicothe, Peoria, Havana, and Bath. It is an inflated shell, heavy anteriorly, and reaches a good size, but on account of its dull purple nacre it is not now used for the manufacture of buttons."

Danglade (1914:38) considered tuberculata as rare in the river and commented that:

> "some examples of this mussel were found in the lower stretches of the river where the water is swifter, as below the Government locks at La Grange, at Diamond Island, and at Hardin. There appears to be a more or less gradual change from the inflated granifera of the upper stretches, where there is but little current and the bottom is composed largely of soft mud, to the much flatter tuberculata of the lower river where the bottom is harder and the current is stronger."

Baker (1928:103-109) recognized three ecological forms of Cyclonaias tuberculata: (i) compressa, a flat shell found in small streams; (ii) tuberculata, a wider and more elongated shell than compressa occurring in medium-sized rivers like the upper Ohio and the Illinois; and (iii) granifera, which was smaller and wider and had higher umbones and a more corpulent shell than tuberculata and which inhabited the large rivers, such as the Mississippi and the lower Illinois. Even though Baker (1928:109) mentioned that the form granifera occurred in the lower Illinois River, he (1928:108) stated that he had not seen this form from the river. Concerning this species in Indiana, Goodrich & van der Schalie (1944: 306) stated that:

> "In passing from the mid-portion of a large stream such as the Wabash into the region at and below Terre Haute one finds that this species has coarser pustules. Formerly the name granifera was applied to the large-river phase of C. tuberculata. It is now known that granifera is merely an ecological form."

This species was not taken alive in the 1966 survey of the Illinois River. Neither Morrison (pers. comm., 4 January 1968) in the 1930's nor Parmalee (pers. comm., 21 November 1966) in the 1950's took a live specimen of this species in their collections from the river. Parmalee (Ibid.) did find several old shells of this species at Naples in 1955. In the period of 1896-1897, Kelly (1899: 401) examined 18 specimens of Q. tuberculata and a specimen of Q. granifera collected near Havana. Calkins

(1874:46) reported that the purple warty-back occurred in the upper river (Starved Rock pool). This species was not taken in the upper and middle river collections made in 1912 by Forbes & Richardson (1913).

A specimen collected from the river at Havana in 1912 (INHS A-224) was identified by Stansbery (pers. comm., 20 July 1967) as the granifera (Lea, 1838) form of C. tuberculata. The few subfossil shells of this species taken in the 1966 survey between river miles 94.3 and 256.5 appeared to be less inflated than the aforementioned form *granifera* specimen. Morrison (pers. comm., 4 January 1968) referred to the U.S. National Museum specimens listed below from the river as Rotundaria tuberculata and made no mention of form. Likewise, Parmalee (pers. comm., 21 November 1966) listed the above mentioned dead shells he collected at Naples as Cyclonaias tuberculata.

Because of the limited number of specimens examined during this study, the author agrees with Stansbery (pers. comm., 31 July 1968) that the purple warty-back should be referred to simply *as* Cyclonaias tuberculata.

The host fish for the purple warty-back is not known.

Museum Records. — Near Chicago (Calkins) USNM 25998; Chillicothe (1907 Freeland & Williams) USNM 676963 and 677041; and Havana (1912) INHS A-224.

Live Mussel Records (1966 Survey).— None.

Old Shell Records (1966 Survey).— River mile 94.3, 219.4, 240.4, and 253.5-256.5. OSM 18283, 18458, 18467, and 18479.

Bullhead (Sheepnose)

Plethobasus cyphyus (Rafinesque, 1820)

Plethobasus cyphyus (Raf.):
Parmalee (1967:35; 1962:9)

Unio Aesopus Green:
Calkins (1874:41)

Pleurobema aesopus Green:
Baker (1906:77)

Pleurobema aesopus (Green):
Danglade (1914:10)

In the early 1870's Calkins (1874:41) found this species occurring abundantly in the Illinois River in La Salle County (Starved Rock pool). Baker (1906:77) reported that the bullhead mussel was collected at Havana. This species was not reported from the upper river in 1912 by Forbes & Richardson (1913). Danglade (1914:41) considered this species rare in the Illinois River in 1912, and he collected live specimens only at Bath and Meredosia. Regarding the bullhead, he stated: "It is brittle and not a good button shell; moreover, being so uncommon in the Illinois, it is disregarded altogether."

No live specimen of this species was taken in the 1966 survey. One subfossil shell was collected at river mile 94.3 (near Browning). Parmalee (pers. comm., 21 November 1966) found dead shells of this species in 1955 at Naples, but he took no live specimen of this species in his collections during the 1950's. Likewise, Morrison (pers. comm., 27 November 1967) did not take a live bullhead mussel in his river collections in the early 1930's.

Regarding the present status of this species in Illinois, Parmalee (1967:35) considered it to be restricted to the Mississippi and Wabash rivers where it was generally uncommon to rare.

Evidently by 1912 the bullhead was a rare species existing only in the lower part of the river. The museum records indicated that the species once occurred upstream as far as Morris (Marseilles pool). Because of these records and other evidence presented here, it appeared to the author that the bullhead formerly occurred throughout much of the river in limited numbers and in the upper river abundantly (Calkins 1874:41). Evidently pollution and the reduction in current caused by the dams eliminated this species from the river.

The host fish for this species was believed by Baker (1928:112) to have been the sauger.

Museum Records. — Near Chicago ("one very old example, perhaps 50 years old when collected" Calkins) USNM 84315; Morris (Shimek Coll.) USNM 515034; and Illinois River without locality (1870's) BK and ("including one example 40 years old" John Wolf, ex James Lewis) USNM 25987.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—River mile 94.3. OSM 18282.

Pleurobema cordatum Complex

Pleurobema cordatum (Raf.):
Parmalee (1967:35)
van der Schalie (pers. comm., 31 August 1967)
Unio coccineus Lea:
Calkins (1874:42)
Unis[o] solidus Lea:
Calkins (1874:45)
Unio obliquus Lam.:
Calkins (1874:44)
Quadrula obliqua Lamarck:
Baker (1906:80-81)
Quadrula coccinea Conrad (= catillus Conrad):
Baker (1906 : 81)
Quadrula solida Lea (= fulgidus Lea):
Baker (1906:81)
Quadrula pyramidata Lea:
Baker ( 1906 : 81 )
Quadrula pyramidata (Lea):
Danglade (1914:9)
Quadrula plena (Lea):
Danglade (1914:9)
Quadrula solida (Lea):
Danglade (1914:9)
Quadrula coccinea (Con.):
Danglade (1914 : 9 )
Quadrula obliqua (Lam.):
Danglade (1914:9)
Quadrula obliqua (Lamarck):
Coker (1921:25)
*Plewrobema* plenum:
Richardson (1928:458)
Pleurobema catillus var. solida:
Richardson (1928:458)
Pleurobema catillus var. coccinea:
Richardson (1928:458)
Pleurobema cordatum:
Richardson (1928:458)
Pleurobema coccineum solida (Lea):
Baker ( 1928 : 118)
Quadrula (Obliquata) catillus (Conrad):
FMNH
Quadrula (Obliquata) coccinea coccinea (Conrad):
FMNH
Quadrula (Obliquata) obliquata (Raf.):
FMNH
Pleurobema (cordatum) pyramidatum:
Parmalee (1962:9)
Pleurobema c. coccineum:
Parmalee (1962:9)

Danglade (1914:9 & 39) recognized five species of mussels of this complex occurring in the Illinois River in 1912, all of which he considered rare except Q. obliqua. About this species Danglade (1914:39) stated:

> "This shell, while not a common one in the Illinois, is found generally distributed throughout the river. It furnishes good button material, but is hardly equal in size or quality to the species in the Ohio River beds."

He (1914:37) did not record taking any species of this complex from the river above Peoria Lake.

No live specimen belonging to this complex was taken in the 1966 survey of the Illinois River. Likewise, neither Parmalee (pers. comm., 21 November 1966) in the 1950's nor Morrison (pers. comm., 27 November 1967) in the 1930's collected any living specimens of this complex from the river.

Calkins (1874:42, 44, & 45) reported that U. coccineus occurred abundantly in the Illinois River in La Salle County (Starved Rock pool). He also found U. obliquus in the river in association with U. solidus. Baker (1906:80-81) reported four species of this complex from the Illinois River. Coker (1921: 25) stated that Q. obliqua was found in the Illinois River. However, Baker (1928:137) did not find this species in the Hinkley and Daniels collections from the Illinois River. Pleurobema *coccineum* solida was reported by Baker (1928: 120) as occurring in the Illinois.

Van der Schalie (pers. comm., 31 August 1967) informed the author of two old records of Pleurobema cordatum (forma?) from the Illinois River in the collections of the University of Michigan Museum of Zoology. He wrote:

> "This species was studied by Ortmann and he clearly indicated that the forms all belong to the central P. cordatum complex. It would simplify matters if the name *Pleurobema cordatum* were used and then append the form names coccineum (small river form) and catil-

**COLOR PLATES**

**Live Mussels**

**Collected in the 1966 Survey**

**of the Illinois River**

## PLATE I

1. Floater, Anodonta grandis grandis Say
2. Floater, Anodonta grandis corpulenta Cooper
3. Three-Ridge, Amblema plicata (Say)
4. Washboard, Megalonaias gigantea (Barnes)
5. Pimple-Back, Quadrula pustulosa (Lea)
6. Maple-Leaf, Quadrula quadrula (Raf.)

## PLATE 2

7. Warty-Back, Quadrula nodulata (Raf.)
8. Paper Pond Shell, Anodonta imbecillis Say
9. Fragile Heel-Splitter, Proptera laevissima (Lea)
10. Pink Heel-Splitter, Proptera alata (Say)
11. Fragile Paper Shell, Leptodea fragilis (Raf.)
12. White Heel-Splitter, Lasmigona complanata (Barnes)

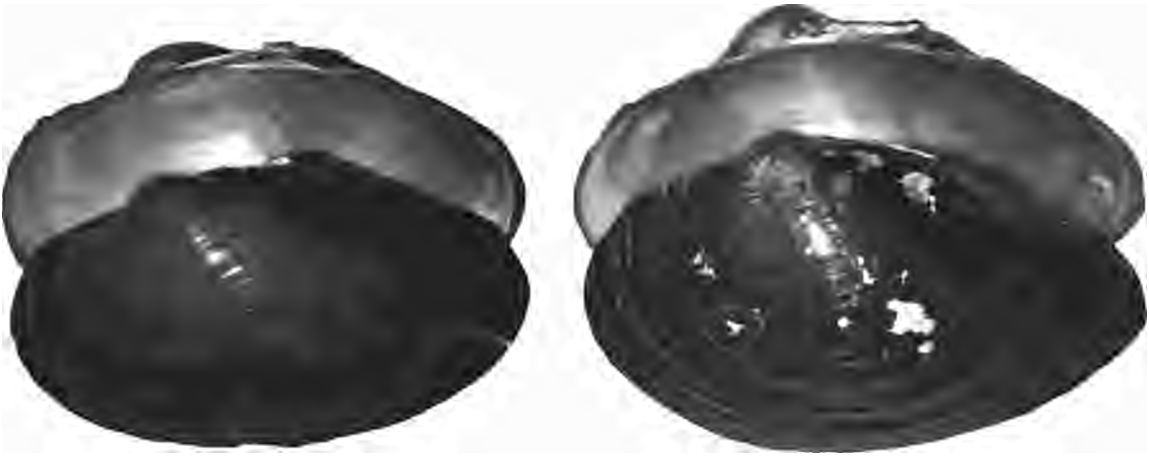
## PLATE 3

13. Rock Pocketbook, Arcidens confragosus (Say)
14. Pig-Toe, Fusconaia flava forma undata (Barnes)
15. Three-Horned Warty-Back, Obliquaria reflexa Raf.
16. Slough Sand-Shell, Lampsilis anodontoides forma fallaciosa (Smith)
17. Fat Mucket, Lampsilis radiata luteola (Lamarck)
18. Ebony Shell, Fusconaia ebena (Lea)

## PLATE 4

19. Heel-Splitter, Anodonta suborbiculata Say
20. Hickory-Nut, Obovaria olivaria (Raf.)
21. Deer-Toe, Truncilla truncata Raf.
22. Fawn's Foot, Truncilla donaciformis (Lea)
23. Liliput Shell, Carunculina parva (Barnes)

The color plates were printed before live specimens of the Buckhorn, Tritogonia verrucosa (Raf.), were collected from the Illinois River in 1969.



— Illinois River Mussels

7

8

9

10

11

12

**PLATE 2 — Illinois River Mussels**

14

18

19

20

21

22

23

PLATE 4 — Illinois River Mussels

*lus* or *pyramidatum* which really are the forms that occur in a large river like the Illinois. Most certainly there is no such species (following Ortmann) as *Pleurobema pyramidatum* that should be listed as a separate entity."

Relative to the P. *cordatum* complex in the Illinois River, Parmalee (pers. comm., 29 June 1967) stated:

"I encountered dead shells (and have some in the collections) commonly at Naples, 2 miles north of Meredosia and 3 miles S.E. of Banner. This was undoubtedly a common species in the Illinois River before pollution and silting. In my opinion and interpretation, *cordatum* is the species and *coccineum, catillus* and *pyramidatum* are all subspecies or variants."

The author examined several specimens belonging to this complex from the river at the Field Museum of Natural History. These specimens were catalogued as to subspecies, and their respective museum numbers were listed later under *Pleurobema cordatum* complex. After conversing with Dr. David H. Stansbery about this complex, the author had no confidence in his own identifications of these museum specimens.

Because of differences of opinion that existed among taxonomists concerning the nature of the P. *cordatum* complex, the author decided to use here only the scientific names applied to old shells of this complex collected in the 1966 surveys and to shell specimens from the river he submitted to Dr. Stansbery for identification. These specimens were deposited in The Ohio State Museum. Stansbery (1967) recently has done extensive work with this complex and has revised it into three described and one undescribed species. Stansbery (pers. comm., 31 July 1968) noted that he could not with clear conscience lump all the species of the P. *cordatum* complex under a single name, since he could demonstrate neither the existence of a cline nor the existence of intermediates connecting these species. This was in essential agreement with Baker (1928: 113-123). As a result of Dr. Stansbery's identifications, the author has accepted two species of this complex as once having occurred in the Illinois River: (i) *Pleurobema coccineum* forma *solida* (Lea, 1838) and (ii) *Pleurobema pyramidatum* (Lea, 1831). Museum specimens not checked by Dr. Stansbery have been listed below under P. *cordatum* complex.

Pleurobema coccineum forma solida (Lea, 1838)

Museum Records.—Havana (1894) OSM 19232; Meredosia (1913) OSM 19231; and Illinois River without locality (1870's) OSM 5018.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—River mile 44.9, 66.0, 196.3-198.1, and 219.4. OSM 18200, 18220, 18445, and 18459.

Pleurobema pyramidatum (Lea, 1831)

Museum Records.—Illinois River without locality (pre-1900) OSM 19230.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

Pleurobema cordatum Complex

Museum Records.—Starved Rock (Frierson Coll.) UMMZ 79705; Canton [?] (pre-1943 Webb Coll.) FMNH 22694; 3 miles SE of Banner (1953 Parmalee) ISM 819 (dead); Havana (1895 Hay) FMNH 6439; and Illinois River without locality FMNH 14313 and (James Lewis) UMMZ 79667.

Elephant's Ear

Elliptio crassidens (Lamarck, 1819)

*Elliptio crassidens* (Lamarck):
Parmalee (1967:29; 1962:9)
Richardson (1928:458)

*Unio crassidens* Lam.:
Calkins (1874:42)

*Unio crassidens* Lea:
Baker (1906:77)

*Unio crassidens* (Lea):
Danglade (1914:10)

Parmalee (1962:9) listed 11 specimens of this species from the Kingston Lake Site middens (1100-1400 AD) located

adjacent to the Illinois River 15 miles southwest of Peoria. It was presumed that these specimens had been taken by the Indians from the river. Calkins (1874:42) considered the elephant's ear an abundant species in the Illinois River in La Salle County (Starved Rock pool) . This species was reported from the river at Utica by Baker (1906:77) . Danglade (1914:37) collected this mussel from the Illinois River in 1912 at Chillicothe, Bath, Meredosia, Florence, Pearl, Kampsville, Diamond Island, Hardin, Twelve-Mile Island, and Grafton (possibly Mississippi River) . Relative to the elephant's ear in the Illinois, Danglade (1914:41) noted :

> "Rare; although found in most of the beds, the percentage is so small that it is practically a negligible quantity. The nacre varies from pink to white. This shell is used for making novelties."

The elephant's ear was not collected from the upper river in 1912 by Forbes & Richardson (1913) .

In the 1966 survey only two old shells of this species were collected and no live specimen was taken. Parmalee (pers. comm., 21 November 1966) collected dead shells of this species in 1955 at Naples. The elephant's ear was not taken from the river by Morrison (pers. comm., 27 November 1967) in the early 1930's.

Formerly this species occurred in much of the Illinois River; however, except in the upper river it apparently was never abundant. It probably disappeared from the river before 1930.

The host fish for the elephant's ear is not known.

Museum Records. — Havana (1894 Baker) UIMNH 22172; and Meredosia (1913) INHS.

Live Mussel Records ( 1966 Survey) – None.

Old Shell Records (1966 Survey ) River mile 129.8 and 156.0. OSM 18314 and 18363.

### Lady-Finger ( Spike )
### Elliptio dilatatus (Rafinesque, 1820)

*Elliptio dilatatus* (Raf.) :
Parmalee (1967 : 29 ; 1962:9)
Richardson (1928:457)
MCZ

*Unio gibbosus* Barnes:
Calkins (1874:42)
Kelly (1899:401)
Forbes & Richardson (1913 : 536 )

*Unio gibbosus* Barnes (= *arctior* Lea) :
Baker (1906:76-77)

*Unio gibbosus* (Barnes) :
Danglade (1914: 10)

*Elliptio (Eurynia) dilatatus dilatatus* (Raf.) :
FMNH

*Elliptio dilatatus* Raf., 1820:
Morrison (pers. comm., 4 January 1968)

Calkins (1874:42) collected this species from the river in La Salle County (Starved Rock pool) in the early 1870's. In the period of 1896-1897, Kelly (1899: 401) examined 25 specimens of lady-fingers collected in the Havana area. In 1912 Forbes & Richardson (1913:535 & 536) did not collect this species any farther upstream than Henry. Danglade (1914 :37) reported taking this mussel in 1912 at all of his principal collecting stations in the river between Henry and Grafton. However, by 1925 Richardson (1928:454-457) found that pollution had destroyed this species in the upper river above Lower Peoria Lake.

Concerning this species in the Illinois River Danglade (1914:41-42) wrote:

> "The lady-finger is not now a commercial shell unless it be white, which is seldom the case. It is found in large quantities along the river, some beds, which the clarnmers avoid as much as possible, having a very large percentage. Above the upper bridge at Peoria there are two small beds of this species; one bed consists mostly of white nacred shells, while in the other the nacre is the ordinary dull purple color. At Meredosia a driveway leading from the river to the bank above is covered with about 60 tons of these shells. They had been purchased at a low price in the hope that there would be a demand for them. Button cutters claim that even the white *gibbosus* do not make good blanks on account of the shell being brittle."

Morrison (pers. comm., 27 November 1967) did not collect this species at Meredosia in 1930, whereas 20 years

earlier it apparently was abundant in that area, as indicated by Danglade. In 1955 Parmalee (pers. comm., 21 November 1966) collected only dead shells of this species at Naples, Meredosia, and near Banner. No live specimen of this species was taken in the 1966 survey, but dead shells were collected at various points along the river.

The lady-finger formerly was an abundant mussel found throughout most of the river. The species probably was eliminated by pollution and siltation between 1925 and 1955.

The fish host of the lady-finger is not known.

Museum Records.—Spring Bay Narrows (1912 Danglade) USNM 678600; Peoria Narrows (1924) INHS 1-F; Peoria Lake (pre-1910) MCZ; Peoria (1870's) BK; Havana (1894 Baker) UIMNH 22174 and (1912) INHS A-33; Grand Island (1912 Danglade) USNM 678601; Naples (1955 Parmalee) ISM 1156-1157 (dead); 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678563 and (1907 Bartsch stat. 109) USNM 678564; and Illinois River without locality (pre-1943 Webb Coll.) FMNH 22017 and (pre-1910) MCZ.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—River mile 44.9, 66.0-66.4, 75.8, 94.3, 106.8, 129.8, 145.7, 156.0, 167.2, 184.5, 219.4, and 253.5-256.5. OSM 18199, 18221, 18255, 18284, 18295, 18315, 18333, 18364, 18378, 18384, 18460, and 18481.

### Pond-Horn

### Uniomerus tetralasmus (Say, 1830)

Uniomerus tetralasmus (Say):
Parmalee (1967:44)

Unio *tetralasmus* Say (= jamesianus Lea):
Baker (1906:77)

In the collection of the University of Illinois Museum of Natural History the author examined a specimen of this species collected at Havana by Baker in 1894. However, the label did not specify Illinois River. Baker (1906:77) did not mention this record from Havana but did state that this species had been collected from Phelps Lake, Fulton County. Relative to Phelps Lake, Kofoid (1903:414-415) noted:

> "This body of water lies on the western side of the river about a mile below the city of Havana, in the elevated bottom-lands below the mouth of Spoon River. . . . At river stages of 11 ft. and above, backwater from Spoon River makes its way through a now abandoned channel to the lake and thence out to the river through the slough."

The river Kofoid referred to was the Illinois River. Phelps Lake was drained and leveed off for agricultural purposes about 60 years ago. The author is of the opinion that the UIMNH specimen labeled Havana was the record referred to by Baker as from Phelps Lake.

No other record or specimen of this species from the river and its adjoining bottomland lakes was located by the author.

Museum Records.—Havana (1894 Baker) UIMNH 22147.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Lastena lata (Rafinesque, 1820)

Lastena lata (Rafinesque):
Parmalee (1967:87)

Lastena lata Rafinesque (= dehiscens Say):
Baker (1906:73)

Baker (1906:73) reported that Marsh collected this species from the Illinois River. This is the only report known to the author of this species having been found in this river. Goodrich & van der Schalie (1944:308) considered this a rare shell throughout its range. According to Stansbery (pers. comm., 31 July 1968):

> "A review of the literature and museum collections reveals this species as restricted to the Ohio River drainage system. It would not be expected from the Illinois River. It is apparently absent from all of its range except the Green River of the Kentucky and the Clinch River of the Southern Appalachians."

In the author's opinion the record by Baker should be considered doubtful.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

Subfamily ANODONTINAE (Rafinesque, 1820) Ortmann, 1910

Rock Pocketbook

Arcidens confragosus (Say, 1829)

(Plate 3-13)

Arcidens confragosus (Say):
Parmalee (1967:51; 1962:9)
Danglade (1914:10)
MCZ

Alasmodonta confragosa Say:
Kelly (1899:401)
Forbes & Richardson (1913:533)

Arcidens confragosus Say:
Baker (1906:74)
Morrison (pers. comm., 4 January 1968)

Arcidens con fragosa (Say):
FMNH

Seventy-five live specimens of this species were taken in the 1966 survey of the Illinois River (Table A-3). The rock pocketbook constituted 1.8 percent of the live mussels taken and ranked sixth in abundance (Tables 6 and 7). In the 1966 collections 77.3 percent of all live specimens of this species were taken in the Alton pool. Only one live specimen was collected in the Peoria pool. As indicated in Table A-3, the rock pocketbook was not taken in the Peoria-Pekin area nor upstream from Middle Peoria Lake, which indicated that it was not as tolerant of pollution as some other species. Subfossil shells were collected in 1966 as far upstream as river mile 219.4 (near Spring Valley). A few specimens of this mussel were observed in sorted commercial shell piles at Meredosia and Kampsville.

In the 1966 survey 26.6 percent of the rock pocketbooks taken alive were 2.5 inches or more in height and 77.3 percent were 7-11 years of age (Table A-19). This species was not abundant enough to be of commercial importance.

Calkins (1847:46) did not mention that he had collected this species (Margaritana con fragosa Say) in the river (Starved Rock pool). However, Baker (1906:74) reported that a specimen of Arcidens was collected at Utica, only a short distance downstream from Starved Rock. In 1912 Forbes & Richardson (1913:533) took this species upstream as far as Hennepin. According to Danglade (1914:37 & 42), the rock pocketbook was found on almost all of the mussel beds that he inspected between Henry and Grafton. He regarded this mussel as not particularly useful as a button shell.

Evidently this species formerly was found upstream as far as Utica and was limited by pollution in the 1920's to approximately its present distribution in the river.

The host fish for this mussel is not known.

Museum Records.—Peru (pre-1910) MCZ; between Peoria and Pekin (1908 Freeland & Williams) USNM 677291; Liverpool (pre-1900 Strode) FMNH 9243; Quiver Lake (1894 Baker) UIMNH 22161, (1899) INHS A-99, and (1955 Parmalee) ISM 1054-1066; Havana (Hay) FMNH 13938, (1910 Zetek) FMNH 68169, and (1912) INHS A-140; Frederick (pre-1943 Webb Coll.) FMNH 21646; Meredosia (1930 Morrison) USNM 678629-678630, (pre-1910) MCZ, and (1955 Parmalee) ISM 1392-1393; Naples (1955 Parmalee) ISM 1096-1098; Pearl (1907 F & W) FMNH 11253 and (1965 Parmalee) ISM 3300-3303; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678551; and 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678552.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB), 10.3-10.5 (RB), 14.9-15.1 (RB), 19.2-19.4 (RB), 24.2-24.4 (LB), 28.9-29.1 (RB), 39.1-39.3 (RB), 40.3-40.5 (RB), 42.2-42.3 (LB), 45.4-45.9 (LB), 48.3 (RB), 51.0-51.3 (RB), 51.2 (LB), 53.8 (LB), 54.3 (RB), 56.3 (LB), 57.5-57.7 (LB), 60.8 (RB), 64.4 (LB), 75.8 (RB), 86.4 (LB), 86.6 (LB), 86.8 (LB), 87.9 (LB), 106.7 (LB), 110.0 (RB), 110.5 (RB), 122.0 (LB), 129.8-130.4 (RB), 132.0 (LB), and 167.5-167.7 (LB). OSM 17700-17703, 17704 (2), 17710, 17716, 17717,

and 17719; FMNH 156985 (2), 156986 (2), 156988 (4), 157003 (4), and 157006 (9).

Old Shell Records (1966 Survey).—River mile 44.9, 75.8, Quiver Lake, 129.8, 156.0, and 219.4. OSM 18201, 18256, 18304, 18316, 18365, and 18461.

### Fluted Shell

Lasmigona costata (Rafinesque, 1820)

Lasmigona costata (Rafinesque):
Parmalee (1967:53)
Margaritana rugosa Barnes:
Calkins (1874:46)
Symphynota costata Rafinesque (= rugosa Barnes):
Baker (1906:74)
Symphynota costata (Raf.):
Danglade (1914:10)

According to Baker (1928:143) the fluted shell occurred in both large and small rivers and had a preference for gravel on riffles but also lived in sand and fine gravel in quiet waters. In the early 1870's the Illinois River in the vicinity of Starved Rock had a sandy bottom which supported a large mussel population (Calkins 1874:11). Calkins (1874:46) reported that the fluted shell occurred abundantly there (Starved Rock pool) in the early 1870's, and from the nearby Fox River (a tributary stream of the Illinois) he collected a specimen (USNM 58168) which was deposited at the U.S. National Museum (Morrison, pers. comm., 14 June 1968).

Baker (1906:74) reported that both Handwerk and Strode had collected this species from the river. The last reported record of the fluted shell from the Illinois known by the author was that of a single specimen taken at Bath by Danglade (1914:42) in 1912.

The author was unable to locate a museum specimen of this species from the Illinois. Van der Schalie (pers. comm., 31 August 1967) and Parmalee (pers. comm., 29 June 1967) were of the opinion that the fluted shell could have occurred in the Illinois River. Stansbery (pers. comm., 31 July 1968) informed the author that he would have expected this species to have occurred in the upper reaches of the Illinois before the river was impounded. Morrison (pers. comm., 4 January 1968) had this to say about the fluted shell:

> "Uncommon in the Wisconsin and Rock Rivers; if ever living in the main Illinois River, it must have been in the neighborhood of the Kankakee, before being polluted out."

In 1924 Morrison (Ibid.) collected a living specimen from the Kankakee River at Wilmington (USNM 678623) and a dead shell from the Des Plaines River at Des Plaines (USNM 678624) in 1932. The author examined a fluted shell taken by Hinkley (UIMNH 14801) from the Des Plaines River. The confluence of the Des Plaines and Kankakee rivers is only about 40 miles upstream from where Calkins (1874:46) found the fluted shell occurring abundantly in the early 1870's.

In the author's opinion the citations presented above indicate that the fluted shell formerly occurred in the Illinois River. Pollution probably eliminated this mussel from the upper river, possibly even before the completion of the Chicago Sanitary and Ship Canal in 1900.

The host fish for the fluted shell is not known.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Lasmigona compressa (Lea, 1829)

Lasmigona compressa (Lea):
Parmalee (1967:52)
Symphynota compressa Lea (= pressa Lea):
Baker (1906:74)

Baker (1906:74) reported that Handwerk collected this species in the Illinois River. This was the only record of this species from the Illinois known to the author, and he was unable to locate a museum record to substantiate it.

This species, according to Baker (1928:141), was found in creeks, in small streams, and far up into the headwaters of rivers. Morrison (pers. comm., 27

November 1967) and Stansbery (pers. comm., 31 July 1968) were of the opinion that compressa probably never had occurred in the Illinois River but rather in its tributary streams.

The author believed that Handwerk's specimen probably was collected either in or near the mouth of a tributary stream of the Illinois rather than from the river proper.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### White Heel-Splitter
### Lasmigona complanata (Barnes, 1823)
### (Plate 2-12)

Lasmigona complanata (Barnes):
Parmalee (1967:52)
Richardson (1928:457)
MCZ
Margaritana complanata Barnes:
Calkins (1874:46)
Alasmodonta *corn*planata Bar.:
Kelly (1899:401)
*Symphynota corn*planat*a* Barnes:
Baker (1906:75)
Forbes & Richardson (1913:529)
*Symphynota* complanata (Barnes):
Danglade (1914:10)

Calkins (1874:46) considered this mussel abundant in the Illinois River in La Salle County (Starved Rock pool). In the 1896-1897 period, Kelly (1899:401) examined 11 specimens from the Havana area. Danglade (1914:42) considered this mussel fairly common in the Illinois River. In 1912 Forbes & Richardson (1913:528-533) collected specimens upstream as far as Starved Rock, and they took 23 live white heel-splitters at Hennepin in that year.

Richardson (1928:456-457) found in the mid-1920's that the upstream range of this species in the Illinois River had been reduced considerably since 1912 as a result of pollution. He took no live specimen above the lower end of Upper Peoria Lake. This was approximately the location (river mile 168.5) where the last live specimen of this species was taken in the 1966 survey.

In 1966 only 13 live white heel-splitters were taken from the entire river (Table A-3). This species ranked 14th in abundance, based on the total number of live mussels taken (Tables 6 and 7), and it constituted 0.3 percent of the total catch (Table A-3). This species had no importance as a commercial shell from the Illinois River in 1966.

Morrison (pers. comm., 27 November 1967) did not collect this species at Meredosia in 1930. However, in 1957 Parmalee (pers. comm., 21 November 1966) took a live specimen at Liverpool (river mile 128.0) and in 1965 another at Pearl (river mile 43.0). In 1955 he did not find live specimens of this species at Naples or Mededosia (Alton pool).

Evidently, the upstream distribution of the white heel-splitter has been limited by pollution since the 1920's to about the lower end of Upper Peoria Lake. This mussel apparently was much more abundant before 1913 than it was in 1966.

The fish host of the white heel-splitter is not known.

Museum Records.—Peru (pre-1910) MCZ; Liverpool (1957 Parmalee) ISM 2255; Quiver Lake (1955 Parmalee) ISM 1039 (dead); Havana (1909) INHS and (1912) INHS a-208; Naples (1955 Parmalee) ISM 1118 (dead); and Pearl (1965 Parmalee) ISM 3299.

Live Mussel Records (1966 Survey).—River mile 14.9-15.1 (RB), 64.4 (LB), 68.6 (RB), 110.1 (LB), 122.0 (LB), 129.8-130.4 (RB), 145.7 (RB), 148.5 (LB), 161.1-161.3 (LB), 165.3-166.1 (RB), and 168.1-168.5 (RB). OSM 17724; FMNH 156961 and 156998.

Old Shell Records (1966 Survey).—River mile 129.8 and 156.0. OSM 18317 and 18366.

### Floater
### Anodonta grandis Complex

Anodonta grandis Say:
Parmalee (1967:47; pers. comm., 21 November 1966)
Forbes & Richardson (1913:533)

Anodonta ovata Lea:
(Calkins 1874:47)
Anodonta grandis Say (= salmonia Lea, ovata Lea) :
Baker (1906:72-73)
Anodonta grandis (Say) :
Danglade (1914 : 10)
Anodonta grandis var. gigantea:
Richardson (1928:457)
Anodonta (Pyganodon) grandis Say:
Morrison (pers. comm., 4 January 1968)
Anodonta (Anodonta) grandis grandis:
FMNH
Anodonta corpulenta Cooper:
Parmalee (1967:47; pers. comm, 21 November 1966)
Calkins (1874:47)
Strode (1891a: 133-134)
Kelly (1899:401)
Baker (1906:73)
Forbes & Richardson (1913:525)
Richardson (1928:457)
Anodonta corpulenta (Cooper) :
Danglade (1914:10)
Anodonta (Pyganodon) corpulenta Cooper:
Morrison (pers. comm., 4 January 1968)

One hundred twenty live specimens belonging to this complex were taken from the Illinois River in the 1966 survey. The author was unable to identify the species of many of the specimens in this collection. At the suggestion of Dr. David Stansbery the entire collection was submitted to him for study and identification. Dr. Stansbery's analysis of this material (pers. comm., 12 September 1967) follows:

> "The relationship of Anodonta grandis Say, 1829, to many of the other Anodonta 'species' of North America is unknown. Clarke (1966) has recently studied the Anodonta cataracta complex of central and eastern Canada and has concluded that all of the described forms of this complex in the east are reducible to one species having but two subspecies. The Anodonta grandis forms of central Canada, he concludes, are all reducible to a single species having but two subspecies (represented in Canada). The task now remains to deal with the relatively few forms of this complex presently recognized in the Mississippi River drainage of central North America. Once accomplished, this should set the stage for dealing with the east and west Gulf Coast (stream) faunas and the lower Atlantic Coast fauna of this complex.
>
> "Simpson (1914) placed most of the grandis-like forms described from the Mississippi River drainage into the synonymy of A. grandis. Most students of the naiads have been content to let them remain so. Only the Anodonta forms of the lakes and big rivers have persisted in the literature into the present as separate species and/or subspecies depending on the author. Baker (1928) was the last author to deal with the big-river Anodonta forms in any detail. He recognized Anodonta grandis Say, 1829, Anodonta gigantea Lea, 1834, and Anodonta corpulenta Cooper, 1834, as separate species. These are the only three forms of the complex with which we are concerned in identifying the Illinois River specimens.
>
> "Simpson (1914:420) concludes that gigantea Lea is a variety of A. grandis and Baker (1928:163) notes that 'Apparently the only sure way of separating grandis from gigantea is by an examination of the glochidia.' These observations supplemented by a careful examination of the material in the OSM collections lead me to conclude that gigantea is most probably the environmental form of A. grandis in large rivers. It is larger, more compressed, has a straighter ventral margin, (all relative intergrading characters) and larger glochidia. This latter character (size of glochidia) is the only distinct difference and its dis-

tinctness may well be due to lack of data from populations which are geographically intermediate.

"Although *Anodonta corpulenta* is also known from large rivers or their bayous (as is *A. g. gigantea),* until I examined the Illinois River specimens I saw no cause for confusing the two. Baker (1928:169) notes that *A. corpulenta* 'may be at once known from *grandis gigantea,* which it most nearly resembles, by its large corpulent shell, alate dorsal margin, on both sides of the urnbones, its swollen umbones, and its nodulous beak sculpture. It is a squarish shell, the height being almost equal to the length. The glochidia are also different, . . .' To these characters I would only add that the nacre is usually a copperypink and that the umbonal swelling is best described as mammae-form.

"The Illinois River material (120 specimens) of this complex here under study consists of 119 measurable specimens and one so badly damaged that its dimensions could not be taken. These specimens constitute 47 lots. The dimensions of length, width and height were taken from each specimen and the height index, width index, and transverse index were calculated for all specimens as well as for the types where possible (i.e., no width is given by Cooper (1855) for the type of *A. corpulenta).*

"In height index the type of *A. grandis* (HI = 67) is 5% greater than the type of *A. gigantea* (HI = 62) but only *5%* less than the type of *A. corpulenta.* In width index the type of *A. grandis* (WI = 44) is 1% greater than the type of *A. gigantea (WI* = 43) . Neither can be compared with the same proportion of the type of *A. corpulenta* since no width dimension or figure of the type was given by Cooper. One is led to believe from the descriptions that *A. corpulenta* is the widest or most corpulent of the complex. Cooper noted that his species is 'much inflated at the umbones, . . . .' Marsh (1887:36) says *A. corpulenta* is 'very much inflated . . . .' Simpson (1914:430) observes this species 'with excessively full and high beaks, the wide urnbonal swelling extending down on the disk . . . .' and Baker (1928: 169) comments on 'its large corpulent shell . . . .' in comparing it with *A. grandis* and *A. gigantea.*

"Marsh (1887:36) in his paper on the shells of Mercer County, Illinois, reveals a broader concept of *A. corpulenta* than most. He states at the close of his description of that species that 'Although *corpulenta* is generally very much inflated, specimens are *often* found that are *much* depressed.' (The underlining is mine.) Earlier Marsh (1887:21) wrote, 'Grandis is the type of a number of . . . very closely allied species, . . . . Typical forms of these species are easily separated when once well known, but intermediate forms are so extremely puzzling that no conchologist can separate them to a certainty.' My respect for Marsh has increased markedly since studying the material from the Illinois River!

"Having concluded that *A. gigantea is* most probably an environmental form of *A. grandis* we are left with the relationship between *A. grandis* (and its many forms) with *A. corpulenta.* The Illinois River specimens have a width index extending from a low of 35 to a high of 51 with a mean of 41.5. This mean is slightly less than the mean of the types of *A. grandis* and *A. gigantea.* Thus *A. corpulenta* appears corpulent not because the shell is wider than *A. grandis* or *A. gigantea* but because the shell is narrower both anterior and posterior to the central swelling. I therefore conclude that the

width index cannot be used to separate A. corpulenta from the others.

"An examination of all of our material of this complex leads me to conclude that A. corpulenta is characterized by:

1) having a peculiar expansion of the umbonal region usually extending to the very beaks, which can best be termed mammae-form.
2) a nacre which is copper-pink.
3) a greater height index than related forms.

"Two of these characters (1 and 3) seem to intergrade by imperceptible degrees with A. grandis which lacks the mammae-form umbones, is more elongate, and rarely (if ever—never in my experience) has a copper-pink nacre. This intergradation seems, at the present time to be limited to the Illinois River material. Material from the Mississippi River and the lower Tennessee River does not intergrade with A. grandis. We have very few specimens of A. corpulenta from the Tennessee River, however, and none which fit the description of A. grandis.

"The fact that A. corpulenta is not simply an environmental form of A. grandis has been dramatically demonstrated here in Ohio. Until 1966 there were no Ohio records for this species. A draw-down of Cowan Lake, an impoundment of Cowan Creek, revealed an extremely large population of A. corpulenta. This is especially noteworthy since Ohio has many such impoundments in which are found populations of A. grandis or no naiads at all. Although A. *imbecillis* is present in Cowan Lake, A. grandis seems to be completely absent. I believe this to be expected if there are no intrinsic reproductive barriers between the two forms. One would expect the few A. grandis specimens present in Cowan Creek to have either been eliminated by the new environment or absorbed by the A. corpulenta population. Introductions of bait fishes from the west and elsewhere have been and are being made in Cowan Lake allowing ample opportunity for the introduction of naiad species as encysted glochidia.

"It appears that, under certain conditions, A. corpulenta and A. grandis can and do live in the same habitat and may intergrade. The Illinois River seems to be just such a situation. Here we find A. corpulenta as the common form but accompanied by specimens which deviate in nacre color, height index, and umbonal swelling. Of the 119 specimens studied 101 were A. corpulenta in every respect. Fourteen of the 18 additional specimens exhibited mixed characters and are interpreted as intergrades. Only 4 specimens possessed all the characters of Anodonta grandis. In view of this evidence, I believe it best to treat corpulenta Cooper, 1834, as a subspecies of grandis Say, 1829.

Hence:

Anodonta grandis grandis Say, 1829.
—a subspecies of ponds, lakes, and all but the largest rivers.

Anodonta grandis corpulenta Cooper, 1834.
—a subspecies of the bayous and ponded parts of our largest rivers until recently. Now turning up in impoundments as it has access to this newly formed favorable habitat."

The author has accepted Dr. Stansbery's opinion that corpulenta should be treated here as a subspecies of grandis. Since the classification of this complex has been modified here, the author be-

lieved that it would be more accurate to list the synonymies of names used by other collectors of grandis and corpulenta from the Illinois River under the heading of Anodonta grandis complex rather than to attempt to allocate them to subspecies. The museum records from the Illinois River have been treated similarly. The old records of A. grandis from the river were more questionable, in the author's opinion, than those of A. *corpulenta*. Possibly some of the A. grandis specimens reported from the river were intergrades between grandis and corpulenta, as was the case with 14 of the specimens taken in the 1966 survey.

Calkins (1874:47) reported collecting A. ovata and A. corpulenta from the Illinois in La Salle County in the early 1870's (Starved Rock pool). At Ottawa in 1912 Forbes & Richardson (1913: 525 & 533) collected a specimen of A. corpulenta which "had quite recently succumbed, the flesh being not yet decayed." At Hennepin in that year they took 14 live specimens of A. corpulenta and 1 dead A. grandis. Richardson (1928 : 456–457) found that the distribution of A. corpulenta had been reduced, as a result of pollution, from as far upstream as Spring Valley in 1912 to no farther up than the lower end of Upper Peoria Lake in the 1924-1925 period. In that period he did not collect A. grandis var. gigantea from Peoria Lake. Strode (1891a :134) found A. corpulenta occurring abundantly in the shallow waters of Thompson Lake (now drained and leveed off from the Illinois River) near Havana. In the early 1930's Morrison (pers. comm., 4 January 1968) collected A. (P.) grandis and A. (P.) corpulenta at Meredosia.

Concerning floaters (Anodonta) in the Illinois, Danglade (1914:42) stated that:

> "They are thin, paperlike shells and have no commercial or economic value, excepting perhaps as they are used occasionally by the mussel fishermen for fish bait or hog feed"

Museum Records.—(Referred to as A. grandis) Between Peoria and Pekin (1908 Freeland & Williams) USNM 678589; between Pekin and Havana (1907 F & W) USNM 677058; Liverpool (1957 Parmalee) ISM 2256 and 2367-2369; Quiver Lake (1955 Parmalee) ISM 1022-1027; Lake Chautauqua (1952) FMNH 54890 and 54898; Thompson Lake (pre-1900 Strode) FMNH 67959; Havana (1894 Baker) UIMNH 22168; Meredosia (1932 Morrison) USNM 678627 and (1955 Parmalee) ISM 1371-1372; Naples (1955 Parmalee) ISM 1099-1102; and Illinois River without locality (1895 Hay) FMNH 6515, (pre-1900 Strode) FMNH 9252, (pre-1943 Webb Coll.) FMNH 21633, and (pre-1910) MCZ.

(Referred to as A. corpulenta) Thompson Lake (pre-1900 Strode) FMNH 9251 and 9256 and UIMNH 15038; backwater slough 1 mile W of Havana (1953 Parmalee) ISM 269; Havana (1912) INHS A-145; Meredosia (1930 Morrison) USNM 678628; and Illinois River without locality UIMNH 7366.

(Referred to as possible A. corpulenta) Quiver Lake (1955 Parmalee) ISM 1028.

### Anodonta grandis grandis Say, 1819
(Plate 1-1)

Only four live specimens of grandis were taken in the 1966 survey of the Illinois (Table A-3). All of these mussels were collected in the La Grange and Peoria pools between river miles 100.0 and 196.1, including one specimen from Quiver Lake. In the author's opinion this subspecies was never as abundant in the Illinois River and its bottomland lakes as *corpulenta*.

According to Parmalee (1967:100), the host fishes for A. grandis are the carp, Cyprinus car*pio* Linnaeus, yellow perch, bluegill, rock bass, and white crappie. All of these fishes are common in the Illinois River proper except the rock bass and yellow perch.

Museum Records.—Utica (pre-1900) OSM 9085; and Illinois River without locality (pre-1900) OSM 10403.

Live Mussel Records (1966 Survey).—River mile 100.0-100.5 (LB), Quiver Lake (LB), 167.2 (RB), and 196.1 (LB).

OSM 17430, 17435, 17447, and 17461.

Old Shell Records (1966 Survey).—None.

Anodonta grandis corpulenta Cooper, 1834
(Plate 1-2)

The *corpulenta* subspecies was distributed throughout the lower three navigation pools of the Illinois River in 1966 (Table A-3); 116 live specimens were taken. *Corpulenta* ranked fifth in abundance in the 1966 collections of live mussels from the entire river, and in the Peoria pool it ranked second in abundance (Tables 6 and 7).

The occurrence of *corpulenta* in the upper parts of the La Grange and Peoria pools indicated that it was one of the species more tolerant of pollution than other mussels. The reports and records on the A. *grandis* complex presented above indicated that *corpulenta* formerly occurred upstream at least as far as Ottawa and that by the 1920's its upstream distribution had been reduced considerably by pollution. The 1966 survey data indicated that this mussel now occurs farther upstream than it did in the 1920's, as reported by Richardson (1928:456-457).

Baker (1928:169) states that the skipjack is the host fish for *corpulenta*. The author is of the opinion that perhaps some other kind or kinds of fishes besides the skipjack serve as hosts for this mussel. This opinion is based on the fact that the skipjack is uncommon in the Illinois River, whereas *corpulenta* is common and widely distributed in the lower three navigation pools.

Museum Records.—Utica (pre-1900) OSM 9086; and Illinois River without locality (pre-1900) OSM 10397 and 23992 (dead).

Live Mussel Records (1966 Survey).—River mile 1.0 **(LB)**, 5.4-5.5 (RB), 13.0 (RB), 13.2-13.5 **(LB)**, 14.9-15.1 (RB), 29.0 (RB), 30.6 (RB), 53.6 **(LB)**, 66.0-66.4 **(LB)**, 68.6 (RB), 75.8 (RB), 86.8 **(LB)**, 106.7 **(LB)**, 110.0 (RB), 115.5 (RB), 122.0 **(LB)**, 129.8-130.4 (RB), 143.7 (RB), 145.7 (RB), 147.7 (RB), 148.5 **(LB)**, 155.9-156.4 (RB), 161.2 (RB), 161.7-161.8 **(LB)**, 162.3 (RB), 162.3 **(LB)**, 164.4-165.1 **(LB)**, 164.5-164.9 (RB), 166.6 **(LB)**, 167.5-167.7 **(LB)**, 168.1-168.5 (RB), 168.2 (RB), 169.3 (RB), 169.5 **(LB)**, 170.5-170.9 **(LB)**, 170.9 (RB), 174.1 **(LB)**, 174.9 **(LB)**, 191.5 **(LB)**, 196.1 **(LB)**, 198.1 (RB), and 229.3 **(LB)**. OSM 17417 (5), 17418 (7), 17419 (6), 17420-17425, 17426 (11), 17427, 17428 (2), 17429, 17431 (3), 17432-17434, 17436 (10), 17437, 17438 (4), 17439 (3), 17440-17442, 17443 (2), 17444, 17445, 17446 (2), 17448 (2), 17449 (9), 17450, 17451 (2), 17452 (4), 17453 (7), 17454 (2), 17455 (2), 17456, 17457 (4), 17458 (2), 17459 **(IA)**, 17460, 17461 (3), 17462, and 17463.

Old Shell Records (1966 Survey).—River mile Meredosia Lake, 66.0-66.4, 75.8, 86.6-86.8, Lake Matanzas, Quiver Lake, 129.8, 156.0, and 184.5. OSM 18263, 18274, 18367, and 18383.

Paper Pond Shell
Anodonta imbecillis Say, 1829
(Plate 2-8)

*Anodonta imbecillis* Say:
Parmalee (1967:48)
Calkins (1874:47)
Baker (1906:72)
Forbes & Richardson (1913:533)
Richardson (1928:457)
MCZ

*Anodonta imbecilis* Say:
Kelly (1899:401)

*Anodonta imbicillis* (Say):
Danglade (1914:10)

*Anodonta imbecillis* (Say):
Danglade (1914:43)

*Anodonta (Anodonta) imbecilis* Say:
Morrison (pers. comm., 4 January 1968)

Regarding the paper pond shell in the Illinois River, Danglade (1914:43) stated: "This small, delicate shell is very abundantly distributed, especially in the more retired places of quiet waters." However, he indicated (1914:37) that this shell was taken only at three of his principal stations (Peoria Lake, Havana, and Bath). Calkins (1874:47) reported

collecting this mussel in La Salle County (Starved Rock pool) in the early 1870's, but in 1912 Forbes & Richardson (1913: 533) found it occurring upstream only as far as Hennepin. By the mid-1920's Richardson (1928:457) found that its upstream range was limited to the lower end of Upper Peoria Lake as a result of pollution. Kelly (1899:401) examined 47 specimens of this mussel from the river at Havana in the 1896-1897 period, and in 1930 Morrison (pers. comm., 4 January 1968) collected it at Meredosia.

In the 1966 survey ony five live paper pond shells were collected at four different sites between river miles 30.6 and 198.1 (above Henry) (Table A-3). These specimens were collected by wading and with the dredge; they were 4-7 years of age. This species was apparently less abundant in the Illinois River in 1966 than it was before 1913; however, it had moved upstream since the mid-1920's.

The fish host for this mussel is *Lepomis* sp. (Parmalee 1967:100).

Museum Records.—Peru (pre-1910) MCZ; Depue Lake (1918 Baker) UIMNH 10982; Mossville (1924) INHS G-5-A; Peoria Lake (1931 Baker) UIMNH 31487 and 31531-31532; Quiver Lake (1955 Parmalee) ISM 1030 and 1038; and Merdeosia (1930 Morrison) USNM 678625-678626.

Live Mussel Records (1966 Survey).—River mile 30.6 (RB), 66.0-66.4 (LB), 129.8-130.4 (RB), and 198.1 (RB). OSM 17743 and 18021.

Old Shell Records (1966 Survey).—None.

### Heel-Splitter
### Anodonta suborbiculata Say, 1831
### (Plate 4-19)

*Anodonta suborbiculata* Say:
Parmalee (1967:48)
Strode (1891a: 133)
Baker (1906:72)
Richardson (1928:457)
*Anodonta suborbiculata* (Say):
Danglade (1914: 10)
*Anodonta (Utterbackiana) suborbiculata* (Say):
FMNH

In 1890 at Thompson Lake (now drained and leveed off from the river) near Havana, Strode (1891a: 133-134) noted:

> "In some places the bottom of the lake seemed to be literally paved with the suborbiculata. With a six-tined potato-digger I would sometimes bring up five or six at a haul; and if the fishermen happened to be making a draw with the great seine, a half barrel of them would sometimes be drawn out at once. . ."

Danglade (1914:37 & 43) collected the heel-splitter from the river at Peoria Lake, Havana, Bath, and Bedford. He mentioned that it was widely distributed in the Illinois and was generally found on mud bottoms in slack water. In the 1924-1925 period Richardson (1928: 457) reported taking this mussel in Middle Peoria Lake. In 1953 Parmalee (pers. comm., 21 November 1966) found the heel-splitter occurring commonly in a mud slough backwater area of the Illinois River near Havana.

In the 1966 survey *suborbiculata* was not taken from the river proper; however, one living specimen was collected from Lake Matanzas, a river bottomland lake located south of Havana.

The host fish for this mussel is not known.

Museum Records.—Mossville (1924) INHS E-5a; Thompson Lake (pre-1900 Strode) FMNH 2574, 9254, 50232, and 68176 and (Hinkley) UIMNH 4709; Havana (1894) INHS and (1894 Baker) UIMNH 22162; 1 mile W of Havana in a backwater slough of the Illinois River (1953 Parmalee) ISM 61-63, 89, and 260.

Live Mussel Records (1966 Survey).—Lake Matanzas (LB). OSM 17723.

Old Shell Records (1966 Survey).—None.

### Slipper-Shell
### Alasmidonta calceolus (Lea, 1829)

*Alasmidonta calceolus* (Lea):
Parmalee (1967:44)
Baker (1928:187)
*Margaritana deltoidea* Lea:
Calkins (1874:46)
*Alasmidonta viridis* Rafinesque, 1820:
Morrison (pers. comm., 14 June 1968)

This small-stream species was reported

by Calkins (1874:46) as occurring in the Illinois River. This report was corroborated by Dr. Morrison (pers. comm., 14 June 1968), who wrote that he had examined in the collections of the U.S. National Museum a specimen of *Alasmidonta* viridis Rafinesque collected from the Illinois River by Calkins. He mentioned that the specimen was labelled "*deltoidea*." Neither Baker (1906) nor Danglade (1914) reported the slipper-shell from the Illinois. However, at a later date Baker (1928:187) stated that this species did occur in the Illinois, but he made no mention of locality or collector. Apparently this species formerly occurred only in limited numbers in the upper river and was eliminated from the river about 1900 by pollution.

The host fish for the slipper-shell is not known.

Museum Records.—Illinois River without locality (1870's Calkins) USNM 26047.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Elk-Toe
Alasmidonta marginata Say, 1818

Alasmidonta marginata (Say):
Parmalee (1967:45; 1962:9)
Margaritana marginata Say:
Calkins (1874:46-47)
Alasmidonta marginata Say:
Baker (1906:75)
Morrison (pers. comm., 14 June 1968)
Alasmidonta (Decurambis) marginata (Say):
FMNH

According to Calkins (1874:46-47) the elk-toe occurred abundantly in the upper river in the early 1870's. Baker (1906:75) reported than Handwerk also had collected this species from the river. Parmalee (1962:7 & 9) found the elk-toe in the Kingston Lake Site middens along the Illinois River (15 miles SW of Peoria); however, he thought that the finding of this headwater or small-stream species was unusual, since all other mussel specimens at the site were large-river species. Dr. Morrison (pers. comm., 14 June 1968) mentioned that in the collections of the U.S. National Museum are specimens of this species taken before 1900 from the Illinois River at Morris and Peoria.

The author was unable to find any record of the elk-toe from the Illinois after the turn of the century. Apparently this species formerly occurred only in the upper and middle parts of the Illinois and was eliminated by pollution following the opening of the Chicago Sanitary and Ship Canal in 1900.

The host fish of the elk-toe is not known.

Museum Records.—Morris (pre-1900 Shimek Coll.) USNM 504536; Peoria (1875 Lewis) USNM 86177; and Illinois River without locality (pre-1943 Webb Coll.) FMNH 21703.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Squaw Foot
Strophitus undulatus (Say, 1817)

Strophitus rugosus (Swainson):
Parmalee (1967:56)
Baker (1928:201)
Strophitus edentulus Lea:
Kelly (1899:401)
Forbes & Richardson (1913:530 & 533)
Strophitus edentulus Say (= shafferiana Lea, wardiana Lea):
Baker (1906:71)
Strophitus edentulus (Say):
Danglade (1914:10)
Strophitus undulatus (Say):
Morrison (pers. comm., 4 January 1968)

Danglade (1914:43) reported that the squaw foot was: "Found rather scattering throughout the various stretches and mussel beds of the river." He (1914:37) collected this mussel at Peoria Lake, Pekin, Bath, Florence, and Hardin. In 1912 Forbes & Richardson (1913:530 & 533) collected a dead shell of this mussel in the La Salle-Peru area and a live specimen at Hennepin. Neither Morrison (pers. comm., 4 January 1968) in the early 1930's nor Parmalee (pers. comm., 29 June 1967) in the 1950's took the squaw foot in the Illinois River.

The squaw foot was not taken in the

1966 Illinois River survey; however, a live specimen (OSM 18183, identified by Dr. Stansbery as *Strophitus undulatus* Say, 1817)[1] was collected in 1966 from the Aux Sable River, a tributary stream of the Illinois.

This species was evidently never common in the Illinois River and it probably disappeared from the river before 1930.

According to Baker (1928:201), the glochidia of this mussel have experimentally gone through metamorphosis on the fins and skin of the largemouth bass and the creek chub, *Semotilus atromaculatus* (Mitchill). Both of these fishes occur in the Illinois River.

Museum Records.—Havana (Smith) UMMZ 74648 and (1894 Baker) UIMNH 22170; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678553; Illinois River without locality (1907 Freeland & Williams) USNM 678590 and INHS.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

Cylindrical Paper Shell

Anodontoides ferussacianus (Lea, 1834)

*Anodontoides ferussacianus* (Lea):
Parmalee (1967:51)
MCZ

*Anodontoides ferrussacianus* [sic]:
Forbes & Richardson (1913:533)

*Anodontoides ferrusacianus* [sic]:
Richardson (1928:457)

"This small, rather fragile, thin-shelled mussel is found mainly in the northern third of the state [Illinois], living in small, quiet streams, on a sand or fine gravel bottom in shallow water" (Parmalee 1967:51).

Forbes & Richardson (1913:533) reported collecting a live specimen of this species from the Illinois River at Hennepin in 1912. Two unmatched valves of this species taken from the river at Peru (pre-1910) were deposited in the Museum of Comparative Zoology. Dr. Stansbery (pers. comm., 20 January 1970) checked these shells for the author and found them to be typical *Anodontoides ferussacianus*.

This small-stream species was not collected in the 1966 survey of the river. The paucity of records for this species from the Illinois indicated that its occurrence there was probably accidental even before 1900.

The host fish of this mussel is not known.

Museum Records.—Peru (pre-1910) MCZ 70919.

Live Mussel Records (1966 Survey) None.

Old Shell Records (1966 Survey).—None.

Subfamily LAMPSILINAE
(von Ihering, 1901) Ortmann, 1910
Three-Horned Warty-Back
Obliquaria reflexa Rafinesque, 1820
(Plate 3-15)

*Obliquaria reflexa* Rafinesque:
Parmalee (1967:77)
Kelly (1899:401)
Forbes & Richardson (1913:536)
Richardson (1928:457)
Morrison (pers. comm., 4 January 1968)

*Unio cornutus* Barnes:
Calkins (1874:41)

*Obliquaria reflexa* Rafinesque (=*cornuta* Barnes):
Baker (1906:71)

*Obliquaria reflexa* (Raf.):
Danglade (1914:10)

According to Danglade (1914:43):

"This mussel is widely distributed and is usually of small size. There are two or three forms of *reflexa* found in the Illinois. In the upper stretches of the river it is of the ordinary shape and size found in other streams, and although it can be used for manufacturing purposes it is not a particularly valuable shell to propagate. In the Peoria Lake region, however, where the current

[1] Stansbery (pers. comm., 20 July 1967) stated: "The reason that *S. undulatus* (Say, 1817) has *S. rugosus* (Swainson, 1822) as a synonym is because: "(1). No one has ever been able to demonstrate that there are indeed two species (one eastern in New York, New England, etc., and one Miss. drainage) and "(2). *Strophitus undulatus* (Say) has five years' priority as the name of this species. Clarke and Berg (1959:43-44) recognized the conspecificity of *undulatus* Say and *rugosus* Swainson in their study of the naiads of upper New York."

is slow and the bottom is composed of soft mud, the shell is often very heavy and rounded anteriorly, while posteriorly it is thin and much elongated, which no doubt is the result of accommodation to natural conditions. In the lower stretches the shell, though heavy and inflated, is considerably smaller than those in the upper portions of the river."

In the early 1870's Calkins (1874:41) collected *O. reflexa* from the river in La Salle County (Starved Rock pool). Forbes & Richardson (1913:536) took this mussel as far upstream as the Henry-Chillicothe section in 1912. However, by the mid-1920's the range of this species extended upstream only to Middle Peoria Lake as a result of pollution (Richardson 1928:456 457). In 1912 Danglade (1914:37) collected the three-horned warty-back at Chillicothe, Peoria Lake, and at most of his other principal stations downstream.

In the 1966 survey the three-horned warty-back was taken alive from the river proper only in the Alton pool between river miles 0.9 and 75.8 (Table A-3). A single live specimen was taken by wading in the La Grange pool at Quiver Lake just above Havana. This species ranked seventh in abundance in the Alton pool and tenth in the entire river (Tables 6 and 7). The shell heights ranged from 0.9 to 1.6 inches; these shells were therefore too small to have any commercial importance in the pearl-culture industry. The 49 live three-horned warty-backs taken in the 1966 survey ranged from 4 to 15 years in age, but 87.8 percent of these mussels were 6-11 years old (Table A-20).

Since the early 1870's the range of the three-horned warty-back has been greatly reduced as a result of pollution, and this mussel now occurs only in the lower navigation pool of the river proper.

The fish host of the three-horned warty-back is not known.

Museum Records.—Peoria Narrows (1924) INHS 1-J; Peoria, above bridge (1912 Danglade) USNM 678604; Quiver Lake (1955 Parmalee) ISM 1050-1052; Havana (1894 Baker) UIMNH 22165-22166, (1895 Hay) FMNH 14892, and (1912) INHS a-138; Meredosia (1930 Morrison) USNM 678650 and (1955 Parmalee) ISM 1366-1370; Naples (1955 Parmalee) ISM 1124-1129; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678568; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678569; 2 miles above Grafton (1907 Bartsch stat. 111) USNM 678570; and Illinois River without locality FMNH 22863 and 22873.

Live Mussel Records (1966 Survey).—River mile 0.9-1.0 (LB), 5.5 (RB), 10.5 (RB), 14.9-15.1 (RB), 21.7-22.0 (RB), 29.0 (RB), 40.3-40.5 (RB), 42.3 (LB), 45.4-45.9 (LB), 51.2 (LB), 54.3 (RB), 54.4 (RB), 58.0 (RB), 62.6 (RB), 64.4 (LB), 69.0 (RB), 72.9 (RB), 75.8 (RB), 79.8 (RB), and Quiver Lake (LB). OSM 18017 and 18019; FMNH 156946, 156949, 156967, 156968, 156976 (2), 156990, and 156991 (4).

Old Shell Records (1966 Survey).—River mile 15.0, 44.9, 66.0-66.4, 75.8, 156.0, 196.1, and 219.4. OSM 18202, 18208, 18222, 18257, 18368, 18434, and 18462.

### Hickory-Nut
### *Obovaria olivaria* (Rafinesque, 1820)
### (Plate 4-20)

*Obovaria olivaria* (Rafinesque):
Parmalee (1967:78; 1962:9)
OSM
*Unio ellipsis* Lea:
Calkins (1874:42)
*Lampsilis ellipsis* Lea:
Kelly (1899:401)
*Obovaria* ellipsis Lea:
Baker (1906:69)
*Obovaria ellipsis* (Lea):
Danglade (1914:10)

One live specimen of the hickory-nut was taken in the 1966 survey with the exploratory crowfoot bar on a hard mud bottom in 11.3 feet of water at river mile 1.0. This specimen was 11 years of age and its shell height was 2.0 inches.

In the early 1870's Calkins (1874:42) reported that this species occurred abundantly in the Illinois River in La Salle County (Starved Rock pool). In the 1896-1897 period Kelly (1899:401) ex-

amined three specimens of this species taken from the river in the Havana area. Baker (1906:69) mentioned that Handwerk collected the hickory-nut in the Illinois. Danglade (1914:44) considered this species comparatively rare in the river in 1912. At that time he (1914:37 & 44) took a few hickory-nuts at Peoria Lake, Florence, Bedford, Pearl, Kampsville, Hardin, Twelve-Mile Island, and Grafton (possibly Mississippi River) .

This species was not taken by Morrison (pers. comm., 4 January 1968) at Meredosia in the early 1930's. He commented that:

> "in 1931 at Fairport, Iowa, in the Mississippi River, this species was almost completely replacing Sintoxia ant rosa [ebena] behind the wing dams on that river."

In the present study only one live specimen of each of these two species was taken from the Illinois River, and both of these records were from near the mouth of the river where it empties into the Mississippi River.

According to Parmalee (1967:78) the hickory-nut occurs: "usually on a sand or gravel bottom in good current." Siltation and pollution probably have been the factors which have virtually eliminated the hickory-nut from the river.

The host fish for the hickory-nut is not known.

Museum Records.—Starved Rock (pre-1900) OSM 10214; Peoria (1870's) BK; and Calhoun County (1928 Baker) UIMNH 27286.

Live Mussel Records (1966 Survey) .—River mile 1.0 (LB). OSM 18014.

Old Shell Records (1966 Survey).—None.

### Obovaria retusa (Lamarck, 1819)

Obovaria retusa (Lamarck) :
Parmalee (1967:94)

Unio retusus Lam.:
Calkins (1874:44)

Obovaria retusa Lamarck:
Baker (1906:69)

Calkins (1874:44) and Strode (Baker 1906 : 69) both supposedly collected this species from the Illinois River. However, the author was unable to locate any other records of this mussel's having been taken from the Illinois. Concerning this species in Illinois, Parmalee (1967:78) stated :

> "Obovaria retusa . . . formerly occurred in the lower Wabash and Ohio rivers, but it has apparently now disappeared from these rivers."

Because of the lack of substantial evidence of the occurrence of this species in the Illinois River, the author considered the above reports of retusa doubtful.

Museum Records.—None.

Live Mussel Records (1966 Survey) .—None.

Old Shell Records (1966 Survey).—None.

### Mucket
### Actinonaias ligamentina (Lamarck, 1819)

Actinonaias carinata (Barnes) :
Parmalee (1967:56; 1962:9)
MCZ

Actinonais [sic] carinata:
Richardson (1928:457)

Unio ligamentinus Lam.:
Calkins (1874:43)

Lam psilis ligamentinus Lam. :
Kelly (1899:401)

Lam psilis ligamentina:
Forbes & Richardson (1913:529)

Lam psilis ligamentina Lamarck (=crassa Say) :
Baker (1906:65)

Lampsilis ligamentina (Lam.):
Danglade (1914:10)

Actinonaias ligamentina Lamarck, 1819:
Morrison (pers. comm., 4 January 1968)
OSM

No live muckets were taken in the 1966 survey; however, old shells of this species were collected at various points along the entire Illinois River from river mile 44.9 to mile 256.5. In the early 1870's Calkins (1874:43) found this mussel occurring abundantly in the upper river (Starved Rock pool). In 1912 Forbes & Richardson (1913:529) took

living muckets as far upstream as the La Salle-Peru area. Richardson (1928: 456-457) reported that by the mid-1920's pollution had eliminated this species from the river, at least from Peoria up.

Before the turn of the century the mucket was common in the Havana area, as evidenced by Kelly's (1899:401) report of examining 24 specimens collected from that part of the river in the 1896-1897 period. In 1912 Danglade (1914:37) collected this species at all of his principal collecting stations between Henry and Grafton with the exception of Meredosia. He (1914:46) found the mucket occurring in small numbers throughout the river but more abundantly in Peoria Lake than elsewhere. Neither Morrison in the early 1930's (pers. comm., 4 January 1968) nor Parmalee in the 1950's (pers. comm., 21 November 1966) collected this species from the river.

Apparently pollution and siltation had eliminated this formerly widely distributed mussel in the Illinois River before 1930.

According to Baker (1928:220) the host fishes for the mucket are: green sunfish; bluegill; smallmouth bass, *Micropterus dolomieui* Lacépède; largemouth bass; yellow perch; white crappie; and white bass. All of these fishes still occur in the Illinois River.

Museum Records.—Peru (pre-1910) MCZ; Peoria (pre-1900) OSM 10232; between Pekin and Havana (pre-1910) MCZ; Havana (1894 Baker) UIMNH 22152 and (1912) INHS A-174; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678571 and (1907 Bartsch stat. 109) USNM 678572; and Illinois River stat. K, (1908 Freeland & Williams) USNM 678605.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey) River mile 44.9, 94.3, 106.8, 129.8, 145.7, 156.0, 196.3-198.1, 219.4, 240.4, and 253.5-256.5. OSM 18205, 18286, 18296, 18318, 18334, 18370, 18464, 18465, 18468, and 18482.

Butterfly

Plagiola lineolata (Rafinesque, 1820)

Plagiola lineolata (Rafinesque):
Parmalee (1967:80-81; 1962:9)
Richardson (1928:457)
MCZ

Plagiola securis Lea:
Kelly (1899:401)
Baker (1906:69)
Forbes & Richardson (1913:536)

Plagiola securis (Lea):
Danglade (1914:10)

Plagiolopsis lineolata (Raf.):
FMNH

Ellipsaria lineolata Rafinesque, 1820:
Morrison (pers. comm., 4 January 1968)

Concerning this species in the Illinois River, Danglade (1914:44) stated:

> "The butterfly, or securis, is not a common species in this river, although many of the beds could be made to yield productively by propagation. On account of its flatter shape and proportionally lighter weight, the male shell is more valuable for commercial purposes than the female."

Danglade (1914:37) reported that this species occurred at all of his principal collecting stations except Henry, Bedford, and Spar Island. In 1912 Forbes & Richardson (1913:536) collected the butterfly in the Henry-Chillicothe section of the river; however, in the mid-1920's this species was not taken in Peoria Lake by Richardson (1928:457). Kelly (1899:401) examined five specimens of this mussel collected in the Havana area.

The butterfly was not taken alive in the 1966 survey, nor was it taken by Morrison (pers. comm., 4 January 1968) in the early 1930's nor Parmalee in the 1950's. The literature citations, museum records, and old shell records included here indicated that the butterfly formerly occurred throughout much of the river, but this mussel probably had disappeared by the mid-1920's. Parmalee (1967:81) stated that:

> "Plagiola is apparently less tolerant

of silting and pollution than many species; it was once fairly common and widespread in the Illinois River, but has now completely disappeared as a result of these factors."

The fish host for the butterfly mussel is the freshwater drum, Aplodinotus grunniens Rafinesque, (Baker 1928:232) still a common fish in the Illinois River.

Museum Records. — Starved Rock FMNH 59280; La Salle (Baker) UIMNH 14073; Peru (pre-1910) MCZ; Peoria (1912) INHS; Fulton County (pre-1900 Strode) FMNH 9217; Havana (1912) INHS; Meredosia (1913) INHS and (pre-1910) MCZ; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678573; and Illinois River without locality (1879 Hinkley) UIMNH 4499 and (1870's) BK.

Live Mussel Records (1966 Survey).— None.

Old Shell Records (1966 Survey).— River mile 44.9, 156.0, and 219.4. OSM 18204, 18369, and 18463.

## Deer-Toe
## Truncilla truncata Rafinesque, 1820
(Plate 4-21)

*Truncilla* truncata Rafinesque:
Parmalee (1967:86)
Richardson (1928:457)
MCZ

Unio elegans Lea:
Calkins (1874:42)

*Plagiola* elegans Lea:
Kelly (1899:401)
Baker (1906:70)
Forbes & Richardson (1913:536)

Plagiola elegans (Lea):
Danglade (1914:10)

Truncilla vermiculata Rafinesque, 1820:
Morrison (pers. comm., 4 January 1968)

Truncilla truncata (Raf.):
FMNH

Danglade (1914:37 & 44) found the deer-toe in small quantities in 1912 at all but three of his principal stations between Henry and Grafton. In the early 1870's Calkins (1874:42) took this species in La Salle County (Starved Rock pool). Forbes & Richardson (1913:536) collected the deer-toe in 1912 upstream as far as the Henry-Chillicothe section. Richardson (1928:456-457) reported that by the mid-1920's pollution had eliminated this species from Peoria north. In the 1896-1897 period, Kelly (1899: 401) examined 25 deer-toes collected in the Havana area.

In the 1966 survey 10 live deer-toes were taken between river miles 1.0 and 106.7. All but two of these specimens were collected in the Alton pool (Table A-3). The deer-toe ranked 15th in abundance in the 1966 survey (Tables 6 and 7). The heights of the shells of this species ranged from 0.9 to 1.3 inches. Danglade (1914:44) reported that in 1912 he examined a deer-toe from the Illinois which had a shell length of 2.75 inches, whereas the largest shell of this species taken in 1966 had a length of only 2.2 inches, too small to be of commercial value. The deer-toes collected in the 1966 survey ranged from 5 to 9 years in age. Evidently pollution has eliminated the deer-toe from the river proper above river mile 106.7.

The fish host of the deer-toe is not known.

Museum Records. — La Salle (pre-1910) MCZ; Peru (pre-1910) MCZ; Peoria, above bridge (1912 Danglade) USNM 678606; Peoria (1913) USNM 678607; Quiver Lake (1955 Parmalee) ISM 1048; Havana (1894 Baker) UIMNH 22167, (1895 Hay) FMNH 6483, (1912) INHS a-122, and (1912) USNM 678608; Bath (1912) USNM 678609; Grand Island near Bath (1912 Danglade) USNM 678611; Meredosia (1912) USNM 678610, (1930 Morrison) USNM 678651, and (1955 Parmalee) ISM 1385-1386; Naples (1955 Parmalee) ISM 1145-1151; Diamond Island, Dark Chute (1912 Danglade) USNM 678487; Hardin (1912 Danglade) USNM 678612; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678574; and Illinois River without locality (1870's) BK.

Live Mussel Records (1966 Survey).— River mile 1.0 (LB), 64.4 (LB), 72.9 (RB), 75.8 (RB), 100.0-100.5 (LB),

and 106.7 (LB). OSM 18015 and 18020; FMNH 156969 (2).

Old Shell Records (1966 Survey).—River mile 15.0, 44.9, 66.0-66.4, 75.8, 94.3, and Quiver Lake. OSM 18203, 18209, 18223, 18285, and 18305.

### Fawn's Foot
Truncilla donaciformis (Lea, 1828)
(Plate 4-22)

Truncilla donaciformis (Lea) :
Parmalee (1967:85)
OSM
Unio zigzag Lea:
Calkins (1874:46)
Plagiola donaciformis Lea:
Kelly (1899 : 401)
Plagiola donaciformis Lea (=*zigzag* Lea) :
Baker (1906:70)
Plagiola donaciformis (Lea) :
Danglade (1914:10)
Truncilla (Amygdalonaias) donaciformis Lea:
Morrison (pers. comm., 4 January 1968)

Danglade (1914:43) considered this small mussel very common in the Illinois although he (1914:37) collected it at only about one-half of his principal stations between Henry and Grafton. The museum records indicate that this species once occurred in much of the river between Starved Rock and Grafton. This species was not collected from the Illinois River in 1912 between Morris and Chillicothe by Forbes & Richardson (1913). The farthest upstream the fawn's foot was taken by Danglade (1914:37) in 1912 was Peoria Lake.

In 1930 Morrison (pers. comm., 4 January 1968) took this species at Meredosia. Parmalee (pers. comm., 21 November 1966) in 1955 found the fawn's foot occurring commonly at Naples, Meredosia, and Quiver Lake. In the 1966 survey only one live specimen of this species was taken, and that was collected by wading at Naples. This species probably was too small to be taken with either the crowfoot bar or the dredge; however, if the species had occurred commonly in the river in 1966 it would have been taken regularly in the wading collections.

Evidently by 1912 pollution had eliminated this mussel from the river above Peoria Lake, and by 1966 it had been drastically affected in the lower river. It apparently occurs now only in small numbers in the Alton navigation pool of the river proper.

The freshwater drum is the usual host fish for the fawn's foot (Baker 1928: 230), and this fish still occurs in the river.

Museum Records.—Starved Rock (pre-1900) OSM 10250 and (pre-1923 Ferriss) FMNH 59226; Utica (pre-1923 Ferriss) FMNH 59246; La Salle (Hinkley) UIMNH 14994; Peoria, above bridge (1912 Danglade) USNM 678613; Quiver Lake (1955 Parmalee) ISM 1 04 0-1 04 7 ; Havana (1894 Baker) UIMNH 22169 and (1912) INHS a-167; Lake Matanzas UIMNH 4542; Meredosia Lake (1909) UIMNH 4523; Meredosia (1930 Morrison) USNM 678652-678653 and (1955 Parmalee) ISM 1387-1391; Naples (1955 Parma-,lee) ISM 1152-1155; 1 mile N of Hardin (1956 Parmalee) ISM 2206 (dead) ; and 2 miles above Grafton (1907 Bartsch stat. 111) USNM 678575.

Live Mussel Records (1966 Survey).—River mile 66.0-66.4 (LB). OSM 18018.

Old Shell Records (1966 Survey).—River mile 15.0 and Quiver Lake. OSM 18210 and 18306.

### Fragile Paper Shell
Leptodea fragilis (Rafinesque, 1820)
(Plate 2-11)

Leptodea fragilis (Rafinesque) :
Parmalee (1967:72)
MCZ
Unio gracilis Barnes:
Calkins (1874:42)
Lam psilis gracilis Bar.:
Kelly (1899:401)
Forbes & Richardson (1913:529)
Baker (1906:68)
Lam psilis gracilis (Barnes) :
Danglade (1914 : 10)
Lam psilis (Leptodea) fragilis (Raf.) :
FMNH

Leptodea fragilis Raf.:
Baker (1928:234)
Richardson (1928:457)
Morrison (pers. comm., 4 January 1968)

The fragile paper shell was widely distributed in the lower three navigation pools of the Illinois River in 1966, and 64 live specimens were taken between river miles 1.0 and 229.0 (Table A-3). It ranked eighth in abundance in 1966 (Tables 6 and 7). The shells ranged from 1 to 13 years of age. The 1-year-old shell was taken in the Alton pool and had a height of 0.3 inch. Shells of this species were too thin to be of any commercial value.

In the 1870's Calkins (1874:42) collected this mussel in La Salle County (Starved Rock pool). In the 1896-1897 period Kelly (1899:401) examined 40 specimens of this species collected in the Havana area. Danglade (1914:37) found the fragile paper shell occurring at all of his principal stations between Henry and Grafton except at Valley City, Bedford, and Six-Mile Island. Forbes & Richardson (1913:529) in 1912 collected this species upstream as far as the La Salle-Peru area. By the 1920's pollution had reduced this mussel's upstream range to Middle Peoria Lake (Richardson 1928:457). As indicated above, in 1966 live specimens of the fragile paper shell were taken at river mile 229.0 (above La Salle), farther upstream than it was taken in 1912 by Forbes & Richardson. The apparent reestablishment of this species upstream since 1912 and the mid-1920's indicated that it was capable of adapting to pollution more successfully than most of the mussels known to have occurred in the Illinois River and that pollution was less severe than it was in the 1920's. It was also one of the few mussel species able to survive the pollution in the Peoria-Pekin section of the river.

The host fish for the fragile paper shell is not known.

Museum Records.-Peru (pre-1910) MCZ; between Peoria and Pekin (1908 Freeland & Williams) USNM 678614; Pekin (1907 F & W) FMNH 11224; between Pekin and Havana (1907 F & W) USNM 677057 and (pre-1910) MCZ; Liverpool (1957 Parmalee) ISM 2257-2259; Clear Lake (1894 Baker) UIMNH 22156; Quiver Lake (1894 Baker) UIMNH 22157 and (1955 Parmalee) ISM 1031-1033; 1 mile W of Havana, backwater slough (1953 Parmalee) ISM 88; Havana (1895 Hay) FMNH 14909 and (1912) INHS A-92; Meredosia (1930 Morrison) USNM 678654 and (1955 Parmalee) ISM 1373-1379; Naples (1955 Parmalee) ISM 1103-1108; 1 mile N of Hardin (1956 Parmalee) ISM 2196-2199 (dead); 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678576; and Calhoun County (1928 Baker) UIMNH 27290.

Live Mussel Records (1966 Survey).-River mile 1.0 (LB), 5.5 (RB), 10.3-10.5 (RB), 13.2-13.5 (LB), 14.9-15.1 (RB), 28.9-29.1 (RB), 47.4-47.7 (LB), 53.6 (LB), 56.3 (LB), 58.0 (RB), 60.8 (RB), 62.4 (RB), 62.6 (LB), 64.4 (LB), 66.0-66.4 (LB), 66.5 (LB), 66.9 (RB), 69.0 (RB), 72.9 (RB), 75.8 (RB), 79.8 (RB), 93.6 (LB), 95.8 (LB), 96.8 (RB), 98.0 (LB), 99.0-99.5 (RB), 100.0-100.5 (LB), 106.7 (LB), 108.8-109.0 (RB), 110.1 (LB), 110.5 (RB), 113.2-114.0 (LB), 115.3 (RB), 115.5 (RB), 122.6-123.0 (LB), 145.7 (RB), 154.3-154.5 (RB), 159.4 (LB), 166.6 (LB), 167.5-167.7 (LB), 199.3 (RB), and 229.0 (RB). OSM 17708, 17712 (2), 17722, 17726, 17746, and 17750 (2); FMNH 156979 (5), 156981 (2), 156984 (4), and 156989 (4).

Old Shell Records (1966 Survey).-River mile 15.0, 129.8, 156.0, 184.5, and 196.3-198.1. OSM 18211, 18319, 18371, 18387, and 18446.

Leptodea leptodon (Rafinesque, 1820)
Leptodea leptodon (Rafinesque)
Parmalee (1967:92)
Lam psilis leptodon Rafinesque (=tenuiscima Lea):
Baker (1906:69)

Baker (1906:69) reported that Ferriss collected this species in the Illinois River. No other record of leptodon from the Illinois was located. Van der Schalie

(pers. comm., 31 August 1967) believed it doubtful that this mussel ever occurred in the Illinois. Parmalee (1967: 92) listed leptodon as a species of doubtful occurrence in Illinois, and he made no mention of its ever having lived in the Illinois River. According to Stansbery (pers. comm., 31 July 1968) :

> "Recent collection records show this species to exist in relic populations in Oklahoma, Arkansas, Missouri, and Kentucky. It may be extirpated from the rest of its former range. Despite its extensive former range, its former presence in the Illinois River (substantiated only by a single literature record unsupported by a museum specimen) is doubtful."

The author was of the opinion that the above record of le ptodon being taken from the Illinois River should be considered as doubtful.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey) .—None.

### Pink Heel-Splitter
### Proptera alata (Say, 1817)
### (Plate 2-10)

Pro ptera alata (Say) :
- Parmalee (1967:81; 1962:9)
- Richardson (1928:457)
- FMNH
- MCZ

Lam psilis alatus Say:
- Kelly (1899:401)

Lam psilis alata Say:
- Baker (1906:68)
- Forbes & Richardson (1913:529)

Lampsilis alata (Say) :
- Danglade (1914 : 10)

Potamilus alata megapterus Rafinesque, 1820:
- Morrison (pers. comm., 4 January 1968)

Potamilus alatus:
- OSM

The extreme upstream records from the Illinois River of this species known to the author were a single specimen taken in the La Salle-Peru section by Forbes & Richardson (1913:529-530) in 1912 and the pre-1910 MCZ collections. Danglade (1914:37 & 44) considered alata fairly common, and he reported taking it at most of his principal stations between Henry and Grafton. In the 1896-1897 period Kelly (1899:401) examined 38 specimens collected in the vicinity of Havana.

Richardson (1928:456-457) reported that by the mid-1920's pollution had eliminated the pink heel-splitter from the river above the Peoria Narrows.

Of this species, 16 live specimens were taken from the Illinois River in the 1966 survey between river miles 1.0 and 196.1 (at Henry) . The pink heel-splitter ranked 13th in abundance (Tables 6 and 7). The shell age determinations indicated that these specimens ranged from 9 to 17 years. This mussel had no value as a commercial shell in 1966. The presence of the pink heel-splitter in the Peoria-Pekin area indicated that this species was one of the more tolerant mussels to pollution; this mussel had extended its range upstream since the mid-1920's from the Peoria Narrows to Henry. However, it evidently was unable to tolerate existing pollution conditions upstream as far as the La Salle-Peru area where it had been taken in 1912 by Forbes & Richardson.

The decrease in the abundance of this species in the river since 1912 apparently was caused by pollution.

The host fish for the pink heel-splitter is not known.

Museum Records.—Peru (pre-1910) MCZ; Peoria Narrows (1925) INHS J-1; Havana (1895 Hay) FMNH 6500, (pre-1900 Strode) UIMNH 15175, and (1912 Danglade) USNM 678615; Meredosia (1955 Parmalee) ISM 1382-1384; Naples (1955 Parmalee) ISM 1119-1121; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678577 and (1907 Bartsch stat. 109) USNM 678578; Calhoun County (1928 Baker) UIMNH 27295; and Illinois River without locality (pre-1900) OSM 14593.

Live Mussel Records (1966 Survey).—River mile 1.0 (LB), 13.0 (RB), 13.2-13.5 (LB), 47.5 (LB), 53.8 (LB), 57.6 (RB), 60.8 (RB), 75.8 (RB), 154.4—

154.5 (RB), 159.7-160.0 (RB), 161.2 (RB), and 196.1 (LB). OSM 17694 and 17744; FMNH 156962-156964, 156978, 156995, and 156996.

Old Shell Records (1966 Survey).—River mile 15.0, 66.0-66.4, 75.8, Quiver Lake, and 184.5. OSM 18212, 18225, 18258, 18307, and 18385.

### Fat Pocketbook
### Proptera capax (Green, 1832)

Proptera capax (Green) :
Parmalee (1967:83)
Unio capax Green:
Calkins (1874:41)
Lam psilis capax (Green) :
Danglade (1914:10)
Potamilus capax:
OSM

Relative to the fat pocketbook, Danglade (1914:46) wrote:

> "This is a rare species in the Illinois, and was found more frequently below locks and dams where the water was swifter."

Danglade (1914:37) did not take this species in 1912 between Henry and Peoria Lake; however, he did collect it at eleven of his principal stations between Pekin and Grafton. Calkins (1874 :41–42) reported taking capax in La Salle County (Starved Rock pool) in the early 1870's. One museum specimen of this species from the river was examined by the author and another was checked by Dr. Stansbery (pers. comm., 22 December 1969).

This species probably disappeared from the upper river by 1900 and from the middle and lower river before 1920.

The fish host for this mussel is not known.

Museum Records.—Illinois River without locality INHS and (pre-1900) OSM 4474.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey) .—None.

### Fragile Heel-Splitter
### Proptera laevissima (Lea, 1829)
### (Plate 2-9)

Leptodea laevissima (Lea):
Parmalee (1967:74)
Richardson (1928:457)
Lampsilis laevissimus Lea:
Kelly (1899:401)
*Lampsilis* laevissima Lea (= ohioensis Say) :
Baker (1906:68)
Forbes & Richardson (1913: 525 & 533)
Proptera laevissima (Lea) :
FMNH
Lam psilis laevissima (Lea) :
Danglade (1914:10)
Potamilus ohiensis Rafinesque, 1820:
Morrison (pers. comm., 4 January 1968)

Baker (1906:68) reported that the fragile heel-splitter was collected from the river at Utica and at other locations downstream. Danglade (1914:37 & 44) considered this mussel fairly common in the Illinois River, and he reported taking it upstream as far as Peoria Lake in 1912. In that same year Forbes & Richardson (1913:525, 533, & 536) took this species at Ottawa (Starved Rock pool) near the mouth of the Fox River and in the Hennepin-Chillicothe section. By the mid-1920's pollution had eliminated the fragile heel-splitter north of the Narrows at Peoria (Richardson 1928:456–457) .

In the 1966 survey this mussel ranked 12th in abundance (Tables 6 and 7) ; 42 live fragile heel-splitters were taken between river miles 1.0 and 196.1 (Table A-3). These shells ranged from 2 to 13 years in age. The 2-year-old mussels (two specimens) were collected in the Alton pool, and the heights of these specimens. were 0.8 inch. The shell of this species was of no commercial value.

Since the fragile heel-splitter was taken in the Peoria-Pekin section, it apparently was one of the mussels more tolerant to pollution; however, it was not collected in the upper part of the Peoria pool. By 1966 the fragile heel-splitter had re-extended its upstream range from the Peoria Narrows (mid-1920's) to Henry (river mile 196.1), a distance of about 29.5 miles. Apparently this species was about as abundant in 1966 as it was before 1913.

The fish hosts known for this mussel are the freshwater drum and the white

crappie (Baker 1928:248). These fishes still occur in the Illinois River.

Museum Records.—Thompson Lake FMNH 23218; Quiver Lake (1955 Parmalee) ISM 1034-1035; Havana (1910 Baker) UIMNH 22159; 1 mile W of Havana, backwater slough of the Illinois River (1953 Parmalee) ISM 264-267; Meredosia (1930 Morrison) USNM 678655 and (1955 Parmalee) ISM 1380-1381; Naples (1955 Parmalee) ISM 1109-1111; 1 mile N of Hardin (1956 Parmalee) ISM 2200-2201 (dead); and 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678579.

Live Mussel Records (1966 Survey).—River mile 1.0 (LB), 13.0 (RB), 42.2-42.3 (LB), 47.5 (LB), 66.0-66.4 (LB), 75.8 (RB), 87.3 (RB), 110.1 (LB), 129.8-130.4 (RB), 145.7 (RB), 154.4-154.5 (RB), 161.2 (LB), 165.3-166.1 (RB), 166.3 (LB), 174.1 (LB), 174.9 (LB), and 196.1 (LB). OSM 17695, 17715, 17727, and 17740; FMNH 156951 (2), 156960 (2), 156974 (2), 156993 (4), and 156994 (2).

Old Shell Records (1966 Survey).—River mile 15.0, 66.0-66.4, 75.8, 83.0, 86.6-86.8, 145.7, 156.0, and 196.3-198.1. OSM 18213, 18224, 18267, 18272, 18335, 18372, and 18447.

## Liliput Shell
## Carunculina parva (Barnes, 1823)
## (Plate 4-23)

Carunculina parva (Barnes):
Parmalee (1967:59)
Richardson (1928:457)
MCZ
Unio parvus Bar.:
Strode (1891a:133)
Lam psilis parvus Bar.:
Kelly (1899:401)
Lam psilis par va Barnes:
Baker (1906:67-68)
Forbes & Richardson (1913:533)
Lam psilis parva (Barnes):
Danglade (1914:10)
Toxolasma parvum parvum (Barnes):
FMNH
Toxolasma parva Barnes:
Morrison (pers. comm., 4 January 1968)

Danglade (1914:45) regarded the liliput shell as a rare species in the Illinois River, and in his survey observed a single specimen taken from Peoria Lake. However, concerning the abundance of this species, Parmalee (1967:59) stated:

> "It has also been observed inhabiting the shallow, mud banks and backwater sloughs of the Illinois River in considerable numbers."

Kelly's (1899:401) data indicated that this shell occurred abundantly in the river in the Havana area in the 1896-1897 period. In 1890 Strode (1891a:133) collected the liliput shell in Thompson Lake (now drained and leveed off) near Havana. Forbes & Richardson (1913:533 & 536) took this species in 1912 at Hennepin and in the Henry-Chillicothe section. Dr. William Clench (pers. comm., 12 August 1969) advised the author that a specimen of this species taken from the river at Peru (pre-1910) was in the MCZ collections. By the mid-1920's pollution had restricted the upstream distribution of this species to no farther than Middle Peoria Lake (Richardson 1928:456-457).

In the early 1930's Morrison (pers. comm., 4 January 1968) collected this shell at Meredosia. However, in the 1950's Parmalee (pers. comm., 21 November 1966) did not collect a live liliput shell at Meredosia or at any of his other collecting sites in the river proper athough he did take live specimens of this mussel in 1953 from a backwater slough about 1 mile west of the river and Havana. In the 1966 survey a single live specimen of this species was taken by wading at river mile 1.0. Apparently by 1966 the liliput shell was confined to the extreme lower section of the river proper.

The host fish for this mussel is not known.

Museum Records.—Peru (pre-1910) MCZ; Peoria (1931 Morrison) USNM 678659 (dead); Quiver Lake (1955 Parmalee) ISM 1053 (dead); 1 mile W of Havana in backwater slough (1953 Parmalee) ISM 268; Beardstown (1870) FMNH 14337; Meredosia (Hinkley) UIMNH 4307, (1909 Baker) UIMNH 21361, (1930 Morrison) USNM 678656–678657, and (1932 Morrison) USNM

678658; 1 mile N of Hardin (1956 Parmalee) ISM 2207 (dead) ; and Illinois River without locality (1870's) BK.

Live Mussel Records (1966 Survey).—River mile 1.0 (LB). OSM 18016.

Old Shell Records (1966 Survey).—River mile 83.0 and Quiver Lake. OSM 18266 and 18308.

### Black Sand-Shell
### Ligumia recta (Lamarck, 1819)

*Ligumia* recta (Lamarck) :
Parmalee (1967:74; 1962:9)
*Unio rectus* Lam.:
Calkins (1874:44)
Lam *psilis rectus* Lam.:
Kelly (1899:401)
Lam *psilis* recta Lamarck:
Baker (1906:66)
Lam *psilis* recta (Lam.) :
Danglade (1914:10)
*Ligumia* recta *latissima* Rafinesque, 1820:
Morrison (pers. comm., 4 January 1968)
*Ligumia latissima* Raf.:
MCZ

In the early 1870's Calkins (1874:44) found the black sand-shell occurring abundantly in the upper Illinois River (Starved Rock pool), and he remarked that the shells here attained a length of 6-7 inches. In the 1896-1897 period Kelly (1899:401) examined 10 specimens of this species collected in the vicinity of Havana. Danglade (1914:37 & 45) considered this shell rather common in 1912; however, he did not take it north of Chillicothe. Forbes & Richardson (1913) and Richardson (1928) did not record this species from the upper and middle river between 1912 and 1925.

The black sand-shell was not taken alive from the Illinois River in the 1966 survey. Neither Morrison (pers. comm., 4 January 1968) in the early 1930's nor Parmalee (pers. comm., 21 November 1966) in the 1950's collected a live specimen of this species from the river.

The museum and old shell records indicated that the black sand-shell formerly was distributed throughout most of the Illinois River. Apparently by 1912 pollution had eliminated this shell above Chillicothe and by 1930 from the entire river.

The host fish for this mussel is not known.

Museum Records.—La Salle County (Baker) UIMNH 15134; Peoria (1870's) BK; Havana (1912) INHS a-78; Meredosia (1907 Freeland) USNM 676953 and (pre-1910) MCZ; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678580; Calhoun County (1928 Baker) UIMNH 27296; Illinois River stat. $K_2$ (1907 Freeland & Williams) USNM 676964; and Illinois River without locality (1870's) BK.

Live Mussel Records (1966 Survey) None.

Old Shell Records (1966 Survey).—River mile 75.8, 129.8, 145.7, 156.0, 240.4, and 253.5-256.5. OSM 18259, 18320, 18336, 18373, 18469, and 18483.

### Pond Mussel
### Ligumia subrostrata (Say, 1831)

*Ligumia subrostrata* (Say) :
Parmalee (1967:75)
Lam *psilis subrostrata* Say (= *mississippiensis* Conrad) :
Baker (1906:67)

Baker (1906:67) reported that Derr collected this shell at Peru in La Salle County; however, the name of the stream was not mentioned. Morrison (pers. comm., 27 November 1967) was of the opinion that this specimen undoubtedly was taken in a tributary stream rather than in the Illinois River.

In 1954 Parmalee (pers. comm., 21 November 1966) collected a pond mussel in a mud slough backwater 1 mile west of Havana and the Illinois River.

The author was of the opinion that these records of *subrostrata* should be considered as records from the Illinois River valley rather than from the Illinois River and its adjoining bottomland lakes.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

Rainbow-Shell
Villosa iris iris (Lea, 1829)

Villosa (= Micromya) iris (Lea) :
Parmalee (1967:75-76)
Unio iris Lea:
Calkins (1874 : 42)

Calkins (1874:42) reported that this species was not abundant in the Illinois River at La Salle County (Starved Rock pool) in the early 1870's. No museum specimen of the rainbow-shell was located from the Illinois River. Morrison (pers. comm., 14 June 1968) informed the author that the collections of the U.S. National Museum contained a specimen (USNM 58260) of this species taken by Calkins from the Vermilion River (a tributary stream of the Illinois) in La Salle County. It was apparent from this record that Calkins was quite familiar with the rainbow-shell, and no doubt he identified it properly as U. iris in his Illinois River collections.

According to Parmalee (1967:76), this species still occurs in the Kankakee, Fox, and Vermilion rivers, tributary streams of the upper Illinois River. The Fox and Vermilion rivers empty into the Illinois near the vicinity where Calkins made his collections.

Relative to the ecology of this species, Ligumia iris novieboraci (Lea), Baker (1928:262) stated that it is:

> "A mussel of small streams, living below riffles on a sandy or mud bottom. Also in riffles on a gravel bottom in less than a meter of water."

In the Starved Rock area where Calkins (1874:11) collected, the river was shallow and the bottom sandy. Evidently this habitat was suitable for the support of a small population of rainbow-shells when Calkins (1874:42) made his collections, and his record of its occurrence there, in the author's opinion, was authentic. Later this excellent mussel habitat was destroyed by pollution, siltation, and the Starved Rock dam.

The fish host for this mussel is not known.

Museum Records.—None.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

Yellow Sand-Shell
Lampsilis anodontoides
forma anodontoides (Lea, 1831)

Lam psilis anodontoides (Lea) :
Parmalee (1967:64)
Forbes & Richardson (1913:536)
Danglade (1914:10)
Richardson (1928:457)
Unio anodontoides Lea:
Calkins (1874:41)
Strode (1891a :133)
Lam psilis anodontoides Lea:
Kelly (1899:401)
Lam psilis anodontoides Lea (= teres Say) :
Baker (1906:66)
Lam psilis (Ligumia) teres teres (Raf.) :
FMNH
Lam psilis teres Rafinesque, 1820:
Morrison (pers. comm., 4 January 1968; 4 June 1968)

Before 1899 L. anodontoides f. anodontoides was not separated from L. anodontoides f. fallaciosa (Smith 1899) ; consequently, the early published records of the occurrence of the yellow sand-shell in the Illinois River by Calkins (1874: 41), Strode (1891a:133) , and Kelly (1899:401) may have referred to either or both forms of anodontoides. In the case of Calkins' record of anodontoides, Morrison (pers. comm., 4 June 1968) wrote:

> "In W. W. Calkins, Proc. Ottawa Acad. Sci., 1874, list of La Salle County, there is the listing of Unio anodontoides from the Illinois River. We have 5 specimens from W. W. Calkins (from the Stearns Collection) from the Illinois River, probably representing this record. These shells, catalogued February 2, 1886, as USNM 40773, were labeled anodontoides. Actually, only the three largest shells of this lot are teres (anodontoides) as we know it today. The two smaller ones are fallaciosa,

so Calkins' record from La Salle County also included fallaciosa from this stretch of the Illinois River. F. C. Baker's record of 'L. anodontoides' (Moll. Chicago Area, I, p. 100, 1898) corroborates the occurrence of fallaciosa farther upstream in the Illinois system and/or northward than teres. Baker's description, p. 100, of the beak sculpture and the figures of his shells, especially the smaller, lower figures, prove that he recorded only Lam psilis fallaciosa (which was named only a few months later) from the Des Plaines River and its tributaries only. In the 1906 Catalogue of Illinois Shells, Baker put this Cook County record under fallaciosa (p. 66) and listed teres only as La Salle County (Huett) and 'Northern Illinois' (Calkins). Since Baker did not have access to our USNM 40773 specimens, he did not know that Calkins had both teres and fallaciosa in the La Salle County, Illinois River collections, collected alive earlier and published in 1874. The fallaciosa of Calkins are now recatalogued as USNM 679106."

Concerning the yellow sand-shell in the Illinois River in 1912, Danglade (1914: 45) stated:

"This species is found sparingly throughout the upper river, but is fairly abundant in the Hardin district, where it is in sufficient quantity to be sorted out and sold separately at an advanced price. This shell is the most valuable of the freshwater mussels . . . . It prefers deep water and clean sandy bottoms."

Danglade (1914:37) did not collect this shell above Peoria Lake; however, Forbes & Richardson (1913:536) took it in 1912 in the Henry-Chillicothe section of the river. In the mid-1920's Richardson (1928:456-457) failed to collect the yellow sand-shell in his survey of Peoria Lake.

In 1930 Morrison (pers. comm., 4 January 1968) took this mussel alive at Meredosia. Parmalee (pers. comm., 21 November 1966) did not take it at Meredosia in 1955 but did collect a live specimen downstream at Naples.

No live yellow sand-shell was taken in the 1966 survey. Of the mussel species tested by Ellis (1936:39), the yellow sand-shell (L. teres) was the most readily killed by silt deposits. Evidently siltation and pollution adversely affected this mussel in the Illinois River.

The fish host for the yellow sand-shell is the longnose gar, Lepisosteus osseus (Linnaeus), and other possible fish hosts are the shortnose gar, Lepisosteus platostomus Rafinesque; alligator gar, Lepisosteus spatula Lacépède; green sunfish; orangespotted sunfish, Lepomis humilis (Girard); largemouth bass; white crappie; and black crappie (Baker 1928:267). All of these fishes, except the alligator gar, still occur in the Illinois River.

Museum Records.—La Salle County (1870's Calkins) USNM 40773; Havana (1895 Hay) FMNH 6392 and (pre-1900 Strode) FMNH 9123; Frederick (Wettengel) FMNH 68411; Meredosia (1912 Danglade) USNM 678616 and (1930 Morrison) USNM 678660; Naples (1955 Parmalee) ISM 928 (dead) and 1158; Buckhorn Landing (1912 Danglade) USNM 678617; and 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678581.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—River mile 167.2. OSM 18379.

### Slough Sand-Shell
### Lampsilis anodontoides forma fallaciosa (Smith, 1899)
### (Plate 3-16)

*Lampsilis* fallaciosa Rafinesque [sic]:
Parmalee (1967:65; 1962:9)

Unio anodontoides Lea:
Calkins (1874:41)

Lam psilis fallaciosa (Smith) Simpson:
Baker (1906:66)
Forbes & Richardson (1913:533)
Richardson (1928:457)

Lam psilis fallaciosa (Smith):
Danglade (1914:10)

Lampsilis fallaciosa Smith, 1898:
Morrison (pers. comm., 4 January 1968; 4 June 1968)

Lam psilis anodontoides Lea:
MCZ
Lam psilis (Ligumia) teres fallaciosa (Simpson):
FMNH

Danglade (1914:37 & 45) reported that the slough sand-shell occurred abundantly in the Illinois River in 1912 and that he collected it at all of his principal stations between Henry and Grafton. Concerning the ecology of this mussel in the river, Danglade (1914:45) stated that it is:

> "usually found standing on end burrowed in the mud of sloughs and bays or along the shore where there is but little current."

These habits of the slough sand-shell made it difficult for us to catch it with the crowfoot bar and dredge in the 1966 survey. In the survey 53 live specimens of this shell were collected (Table A-3) of which 66.0 percent were taken by wading. This shell ranked ninth in abundance; however, it probably occurred more abundantly than was reflected by our collections (Tables 6 and 7). The author believed that if more wading collections had been made in the survey this mussel probably would have ranked about sixth in abundance rather than ninth. The mean height of the slough sand-shell was 1.5 inches (range 1.0-2.0 inches), and the ages of the shells ranged from 3 to 12 years. The shell of this species was of no commercial value.

The Lam psilis anodontoides shells from the Illinois River in the Museum of Comparative Zoology were checked for the author by Dr. Stansbery (pers. comm., 20 January 1970) and he determined them to be form fallaciosa.

Calkins (1874:41) collected this shell in the early 1870's as discussed above under L. anodontoides f. anodontoides, in the river at La Salle County (Starved Rock pool). In the 1966 survey two live slough sand-shells were taken at about river mile 226.1 (at La Salle), only about 5 miles below Starved Rock where Calkins (1874:11) did much of his collecting in the river. The slough sand-shell was collected about 18.5 miles farther upstream in 1966 than it was in 1912 by Forbes & Richardson (1913:533). In the mid-1920's Richardson (1928:457) did not take this shell above the lower end of Upper Peoria Lake. Apparently the slough sand-shell was one of the more tolerant species of mussels to pollution in the Illinois.

The white crappie, shortnose gar, and the shovelnose sturgeon, Scaphirhynchus platorynchus (Rafinesque), are believed to be the host fishes for the slough sand-shell (Baker 1928:269). The shovelnose sturgeon is now extremely rare in the Illinois River.

Museum Records.—La Salle County (1870's Calkins) USNM 679106; Peru (pre-1910) MCZ 70918; Spring Valley, "Sandy River Drift" (1924 Morrison) USNM 678668 (dead); Mossville (1925) INHS C-5; Peoria Narrows (1924) INHS 1-B; Peoria, above bridge (1912 Danglade) USNM 678618; Peoria (1870's) BK, (1931 Morrison) USNM 678661 and 678663, and (pre-1910) MCZ 29925; between Pekin and Havana USNM 677042; Liverpool (1957 Parmalee) ISM 2370-2377; Quiver Lake (1955 Parmalee) ISM 9 9 6-1 0 01; Havana (1894 Baker) UIMNH 22151, (1909 Freeland) USNM 678619, (1912 Danglade) USNM 678620, and (1912) INHS a-22-S; Frederick (pre-1917 Zetek) FMNH 67968; 2 miles N of Beardstown (1959 Parmalee) ISM 2869-2870; Beardstown (1910) INHS F-92; Meredosia (1930 Morrison) USNM 678662, (1932 Morrison) USNM 678664, and (1955 Parmalee) ISM 1415-1418; Naples (1955 Parmalee) ISM 1159-1164; 1 mile N of Hardin (1956 Parmalee) ISM 2204-2205 (dead); 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678582 and (1907 Bartsch stat. 109) USNM 678583; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678584; and Illinois River without locality (1907 Freeland & Williams) FMNH 11231.

Live Mussel Records (1966 Survey).—River mile 1.0 (LB), 13.0 (RB), 47.5 (LB), 56.3 (LB), 57.6 (RB), 58.9 (RB), 66.0-66.4 (LB), 73.7 (RB), 75.8 (RB), 86.8 (LB), 87.3 (RB), 87.9 (LB), 95.8 (LB), 100.0-100.5 (LB), 129.8-130.4

(RB), 163.0 (LB), 164.5-165.3 (LB), 166.3 (LB), 167.7 (LB), 169.5 (LB), 174.1-174.9 (RB), 174.1 (LB), 174.9 (LB), 184.5 (RB), 196.1 (LB), 198.1 (RB), 224.0 (LB), and 225.8-226.1 (RB). OSM 17347 (3), 17696, 17718, 17721, 17734, 17741, 17745, and 17748; FMNH 156980 (2), 157001 (2), and 157007 (10).

Old Shell Records (1966 Survey).—River mile 15.0, 44.9, 66.0-66.4, 75.8, 83.0, 86.6-86.8, 106.8, Quiver Lake, 129.8, 145.7, 156.0, 184.5, 196.1, and 196.3-198.1. OSM 18206, 18214, 18260, 18268, 18273, 18297, 18309, 18337, 18374, 18386, and 18435.

### Fat Mucket
### Lampsilis radiata luteola
### (Lamarck, 1819)
### (Plate 3-17)

Lampsilis siliquoidea (Barnes):
Parmalee (1967:68; 1962:9)
Richardson (1928:457)
MCZ

Unio luteolus Lam.:
Calkins (1874:42-43)

Lampsilis luteolus Lam.:
Kelly (1899:401)

Lampsilis luteola Lamarck (=siliquoides Barnes, distans Anthony):
Baker (1906:65)

Lampsilis luteola (Lam.):
Danglade (1914:10)
Forbes & Richardson (1913:533)

Lampsilis luteola Lamarck, 1819:
Morrison (pers. comm., 4 January 1968)

Lampsilis (Ligumia) siliquoidea siliquoidea (Barnes):
FMNH

In the early 1870's Calkins (1874:42-43) found the fat mucket occurring abundantly in the Illinois River at La Salle County (Starved Rock pool). Kelly (1899:401) examined 11 specimens collected in the Havana area in the 1896-1897 period. Danglade (1914:46) considered the fat mucket widely distributed in the Illinois and found that it was more plentiful in Peoria Lake than elsewhere. In 1912 Danglade (1914:37) took this mucket at all of his principal stations between Henry and Beardstown but collected it only intermittently at his stations between Beardstown and Grafton.

In the 1966 survey of the Illinois River only eight live fat muckets were collected (Table A-3). Stansbery (pers. comm., 26 September 1967) referred to these specimens as Lampsilis radiata siliquoidea (Barnes, 1823) based on the intergrading of radiata and siliquoidea discovered by Clarke and Berg (1959: 58-62). Later, Stansbery (pers. comm., 14 August 1969) advised the author to refer to the Illinois River material as *Lampsilis* radiata luteola (Lam., 1819).

The fat mucket ranked 16th in abundance in the 1966 survey (Tables 6 and 7) and the ages of the specimens collected ranged from 11 to 20 years.

Live fat muckets were collected in 1966 between river miles 110.5 (below Havana) and 169.3 (Peoria Lake). Six of the eight fat muckets came from Peoria Lake, where in 1912 Danglade (1914:46) also found this mussel occurring in its greatest abundance. In 1912 Forbes & Richardson (1913:533) collected the fat mucket upstream as far as Hennepin. In the mid-1920's Richardson (1928:456-457) found that pollution had limited the upstream distribution of this mussel to the lower end of Upper Peoria Lake, only about 3 miles above its farthest upstream location in the 1966 survey. In the Alton pool, Morrison (pers. comm., 4 January 1968) collected this mussel at Meredosia in 1930, and in 1955 Parmalee (pers. comm., 21 November 1966) collected it at Meredosia and Naples. As indicated above, the fat mucket was not taken alive in the Alton pool in the 1966 survey; however, a single specimen of this mussel was observed in a culled commercial shell pile at Meredosia. The present scarcity and limited range of this once abundant mussel together with the lack of any young breeding stock portended its possible elimination from the Illinois River.

The bluegill, yellow perch, and walleye, S t izostedion vitreum vitreum (Mitchill), are the known natural host

fishes for the fat mucket (Baker 1928: 273), but the walleye is uncommon in the Illinois River.

Museum Records. — La Salle (pre-1910) MCZ; Peru (pre-1910) MCZ; Havana (1894 Baker) UIMNH 22145, (1895 Hay) FMNH 14074, (1910 Zetek) FMNH 59306 and 68163, and (1912 Danglade) USNM 678621; Meredosia (1930 Morrison) USNM 678665, (pre-1910) MCZ, and (1955 Parmalee) ISM 1413-1414; Naples (1955 Parmalee) ISM 1165-1169; and 1 mile below Hardin (1907 Bartsch stat. 109) USNM 678585.

Live Mussel Records (1966 Survey).— River mile 110.5 (RB), 122.2 Quiver Lake (LB), 166.6 (LB), 167.7 (LB), 168.2 (RB), and 169.3 (RB) OSM 17725, 17730 (2), 17733, and 17739; FMNH 156997. (1969): River mile 162.3 (LB). OSM 22277.

Old Shell Records (1966 Survey).— River mile 66.0-66.4, 75.8, 106.8, Quiver Lake, 145.7, 156.0, 167.2, 184.5, and 196.3-198.1. OSM 18158, 18226, 18261, 18298, 18338, 18375, 18380, and 18448.

Pocketbook

Lampsilis ventricosa (Barnes, 1823)

Lampsilis ventricosa (Barnes):
Parmalee (1967:70; 1962:9)
Forbes & Richardson (1913:525 & 533)
Richardson (1928:457)
Danglade (1914:10)
MCZ

Lampsilis ventricosus Bar.:
Kelly (1899:401)

Lampsilis ventricosa Barnes (= occidens Lea, subovata Lea):
Baker (1906:64)

Lampsilis (Lam psilis) cardium (Raf.):
FMNH

Lampsilis occidens:
Richardson (1928:457)

Lampsilis cardium Rafinesque, 1820:
Morrison (pers. comm., 4 January 1968)

No live pocketbook was taken in the 1966 survey of the Illinois River. Neither Morrison (pers. comm., 4 January 1968) in the early 1930's nor Parmalee (pers. comm., 21 November 1966) in the 1950's collected a live pocketbook from the Illinois.

Cvancara (1963:223) recognized the possibility that a cline may exist in the Lam psilis ovata complex; however, he mentioned that considerable study remained to be done on the anatomy and genetics of the three species involved in this complex. Morrison (pers. comm., 4 January 1968) referred to the Illinois River specimens of this mussel in the U. S. National Museum collections as L. cardium Rafinesque, 1820, and Stansbery (pers. comm., 13 January 1968) identified the two old shells collected in the 1966 survey as L. ovata forma ventricosa (Barnes, 1823). Since no special study was made of the limited number of Illinois River museum specimens available, the author decided to refer to them here merely as L. ventricosa, the usual reference to the northern form (Cvancara 1963:222).

This species was not taken in the upper river by Calkins (1874). In 1912 a live pocketbook was collected by Forbes & Richardson (1913:525) in the Illinois River at Ottawa near the mouth of the Fox River. In that same year they (1913:533) took two dead shells of this species at Hennepin. Danglade (1914:37) did not collect this species in the Henry-Chillicothe section of the river, but he did take it at most of his principal stations between Peoria Lake and Grafton. In the 1896-1897 period Kelly (1899:401) examined 10 specimens of this mussel from the Havana area.

In 1912 Danglade (1914:46) considered the pocketbook an uncommon mussel in the Illinois. By the mid-1920's this species had disappeared from Peoria Lake (Richardson 1928:457). According to Parmalee (1967:70): "The Pocketbook thrives on a sand or gravel bottom, in current at depths of less than one foot to over 10 feet." Siltation and pollution probably eliminated this mussel from the Illinois River between 1918 and 1930.

The natural host fishes for the pocket-

book are the white crappie and the sauger (Baker 1928:284).

Museum Records.—Peru (pre-1910) MCZ; between Pekin and Havana (1907 Freeland & Williams) USNM 677059; Havana (1894 Baker) UIMNH 22154; Meredosia (1907) USNM 676952; Florence (1909 Freeland) USNM 678622; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678586; 10 miles below Hardin (1907 Bartsch stat. 110) USNM 678587; and Illinois River without locality (1895 Hay) FMNH 14070, (pre-1943 Webb Coll.) FMNH 23307, and (1870's) BK.

Live Mussel Records (1966 Survey) .— None.

Old Shell Records (1966 Survey).— River mile 145.7 and 219.4. OSM 18339 and 18466.

### Lampsilis orbiculata Complex

Whether Lampsilis orbiculata and L. higginsi(i) are separate species remains an open question (Stansbery, pers. comm.. 26 September 1967; van der Schalie, pers. comm., 19 January 1968). Morrison (pers. comm., 27 November 1967) recognizes L. abruptus Say, 1831 ("orbiculatus auct, NON Hild.") and L. higginsi Lea, 1868 as two separate species. Stansbery (pers. comm., 26 September 1967) considers that:

> "Lampsilis orbiculata and *Lampsilis* higginsii are distinguishable but I have not enough specimens (nor have I seen enough material in other museums) to enable me to infer whether or not they are conspecific. This being the case, I carry them simply as forms of the same nominal species. I will not be surprised if they are found to be conspecific nor would I be surprised to find they are different species. I just don't know at present."

Since this is an unsettled problem needing further study, the author has followed Stansbery's and van der Schaile's opinions and has treated the Illinois River material as forms of Lampsilis orbiculata.

No live specimen belonging to this complex was taken in the 1966 survey of the river. As a result, the author has depended upon old shells taken in the 1966 survey, literature records, and museum records to establish the former occurrence of this complex in the Illinois River. Since the identification of the two forms, or species, involved here is quite difficult, the question is raised as to the validity of the Illinois River records of the two species or forms of this complex in the literature and of the identifications made years ago of museum specimens. The museum specimens of this complex from the Illinois River that have not been checked recently are listed as L. orbiculata complex. This list also includes the specimens examined by the author and one old shell taken in the 1966 survey and checked by Dr. Stansbery. Other Illinois River specimens belonging to this complex and deposited in various collections were checked by the following persons: Benjamin Koons' specimens, Illinois Natural History Survey specimens, and U. S. National Museum collections by Dr. Morrison; subfossil shells taken in the 1966 survey by Dr. Stansbery; and the Illinois State Museum collection by Dr. Parmalee. The author has used the identifications made by these taxonomists as the basis for his discussion of the two forms or species of this complex under the next headings of L. orbiculata forma orbiculata and L. orbiculata forma higginsii.

Museum Records. — (L. orbiculata complex) Starved Rock (Hinkley) UIMNH 4117; La Salle County (Daniels) UMMZ 86345; Havana (1894 Baker) UIMNH 22153 and (Smith) UMMZ 84351; and Illinois River without locality (1861 Hall) FMNH 14233.

Live Mussel Records (1966 Survey).— None.

Old Shell Records (1966 Survey).— River mile 253.5. OSM 18484.

### Lampsilis orbiculata forma orbiculata (Hildreth, 1820)

Lampsilis orbiculata (Hildreth) :
Pannalee (1967:67)
Danglade (1914:10)
Lampsilis orbiculata Hildreth:
Baker (1906:66)
Lampsilis abruptus Say, 1831:
Morrison (pers. comm., 4 January 1968)

According to Baker (1906:66) this form or species was collected from the

Illinois River by Strode. Concerning orbiculata, Danglade (1914:46) stated:

> "There are two examples in our collection, one from Chillicothe and the other from Peoria. The nacre of one is rather pinkish. This species is difficult to separate from higginsii, but is generally more southern in distribution."

Morrison (pers. comm., 4 January 1968) examined two specimens in the collections of the U. S. National Museum taken from the Illinois River 1 mile below Hardin in 1907. He identified them as L. abruptus and L. higginsi. This was of particular interest in that both of these species or forms had been found occurring together in the river. Morrison (pers. comm., 27 November 1967) commented that: "The geographic range of abruptus overlaps that of higginsi in the region of the Ohio-Mississippi confluence."

The only record recognized by the author of the occurrence of L. orbiculata f. orbiculata (abruptus) in the Illinois was the one mentioned above from the lower river furnished by Dr. Morrison. It appeared to the author that this form or species was never common in the Illinois and occurred only in the lower part of the river. The literature citations given above for the occurrence of L. orbiculata f. orbiculata may refer to either or both of the forms or species of the L. orbiculata complex. This mussel had probably disappeared from the Illinois River before 1930.

The fish host of L. orbiculata f. *orbiculata* is not known.

Museum Records.-1 mile below Hardin (1907 Bartsch stat. 108) USNM 678666.

Live Mussel Records (1966 Survey).—None.

Old Shell Records (1966 Survey).—None.

### Higgin's Eye
### Lampsilis orbiculata
### forma higginsii (Lea, 1857)

Lampsilis higginsii (Lea):
- Parmalee (1967:67)
- Danglade (1914:10)
- Baker (1928:294)

Unio orbiculatus Hildreth:
- Calkins (1874:44)

Lampsilis higginsii Lea:
- Kelly (1899:401)
- Baker (1906:66)

Lampsilis higginsii var. grandis Simpson, 1914:
- Simpson (1914:79)

Lampsilis higginsi Lea, 1868:
- Morrison (pers. comm., 4 January 1968)

Calkins (1874:44) found U. *orbiculatus* occurring abundantly in the Illinois River at La Salle County (Starved Rock pool) in the early 1870's. Morrison (pers. comm., 4 January 1968) identified a specimen collected by Calkins from the river as L. higginsi. This record and Simpson's (1914:79) report of finding L. higginsii var. grandis occurring fairly abundantly in the river near Utica—in the vicinity where Calkins (1874:11) collected U. orbiculatus—led the author to believe that Calkins took L. orbiculata f. higginsii rather than L. orbiculata f. orbiculata from the river in La Salle County.

The author submitted four specimens of the L. orbiculata complex from the Benjamin Koons collection and the collection of the Illinois Natural History Survey to Dr. Morrison for identification. Morrison (pers. comm., 4 January 1968) stated that:

> "The four specimens sent for check are indeed Lampsilis higginsi Lea. The large female with the more widely produced post basal region is the form called Lampsilis higginsi grandis by Simpson (1914:79). Without a great many more specimens available for study, I would not use the grandis form name."

Two of these specimens were collected from the river at Havana in 1895 and 1912. Kelly (1899:401) reported that he examined a single specimen of L. higginsii in the 1896-1897 period from the Havana area of the river.

A subfossil shell collected in the 1966 survey at river mile 94.3 (below Browning) was identified by Stansbery (pers. comm., 13 January 1968) as Lampsilis orbiculata f. higginsii. Parmalee (pers. comm., 29 June 1967) indicated that the Illinois State Museum contained two specimens of L. higginsii collected in the 1870's at Peoria.

Danglade (1914:37) reported taking

*higginsii* at Chillicothe, Peoria Lake, Havana, Bath, Beardstown, Meredosia, Florence, Pearl, Kampsville, Hardin, and Twelve-Mile Island. He (1914:46) considered *higginsii* as uncommon but widely distributed, especially in the lower half of the river. Neither Forbes & Richardson (1913) in 1912 nor Richardson (1928) in the mid-1920's reported taking a mussel belonging to the *L. orbiculata* complex above Peoria. Apparently *higginsii* formerly was widely distributed in the Illinois River before 1900 and gradually was eliminated by pollution and siltation before 1930.

The known host fish for *higginsii* is the sauger (Baker 1928:294). As mentioned earlier, this is an uncommon fish in the Illinois River.

Museum Records. —Peoria (1870's) ISM 769-770; Havana (1895) INHS and (1912) OSM 23250; 1 mile below Hardin (1907 Bartsch stat. 108) USNM 678588; and Illinois River without locality (Calkins) USNM 58129 and (1870's) OSM 23249.

**Live Mussel Records** (1966 Survey).— None.

**Old Shell Records** (1966 Survey). River mile 94.3. OSM 18287.

### Snuffbox

Dysnomia triquetra (Rafinesque, 1820)

*Dysnomia triquetra* (Rafinesque):
Parmalee (1967:62)

*Unio triangularis* Barnes:
Calkins (1874:45)

*Truncilla triquetra* Rafinesque (= *triangularis* Lea):
Baker (1906:63)

The snuffbox was taken by Calkins (1874:45) in the Illinois River in La Salle County (Starved Rock pool) in the early 1870's. According to Baker (1906: 63), this species was collected from the river by Handwerk. The author examined a shell (UIMNH 15257) of this species collected by Baker at La Salle; however, the name of the stream was not recorded. Possibly this shell came from the Illinois. Another shell of this species, examined by the author, was collected by Baker in 1911 from the Illinois River in Fulton County. The snuffbox was not taken from the river by Danglade (1914). Evidently this species was never common in the Illinois and was probably quite scarce by 1911.

The fish host of the snuffbox is not known.

**Museum Records. —** Fulton County (1911 Baker) UIMNH 3766.

**Live Mussel Records** (1966 Survey). None.

**Old Shell Records** (1966 Survey).- None.

## EFFECTS OF POLLUTION

In the preceding section it has been established that at least 49 different kinds of mussels were present in the Illinois River and its adjoining bottomland lakes in the 1870-1900 period (Table 5). Apparently between the 1870-1900 and 1906-1912 periods[1] three typical small stream species of mussels (*A. calceolus, A. marginata,* and *V. iris iris*) were ex-

Table 9.—Kinds of mussels extirpated from the Illinois River and its bottomland lakes between 1900 and 1969.

*Cumberlandia* monodonta (Spectacle-Case)
Fusconaia *flava* f. flava (Wabash Pig-Toe)
Quadrula *metanevra* (Monkey-Face)
Cyclonaias tuberculata (Purple Warty-Back)
Plethobasus *cyphyus* (Bullhead)
Pleurobema coccineum f. solida
Pleurobema *pyramidatum*
*Elliptio* crassidens (Elephant's Ear)
Elliptio dilatatus (Lady-Finger)
*Uniomerus* tetralasmus (Pond-Horn)"
Lasmigona *costata* (Fluted Shell)
Alasmidonta calceolus (Slipper-Shell)
Alasmidonta marginata (Elk-Toe)
Strophitus *undulatus* (Squaw Foot)
*Anodontoides* ferussacianus (Cylindrical Paper Shell)
Actinonaias ligamentina (Mucket)
Plagiola lineolata (Butterfly)
Proptera capax (Fat Pocketbook)
*Ligumia* recta (Black Sand-Shell)
Villosa iris iris (Rainbow-Shell)
Lampsilis anodontoides f. anodontoides (Yellow Sand-Shell)
Lampsilis ventricosa (Pocketbook)
Lampsilis orbiculata f. orbiculata
Lampsilis *orbiculata* f. higginsii (Higgin's Eye)
Dysnomia triquetra (Snuffbox)

*Anodonta suborbiculata* (Heel-Splitter) was not collected from the mainstream of the Illinois River in 1966, but one living specimen was taken in a bottomland lake adjoining the river.

[b] Not reported from the mainstream of the Illinois River.

[1] The 1870-1900 and 1906-1912 periods were chosen arbitrarily and were not necessarily inclusive dates of the occurrence of a mussel species in the Illinois River. However, at some time during a period in which a species was listed as present, it was known to have occurred in the river.

tirpated from the mainstream of the Illinois. In the 1966-1969 period only 24 kinds of mussels were taken alive, indicating

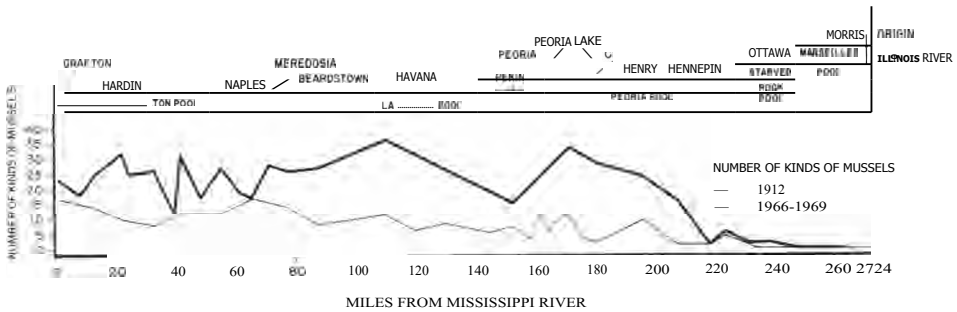



Fig. 9.—Kinds of living mussels taken in the Illinois River in 1912 and in the 1966-1969 period. Note that by 1912 pollution already had affected the mussel fauna of the upper part of the river and that by 1966 the mussel fauna of virtually the entire river had been affected. In the lower part of the river the mussel fauna changed less than it did in the remainder of the river between 1912 and 1966. In 1966 the commercial mussel fishery was confined to the lower 87 miles of the river, but in 1969 it was resumed in the vicinity of Peoria.

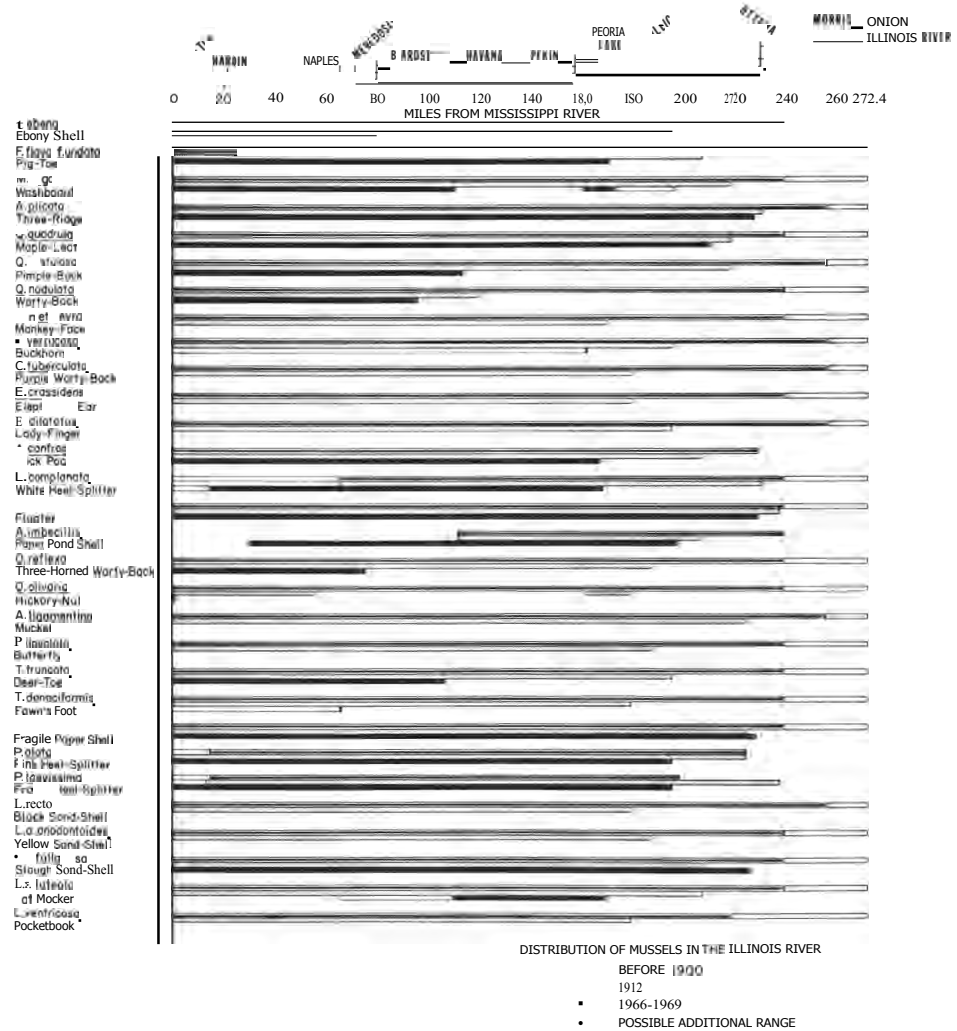



Fig. 10.—Changes in the distribution of the more common mussels of the Illinois River from before 1900 to the 1966-1969 period. Note that some of the formerly common kinds of mussels were not taken alive in the 1966-1969 period. The possible additional ranges of the mussels were based on the author's opinion and were not substantiated by records.

that during the past three-quarters of a century 25 kinds of mussels have been extirpated from the Illinois River and its adjoining bottomland lakes (Tables 5, 9, and A-3) . Data presented in the preceding section indicated that most of these mussels were not eliminated from the river until after 1912 (Fig. 9) . However, by 1912 the distribution of most of the mussels had been reduced, and since 1912 further reductions have occurred in the distribution and abundance of most of the surviving kinds of mussels in the river (Fig. 10) . Five (F. ebena, A. suborbiculata, 0. olivaria, T. donaciformis, and C. parva) of the 24 kinds of living mussels taken in the present study were represented by only single specimens.

In this section the author has attempted to recapitulate the effects that domestic, industrial, and agricultural pollution have had upon the mussel fauna of the various parts of the Illinois River since the 1870-1900 period. Untreated domestic and industrial wastes were being emptied into the river and its tributaries before 1900. In 1900 the pollution load of the river was increased greatly following the opening of the Chicago Sanitary and Ship Canal. No doubt, some species of mussels had been affected adversely by pollution in certain localities of the river even before 1900.

### Upper River

The upper Illinois River as designated here extends from its source at the confluence of the Des Plaines and Kankakee rivers (river mile 272.9) downstream to the Starved Rock dam (river mile 231.0) near Utica (Fig. 1) . This upper portion of the river encompasses the lower 1.4 miles of the Dresden pool, the Marseilles pool, and the Starved Rock pool.

In the 1870-1900 period there were at least 38 different kinds of mussels living in the upper river (Table A-21), whereas in 1966 none were collected there. In the early 1870's Calkins (1874: 11) found that:

> "At the Starved Rock and in its vicinity, the river, here shallow, is literally filled with clams lying half buried in the sandy bottom."

Since 1933 this section of the river has been impounded by the Starved Rock dam.

A drastic change began to occur in the river in 1900 following the opening of the Chicago Sanitary and Ship Canal. Lake Michigan water, laden with sewage and unti eated industrial wastes from the Chicago area, flowed into the Des Plaines River and thence into the upper Illinois, a distance of about 57 river miles from Chicago. In 1909 Wilson & Clark (1912:34) noted that:

> "The Des Plaines River, which joins the Kankakee to form the Illinois River, is simply an immense sewer bringing down the Chicago drainage. Both rivers, but especially the Des Plaines, are full of the characteristic algae and other vegetation which grow in such waters, and the combination of a copious vegetation with the sewage has effectually killed off all the mussels in the vicinity. Not a single living specimen could be found in either river, but there were hundreds of dead shells along the banks, most of them old and well bleached but still capable of identification."

In 1912 in the vicinity of Morris (63 river miles from Lake Michigan) Forbes & Richardson (1913:517) found no mussels living in the heavily polluted mainstream; however, they did take seven species of dead mussels there. A little farther downstream they (1913: 518) observed that:

> "In midsummer, 1911, the water at the Marseilles dam had a grayish look and a disagreeable odor, but with perceptibly less material in suspension than at Morris."

Forbes & Richardson (1913:525) in 1912 reported that at about 7 miles below the Marseilles dam at Ottawa there was a lessening of contamination. They stated that:

> "Diligent use of the crow-foot

The author was aware of the possibility that one or more rare species may have been missed in the 1966-1969 study; however, for purposes of this paper he has treated any kind of mussel formerly occurring in the river but not taken alive during the 1966-1969 period as having been extirpated from the river.

dredge in various situations brought to light no living mussels except on a bar in Fox River water just outside the mouth of that stream. Here two species were obtained alive—Lam psilis ventricosa and L. laevissima—and dead shells of eight other species. . . . The number of dead shells of both Unios and univalves, as compared with the living specimens found, was indicative of an environment still difficult for mollusks."

By 1912 pollution had virtually eliminated the mussel population of the river in the vicinity of Starved Rock (Forbes & Richardson 1913:527-528) . From this part of the river in the early 1870's Calkins (1874) collected 35 kinds of mussels (recognized by the present author), whereas in 1912 Forbes & Richardson (1913:528) found living specimens there of only two species of mussels (A. plicata and L. complanata).

During the summer months dissolved oxygen in the upper river in the 1911-1928 period was extremely low, ranging from 0.1 to 0.9 ppm (Mills, Starrett, & Bellrose 1966:9) . Probably the upper river's low dissolved oxygen content was an important factor reducing the mussel popuation during at least the first part of this century. As indicated in Table A-2 and Fig. 11, the dissolved oxygen in the upper river is now relatively high as compared to that of the 1911-1928 period, except possibly following a heavy rainstorm in the Chicago area. During such a storm the capacities of the combined interceptor sewers and of the treatment plants may be exceeded, and polluted waters are then discharged into the waterway.

Forbes & Richardson (1913:507) described the deplorable condition of the upper river at Morris in 1912:

"The water here was grayish, sloppy, and everywhere clouded with tufts of Sphaerotilus and Carchesium. The odor was continuously foul, with a distinct privy smell in the hottest weather. Bubbles of gas were continually breaking at the surface from a soft bar of sludge . . . . On the warmest days putrescent masses of soft, grayish black, mucky matter, from the diameter of a walnut to that of a milkpan, were floating on the surface."

In 1966 the water at Morris and downstream from there had the appearance of that of a relatively clean stream. The water had only a slight chemical odor but not enough to deter the use of the river here by boaters, water skiers, and some bathers. However, the bacterial counts (Table A-1) indicated that the entire river in 1966 was unfit for swimming.

The vast improvements which have occurred in the dissolved oxygen content and the putrid condition of the upper river since the 1912-1928 period are, according to Mills, Starrett, & Bellrose (1966:9), a result of

"the construction and operation of the tremendous sewage treatment plants by the Chicago Sanitary District through a program instituted in 1922, and the lock and dam system built in the 1930's which slowed up the movement of the water. The adoption of better water pollution laws by the state also had its effect."

The improvement in the treatment of domestic and industrial wastes in the past two decades by the cities along the Des Plaines, Kankakee, and upper Illinois rivers also has helped to reduce the biochemical oxygen demand in the upper Illinois. In spite of the amelioration in the dissolved oxygen content and the appearance of the water during the past 40 years, the upper river still provides a poor environment for fish and mussel life (Fig. 10 and 11; Tables 10 and A-3) (Mills, Starrett, & Bellrose 1966 : 11-13 & 14-17) .

As mentioned earlier, no living mussel was taken in the upper river in the 1966 survey. This indicated that the upper river has remained unsuitabe even for reestablishing populations of mussel species possessing some tolerance to pollution. Such tolerant mussels are living only a short distance downstream in the Peoria pool (Table A-3) . The dissolved oxygen determinations and crowfoot bar catches for the entire river (Fig. 11)

indicated that in 1966 mussels were living in the lower La Grange pool in water containing less dissolved oxygen than was observed in the upper river.

The determinations of the maximum amounts of ammonia nitrogen (N) cited in this study were made in 1967 (Allan Poole, pers. comm., 11 March 1968) .

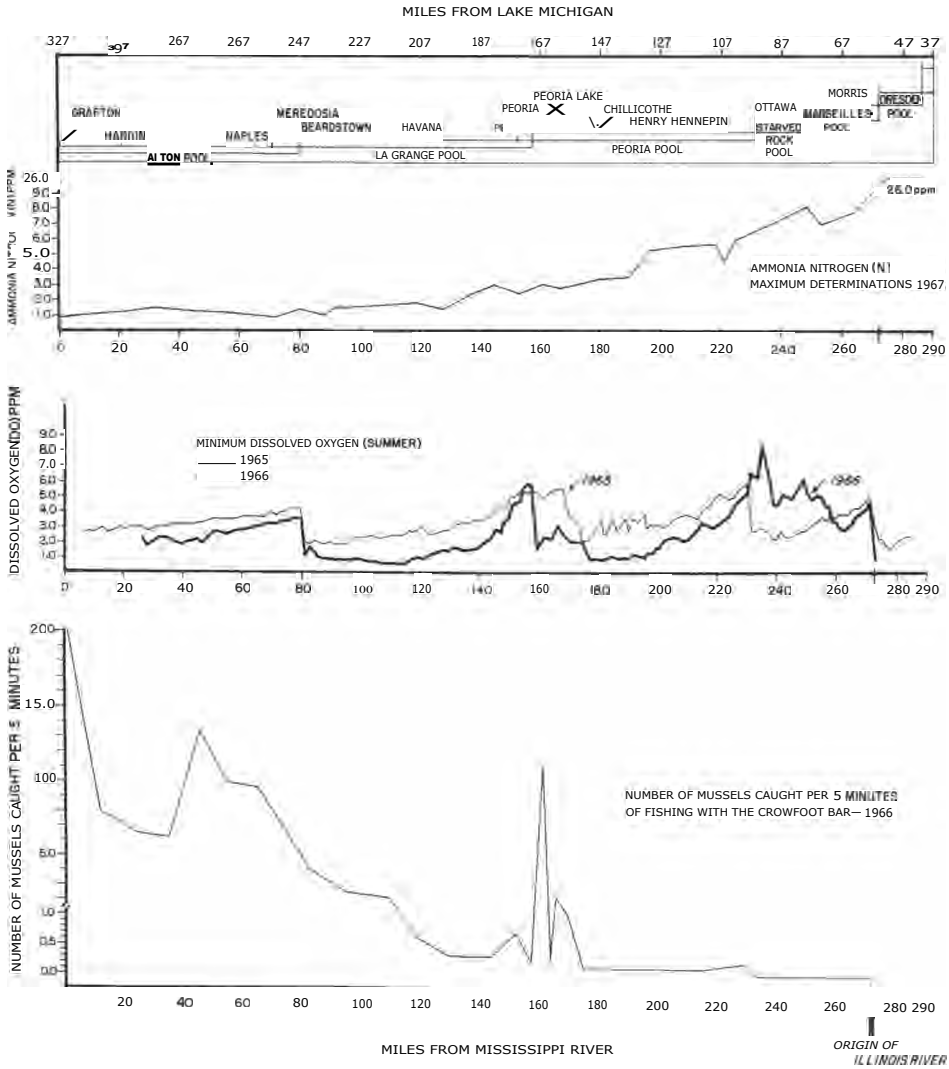



Fig. 11.—Maximum amounts of ammonia nitrogen (N) and dissolved oxygen in the Illinois River and numbers of mussels caught per 5 minutes of fishing with the crowfoot bar in the 1966 survey. The ammonia nitrogen (N) determinations were furnished by Mr. Allan Poole (pers. comm., 11 March 1968). The 1965 and 1966 dissolved oxygen determinations were made from water samples taken 3 feet below the surface of the river in the navigation channel by the author. Increases in the dissolved oxygen content of the river are apparent below the various navigation dams and in Peoria Lake. The 1966 crowfoot bar catches, expressed on a unit-of-effort basis, reflect the relative abundance of mussels in various parts of the river. (Mussels in Lower and Middle Peoria lakes were found to be more abundant than crowfoot bar collections indicated.) The steady upstream decline in the mussel population in the La Grange pool in 1966 apparently was associated with pollution from the Peoria-Pekin metropolitan area and in the upper part of the river with pollution from the Chicago-Joliet area. About 1 mile above Peoria (river mile 162.0) the mussel population increased markedly. Note the decline in the mussel population and the increase in ammonia nitrogen (N) upstream from Middle Peoria Lake.

Table 10.—Numbers of kinds of mussels occurring in the navigation pools of the Illinois River proper in the 1870-1900 period, in 1912, and in the 1966-1969 period.

| Navigation Pool | Kinds of Mussels | | |
|---|---|---|---|
| | 1870–1900 | 1912 | 1966-1969 |
| Alton | 39 | 38 | 20 |
| La Grange | 41 | 38 | 17 |
| Peoria | 41 | 37 | 16 |
| Upper River | 38 | 4 | 0 |

The author has assumed that these 1967 maximum determinations were rather typical of the river for at least the preceding 5 years (Fig. 11) . According to Barth et al. (1966:1211) :

> "Contemporary American treatment plants are designed on the basis of solids and BOD removal with little regard to nitrogen transformation."

This point might well apply to phosphorus also. (No correlation appeared to exist between the abundance of mussels and amounts of total phosphates present in the river.) Industrial wastes and agricultural runoff also are involved here.

Possibly a high amount of ammonia nitrogen (N) has a deleterious effect on mussels similar to its supposed effect on fishes. According to Spicer (1952) ammoniacal nitrogen over 1 ppm in a river is not very attractive to fish, and if the value exceeds 5 ppm even few, if any, coarse fish will occur in the stream. Ellis (1937:393) found that waters containing 2.0-3.0 ppm of ammonia and supporting a good fish fauna had high dissolved oxygen contents (5.5-7.0 ppm) . The maximum determinations of ammonia nitrogen (N) exceeded 6.0 ppm throughout the upper river, and in this section no living mussels were found in 1966. As indicated in Fig. 11 and Table A-3, in 1966 mussel life began to appear in the river below the Starved Rock dam where the maximum amount of ammonia nitrogen (N) did not exceed 6.0 ppm. This relationship between mussel life and ammonia nitrogen (N) in the river may be considered either suggestive or accidental. The chemistry of a polluted river, such as the Illinois, is, in the author's opinion, too complex to allow one to infer from field data that one chemical or condition was the sole limiting factor.

It is apparent from the data shown in Fig. 11 that various pollutants, such as heavy metals (Wurtz 1962:54), possibly including ammonia nitrogen (N), adversely affected mussel life in the Illinois. The distance and time required for at least partial dissipation of domestic and industrial pollutants below the Chicago-Joliet and Peoria-Pekin metropolitan areas were reflected by the absence, presence, and abundance of certain species of mussels (Fig. 11; Table A-3) . Experimental deletion-type bioassay studies with various life stages of living mussels and/or other aquatic organisms in river waters and bottom muds from which various pollutants could be eliminated (the opposite of the usual additive type of bioassay) might be extremely helpful to sanitary and industrial engineers. Such analyses might isolate the key pollutants limiting mussels and other aquatic life in a stream, thereby greatly reducing costs in the construction and operation of advanced waste treatment plants.

Thompson (1928:301) reported that fish life was eliminated by pollution from the upper river between 1912 and 1917; however, by the early 1940's some species of fishes had become reestablished in the upper river (INHS files) . In the late 1950's and the 1960's many of the important host fishes of mussels were scarce in the upper river as indicated by the author's electrofishing data presented in Table 11. The only common endemic fishes taken regularly in the upper river were emerald shiners, Notropis atherinoides Rafinesque, and black bullheads, Ictalurus melas (Rafinesque . The most abundant fishes in the upper river were carp; goldfish, Carassius auratus (Linnaeus) ; and carp-goldfish hybrids (Fig. 12) . Evidently these exotic Asiatic fishes have been able to adapt to the adverse conditions of the upper river. Whether mussels can use these abundant exotic species in the river as host fishes was not known to the author. However, even

Table 11.—Average numbers of common host fishes of mussels caught per 30 minutes of electrofishing in the navigation pools of the Illinois River (1962-1966).

| Kind of Fish | Alton Pool | La Grange Pool | Peoria Pool | Starved Rock Pool | Marseilles Pool |
|---|---|---|---|---|---|
| Channel catfish | 3.73 | 1.42 | 0.09 | 0.52 | 0.00 |
| Freshwater drum | 1.16 | 1.01 | 0.20 | 0.04 | 0.03 |
| Sunfishes (Centrarchidae)[a] | 8.31 | 16.99 | 13.41 | 0.40 | 0.71 |

[a] Includes rock bass; [illegible], *Lepomis gulosus* (C[illegible]); green sunfish; pumpkinseed; [illegible] sunfish; [illegible]; sunfish hybrids; smallmouth bass; largemouth bass; white crappie; and black crappie.

though the known host fishes usually were scarce, in the upper river, the author believed that sufficient numbers of fishes carrying glochidia during the past decade could have moved into the upper river either from tributaries or from downstream to have restocked the river with at least a few species of mussels had the environment otherwise been suitable for mussels. Evidence that tributaries may be mussel sources appeared in 1966 when four species of live mussels were collected in the Aux Sable River near its mouth where the stream empties into the Marseilles pool.

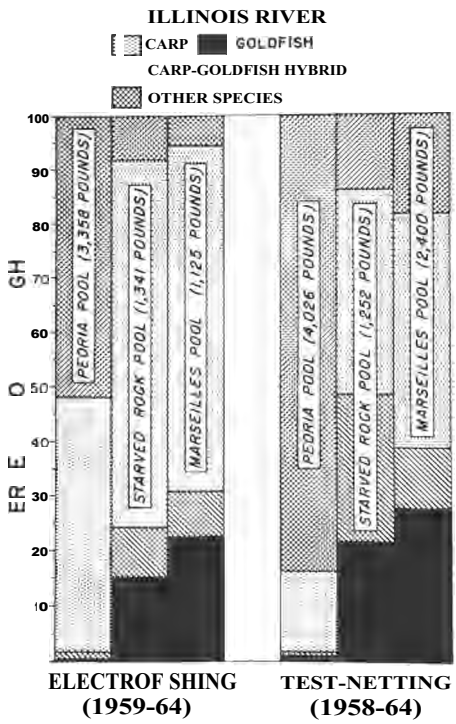



**Fig. 12.—Fishes taken** with the electric shocker and with 1-inch wing nets in the Peoria, Starved Rock, and Marseilles navigation pools of the Illinois River. Note that the catches in the upper river (Marseilles and Starved Rock pools) were dominated by carp, goldfish, and carp-goldfish hybrids, whereas in the adjacent downstream Peoria pool endemic species formed an important part of the catches.

Siltation in the upper river was minor as compared with that in the Alton pool where mussels were abundant enough to support a commercial fishery in 1966 (Fig. 11) . The navigation dams possibly have reduced the flow of the current enough to make the environment in the river unsuitable for the reestablishment of several current-inhabiting species of mussels present before 1900. However, the reduction in current would not have been sufficient to have prevented the reestablishment of a number of other species still found in the remainder of the channelized river.

It appeared from this study, that in spite of the tremendous efforts made since the 1920's by Chicago and other cities and by industries along the Illinois River waterway to initiate and later to improve the treatment of wastes, the upper river evidently remained unsatisfactory for mussel life.

## Peoria Pool

The Illinois River flows from the upper river through and over the Starved Rock lock and dam into the Peoria pool and continues 51.8 miles downstream to below Chillicothe where it widens abruptly into two shallow fluviatile lakes (Type 49) known as Upper (or Upper

and Middle) and Lower Peoria lakes (about 1.5 miles average width). The river here is two lakes for 16.4 miles of the navigation channel except at the Peoria Narrows (Fig. 13) where an alluvial fan separates the lakes. At Peoria the river constricts to a normal width of about 0.17 mile and continues 5.2 miles downstream to the Peoria dam.

Since 1870 at least 41 kinds of mussels (Table A-21) have been known to occur in the Peoria pool (73.4 miles long). In the 1966-1969 period 16 kinds of mussels were found living in the Peoria pool. However, in the upper 56.1 miles and lower 1.9 miles of this pool living mussels were relatively scarce as compared with the numbers found in the remainder of the pool (Table A-3 and Fig. 11). The extirpation of 25 kinds of mussels together with reductions in the distribution and abundance of the surviving kinds probably occurred here mainly after 1912 rather than before, as was the case in the upper river.

Starved Rock Dam to Chillicothe.—Between 1871 and 1900 some pollutants from Chicago were coming into the Illinois River at La Salle (Fig. 1) through the Illinois and Michigan Canal (Kofoid 1903:201-202; Walker 1956:6). Concerning pollution in the Starved-Rock-dam-to-Chillicothe section of the Peoria pool in 1911 and 1912, Forbes & Richardson (1913:543-544) reported that:

> "It was at Spring Valley, fifty-seven miles below the mouth of the Des Plaines, that, in summer time, the last visible symptoms of water pollution were to be seen. The water here had not yet recovered its normal slightly greenish tint, but was still grayish with suspended specks of septic and pollutional plankton; and it still smelled slightly of sewage, in part no doubt because of local contamination from Peru and La Salle, a few miles above. . . . A considerable variety of aquatic insect larvae, of living mussels, and of gastropod mollusks, and a much smaller proportion of dead shells, testified further to an improved environment. . . .
>
> At Hennepin it may be fairly said that virtualy normal conditions were found, except for the state of the bottom in winter time; although it must be confessed that our chemical data, especially those for the mid-

Fig. 13.—The Peoria Narrows, separating Upper (Middle) and Lower Peoria lakes. Upstream beyond the Narrows is Upper (Middle) Peoria Lake. Photo by the author.

summer low-water of 1911, were hardly consistent with this statement. . . .

Henry to Chillicothe. — In this, the last section of the upper Illinois systematically studied by us in 1911 and 1912, the process of renovation is simply carried a little farther on than in the Henry-to-Hennepin section just above. It is only in the winter time that the effects of pollution are manifest here to the senses . . . ."

By 1915 the river from Chillicothe upstream had unwholesome conditions in the bottom muds (Richardson 1921*b*: 33) . In 1912 Richardson (1928:456) determined the dissolved oxygen to be about 3 ppm at Chillicothe, whereas in the early 1920's zero was the usual lower limit of oxygen at this site. According to Forbes & Richardson (1919 :145) :

"More recent evidence of a still continued gradual creeping downstream of pollutional conditions is found by comparison of collections made in 1911 with those obtained in August, 1918. In the former year a foul-water fungus (Sphaerotilus natans) disappeared from both channel and shore at or near Starved Rock, while August 28 to 30, 1918, it was found in the river at Henry, 35 miles below Starved Rock, and also at Lacon, 6 miles still farther down."

During the 1914-1925 period evidently pollution was so severe in the Starved-Rock-to-Chillicothe section that all of the mussel life was eliminated. Richardson's Table XXI (1928:457) indicated that in the 1924-1925 period he took no live mussel above Upper Peoria Lake (Table 12) .

The increase in pollution after 1912 in this section of the river as well as farther downstream was related to several factors which developed in the Chicago area. In the 1914-1920 period, according to Richardson (1928:398) :

"the Chicago population is estimated to have increased around 10 per cent, to about 2,701,000; and the stock yards wastes, in population equivalent equal to 1,040,000, were about 19 per cent greater than in 1914, after having fallen off 353,000 since the peak of the war-time activity of 1918. Between 1914 and 1920, all of the wastes from the sources above described were received by the Sanitary Canal and Illinois River wholly untreated and subject after delivery only to the effects and processes of dilution and biological purification, varying with river levels, temperature, and other physical conditions, as chance might offer."

Other untreated wastes from the Chicago area in this period were estimated by Richardson (Ibid.) to have had an additional population equivalent of about 500,000.

In the 1920's the additional sewage from the expanding human population of the Chicago area began to be affected by the treatment of sewage and the reduction of certain industrial wastes entering the canal (Richardson 1928:399) . By 1960 the wastes before treatment in the Chicago metropolitan area had a population equivalent of 9.50 million, but after treatment they amounted to a population equivalent of only 1.15 mil-

Table 12.—Numbers of kinds of mussels living in various parts of the Peoria navigation pool of the Illinois River in 1912, the 1924-1925 period, and the 1966-1969 period.

| Location | Kinds of Living Mussels | | |
|---|---|---|---|
| | 1912 | 1924-1925[b] | 1966-1969[c] |
| La Salle-Peru | 5 | 0 | 4 |
| Spring Valley | 1 | 0 | 1 |
| Hennepin | 17 | 0 | 1 |
| Henry | 24 | 0 | 9 |
| Chillicothe | 28 | 0 | 2 |
| Peoria Lake | 35 | 16 | 12 |

[a] Forbes & Richardson (1913:529-536); D[illegible] (1914:37).
[b] Richardson (1928:455 & 457, Tables XX and XXI). From the latter table the author inferred that no mussel life existed in the river in 1924-1925 above Upper Peoria Lake.
[c] Present study.

lion (United States Public Heath Service 1963: 111-3). This fact indicated a reduction of about 77 percent since 1918 in the wastes entering the Illinois River waterway from the Chicago area. This is a remarkable engineering achievement, for the population equivalent of wastes before treatment in 1960 was about double the population equivalent of 1918.

In the 1966 survey 32 living mussels were taken in the Starved-Rock-to-Chillicothe section of the Peoria pool (Table A-3). Ten different kinds of mussels were represented in these collections of which 50.0 percent were three-ridges (A. plicata) and floaters (A. g. corpulenta). The presence of living mussels in 1966 in this section of the river indicated an improvement in conditions for mussels since the 1918-1925 period. The dissolved oxygen content of the river in the lower part of this section of the Peoria pool tended to be quite low in midsummer (Fig. 11) ; however, the author has never recorded zero readings as did Richardson (1928:456) at Chillicothe in the early 1920's. The maximum determinations of ammonia nitrogen (N) (range 3.4-6.0 ppm) in this section of the river did not exceed 6.0 ppm in 1967 as they did in the upper river where no living mussel was taken in 1966 (Fig. 11). The range of maximum total phosphates ($PO_4$) in this section of the river in 1967 was 2.5-5.5 ppm.

La Salle-Peru.—In 1912 Forbes & Richardson (1913:529) collected mussels between Utica and Peru with a crowfoot bar and wrote that:

> "The large proportion of dead specimens, as compared with the ratios obtained farther down the stream, indicate unfavorable conditions for mussels in the stretch of river between Utica and Peru."

A comparison of the numbers and kinds of mussels taken in 1912 and 1966 was made in Table 13. Two of the four kinds of mussels taken in 1966 in this area were also collected there by Forbes & Richardson. With the exception of the mucket (A. *ligamentina*), the other species taken alive there in 1912 were found a short distance downstream in 1966. The mucket was not collected alive anywhere in the Illinois River in the present

Table 13.—Numbers and kinds of mussels taken alive and dead in the LaSalle-Peru area of the Illinois River in 1912 and 1966.

| Kind of Mussel | Mussels Taken | | |
|---|---|---|---|
| | 1912[a] | | 1966[b] |
| | Alive | Dead | Alive |
| F. ebena (Ebony Shell) | 0 | 1 | |
| A. *plicata* (Three-Ridge) | 5 | 3 | |
| *Q. pustulosa* (Pimple-Back) | 0 | 1 | |
| Quadrula sp. | 0 | 3 | |
| L. complanata (White Heel-Splitter) | 1 | 2 | |
| A. g. corpulenta (Floater) | 0 | 0 | |
| S. undulatus (Squaw Foot) | 0 | 1 | |
| 0. reflexa (Three-Horned Warty-Back) | 0 | 1 | |
| A. ligamentina (Mucket) | 4 | 3 | |
| L. *fragilis* (Fragile Paper Shell) | 1 | 1 | 2 |
| P. alata (Pink Heel-Splitter) | 1 | 4 | 0 |
| L. a. f. fallaciosa (Slough Sand-Shell) | 0 | 0 | 2 |
| L. ventricosa (Pocketbook) | 0 | 4 | 0 |
| Totals | 12 | 24 | 6 |

[a] Forbes & Richardson (1913:530).
[b] Present survey (river miles 220.7-229.3).

study, and the author was surprised to learn that this species was able to survive the poor conditions existing for mussels in this part of the river in 1912.

A floater (A. g. corpulenta) was collected just below Utica at river mile 229.3, the farthest upstream point where a live mussel was taken in 1966. In the La Salle-Peru area the maximum ammonia nitrogen (N) determination in 1967 was 6.0 ppm (Fig. 11), and as was shown in Table 13, a few specimens of four kinds of mussels were able to withstand this high concentration of ammonia nitrogen for at least a short time. The author has found that the midsummer dissolved oxygen content of the river in this area usually has been over 4.5 ppm (Fig. 11) . The relatively high oxygen content of the river here is caused by the water mixing with the air as it falls over the Starved Rock dam just upstream from the La Salle-Peru area. As has been discussed for the upper river, the author does not consider dissolved oxygen a limiting factor for mussels in the La Salle-Peru section of the river.

Hennepin.—In the Hennepin area in 1912 Forbes & Richardson (1913:533) collected 187 living mussels of 17 different kinds (Fig. 9) . These collections included in part 60 slough sand-shells (L. a. f. fallaciosa), 45 three-ridges (A. *plicata*), 23 white heel-splitters (L. complanata), 14 floaters (A. g. corpulenta), and 11 washboards (M. gigantea). In 1966 only one live three-ridge (A. *plicata*) was taken in this part of the river.

Henry.—Forbes & Richardson (1913: 533 & 536) and Danglade (1914:37) reported taking 24 different kinds of live mussels in the Henry area in 1912, but in 1966 only 9 kinds were collected alive there (Table A-22) . Danglade (1914:14) took 128 living mussels there in 1 hour of fishing with a crowfoot bar, whereas in 3 hours of similar fishing in 1966 only 4 live mussels were caught (Table 14) . The comparison in Table 14 of crowfoot bar catches made in 1912 and 1966 clearly reflected the impact of pollution on the mussel population in this part of the river during the intervening 54 years.

Chillicothe.—From the river near Chillicothe in 1912, Forbes & Richardson (1913:533 & 536) and Danglade (1914:

Table 14.—Numbers and kinds of live mussels taken with the crowfoot bar in the Illinois River in the vicinity of Henry in 1912 and 1966.

| Kind of Mussel | Mussels Taken in 1 Hour of Fishing in 1912[a] | Mussels Taken in 3 Hours of Fishing in 1966[b] |
|---|---|---|
| F. f. f. undata (Pig-Toe) | 5 | 0 |
| M. gigantea (Washboard) | 4 | 0[c] |
| A. plicata (Three-Ridge) | 70 | 0[c] |
| Q. quadrula (Maple-Leaf) | 2 | |
| Q. *pustulosa* (Pimple-Back) | 5 | |
| T. verrucosa (Buckhorn) | | |
| E. dilatatus (Lady-Finger) | | |
| A. confragosus (Rock Pocketbook) | 2 | |
| L. complanata (White Heel-Splitter) | 2 | |
| A. g. corpulenta (Floater) | 2 | 2 |
| S. undulatus (Squaw Foot) | | |
| A. ligamentina (Mucket) | 25 | |
| T. truncata (Deer-Toe) | | |
| L. fragilis (Fragile Paper Shell) | 4 | |
| P. alata (Pink Heel-Splitter) | 2 | 0[c] |
| L. a. f. fallaciosa (Slough Sand-Shell) | | |
| Total | 128 | 4 |

[a] [illegible] (1914:14). The collection may have been made in 1911; however, in this paper the author has used only the 1912 date.

[b] Present survey. Collections from river miles 190.0-199.3.

[c] This mussel was taken here in 1966 either by dredging or wading. Also collected here in 1966 either by dredging or wading were A. [illegible] (Floater), A. *imbecillis* (Paper Pond Shell), and P. *lacvissima* (Fragile Heel-Splitter).

37) reported collecting 28 different kinds of mussels (Table A-22) . Danglade (1914:15) caught 223 mussels with a two-bar haul over the lower end of a productive mussel bed located just above Chillicothe. Part of his catch included 83 three-ridges (A. plicata), 25 fat muckets (L. r. luteola), 24 washboards (M. gigantea), 22 lady-fingers (E. dilatatus), 17 pimple-backs (Q. *pustulosa*), 17 pig-toes (F. f. f. undata), and 12 muckets ( A. ligamentina). Danglade ( Ibid.) mentioned that in earlier years 10-12 ebony shells (F. ebena) had been caught per haul from this bed by commercial clammers, whereas in 1912 only an occasional ebony shell was taken. Probably by 1918 this mussel bed had been wiped out by pollution, and apparently conditions have never been favorable enough since for the bed to become reestablished. In this area in 1966 the only living mussels taken were five three-ridges (A. plicata) and one slough sand-shell (L. a. f. fallaciosa).

Peoria Lake.—The mussel life in the broad expanse of Peoria Lake between Chillicothe and Peoria was described in 1911 and 1912 by Danglade (1914:14) :

> "The slow current, the large volume of water, the good average depth and soft mud bottom are suitable for mussel growth, and there are consequently many fine mussel beds and an enormous quantity of shells, making this at present probably one of the best mussel-producing districts in the United States."

During that period at least 35 different kinds of mussels lived in Peoria Lake (Table A-23).

Between the 1913-1915 period and 1920 pollution had virtually eliminated the former normal bottom animals of the river between Chillicothe and Beardstown, including those of Peoria Lake (Richardson 1925a:327). This encroachment of pollution from upstream and its effects on the mussel life of Peoria Lake were described by Richardson (1928:454) :

> "The mussels died out rapidly in all three sections of the lake during and after 1917 until commercial clamming entirely ceased because of failure to obtain shells. In the summer of 1920 a single clammer operated a bar for a few days in the channel of the Lower Lake opposite the center of Peoria, but took nothing but dead shells except for an occasional live specimen of Amblema rariplicata or still less frequently Quadrula pustulosa. In 1920-1922 the Natural History Survey took single examples of three species (Amblema rariplicata, Anodonta imbecillis, and Quadrula *pustulosa*) . . . Commercial clamming on a scale much reduced from that of the pre-1920 period began again in 1924 and has been continued sporadically by a few clammers since. The only commercial species obtained since then in salable quantity, however, has been the common three-ridge, Amblema rariplicata."

Dr. Morrison (pers. comm., 12 August 1969 and 6 March 1970) wrote that there was very little mussel life in Peoria Lake in 1931 and that he took only three living mussels there.

In this study 12 different kinds of mussels were taken alive in Peoria Lake, indicating that at least 23 kinds had been extirpated from this part of the river since 1912 and 4 since the 1924-1925 period (Tables A-3, A-23, and 15) .

Richardson (1928:455) considered Upper Peoria Lake as two separate lakes —Middle Peoria Lake (river miles 167.2-174.9) between the Peoria Narrows and Spring Bay, and Upper Peoria Lake (river miles 174.9-179.7) from Spring Bay to below Chillicothe. The author has followed Richardson's division of Upper Peoria Lake into two lakes in order to compare his 1924-1925 mussel collections with those made in the present study (Table 15) . Even though his division of Upper Peoria Lake into two lakes was artificial, this separation was useful in treating the 1966 data of this lake.

Apparently Upper Peoria Lake as designated here with its broad expanse of water and virtual absence of current tended to serve as a partial recovery zone for the river. The dissolved oxygen curves shown in Fig. 11 clearly indicated a sharp increase in the dissolved oxygen

Table 1 5 —Kinds of mussels present in Peoria Lake in the 1 9 24-1 925 and 1 966-1 9 69 periods.[a]

| *Kind of Mussel* | *Mussels in Peoria Lake* | | | |
|---|---|---|---|---|
| | Upper | | Middle and Lower | |
| | 1924-1925 | 1966-1969 | 1924-1925 | 1966-1969 |
| *F. f. f. undata* (Pig-Toe) | P[b] | A | | |
| *M. gigantea* (Washboard) | A | | A | |
| *A. plicata* (Three-Ridge) | | A | | |
| *Q. quadrula* (Maple-Leaf) | | A | | |
| Q. *pustulosa* (Pimple-Back) | A | A | | A[c] |
| *E. dilatatus* (Lady-Finger) | A | A | | A |
| *A. confragosus* (Rock Pocketbook) | A | A | A | |
| *L. complanata* (White Heel-Splitter) | | A | A | |
| *A. g. grandis* (Floater) | A | A | A | |
| *A. g. corpulenta* (Floater) | | | | |
| *A. imbecillis* (Paper Pond Shell) | | A | | A |
| *A. suborbiculata* (Heel-Splitter) | A | A | | A |
| *0. reflexa* (Three-Horned Warty-Back) | A | A | | A |
| *L. fragilis* (Fragile Paper Shell) | A | A | | |
| *P. alata* (Pink Heel-Splitter) | A | A | | A |
| *P. laevissima* (Fragile Heel-Splitter) | A | | | |
| *C. parva* (Liliput Shell) | A | A | | A |
| *L. a. f.fallaciosa* (Slough Sand-Shell) | | | | |
| *L.* r. *luteola* (Fat Mucket) | | A | | |
| *Total* | *8* | *3* | *15* | *12* |

[a] Richardson (1928:455), 1966 survey, and 1969 commercial data.
[b] P denotes present and A designates absent.
[c] Taken by commercial fisherman in 1969 from the Illinois River just below Peoria Lake.

content of the river at the upper end of Middle Peoria Lake (river mile 174.9). Likewise, in coming downstream in the 1966 survey the first relatively large-sized population of mussels was encountered in Middle Peoria Lake (Fig. 11 and Table A-3). In Upper Peoria Lake in 1966 only 6 live mussels of 3 species were collected, whereas in Middle Peoria Lake 533 live mussels of 11 different kinds were taken.

In the 1924-1925 period Richardson (1928:455) collected eight kinds of mussels from Upper Peoria Lake, all taken at its lower end. Richardson (Ibid.) was of the opinion that the 11 species of mussels he took in the 1924-1925 period in Middle Peoria Lake (Table 15) probably had remained "through the worst of the wave of pollution that destroyed the more sensitive *Mollusca* about ten years ago." In the 1924-1925 period Richardson (1928:455) collected the liliput shell (C. *parva*) in Middle Peoria Lake and the three-horned warty-back (0. reflexa) in both Middle and Lower Peoria lakes. In 1966 both of these species were confined to the lower part of the river. Evidently the adults of these species were able to withstand the severe pollution in Peoria Lake during the period of World War I but were unable to maintain populations in subsequent years.

In 1966, beds comprised largely of three-ridges (A. plicata) were found in Middle and Lower Peoria lakes, and these beds were extensive enough to interest commercial mussel fishermen. No commercial fishing had been conducted in the Peoria pool for a number of years prior to 1969. In that year commercial mussel fishermen removed about 100,000 pounds of mussels (10 percent dead shells) from Lower and Middle Peoria lakes; however, 85,941 pounds (10 percent dead shells) of these mussels were dredged from one bed at river

mile 164.1 (LB) in Lower Peoria Lake (Webb Moss, pers. comm., 30 October 1969). They also found mussels occurring abundantly in Middle Peoria Lake but did little fishing there in 1969. The 1966 survey data and the above commercial statistics indicated that mussels were much more abundant in Middle and Lower Peoria lakes in the 1966-1969 period than they were in the 1918-1931 period. The author is of the opinion that through the years natural selection has played an important role in reestablishing the mussel beds in Peoria Lake. Improved treatment of municipal and industrial wastes in the Chicago area and elsewhere along the upper Illinois River waterway have also undoubtedly helped to improve Peoria Lake as a mussel habitat. However, conditions had not improved enough in Peoria Lake to permit the reestablishment of 23 kinds of mussels known to have lived in this part of the river in 1912.

Foot of Peoria Lake to Peoria Dam.—The Illinois River abruptly narrows at Peoria and flows downstream 5.2 miles to the Peoria lock and dam. A power plant (fossil fuel) is located on the left bank of the upper end of this section of the river, and it has not been determined what effect the heated discharge from this plant has on mussel life in this section of the river. However, on the left bank of the upper part of this section of the river (river miles 161.1-162.3) occurred the largest standing crop of living mussels found in the entire river in the 1966 survey (at river mile 161.6 total phosphates were 5.7 ppm, and ammonia nitrogen was 3.0 ppm) . The estimated standing crop here in 1966 was 6,040 pounds (live weight) of mussels per acre. The three-ridge (A. plicata) comprised 85.3 percent of the mussels taken here in the 1966 survey. In 1969 commercial mussel fishermen removed from these unfished waters 108,500 pounds (live weight) of mussels (Webb Moss, pers. comm., 30 October 1969). In the 1966-1969 period 11 kinds of mussels were collected from the upper part of this section of the river, including the pimpleback (Q. *pustulosa*) and the buckhorn (T. verrucosa). Conditions evidently were better here for mussels than they were in Middle and Lower Peoria lakes; however, the differences were not as great as was indicated by the 1966 crowfoot bar catch data shown in Fig. 11. Catches in Peoria Lake would have been much higher had there been more current there (the current is not perceptible in Peoria Lake at normal pool stage), since the crowfoot bar is less efficient in slack water than in moving water. No sampling was done in this section between river miles 160.0 and 161.1.

The lower part of this section of the river (river miles 158.1-160.0) was below the outlets of the treated sewage and industrial effluents from East Peoria and Peoria. The demarkation between the upper and lower parts of this section of the river was reflected by a sharp decline in the mussel population (Fig. 11) . In the upper part of this section of the river (river miles 161.1-162.3) the crowfoot bar catch was 11.0 mussels per 5 minutes of fishing, whereas in the lower part the catch was only 0.2 mussel per 5 minutes of fishing (Fig. 11; Table A-3). In 1966 wastes from East Peoria received only primary treatment. The city of Peoria has had a modern sewage treatment plant (river mile 160.2) for a number of years, and in the late 1960's it began tertiary treatment. In 1966, according to Mr. Edwin Fall of the Greater Peoria Sanitary District (pers. comm., 24 February 1969), the untreated wastes coming into the Peoria treatment plant had a population equivalent of 381,000, but the treated wastes going into the river had a population equivalent of 57,000.

### La Grange Pool

The additional pollution load discharged into the river from the Peoria-Pekin area had a noticeable effect upon the mussel life in the upper part of the La Grange pool in 1966 (Fig. 11). In 1960 the estimated BOD load discharged into the river from industrial sources in the Peoria-Pekin area had a popula-

tion equivalent of 386,000 (United States Public Health Service 1963: III-5). Mr. Edwin Fall (pers. comm., 24 February 1969) informed the author that the estimated population equivalent of treated and untreated domestic and industrial wastes entering the river in 1960 from Peoria was about 100,000, but as indicated above, this has been reduced considerably since 1960. The remaining 150 miles of the river from Pekin to Grafton received only agricultural runoff and effluents from small communities and a few small industries.

Kofoid (1903:198-203) reported that in 1897 sewage from Chicago entering the Illinois River through the Illinois and Michigan Canal at La Salle and from the Peoria-Pekin area was one of the most important factors causing an abundance of plankton in the Havana area. Apparently pollution did not become detrimental to aquatic life in the La Grange pool until after 1915 (Richardson 1921b:49). Richardson (1925b: 411) limited his collecting to small bottom fauna organisms in the La Grange and Alton pools, and as a result, the effects of pollution in the 1915-1920 period on mussel life in these pools were not recorded. Between the 1913-1915 period and the summer of 1920 the dissolved oxygen at Havana dropped from 4 ppm to 1 ppm (Richardson 1925a: 327-328). During this period pollution eliminated about 70 kinds of benthic organisms other than mussels from the river near Havana and 24 or more kinds between Havana and Beardstown (Richardson 1925b:410-413) (Fig. 14). In 1917 Richardson (1925a:329) observed a heavy mortality of snails in various parts of the river between Spring Valley and Havana.

Between 1870 and 1912 at least 43 different kinds of mussels were known to have occurred in the mainstream of the La Grange pool (Table A-21), whereas only 18 kinds were collected alive from the mainstream of this pool in 1966 (Table A-3). No doubt this drastic reduction in the mussel fauna of this pool occurred largely in the 1915-1920 period simultaneously with the destruction of other benthic organisms by domestic and industrial pollution from Chicago and the Peoria-Pekin area as described by Richardson (1921a, 1921b, 1925a, 1925b, and 1928). Silt pollution probably also has affected certain species of mussels in the La Grange pool, such as the yellow sand-shell (L. a. f. anodontoides).

Peoria Dam to Havana.—In 1912 Danglade (1914:17) found five mussel beds between Peoria and Pekin and sev-

Fig. 14.—**The Illinois River at Beardstown, showing a towboat moving upstream. This** section of the river **is in the La Grange navigation pool. Photo by the author.**

eral beds between Pekin and Havana. No mussel bed was detected in this section of the La Grange pool in 1966. Danglade (1914:18) determined the species composition of mussels in the Liverpool area of the river (between Pekin and Havana) in 1912 to be 36 percent three-ridges (A. plicata), 30 percent pimple-backs (Q,. pustulosa), 5 percent washboards (M. gigantea), 4 percent muckets (A. ligamentina), 8 percent other commercial shells, and 17 percent noncommercial shells. In that area in 1966 only 36 living mussels of the following kinds were collected : 22.2 percent maple-leafs (Q. quadrula), 13.9 percent three-ridges (A. plicata), and 63.9 percent noncommercial species (Table A-3) .

In the mainstream of the river between the Peoria dam and Havana 32 kinds of mussels were taken in 1912 by Danglade (1914:37), whereas only 11 kinds were collected from this section in 1966 (Table A-24) . The 1966 collections from the mainstream of this section did not include five kinds of mussels taken alive that year in Quiver Lake (Table A-24) . As has been mentioned earlier, Quiver Lake, located just above Havana, is merely a slough connected with the river. The lower part of the lake is a large expanse of the river. Natural springs on the bluff side (LB) of this lake evidently provided a more suitable habitat for mussels than did the mainstream; however, the species taken in Quiver Lake were collected in the river farther downstream.

Below Havana to La Grange Dam.—The size of the mussel population in 1966, as reflected by the crowfoot bar catches shown in Fig. 11, increased steadily as we proceeded downstream from below Havana (river mile 120.0) . In 1966 a few washboards (M. gigantea), pimple-backs (Q. *pustulosa*), warty-backs (Q. nodulata), and deer-toes (T. truncata) appeared in the collections made in this section of the river (Fig. 10) .

As the data in Fig. 11 indicate, the increase in the abundance of mussels in the lower part of the La Grange pool was accompanied by slight decreases in the maximum amounts of ammonia nitrogen (N) . However, in this section of the pool the dissolved oxygen in midsummer sometimes becomes quite low (Table A-2 and Fig. 11). Low dissolved oxygen content and heavy siltation may have been important factors contributing to the loss of certain species of mussels since 1912 in this section of the river. The 1966 collections indicated that the mussel population there included 67.0 percent three-ridges (A. plicata) and 13.2 percent maple-leafs (Q. quadrula). These two abundant species the author considered somewhat tolerant of pollution and siltation.

In 1912 Danglade (1914:19-20) found pimple-backs (Q. *pustulosa*), washboards (M. gigantea), lady-fingers (E. dilatatus), and three-ridges (A. *plicata*) the most abundant species in this section. These species, excepting the lady-finger, were among the most abundant species found on downstream in the Alton pool in 1966 (Fig. 10; Tables 6, 7, and A-3) . Another apparent effect of pollution and siltation in the lower La Grange pool since 1912 has been the extirpation of 23 different kinds of mussels (Table A-25) .

### Alton Pool

During the past three-quarters of a century 21 different kinds of mussels have been extirpated from this lower 80.2 miles of the river (Tables A-3 and A-21; Fig. 15) . Concerning conditions in the Alton pool in 1912, Danglade (1914:7) commented :

> "Whether or not the great amount of sewage that is annually poured into the river is detrimental to the aquatic life in the lower stretches, the fact remains that from Chillicothe to near the mouth, with few exceptions, the Illinois is indeed a wonderfully productive stream in fishes and mussels, and far exceeds in these resources many rivers not having similar physical conditions."

In 1912 Danglade (1914:21-25) noted that some of the mussel beds in the upper part of the Alton pool were "playing out," but in the middle and lower parts of this pool the beds were very productive. Many of these beds were still pro-

**Fig. 15.—The Alton navigation pool of the Illinois River at Hardin. Photo by the author.**

ductive enough in 1966 to support a commercial mussel fishery. At least 38 different kinds of mussels were taken from this pool in 1912 by Danglade (1914:37), whereas only 20 kinds were collected there in the 1966 survey (Table A-3) .

However, fewer species have been eliminated from the Alton pool than have been extirpated elsewhere in the river during the past 54 years (Fig. 10) . Also, in 1966 mussels were much more abundant there than they were in the other pools except for one small area just below Peoria Lake and in Lower Peoria Lake (Fig. 11) . Only in the Alton pool were conditions suitable in 1966 for the support of relatively large-sized populations of pimple-backs (Q. *pustulosa*) and washboards (M. gigantea) and moderate-sized populations of warty-backs (Q. nodulata) and three-horned warty-backs (0. reflexa). The species composition and abundance of mussels in the Alton pool in 1966 clearly indicated that by the time the water reached this pool some semblance of recovery in water quality had occurred although not enough to support the variety and numbers of mussels known to have existed there in 1912.

Richardson (1921*a*:405) noted that in the Alton pool:

> "Inside the 7-foot line in 1915 a soft light-colored silt 2 inches to more than 12 inches deep was found at most of our collecting stations."

Siltation probably has limited the distribution and abundance of such species as the yellow sand-shell (L. a. f. anodontoides) during the past 75 or more years in this pool. However, the prime limiting factor in the Alton pool probably has been the effects of domestic and industrial pollution from upstream sources.

A comparison of the collections of mussels made in the vicinity of Meredosia (river mile 71.2) between 1912 and 1966 indicated that the mussel fauna of the Alton pool was affected adversely by pollution between 1912 and 1930 but that conditions for mussels probably have worsened since 1930 (Table 16) . Only single live specimens of the ebony shell (F. ebena), the fawn's foot (T. donaciformis), and the liliput shell (C. parva) were taken in the 1966 survey, and all of these were taken downstream from Meredosia. The paper pond shell (A. imbecillis) was not collected at Meredosia in 1966 but was taken just below there at Naples. In 1930 and 1955 the buckhorn (T. verrucosa) was present at Meredosia, but in the 1966-1969 period it was only taken farther upstream in the Peoria pool; however, the author believed that this species may still occur rarely in the Alton pool. The yellow sand-shell (L. a. f. anodontoides) was the only mussel taken in 1930 at Meredosia that was not collected alive from some location in the river during the 1966-1969 period (Fig. 10) . This species

Table 16.—Kinds of mussels taken alive from the Illinois River in the vicinity of Meredosia in 1912, 1930, 1955, and 1966.

| Kind of Mussel | Mussels Taken | | | |
|---|---|---|---|---|
| | 1912 | 1930" | 1955 | 1966" |
| F. *ebena* (Ebony Shell) | P[e] | P | A | A |
| F. *f.* f. *undata* (Pig-Toe) | P | A | A | P |
| M. *gigantea* (Washboard) | P | P | P | P |
| A. *plicata* (Three-Ridge) | P | P | P | P |
| Q. *quadrula* (Maple-Leaf) | P | P | P | P |
| Q. *pustulosa* (Pimple-Back) | P | P | P | P |
| Q. *nodulata* (Warty-Back) | P | P | P | P |
| Q. *metanevra* (Monkey-Face) | P | A | A | A |
| T. *verrucosa* (Buckhorn) | P | P | P | A |
| C. *tuberculata* (Purple Warty-Back) | P | A | A | A |
| P. *cyphyus* (Bullhead) | P | A | A | A |
| P. *coccineum* f. *solida* | P | A | A | A |
| E. *crassidens* (Elephant's Ear) | P | A | A | A |
| E. *dilatatus* (Lady-Finger) | P | A | A | A |
| A. *confragosus* (Rock Pocketbook) | P | P | P | P |
| L. *complanata* (White Heel-Splitter) | P | A | A | A |
| A. *grandis* complex (Floater) | P | P | P | P |
| A. *imbecillis* (Paper Pond Shell) | A | P | A | A |
| *O. reflexa* (Three-Horned Warty-Back) | P | P | P | P |
| A. *ligamentina* (Mucket) | P | A | A | A |
| P. *lineolata* (Butterfly) | P | A | A | A |
| T. *truncata* (Deer-Toe) | P | P | P | P |
| T. *donaciformis* (Fawn's Foot) | P | P | P | A |
| L. *fragilis* (Fragile Paper Shell) | P | P | P | P |
| P. *alata* (Pink Heel-Splitter) | P | A | P | P |
| P. *laevissima* (Fragile Heel-Splitter) | P | P | P | P |
| C. *parva* (Liliput Shell) | A | P | A | A |
| L. recta (Black Sand-Shell) | P | A | A | A |
| L. a. f. *anodontoides* (Yellow Sand-Shell) | P | P | A | A |
| L. a. *f..fallaciosa* (Slough Sand-Shell) | P | P | P | P |
| L. r. *luteola* (Fat Mucket) | P | P | P | A |
| L. *ventricosa* (Pocketbook) | P | A | A | A |
| L. *o.* f. *higginsii* (Higgin's Eye) | P | A | A | A |
| Total | *31* | *19* | *16* | *14* |

[e] Collections by Daniels (1914:37) at the old La Grange lock and dam and at Meredosia.
" Collections made in the early 1930's in the vicinity of Meredosia by Dr. J. P. E. Morrison (pers. comm., 4 January 1968).
Collections made 2 miles above Meredosia in 1955 by Dr. Paul W. Parmalee (pers. comm., 21 November 1966).
" 1966 survey in the vicinity of Meredosia (river miles 70.8-79.8).
• P designates present and A designates absent.

was taken alive by Dr. Parmalee in 1955 (pers. comm., 21 November 1966) from the Alton pool and may still occur there as a rare species. The absence of this species in the 1966-1969 study and the present restricted range and scarcity of the four other species mentioned above, all of which were taken alive at Meredosia by Dr. Morrison in 1930, suggested that pollution affecting mussels probably has slightly increased in this section of the river since 1930.

## ORGANOCHLORINE PESTICIDES

The entire bodies (excluding shells) of 14 mussels representing seven species collected from five different locations in the Illinois River during the 1966 survey were analyzed for the presence of organochlorine pesticides (Table 17). All of the mussels analyzed contained residues of these pesticides; however, no measureable peaks were detected in a washboard (*M.* gigantea) collected from

Table 17.–Organochlorine pesticides present in mussels collected from the Illinois River during August 1966.a

| Kind of Mussel | River Mile Number Where Mussel Was Taken | Pesticides in Parts Per Million | | | | |
|---|---|---|---|---|---|---|
| | | DDT | DDE | Heptachlor Epoxide | Dieldrin | Total |
| *M. gigantea* (Washboard) | 42.3 | | 0.0322 | 0.0135 | 0.0063 | 0.0520 |
| " " " | 106.7 | | NMP[b] | NMP | NMP | NMP |
| A. plicata (Three-Ridge) | 42.3 | | 0.0107 | 0.0056 | ... | 0.0163 |
| " " | 106.7 | ... | 0.0143 | 0.0257 | 0.0143 | 0.0543 |
| " " | 171.8 | ... | 0.0275 | 0.0247 | 0.0063 | 0.0585 |
| " | 174.1 | 0.0281 | 0.0056 | 0.0091 | 0.0094 | 0.0522 |
| Q. quadrula (Maple-Leaf) | 42.3 | | 0.0089 | 0.0056 | ... | 0.0145 |
| " | 106.7 | | 0.0071 | 0.0097 | 0.0045 | 0.0213 |
| Q. *pustulosa* (Pimple-Back) | 42.3 | | 0.0054 | 0.0021 | ... | 0.0075 |
| A. g. corpulenta (Floater) | 106.7 | | 0.0179 | 0.0139 | ... | 0.0318 |
| " " " | 174.1 | | 0.0303 | 0.0110 | 0.0073 | 0.0486 |
| " " " | 196.1 | | 0.0066 | 0.0143 | 0.0052 | 0.0261 |
| L. fragilis (Fragile Paper Shell) | 106.7 | ... | 0.0115 | 0.0111 | 0.0054 | 0.0280 |
| P. alata (Pink Heel-Splitter) | 196.1 | 0.0225 | 0.0066 | 0.0169 | 0.0063 | 0.0523 |

a Determinations were made by Dr. W. N. Bruce of the Illinois Natural History Survey.
b NMP indicates no measurable peak.

the La Grange pool at river mile 106.7. From this same site measurable amounts of these pesticides were found in four other species of mussels (Table 17) .

The analysis indicated that considerable variation occurred in the amounts of pesticide residues the mussels contained; however, in no instance did the total concentration exceed 0.0585 ppm, and the average content was 0.0331 ppm. These values may give some insight as to the organochlorine concentrations in the river, since mussels are considered excellent monitors of these pesticides in the freshwater environment (Bedford, Roelfs, & Zabik 1968:125) . Because the Illinois River is located in the agricultural belt of the midwest, the amounts of pesticide residues in the mussels analyzed in this study were expected to be much greater than they were. Possibly they were low because some of the pesticides had been adsorbed in the bottom muds of the tributary streams of the Illinois River.

It was not known what effect, if any, organochlorine pesticides have had upon the mussel population of the river. The present trend among Illinois farmers is toward the use of organophosphate pesticides, which are less persistent in the environment than the organochlorine pesticides (Dr. W. N. Bruce, pers. comm., 1 May 1969) .

## CONSERVATION AND MANAGEMENT

The foregoing analysis indicated that during the past 75 years the Illinois River has changed from an excellent mussel stream to a poor one. The major factors involved in this change have been domestic, industrial, and agricultural pollution. Any environmental improvement for mussel life as well as other aquatic life in the Illinois River can be obtained only through a reduction or more advanced treatment of the wastes being discharged into the river, together with the development and adoption of a new soil conservation plan on the river's watershed to control rapid runoff. These are the basic management needs for the river, and if they are not developed and applied, the environment for aquatic life in much of the Illinois River will continue to deteriorate.

Other management recommendations developed as a result of this study involved the commercial mussel fishery of the river. In 1964 and 1965 a small amount of commercial mussel fishing

was done above Beardstown near Browning and Bath. However, in 1966 all mussel fishing was done in the lower 87 miles of the river between Beardstown and its mouth. This was the only known continuous stretch of the river containing a sufficient number of mussel beds large enough to attract commercial clammers in 1966 (Fig. 16) . The locations of the beds fished commercially in 1966 are given in Table A-26. In addition, three-ridges occurred abundantly enough in 1966 just below Lower Peoria Lake and in Lower and Middle Peoria lakes to have provided commercial fishing.[1]

Considerable variation existed in the estimates of the standing crops of mussels in the commercial beds sampled with

[1] Commercial mussel fishermen removed 208,500 pounds of shells from those waters in 1969 (Webb Moss, pers. comm., 30 October 1969).

Fig. 16.—Johnboats used by commercial mussel fishermen in the Alton navigation pool of the Illinois River in 1966. Photo by Alvin C. Lopinot.

the dredge in 1966 (Table A-27) . These variations were probably the result of sampling errors, differences in the carrying capacities of the beds, and differences in fishing pressure on various beds. The estimates of the standing crops of mussels in two unfished beds in the Peoria pool (river miles 162.3 and 168.2) were thought by the author to give some indication of the number of pounds per acre of commercial-sized mussels (height 2.5 inches or more) that might have been expected in the beds of the lower river in 1966 had they not been fished in recent years. The estimated standing crops of shells of commercial size in these two unfished beds in the Peoria pool were 536 pounds and 2,030 pounds per acre, whereas in the commercially fished beds of the lower river the standing crops of these shells ranged from 51 to 1,312 pounds per acre. These differences in standing crops suggested that many of the beds in the lower river had been heavily fished in recent years.

Additional evidence of heavy fishing pressure in the lower river was reflected by size differences in the three-ridges (A. plicata) taken in the survey in the lower river (Alton pool) and the Peoria pool. The three-ridge was the most abundant commercial shell occurring in the river in 1966. In the survey collections in the Alton pool only 39.8 percent of the three-ridges taken (1,598 shells) were of commercial size, whereas in the unfished Peoria pool 64.0 percent of the three-ridges taken (689 shells) were of commercial size. This highly significant difference in the sizes of the three-ridges between the pools was believed to be the result of the selective removal of the large, desirable, commercial-sized shells by commercial clammers. The growth rate of the three-ridge was better in the Peoria pool than it was in the Alton pool, but it was not great enough to account for the differential in commercial-sized shells found in the two pools (Table A-13) .

In 1967 and 1968 little commercial mussel fishing was done in the Illinois River because of the lack of a market for the shells. The market for Illinois River shells picked up again in 1969. In the author's opinion, the mussel fishery should be carefully regulated to prevent overfishing. The fishery could be regulated by a Department of Conservation temporary administrative order restricting mussel fishing in the river to a limited period during a year when a market demand for shells was anticipated. In slack years the fishery would regulate itself. Shell buyers should be required to furnish the Department of Conservation with accurate statistics on the numbers of tons purchased by them from Illinois River fishermen. Such statistics would be of value in making annual appraisals of the condition of the mussel fishery.

The Japanese need relatively large, thick shells for the nuclei used in the culturing of pearls. Their buyers wanted only shells having a minimum height of 2.5 inches, and they preferred three-ridges and washboards of 3.0 inches or more in height. As was mentioned earlier, the mussel fishery on the Illinois River in 1966 depended largely upon the abundant three-ridge shell. In this study it was found that in the Illinois River the three-ridge did not attain the height of 2.5 inches until it was 10-12 years of age and that it required 18-20 years to attain a height of 3.0 inches (Table A-13) . As a result of this slow growth, very few three-ridges having a height of 3.0 inches or more were found in the river (Table A-12).

The washboard was not nearly as abundant as was the three-ridge, but because of its size, it was the second most important commercial shell occurring in the river (Table 18) . In the Illinois River washboards attained a height of 2.5 inches within 7 years and a height of 3.0 inches within 9 years (Table A-11). In the 1966 survey collections 90.3 percent of the washboards taken had a height of 3.0 inches or more (Table A-10). Most of the washboards taken commercially were of the preferred

size; however, the bulk of the commercial fishery depended upon three-ridges having a height of 2.5-3.0 inches. Therefore, the adoption of a law requiring that three-ridges taken commercially from Illinois waters have a minimum height of 3.0 inches would virtually eliminate the commercial mussel fishery on the Illinois River.

Table 18.—Species composition of mussel shells in sorted commercial piles along the Illinois River at Meredosia and Kampsville in 1966.

| Kind of Mussel | Number Measured | Percent of Shells in Commercial Piles |
|---|---|---|
| Three-Ridge | 957 | 74.8 |
| Washboard | 200 | 15.6 |
| Maple-Leaf | 64 | 5.0 |
| Pimple-Back | 28 | 2.2 |
| Others | 30 | 2.4 |
| Total | 1,279 | 100.0 |

Included pig-toe, slough sand-shell, floaters, rock pocketbook, and white heel-splitter (none of these was of any value either because of size or shell thickness and texture).

In 1966 Illinois regulations permitted the taking of rough shells 1.75 inches and smooth shells 3.0 inches or larger in their greatest dimensions. Under these regulations mussel fishermen were permitted to take shells that were too small for use by the pearl-culture industry. The buyers culled out many of the small shells and informed the fishermen that they needed shells having a height of at least 2.5 inches. The sorted piles of shells (Fig. 17) contained a variety of species of mussels living in the Alton pool, some of which had heights of only 1.5 inches. Many of the shells that had been sorted out were of noncommercial

Fig. 17.—A shell buyer's operation in 1966 below Kampsville, Illinois. Most of these shells were three-ridges (*A. plicata*) and washboards (*M. gigantea*) taken by commercial mussel fishermen from the Alton pool of the Illinois River. Photo by Alvin C. Lopinot.

species. In the sorted commercial shell piles examined by us in 1966 few species other than three-ridges and washboards were of commercial sizes (Table 18) . In the Illinois River very few maple-leaf and pimple-back shells attained a height of 2.5 inches or more (Tables 18, A-15, and A-16), and as a result, most of these shells taken by clammers were wasted because of their small sizes. In 1967 the Seventy-fifth General Assembly of Illinois passed a law making it unlawful to take mussels in Illinois with shells less than 2.5 inches on the shortest line from the center of the hinge side and at a right angle across the shell to the outer edge (height) . The enforcement of this law should reduce the former wanton waste of mussels occurring in the Illinois River.

Other new state regulations on mussel fishing specify the methods and kinds of equipment that commercial clammers may use to take mussels in the Illinois River. These are crowfoot bars, hand picking (wading), hand rakes, hand forks, and hand dredges. Wisely, these regulations prohibited the use of basket dredges, self-contained or ancillary air diving devices, and mechanical or suction devices. Various analyses of the efficiency and selectivity of the methods of mussel fishing employed in the 1966 survey are contained in the appendix of this paper (Tables A-10, A-12, A-15, A-16, A-28, A-29, and A-30) . As indicated in these analyses, large numbers of small mussels were taken with the crowfoot bar and hand dredge. No attempt was made to determine the mortality of small mussels caught with the crowfoot bar or dredge and returned to the river. In our collections made by wading, mussels of all sizes were kept. However, commercial clammers using the wading method could be very selective in the sizes of mussels taken.

Conservation and management planners interested in the pearly mussels of the Illinois River should look beyond the mussels' value as a commercial resource and consider that these organisms are an intricate part of the ecosystem of the river. The present study has demonstrated that 25 kinds of mussels already have been extirpated from the river by the effects of man's activities, and if remedial measures are not taken soon, others will also vanish.

## SUMMARY

1.—The Illinois River is 272.9 miles long and is formed by the confluence of the Des Plaines and Kankakee rivers southwest of Chicago. It empties into the Mississippi River at Grafton, Illinois. Since 1900 Lake Michigan water has been diverted through the Chicago Sanitary and Ship Canal into the Des Plaines River and thence into the Illinois. Through the years this canal has transported the treated and untreated wastes from the Chicago area into the Illinois River system. These wastes together with those from other cities, industries, and agriculture along the Illinois waterway have drastically affected the biota of the river. There were only minor sources of domestic and industrial pollution along the lower 150 miles of the river. Locks and dams, together with dredging, maintain a 9-foot navigation channel to form the Illinois waterway connecting the Mississippi River with Lake Michigan.

2.—A considerable amount of historical biological and chemical data relative to the Illinois River has been published. These data, together with museum records, furnished the background for the present biological investigation.

3.—In 1966 a survey of the pearly mussels (Unionacea) of the Illinois River was made. In this survey 4,247 live mussels were taken in 429 collections from various parts of the river. These collections were made with an exploratory crowfoot bar, with a dredge, and by wading. The largest estimated standing crop of live mussels found in the river was 6,040 pounds per acre. (Several live mussels were obtained from commercial mussel fishermen operating in the Peoria pool in 1969, and the records of these shells are included in the text.)

4.—Subfossil shell collections were made at 21 locations along the Illinois River in 1966.

5.—Twenty-four kinds of living mussels were taken from the Illinois River and its bottomland lakes in the 1966-1969 period. Five species were represented by single specimens. The threeridge (A. plicata) was the most abundant mussel and made up 62.4 percent of the mussels collected. Mussels which were fairly common were the pimpleback (Q. *pustulosa*), the maple-leaf (Q. quadrula), the washboard (M. gigantea), and the floater (A. g. corpulenta).

6.—At least 49 different kinds of mussels were present in the Illinois River and its adjoining bottomland lakes in the 1870-1900 period. Since that period 25 kinds of mussels apparently have been extirpated from these waters. The distribution of many of the surviving species is now quite limited. Domestic and industrial pollution have been major factors adversely affecting mussel life in the Illinois River. Siltation probably also has affected certain species of mussels, such as the yellow sand-shell (L. a. f. anodontoides).

7.—At least 38 different kinds of mussels are known to have occurred in the upper river ( Starved Rock and Marseilles navigation pools) in the 1870-1900 period. By 1912 pollution had virtually wiped out the mussels in this section, and in the 1966 survey no living mussel was taken there. As a result of waste treatment, the dissolved oxygen content of the upper river was much higher in the mid-1960's than it had been in the 1911-1928 period.

8.—By 1930 pollution had affected in varying degrees the mussel life of the entire river. Pollution has had less effect on mussels in the lower part of the river than it has had in the upper portion; however, even in the lower river 21 kinds of mussels have been extirpated in the past 75 years.

9.—The species of mussels found most tolerant to pollution in the Illinois River were the three-ridge (A. plicata), the floater (A. g. corpulenta), the slough sand-shell (L. a. f. fallaciosa), the maple-leaf (Q. quadrula), the fragile paper shell (L. fragilis), the pink heel-splitter (P. alata), and the fragile heel-splitter (P. *laevissima*).

10.—The distance and time required for at least partial dissipation of domestic and industrial pollutants below the Chicago-Joliet and Peoria-Pekin metropolitan areas were reflected by the absence, presence, and abundance of certain species of mussels.

11.—Experimental deletion-type bioassay studies with living mussels and/or other aquatic organisms in river waters and bottom muds might be of value to sanitary and industrial engineers. Such studies might isolate the key pollutants limiting mussels and other aquatic life in a stream, thereby greatly reducing costs in the construction and operation of advanced waste treatment plants.

12.—Comparisons between old and new base-line data for mussels revealed that, in spite of the great reduction since 1922 in the biochemical oxygen demand of the wastes discharged into the Illinois waterway, conditions for mussel life have remained poor in most parts of the river.

13.—It was believed that natural selection has played an important role in reestablishing the mussel beds in Peoria Lake. Improved treatment of municipal and industrial wastes have also undoubtedly helped to improve Peoria Lake as a mussel habitat.

14.—The average amount of organochlorine pesticides in the mussels analyzed from the Illinois River in 1966 was 0.0331 ppm.

15.—Length and height measurements were made of the shells taken alive in the 1966 survey and of some shells in commercial shell piles along the river. Age determinations were made of most of the live mussels taken in the survey.

16.—During the first part of this century the Illinois River supported a large commercial mussel fishery. The effects of pollution on mussel life and the use of plastics for making buttons virtually

eliminated this mussel fishing industry. Recently the demand for shells by the Japanese pearl-culture industry has rejuvenated commercial mussel fishing on the Illinois River.

17.—In 1966 a total of 1,118.4 tons of shells were removed from the Illinois River commercially. These shells were valued at $109,460.83. All of the 1966 commercial mussel fishing on the Illinois River was done on its lower 87 miles. The locations of the mussel beds fished commercially in 1966 and estimates of standing crops of many of these beds are included in this paper. In 1969 commercial mussel fishing was resumed in the vicinity of Peoria where 104.3 tons of shells were removed in that year.

18.—The three-ridge (A. plicata) comprised 74.8 percent of the shells taken commercially from the Illinois River in 1966. The second most important commercial shell was the washboard (M. gigantea).

19.—The three-ridge mussel required 10-12 years to attain the minimum commercial size of 2.5 inches in height in the Illinois River. The washboard attained this height within 7 years. Most of the desirable Quadrula species in this river were too small for commercial use.

20.—The survey data indicated that the mussel beds had recently received heavy fishing pressure in the lower river. Conservation and management recommendations for the mussel fishery are suggested in this paper.

## LITERATURE CITED


BAKER, FRANK COLLINS. 1898. The mollusca of the Chicago area. The Pelecypoda. Part I of the natural history survey. Chicago Academy of Sciences Bulletin 3. 130 p.

_____. 1906. A catalogue of the mollusca of Illinois. Illinois State Laboratory of Natural History Bulletin 7(6) :53-136.

_____. 1928. The fresh water mollusca of Wisconsin. Part II, Pelecypoda. Wisconsin Geological and Natural History Survey Bulletin 70. 495 p. (Also University of Wisconsin Bulletin, Serial 1527, General Series 1301)

BARROWS, HARLAN H. 1910. Geography of the middle Illinois valley. Illinois State Geological Survey Bulletin 15. 128 p.

BARTH, E. F., M. MULBARGER, B. V. SALOTTO, and M. B. ETTINGER. 1966. Removal of nitrogen by municipal wastewater treatment plants. Water Pollution Control Federation Journal 38(7) :1208-1219.

BEDFORD, J. W., E. W. ROELOFS, and M. J. ZABIK. 1968. The freshwater mussel as a biological monitor of pesticide concentrations in a lotic environment. Limnology and Oceanography 13(1):118-126.

BINGHAM, ROY L. 1968. Reproductive seasons of eight freshwater mussels from the Wabash, White, and East Fork of the White rivers of Indiana. Indiana Department of Natural Resources, Division of Fish and Game, Report of subproject 1, survey of the commercial mussel fauna of the Wabash and White rivers. Mimeographed. 102 p.

BROWN, CARL B., J. B. STALL, and E. E. DETURK. 1947. The causes and effects of sedimentation in Lake Decatur. Illinois Water Survey Bulletin 37. 62 p.

CAHN, A. R. 1949. Pearl culture in Japan. General Headquarters Supreme COmmander for the Allied Powers, Natural Resources Section Report 122. 91 p.

CALKINS, W. W. 1874. The land & fresh water shells of La Salle County, Ills. Ottawa Academy of Natural Sciences Proceedings. 48 p.

CALL, RICHARD ELLSWORTH. 1900. A descriptive illustrated catalogue of the mollusca of Indiana. Indiana Department of Geology and Natural Resources 24th Annual Report for 1899:335-536.

CLARKE, A. H. JR. 1966. Genetic and ecophenctypic relationships in northern Anodonta populations. American Malacological Union Annual Reports for 1966:24-26.

_____, and CLIFFORD O. BERG. 1959. The freshwater mussels of central New York with an illustrated key to the species of northeastern North America. Cornell University Agricultural Experiment Station, New York State College of Agriculture Memoir 367. 80 p.

COKER, ROBERT E. 1921. Fresh-water mussels and mussel industries of the United States. U. S. Bureau of Fisheries Bulletin for 1917-1918, 36:11-89.

COOPER, WILLIAM. 1855. List of shells collected by Mr. Schoolcraft, in the Western and Northwestern Territory, p. 515-518. *In* Henry R. Schoolcraft, Summary narrative of an exploratory expedition to the sources of the Mississippi River, in 1820: resumed and completed, by the discovery of its origin in Itasca Lake, in 1832. Lippincott, Grambo, and Co., Philadelphia.

CVANCARA, ALAN M. 1963. Clines in three species of Lampsilis (Pelecypoda: Unionidae) . Malacologia 1 ( 2 ) : 215-225.

DANGLADE, ERNEST. 1914. The mussel resources of the Illinois River. U. S. Bureau of Fisheries, appendix 6 to the report of the U. S. Commissioner of Fisheries for 1913. 48 p.

ELLIS, M. M. 1936. Erosion silt as a factor in aquatic environments. Ecology 17(1) :29-42.

_____. 1937. Detection and measurement of stream pollution. U. S. Bureau of Fisheries Bulletin 22:365-437.

FORBES, STEPHEN A., and R. E. RICHARDSON. 1913. Studies on the biology of the upper Illinois River. Illinois State Laboratory of Natural History Bulletin 9(10) :481-574.

_____, and _____ 1919. Some recent changes in Illinois River biology. Illinois State Natural History Survey Bulletin 13 (6) :139-156.

_____, and _____ 1920. The fishes of Illinois. Second ed. Illinois Natural History Survey. cxxxvi + 357 p.

GOODRICH, CALVIN, and HENRY VAN DER SCHALIE. 1944. A revision of the mollusca of Indiana. American Midland Naturalist 32(2) :257-326.

HOSKINS, J. K., C. C. RUCHHOFT, and L. G. WILLIAMS. 1927. A study of the pollution and natural purification of the Illinois River. I. Surveys and laboratory studies. U. S. Public Health Service Bulletin 171. 208 p.

HUTCHINSON, G. EVELYN. 1957. A treatise cn limnology. Vol. I. Geography, physics, and chemistry. John Wiley & Sons, Inc., New York. 1,015 p.

ILLINOIS COOPERATIVE CROP REPORTING SERVICE. 1965. Illinois agricultural statistics annual summary. Illinois Department of Agriculture and U. S. Department of Agriculture Bulletin 65-1. 109 p.

ILLINOIS STATE SANITARY WATER BOARD. 1967. Illinois water quality data-1966 with data analysis. Illinois State Sanitary Water Board in cooperation with the Illinois Department of Public Health. 109 p.

JACKSON, HARRY O., and WILLIAM C. STARRETT. 1959. Turbidity and sedimentation at Lake Chautauqua, Illinois. Journal of Wildlife Management 23(2) :157-168.

KELLY, H. M. 1899. A statistical study of the

parasites of the Unionidae. Illinois State Laboratory of Natural History Bulletin 5(8):399-418.

KEUP, LOWELL E., WILLIAM MARCUS INGRAM, JACK GECKLER, and WILLIAM BLISS HORNING, II. 1965. Biology of Chicago's waterways. U. S. Department of Health, Education, and Welfare, Division of Water Supply and Pollution Control, Environmental Health Series. Public Health Service Publication 999-WP-32. 20 p.

KOFOID, C. A. 1903. Plankton studies. IV. The plankton of the Illinois River, 1894-1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. Illinois State Laboratory of Natural History Bulletin 6(2) :95-635.

LOPINOT, AL C. 1967. The Illinois mussel. Outdoor Illinois 6(3) :8-15.

MARSH, WILLIAM A. 1887-1889. Brief notes on the land and fresh-water shells of Mercer Co., Ill. Conchologists' Exchange 1 (8) :42-43, 1(9&10) :50-51, 1(11):62-63, 1(12):74-75, 2(1):4-5, 2(2):20-21, 2(3): 36-37, 2(4) :48-50, 2(5) :65-67, 2(6) :80-81, 2(7):90-92, 2(8):103-104, 2(9):110-111. Nautilus 3(2) :23-24, 3(3) :34-35.

MEYER, EDWARD R. 1968. The distribution and abundance of freshwater mussels of the family Unionidae (Pelecypoda) of the Wabash, White, and East Fork of the White rivers of Indiana. Indiana Department of Natural Resources, Division of Fish and Game, Report of subproject 2, survey of the commercial mussel fauna of the Wabash and White rivers. Mimeographed. 68 p.

MILLS, HARLOW B., WILLIAM C. STARRETT, and FRANK C. BELLROSE. 1966. Man's effect on the fish and wildlife of the Illinois River. Illinois Natural History Survey Biological Notes 57. 24 p.

ORTMANN, A. E. 1918. The nayades (freshwater mussels) of the upper Tennessee drainage. With notes on synonymy and distribution. American Philosophical Society Proceedings 57:521-626.

_____ 1919. A monograph of the naiades of Pennsylvania. Part III. Systematic account of the genera and species. Memoirs of the Carnegie Museum 8(1) :1-384.

_____. 1920. Correlation of shape and station in freshwater mussels (Naiades). American Philosophical Society Proceedings 59:269-312.

PARMALEE, PAUL W. 1962. Additional faunal records from the Kingston Lake Site, Illinois. Illinois State Academy of Science Transactions 55(1) :6-12.

_____. 1967. The fresh-water mussels of Illinois. Illinois State Museum, Popular Science Series, Vol. 8. 108 p.

PURDY, W. C. 1930. A study of the pollution and natural purification of the Illinois River. II. The plankton and related organisms. U. S. Public Health Service Bulletin 198. 212 p.

RICHARDSON, ROBERT E. 1921a. The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: its valuation; its sources of food supply; and its relation to the fishery. Illinois State Natural History Survey Bulletin 13(15) :363-522.

_____. 1921b. Changes in the bottom and shore fauna of the middle Illinois River and its connecting lakes since 1913-1915 as a result of the increase, southward, of sewage pollution. Illinois State Natural History Survey Bulletin 14(4) :33-75.

_____. 1925a. Changes in the small bottom fauna of Peoria Lake, 1920 to 1922. Illinois State Natural History Survey Bulletin 15(5) :327-388.

_____. 1925b. Illinois River bottom fauna in 1923. Illinois State Natural History Survey Bulletin 15(6) :391-422.

_____. 1928. The bottom fauna of the middle Illinois River, 1913-1925. Its distribution, abundance, valuation, and index value in the study of stream pollution. Illinois State Natural History Survey Bulletin 17(12):387-475.

SIMPSON, CHARLES TORREY. 1914. A descriptive catalogue of the naiades, or pearly fresh-water mussels. Bryant Walker, Detroit. 1,540 p.

SMITH, HUGH M. 1899. The mussel fishery and pearl-button industry of the Mississippi River. U. S. Fish Commission Bulletin for 1898, 18:289-314.

SPICER, J. I. 1952. Personal impressions of the Rivers (Prevention of Pollution) Act, 1951. Institute of Sewage Purification Journal 3: 181-194. *In* Louis Klein. 1959. River pollution. I. Chemical analysis, p. 113. Butterworth & Co. (Publishers) Ltd., London. (Original not seen.)

STALL, JOHN B. 1966. Man's role in affecting the sedimentation of streams and reservoirs. Second Annual American Water Resources Conference Proceedings: 79-95.

_____ and S. W. MELSTED. 1951. The silting of Lake Chautauqua, Havana, Illinois. Illinois State Water Survey, in cooperation with Illinois Agricultural Experiment Station, Report of Investigation 8. 15 p.

STANSBERY, DAVID HONOR. 1960. The Unioninae (Mollusca, Pelecypoda, Naiadacea) of Fishery Bay, South Bass Island, Lake Erie. Ph.D. Thesis. The Ohio State University, Columbus. 216 p.

_____. 1961. The naiades (Mollusca, Pelecypoda, Unionacea) of Fishery Bay, South Bass Island, Lake Erie. Part I. Introduction, history, faunal origins, and physiography. Sterkiana 5. 37 p.

_____. 1962. The naiades recorded from the Ohio River system of North America (Mollusca: Pelecypoda: Unionacea). A checklist compiled from literature and museum records. The Ohio State University and The Ohio State Museum. Mimeographed. 6 p.

_____. 1966. Observations on the habitat distribution of the naiad *Cumberlandia* monodonta (Say, 1829). American Malacological Union Annual Reports for 1966: 29-30. (Abstract)

_____. 1967. A provisional classification of the Pleurobema cord atum (Rafinesque, 1820) complex in the Mississippi River drainage basin of North America (Mollusca: Pelecypoda: Unionacea). Paper presented at the 15th annual meeting of the Midwest Benthological Society at Carbondale, Illinois. Mimeographed. 2 p.

STARRETT, WILLIAM C., and ARNOLD W. FRITZ. 1965. A biological investigation of the fishes of Lake Chautauqua, Illinois. Illinois Natural History Survey Bulletin 29(1) :1-104.

STEIN, CAROL B. 1968. Studies in the life history of the naiad, Amblema plicata (Say, 1817). American Malacological Union Annual Reports for 1968:46-47.

STRODE, W. S. 1891a. Mollusks of Thompson's Lake, Illinois. Nautilus 4(12) :133-134.

_____. 1891b. Destruction of Anodonta corpulenta Cpr. at Thompson's Lake, Ill. Nautilus 5(8) :89-90.

SULLIVAN, WILLIAM T., and RALPH L. EVANS. 1968. Major U. S. river reflects surfactant changes. Environmental Science & Technology 2(3) :194-200.

_____, and DAVID L. HULLINGER. 1969. Phosphates in Peoria Lake. A quantitative and qualitative evaluation of a nutrient in natural waters. Illinois State Academy of Science Transactions 62(2) :198-217.

THOMPSON, DAVID H. 1928. The "knothead" carp of the Illinois River. Illinois State Natural History Survey Bulletin 17(8) :285-320.

U. S. GEOLOGICAL SURVEY. 1967. Water resources data for Illinois 1966. Part 1: Surface water records. Part 2: Water quality records. U. S. Department of the Interior, Geological Survey. 249 p.

U. S. PUBLIC HEALTH SERVICE. 1963. Report on the Illinois River system, water quality conditions: Part 1, Text. U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, Great Lakes-Illinois River Basins Project. 158 p.

VAN DER SCHALIE, HENRY, and ANNETTE VAN DER SCH ALIE . 1950. The mussels of the Mississippi River. American Midland Naturalist 44(2) :448-466.

VERDUIN, JACOB. 1967. Eutrophication and agriculture in the United States, p. 163-172. In Nyle C. Brady, Editor, Agriculture and the quality of our environment. American Association for the Advancement of Science, Washington, D.C.

VERTREES, HERBERT H. 1913. Pearls and pearling. Fur News Publishing Co., New York. 203 p.

WALKER, WARD. [1956.] The story of the metropolitan sanitary district of greater Chicago. The seventh wonder of America. Metropolitan Sanitary District of Greater Chicago. 39 p.

WILSON, CHARLES B., and H. WALTON CLARK. 1912. The mussel fauna of the Kankakee basin. U. S. Bureau of Fisheries Document 758. 52 p.

WURTZ, CHARLES B. 1962. Zinc effects on fresh-water mollusks. Nautilus 76(2) :53-61.

Table A-1.—Ranges and averages of chemical and bacteriological determinations made on the Illinois River in 1966 by the Illinois State Sanitary Water Board (1967).

| *Analyses* | *Alton Pool* | *La Grange Pool* | | *Peoria Pool* | | | *Starved Rock Pool* | *Marseilles Pool* |
|---|---|---|---|---|---|---|---|---|
| | 71.2[a] | 87.9 | 119.7 | 161.6 | 189.2 | 218.4 | 239.7 | 263.5 |
| Hardness ppm | | | | | | | | |
| Range | 240-444 | 240-432 | 240-444 | 232-448 | 216-440 | 220-416 | 204-356 | 212-388 |
| *Average* | *307* | *301* | *306* | *322* | *320* | *318* | *249* | *293* |
| Chlorides ppm | | | | | | | | |
| Range | 22-72 | 22-60 | 18-96 | 28-68 | 28-64 | 24-62 | 27-58 | 26-80 |
| *Average* | *41* | *41* | *46* | *46* | *45* | *44* | *49* | *55* |
| Sulfate ppm | | | | | | | | |
| Range | 20-66 | 11-49 | 12-54 | 19-90 | 22-98 | 17-90 | | 14-123 |
| *Average* | *33* | *31* | *32* | *36* | *37* | *39* | | *44* |
| Total Solids ppm | | | | | | | | |
| Range | 350-500 | 340-490 | 330-540 | 370-550 | 330-550 | 350-540 | 349-476 | 360-550 |
| *Average* | *413* | *413* | *427* | *437* | *439* | *451* | *396* | *458* |
| BOD ppm | | | | | | | | |
| Range | 0-8 | 1-8 | 0-8 | 2-9 | 3-10 | 3-10 | 1-30 | 3-8 |
| *Average* | *4* | *5* | *6* | *6* | *6* | *6* | *15* | *6* |
| Nitrate ppm | | | | | | | | |
| Range | | | | 26-26 | | | | 4-5 |
| *Average* | | | | *26* | | | | *4* |

[a] River miles, i.e., miles from the mouth of the Illinois River at Grafton, Illinois.

Table A-1-Continued

| Analyses | AltonPool | La Grange Pool | | | Peoria Pool | | Starved Rock Pool | Marseilles Pool |
|---|---|---|---|---|---|---|---|---|
| | 71.2* | 87.9 | 119.7 | 161.6 | 189.2 | 218.4 | 239.7 | 263.5 |
| **Radioactivity** | | | | | | | | |
| **Alpha picocurie Per liter** | | | | | | | | |
| **Range** | 0-12 | 0-8 | 0-9 | 0-5 | 0-4 | 2-6 | 0-1 | 1-5 |
| *Average* | *3* | *2* | *3* | *3* | *2* | ***2*** | ***0*** | ***3*** |
| ***Beta* picocurie Per liter** | | | | | | | | |
| **Range** | 0-23 | 0-43 | 0-32 | 0-49 | 0-25 | 0-25 | 4-20 | 0-29 |
| *Average* | ***7*** | ***12*** | ***12*** | ***17*** | ***11*** | ***10*** | ***9*** | ***14*** |
| **Bacterial Counts** | | | | | | | | |
| Coliform Per **100 ml** | | | | | | | | |
| **Range** | 210-35,000 | 110-34,000 | 920-76,000 | 10-10,000 | 40-52,000 | 340-80,000 | 900-300,000 | 260-44,000 |
| *Average* | ***9,872*** | ***13,675*** | ***25,743*** | *1,690* | *6,302* | ***17,840*** | ***49,222*** | ***11,634*** |
| **Enterococcus Per** 100 ml | | | | | | | | |
| **Range** | 6-33,000 | 2-17,000 | 6-16,000 | 2-4,200 | 2-1,300 | 4-4,000 | 0-7,000 | 2-260 |
| *Average* | ***2,900*** | ***1,497*** | ***1,539*** | *413* | *137* | ***644*** | ***1,244*** | ***54*** |
| **Standard Plate Count Per ml** | | | | | | | | |
| **Range** | 1,700-160,000 | 2,400-78,000 | 2,100-440,000 | 1,300-370,000 | 1,500-35,000 | 2,300-190,000 | 7,300-1,500,000 | 8,100-590,000 |
| *Average* | ***25,050*** | ***25,475*** | ***67,641*** | ***38,858*** | ***11,033*** | ***41,218*** | ***158,665*** | ***143,918*** |

Table A-2.-Dissolved oxygen, total alkalinity (methyl orange), pH, temperature, and ABS (detergent) determinations made in the Illinois River channel in July and August 1966.

| *River Mile*[a] | *Dissolved Oxygen in ppm*[b] | *Alkalinity in ppm* | *pH* | *Temperature in Degrees Centigrade"* | *ABS (Detergent) in ppm* |
|---|---|---|---|---|---|
| | | Alton Pool | | | |
| 26.0 | 2.3-2.6 | ... | 7.7 | 26.8 | 0.05 |
| 28.9 | 1.8-2.1 | 127 | 7.6 | 26.8 | 0.05 |
| 31.5 | 2.3 | ... | ... | 26.8 | ... |
| 34.2 | 2.3 | 127 | 7.6 | 26.8 | 0.1 |
| 36.3 | 2.1 | ... | | 26.8 | ... |
| 39.3 | 1.9-2.0 | 131 | 7.7 | 26.8 | 0.1 |
| 41.4 | 2.1 | | ... | 26.8 | |
| 42.8 | 2.1-2.2 | | 7.6 | 26.8 | |
| 44.9 | 2.2 | | ... | 26.7 | |
| 46.1 | 2.0-2.3 | ... | 7.6 | 26.8 | 0.1 |
| 50.0 | 2.7 | 135 | 7.6 | 26.8 | 0.1 |
| 52.7 | 2.7 | | ... | 26.8 | |
| 54.8 | 2.6-2.7 | | 7.6 | 26.8 | ... |
| 56.4 | ... | | ... | 26.5 | 0.1 |
| 57.8 | 2.8 | | | 26.6 | |
| 60.8 | 2.9 | ... | | 26.4 | ... |
| 62.6 | 3.0 | 135 | 7.7 | 26.2 | 0.1 |
| 64.4 | 3.1 | ... | ... | 26.2 | ... |
| 66.6 | 3.2 | 135 | 7.7 | 26.4 | 0.1 |
| 68.4 | 3.3 | | ... | 26.4 | |
| 69.4 | 3.3-3.4 | | 7.7 | 26.4 | |
| 71.2 | 3.3 | ... | | 26.4 | ... |
| 73.0 | 3.4 | 143 | 7.7 | 26.4 | 0.1 |
| 74.5 | 3.4 | | ... | 26.6 | |
| 75.9 | 3.5-3.7 | | ... | 26.7 | |
| 76.9 | 3.6 | | 7.7 | 26.7 | |
| 78.4 | 3.7 | | ... | 26.7 | |
| 79.3 | 3.6 | 143 | 7.7 | 26.7 | 0.1 |

[a] Number of miles from mouth of Illinois River at Grafton, Illinois.
[b] Samples taken at 3 feet below the surface.

Table A-2.—Continued

| River Mile[a] | Dissolved Oxygen in ppm[b] | Alkalinity in ppm | pH | Temperature in Degrees Centigrade[b] | ABS (Detergent) in ppm |
|---|---|---|---|---|---|
| | | La Grange Pool | | | |
| 81.0 | 1.1-1.6 | 147 | 7.5 | 26.8 | 0.1 |
| 82.3 | 1.6 | | ... | 26.7 | |
| 84.1 | 1.3-1.9 | | 7.6 | 26.7 | |
| 85.5 | 1.0-1.6 | .. | ... | 26.7 | ... |
| 87.0 | 0.9-1.5 | 14 | 7.5 | 26.3 | 0.1 |
| 89.2 | 0.9 | | | 26.5 | ... |
| 90.2 | 0.9-1.0 | 64 | 7.4 | 26.6 | 0.1 |
| 91.5 | 0.8 | | 7.3 | 26.5 | |
| 94.3 | 0.8 | | 7.3 | 26.6 | |
| 95.3 | 0.8-0.9 | | ... | 26.6 | |
| 97.3 | 0.8 | | 7.3 | 26.5 | |
| 98.2 | 0.9-1.1 | ... | | 26.4 | ... |
| 99.5 | 0.9 | 143 | .3 | 26.4 | 0.1 |
| 100.9 | 0.8 | | .. | 26.4 | |
| 103.4 | 0.7-0.8 | | .4 | 26.7 | |
| 105.5 | 0.7 | ... | ... | 26.8 | ... |
| 106.9 | 0.6 | 143 | 7.4 | 26.8 | 0.1 |
| 110.2 | 0.6-0.7 | | | 26.7 | |
| 113.3 | 0.6-0.7 | | 7.3 | 26.6 | |
| 114.3 | 0.5-0.6 | | ... | 26.6 | |
| 116.3 | 0.8 | | 7.3 | 26.6 | |
| 117.6 | 0.9-1.0 | | ... | 26.4 | ... |
| 119.7 | 1.0 | 113 | 7.3 | 26.6 | 0.1 |
| 120.0 | 1.0 | ... | | 26.7 | ... |
| 121.1 | 0.9-1.0 | 143 | 7.4 | 26.8 | 0.1 |
| 122.8 | 1.0-1.2 | | 7.4 | 26.6 | |
| 123.6 | 1.2 | | .. | 26.8 | ... |
| 125.8 | 1.3-1.5 | ) | .4 | 26.3-26.4 | 0.1 |
| 128.0 | 1.5-1.6 | | .. | 26.8 | |
| 129.5 | 1.4 | | .4 | 26.6 | |
| 132.0 | 1.7-1.8 | ... | | 26.6-26.8 | ... |
| 134.0 | 1.5 | 154 | 7.4 | 26.4 | 0.1 |
| 135.7 | 1.5 | | 7.4 | 26.3 | |
| 139.0 | 1.6 | ... | | 26.4 | |
| 140.8 | 1.9 | 147 | 7.4 | 26.6 | 0.1 |
| 143.2 | 2.3-2.4 | | 7.4 | 26.7 | ... |
| 145.5 | 2.9 | 113 | 7.4 | 26.5 | 0.1 |
| 147.3 | 2.7 | | ... | 26.6 | |
| 148.5 | 3.4 | | 7.4 | 26.5 | |
| 149.4 | 3.5 | ... | ... | 26.3 | ... |
| 151.2 | 4.3 | 147 | 7.5 | 26.3 | 0.1 |
| 152.0 | 4.6-4.7 | | | 26.3 | ... |
| 153.5 | 4.7 | 150 | | 26.6 | 0.1 |
| 154.9 | 5.4-5.5 | | | 26.3 | |
| 156.5 | 5.8-6.0 | ... | | 26.5-26.7 | ... |
| 157.1 | 5.8 | 143 | 7.5 | 26.7 | 0.1 |

Table A-2.—Continued

| River Mile[a] | Dissolved Oxygen in ppm[b] | Alkalinity in ppm | pH | Temperature in Degrees Centigrade[b] | ABS (Detergent) in ppm |
|---|---|---|---|---|---|
| | | Peoria Pool | | | |
| 159.4 | 1.5-1.9 | 154 | 7.7 | 28.6-28.8 | 0.1 |
| 161.1 | 2.2-2.3 | | ... | 28.9 | |
| 162.4 | 2.3-4.7 | | 8.0 | 28.7-28.8 | ... |
| 164.4 | 2.2-4.7 | 150 | 8.3 | 28.0-28.8 | 0.1 |
| 165.3 | 2.6-2.9 | ... | ... | 28.2-28.4 | ... |
| 166.8 | 3.1-4.1 | 154 | 7.7 | 28.3-28.6 | 0.1 |
| 168.9 | 2.5-5.4 | | ... | 28.3-29.3 | |
| 170.9 | 2.1-4.2 | ... | 8.4 | 29.0-29.3 | ... |
| 173.4 | 2.1-5.9 | 143 | 8.7 | 28.8-29.3 | 0.1 |
| 174.9 | 2.0-3.3 | | 7.6 | 29.1-29.4 | |
| 176.6 | 1.2 | | 7.5 | 28.9 | |
| 177.4 | 0.9-1.1 | | ... | 29.0 | ... |
| 179.0 | 0.9-1.0 | 7 | 7.4 | 29.1 | 0.1 |
| 179.7 | 0.9 | | ... | 29.1 | |
| 181.0 | 0.9 | ... | ... | 29.2 | ... |
| 181.3 | 0.9 | 147 | 7.4 | 29.2 | 0.1 |
| 182.8 | 0.9 | | 7.3 | 29.5 | |
| 184.1 | 1.1 | ... | | 29.4-29.5 | |
| 186.4 | 0.9-1.1 | 147 | 7.3 | 29.6-29.7 | |
| 189.0 | 1.0 | | | 29.8 | |
| 190.0 | 0.9 | 143 | 7.3 | 29.8 | 0.2 |
| 191.6 | 1.2 | | 7.3 | 29.8 | |
| 193.3 | 1.1 | ... | | 29.8 | |
| 195.8 | 1.0-1.2 | 143 | 7.2 | 29.8-29.9 | 0.2 |
| 196.2 | 1.2 | 147 | 7.4 | 29.2 | 0.1 |
| 197.2 | 1.2 | ... | | 29.7 | |
| 198.1 | 1.3-1.4 | 147 | 7.4 | 29.7 | |
| 199.3 | 1.6 | | 7.4 | 29.7 | |
| 200.4 | 1.6-1.7 | ... | | 29.7 | .. |
| 201.0 | 1.9 | 150 | 7.3 | 29.8 | 0. |
| 202.9 | 2.2 | | | 29.9 | |
| 204.0 | 2.3 | | ... | 30.0 | .. |
| 205.0 | 2.4 | 154 | 7.4 | 30.0 | 0. |
| 207.6 | 2.3 | | 7.4 | 29.8 | |
| 209.4 | 2.1-2.2 | | ... | 29.8 | .. |
| 210.7 | 2.3-2.5 | 60 | 7.4 | 30.0-30.3 | 0. |
| 213.4 | 3.0 | | 7.4 | 29.8 | |
| 214.9 | 3.3 | | 7.4 | 29.8 | |
| 217.1 | 3.1 | ... | .. | 29.9 | .. |
| 219.1 | 3.1-3.2 | 143 | .4 | 29.9 | 0. |
| 220.7 | 3.3 | | | 29.9 | |
| 223.9 | 3.8 | | .4 | 29.9 | |
| 225.8 | 4.5 | | .. | 30.0 | |
| 226.3 | 4.7-4.8 | | .4 | 30.0 | |
| 228.1 | 5.0 | | ... | 30.0 | .. |
| 229.7 | 5.3 | 158 | 7.4 | 30.0 | 0. |

Table A-2.--Continued

| River *Mile*[a] | *Dissolved Oxygen in ppm*[b] | *Alkalinity in ppm* | pH | Temperature in Degrees Centigrade[a] | ABS (Detergent) *in ppm* |
|---|---|---|---|---|---|
| | | Starved Rock Pool | | | |
| 231.7 | 6.6–9.1 | 143 | 7.8 | 27.8–28.3 | 0.1 |
| 233.0 | 6.3–6.4 | | 7.9 | 28.1–29.3 | |
| 234.5 | 8.4–8.9 | | 8.1 | 28.3–28.6 | .. |
| 237.2 | 5.9–6.1 | 143 | 7.7 | 29.0 | 0. |
| 238.5 | 4.7–5.4 | | 7.6 | 28.8 | |
| 239.9 | 4.4–4.6 | | ... | 28.8 | ... |
| 240.6 | 4.7 | 143 | 7.5 | 29.0 | 0.1 |
| 241.5 | 5.2 | | 7.4 | 29.1 | |
| 242.9 | 5.1 | ... | | 29.3 | ... |
| 244.1 | 4.9–5.8 | 143 | 7.3 | 29.1 | 0.2 |
| | | Marseilles Pool | | | |
| 248.2 | 6.2–6.4 | 130 | 7.8 | 29.1 | 0.1 |
| 249.4 | 5.4 | | | 29.3 | |
| 251.0 | 5.0–5.8 | | 7.5 | 29.3 | |
| 251.8 | 4.9 | | 7.7 | 29.3 | |
| 253.0 | 5.1–5.8 | | ... | 29.8 | |
| 253.6 | 5.0 | | 7.7 | 29.8 | |
| 255.0 | 4.9–5.1 | | | 29.6 | ... |
| 256.0 | 4.4 | 147 | 7.5 | 29.8 | 0.2 |
| 257.6 | 4.2 | | | 29.8 | |
| 258.8 | 3.5 | | ... | 29.8 | |
| 259.3 | 3.5 | | 7.3 | 29.8 | |
| 260.7 | 3.0–3.2 | | | 29.8 | |
| 261.0 | 3.0–3.2 | | ... | 29.8 | |
| 262.3 | 2.8–2.9 | ... | 7.3 | 29.8 | ... |
| 263.7 | 3.0–3.3 | 150 | 7.3 | 29.8 | 0.2 |
| 265.0 | 3.3 | | 7.3 | 29.8 | |
| 265.8 | 3.7 | | | 30.0 | |
| 266.4 | 3.8 | | | 30.3 | |
| 267.2 | 3.9–4.0 | | 3.3 | 30.6 | |
| 269.5 | 4.2–4.4 | | | 31.0 | .. |
| 270.6 | 4.7–4.8 | 155 | 7.3 | 31.0–31.3 | 0. |
| | | Dresden Pool | | | |
| 272.1 | 0.9–1.0 | 162 | 7.4 | 31.0 | 0.4 |

Table A-3.-Numbers and kinds of live mussels taken during the 1966 survey of the Illinois River, by navigation pool and river section

| Species | *Alton Pool* — River Milea or Bottomland Lakeb | | | | | | | | | *La Grange Pool* — River Mile or Bottomland Lake | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.9 to 5.5 | 10.5 to 15.1 | 19.2 to 29.0 | 30.5 to 39.2 | 40.3 to 48.3 | 51.0 to 58.9 | 60.8 to 69.4 | 70.8 to 79.8 | Total From Alton Pool | 80.3 to 87.9 | 90.2 to 100.5 | 106.6 to 114.0 | Bath Chute | Lake Matan-zas | 115.3 to 123.0 | Qui-ver Lake | 125.0 to 135.5 | 140.5 to 149.7 | 150.6 to 156.6 | Total From La Grange Pool |
| *Fusconaia ebena* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fusconaia f. f. undata* | 1 | 3 | 3 | 0 | 1 | 3 | 1 | 14 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| *Megalonaias gigantea* | 31 | 6 | 30 | 21 | 20 | 47 | 24 | 4 | 183 | 5 | 2 | 7 | 7 | 0 | 0 | 2 | 0 | 0 | 0 | 23 |
| *Amblema plicata* | 177 | 124 | 133 | 100 | 235 | 226 | 432 | 171 | 1,598 | 37 | 82 | 140 | 15 | 0 | 25 | 49 | 5 | 3 | 7 | 363 |
| *Quadrula quadrula* | 29 | 11 | 7 | 22 | 39 | 29 | 94 | 36 | 267 | 10 | 17 | 21 | 6 | 0 | 13 | 3 | 8 | 0 | 8 | 86 |
| *Quadrula pustulosa* | 12 | 18 | 13 | 23 | 94 | 67 | 154 | 32 | 413 | 0 | 1 | 8 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 13 |
| *Quadrula nodulata* | 6 | 3 | 1 | 6 | 7 | 1 | 25 | 14 | 63 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Arcidens confragosus* | 1 | 20 | 4 | 4 | 9 | 15 | 4 | 1 | 58 | 5 | 0 | 4 | 2 | 0 | 1 | 0 | 4 | 0 | 0 | 16 |
| *Lasmigona complanata* | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 5 |
| *Anodonta g. grandis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| *Anodonta g. corpulenta* | 18 | 3 | 1 | 1 | 0 | 1 | 12 | 2 | 38 | 1 | 0 | 3 | 1 | 0 | 2 | 0 | 10 | 9 | 1 | 27 |
| *Anodonta imbecillis* | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| *Anodonta suborbiculata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Obliquaria reflexa* | 20 | 4 | 3 | 0 | 3 | 5 | 5 | 8 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| *Obovaria olivaria* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Truncilla truncata* | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 8 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *Truncilla donaciformis* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leptodea fragilis* | 2 | 3 | 1 | 0 | 2 | 5 | 14 | 10 | 37 | 0 | 7 | 7 | 1 | 0 | 4 | 0 | 0 | 1 | 1 | 21 |
| *Proptera alata* | 3 | 2 | 0 | 0 | 1 | 2 | 1 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| *Proptera laevissima* | 13 | 2 | 0 | 0 | 2 | 0 | 2 | 1 | 20 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | 4 | 1 | 12 |
| *Carunculina parva* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lampsilis a. L. fallaciosa* | 7 | 1 | 0 | 0 | 1 | 4 | 4 | 12 | 29 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 |
| *Lampsilis r. luteola* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| *Total* | *326* | *201* | *196* | *178* | *414* | *405* | *777* | *310* | *2,807* | *67* | *115* | *193* | *34* | *1* | *46* | *60* | *36* | *19* | *20* | *591* |

Miles from the mouth of the Illinois River at Grafton, Illinois
b Meredosia Lake was fished for mussels, but none was taken there.

Table A-3.—Continued

| Species | Peoria Pool | | | | | | | | | | | Total From Peoria Pool | Starved Rock Pool | Marseilles Pool | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | River Mile | | | | | | | | | | | | | | |
| | 158.1 to 160.0 | 161.1 to 162.3[c] | 163.0 to 166.1" | 166.3 to 166.6" | 167.2 to 174.9[d] | 174.9 to 179.7 | 180.5 to 188.0 | 190.0 to 199.3 | 200.4 to 209.4 | 210.7 to 219.8 | 220.7 to 229.3 | | | | |
| *Fusconaia ebena* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Fusconaia f. f. undata* | 0 | 7 | 0 | 2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 0 | 0 | 46 |
| *Megalonaias gigantea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 207 |
| *Amblema plicata* | 1 | 185 | 24 | 16 | 454 | 0 | 5 | 2 | 1 | 0 | 1 | 689 | 0 | 0 | 2,650 |
| *Quadrula quadrula* | 0 | 16 | 0 | 1 | 19 | 0 | 0 | 0 | 0 | 1 | 0 | 37 | 0 | 0 | 390 |
| *Quadrula pustulosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 425 |
| *Quadrula nodulata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 66 |
| *Arcidens confragosus* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 78 |
| *Lasmigona complanata* | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 13 |
| *Anodonta g. grandis* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 4 |
| *Anodonta g. corpulenta* | 0 | 4 | 2 | 2 | 34 | 2 | 0 | 6 | 0 | 0 | 1 | 51 | 0 | 0 | 116 |
| *Anodonta imbecillis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 5 |
| *Anodonta suborbiculata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Obliquaria reflexa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 |
| *Obovaria olivaria* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Truncilla truncata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Truncilla donaciformis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Leptodea fragilis* | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 6 | 0 | 0 | 64 |
| *Proptera alata* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 5 | 0 | 0 | 16 |
| *Proptera laevissima* | 0 | 3 | 2 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 10 | 0 | 0 | 42 |
| *Carunculina parva* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Lam psilis a. f. fallaciosa* | 0 | 0 | 2 | 1 | 6 | 2 | 1 | 2 | 0 | 0 | 2 | 16 | 0 | 0 | 53 |
| *Lampsilis r. luteola* | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 8 |
| *Total* | 3 | 217 | 31 | 27 | 533 | 6 | 6 | 18 | 1 | 1 | 6 | 849 | 0 | 0 | 4,247 |

[c] From this section of the river in 1969 these additional kinds of mussels were collected: *Megalonaias gigantea*, *Quadrula pustulosa*, *Tritogonia verrucosa*, and *Lampcilia r. luteola*.

[d] From these sections of the river in 1969 commercial mussel fishermen took a few living *Megalonaias gigantea* specimens.

Table A-4.—Numbers of collections and time expended in fishing for mussels by three methods in the Alton navigation pool of the Illinois River in the 1966 survey.

| *River Mile* | *Crowfoot Bar* | | *Dredge* | | *Wading* | |
|---|---|---|---|---|---|---|
| | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Hours |
| 0.9– 5.5 | 6 | 30:48 | 2 | 4:28 | 1 | 1.5 |
| 10.5-15.1 | 9 | 89:36 | 2 | 4:22 | 1 | 1.5 |
| 19.2-29.0 | 13 | 116:20 | 3 | 5:49 | 0 | |
| 30.5-39.2 | 12 | 115:38 | 3 | 6:41 | 0 | |
| 40.3-48.3 | 12 | 110:26 | 3 | 6:29 | 1 | 1.0 |
| 51.0-58.9 | 21 | 148:27 | 6 | 7:38 | 0 | |
| 60.8-69.4 | 21 | 213:59 | 8 | 9:33 | 1 | 5.0 |
| Meredosia Lake | 5 | 92:04 | 2 | 13:31 | 0 | .... |
| 70.8-79.8 | 14 | 109:15 | 1 | 0:50 | 1 | 3.0 |
| *Total* | *113* | *1,026:33* | *30* | *59:21* | *5* | *12.0* |

Table A-5.—Numbers of collections and time expended in fishing for mussels by three methods in the La Grange navigation pool of the Illinois River in the 1966 survey.

| *River Mile* | *Crowfoot Bar* | | *Dredge* | | *Wading* | |
|---|---|---|---|---|---|---|
| | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Hours |
| 80.3– 87.9 | 6 | 53:40 | 1 | 2:25 | 3 | 2.75 |
| 90.2-100.5 | 19 | 202:07 | 4 | 13:49 | 0 | .... |
| 106.6-114.0 | 14 | 176:49 | 4 | 7:26 | 1 | 2.00 |
| Bath Chute | 6 | 78:03 | 3 | 7:29 | 0 | .... |
| Lake Matanzas | 2 | 71:20 | 2 | 14:37 | 1 | 1.00 |
| 115.3-123.0 | 13 | 185:02 | 3 | 4:52 | 1 | 1.50 |
| Quiver Lake | 1 | 46:22 | 2 | 10:28 | 1 | 1.50 |
| 125.0-135.5 | 13 | 197:38 | 2 | 5:35 | 2 | 3.50 |
| 140.5-149.7 | 14 | 175:20 | 2 | 2:44 | 1 | 0.50 |
| 150.6-156.6 | 8 | 128:39 | 1 | 1:06 | 0 | .... |
| *Total* | *96* | *1,315:00* | *24* | *70:31* | *10* | *12.75* |

Table A-6.--Numbers of collections and time expended in fishing for mussels by three methods in the Peoria navigation pool of the Illinois River in the 1966 survey.

| River Mile | Crowfoot Bar | | Dredge | | Wading | |
|---|---|---|---|---|---|---|
| | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Hours |
| 158.1-160.0 | 3 | 83:06 | 0 | ... | 0 | |
| 161.1-162.3 | 7 | 45:55 | 3 | 3:07 | 0 | |
| 163.0-166.1 | 5 | 135:35 | 4 | 93:58 | 0 | ... |
| 166.3-166.6 | 1 | 31:26 | 0 | ... | 1 | 1.5 |
| 167.2-174.9 | 18 | 447:37 | 9 | 76:58 | 5 | 7.5 |
| 174.9-179.7 | 4 | 136:13 | 1 | 17:41 | 1 | 1.5 |
| 180.5-188.0 | 10 | 151:00 | 1 | 1:06 | 3 | 4.0 |
| 190.0-199.3 | 12 | 181:33 | 1 | 1:08 | 3 | 3.5 |
| 200.4-209.4 | 8 | 158:33 | 0 | ... | 2 | 3.0 |
| 210.7-219.8 | 8 | 130:50 | 0 | ... | 1 | 0.5 |
| 220.7-229.3 | 7 | 121:44 | 1 | 0:44 | 0 | |
| Total | 83 | 1,623:32 | 20 | 194:42 | 16 | 21.5 |

Table A-7.—Numbers of collections and time expended in fishing for mussels by three methods in the Starved Rock navigation pool of the Illinois River in the 1966 survey.

| River Mile | Crowfoot Bar | | Dredge | | Wading | |
|---|---|---|---|---|---|---|
| | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Hours |
| 233.7-236.5 | 5 | 77:26 | 0 | | 1 | 0.25 |
| 239.0-244.3 | 7 | 73:07 | 0 | | 0 | |
| Total | 12 | 150:33 | 0 | | 1 | 0.25 |

Table A-8.—Numbers of collections and time expended in fishing for mussels by three methods in the Marseilles navigation pool of the Illinois River in the 1966 survey.

| River Mile | Crowfoot Bar | | Dredge | | Wading | |
|---|---|---|---|---|---|---|
| | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Minutes and Seconds | Number of Collections | Time Used in Hours |
| 249.2-259.0 | 11 | 139:09 | 0 | | 0 | |
| 260.2-272.0 | 7 | 104:56 | 0 | | 1 | 1.5 |
| Total | 18 | 244:05 | 0 | | 1 | 1.5 |

Table A-9.-Average observed lengths and heights of pig-toes **(Fusconaia flava** f. **undata)** of various ages from the 1966 Illinois River collections.

| *Age in Years* | *Average Length in Inches* | *Average Height in Inches* | *Number of Mussels* |
|---|---|---|---|
| 5 | 2.1 | 1.6 | 1 |
| 6 | 2.3 | 1.8 | 1 |
| 7 | 2.0 | 1.6 | 4 |
| 8 | 2.1 | 1.7 | 6 |
| 9 | 2.3 | 1.9 | 10 |
| 10 | 2.6 | 2.1 | 7 |
| 11 | 2.6 | 1.9 | 7 |
| 12 | 2.7 | 2.2 | 4 |
| 13 | 2.9 | 2.4 | 1 |
| 14 | 2.8 | 2.3 | 2 |
| 15 | -- | -- | 0 |
| 16 | 2.8 | 2.4 | 2 |
| 17 | 2.5 | 2.0 | 1 |
| *Total* | | | *46* |

Table A-10.—Height frequency distribution of washboards **(Megalonaias gigantea)** taken from the Illinois River by crowfoot bar, dredge, and wading in the 1966 survey.

| *Height in Inches* | *Crowfoot Bar* | | *Dredge* | | *Wading* | | *Total* | |
|---|---|---|---|---|---|---|---|---|
| | Number Caught | *Percent of Catch* | Number Caught | *Percent of Catch* | Number Caught | *Percent of Catch* | Number Caught | *Percent of Catch* |
| 2.1 | 2 | 1.4 | 0 | 0.0 | 0 | 0.0 | 2 | 1.0 |
| 2.2 | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 | 1 | 0.5 |
| 2.3 | 0 | 0.0 | 1 | 2.7 | 0 | 0.0 | 1 | 0.5 |
| 2.4 | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 | 1 | 0.5 |
| 2.5 | 0 | 0.0 | 2 | 5.4 | 0 | 0.0 | 2 | 1.0 |
| 2.6 | 3 | 2.1 | 0 | 0.0 | 0 | 0.0 | 3 | 1.4 |
| 2.7 | 2 | 1.4 | 0 | 0.0 | 0 | 0.0 | 2 | 1.0 |
| 2.8 | 2 | 1.4 | 0 | 0.0 | 0 | 0.0 | 2 | 1.0 |
| 2.9 | 5 | 3.5 | 1 | 2.7 | 0 | 0.0 | 6 | 2.9 |
| 3.0 | 6 | 4.2 | 1 | 2.7 | 1 | 3.9 | 8 | 3.9 |
| 3.1 | 4 | 2.8 | 1 | 2.7 | 3 | 11.5 | 8 | 3.9 |
| 3.2 | 6 | 4.2 | 0 | 0.0 | 4 | 15.4 | 10 | 4.8 |
| 3.3 | 6 | 4.2 | 2 | 5.4 | 1 | 3.9 | 9 | 4.3 |
| 3.4 | 11 | 7.6 | 3 | 8.1 | 1 | 3.9 | 15 | 7.3 |
| 3.5 | 17 | 11.8 | 3 | 8.1 | 1 | 3.9 | 21 | 10.1 |
| 3.6 | 11 | 7.6 | 2 | 5.4 | 3 | 11.5 | 16 | 7.7 |
| 3.7 | 11 | 7.6 | 4 | 10.9 | 2 | 7.7 | 17 | 8.2 |
| 3.8 | 11 | 7.6 | 2 | 5.4 | 4 | 15.4 | 17 | 8.2 |
| 3.9 | 13 | 9.0 | 1 | 2.7 | 0 | 0.0 | 14 | 6.8 |
| 4.0 | 7 | 4.9 | 3 | 8.1 | 1 | 3.8 | 11 | 5.3 |
| 4.1 | 8 | 5.5 | 1 | 2.7 | 0 | 0.0 | 9 | 4.3 |
| 4.2 | 11 | 7.6 | 4 | 10.8 | 1 | 3.8 | 16 | 7.7 |
| 4.3 | 3 | 2.1 | 0 | 0.0 | 2 | 7.7 | 5 | 2.4 |
| 4.4 | 0 | 0.0 | 3 | 8.1 | 0 | 0.0 | 3 | 1.4 |
| 4.5 | 2 | 1.4 | 3 | 8.1 | 1 | 3.8 | 6 | 2.9 |
| 4.6 | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 | 1 | 0.5 |
| 4.7 | 0 | 0.0 | 0 | 0.0 | 1 | 3.8 | 1 | 0.5 |
| *Total* | *144* | *100.0* | *37* | *100.0* | *26* | *100.0* | *207* | *100.0* |

Table A-11.—Average observed lengths and heights of washboards (Megalonaias gigantea) of various ages from the 1966 Illinois River collections.

| Age in Years | Alton Pool | | | Above La Grange Dam | | | Entire River | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels |
| 5 | 3.3 | 2.1 | 1 | 3.7 | 2.5 | 1 | 3.5 | 2.3 | 2 |
| 6 | 3.5 | 2.4 | 2 | | ... | 0 | 3.5 | 2.4 | 2 |
| 7 | 3.8 | 2.5 | 4 | | | 0 | 3.8 | 2.5 | 4 |
| 8 | 4.3 | 2.7 | 5 | | | 0 | 4.3 | 2.7 | 5 |
| 9 | 4.6 | 3.0 | 8 | ... | ... | 0 | 4.6 | 3.0 | 8 |
| 10 | 4.8 | 3.2 | 7 | 5.7 | 3.8 | 1 | 4.9 | 3.3 | 8 |
| 11 | 5.0 | 3.3 | 22 | 5.8 | 3.6 | 3 | 5.1 | 3.3 | 25 |
| 12 | 5.2 | 3.4 | 23 | 5.5 | 3.6 | 2 | 5.2 | 3.4 | 25 |
| 13 | 5.2 | 3.4 | 17 | 5.9 | 3.8 | 3 | 5.3 | 3.4 | 20 |
| 14 | 5.7 | 3.7 | 13 | 6.1 | 4.0 | 2 | 5.8 | 3.7 | 15 |
| 15 | 5.6 | 3.7 | 18 | 6.5 | 4.2 | 4 | 5.8 | 3.8 | 22 |
| 16 | 6.0 | 3.8 | 17 | 6.4 | 4.2 | 2 | 6.1 | 3.9 | 19 |
| 17 | 6.1 | 3.9 | 5 | 6.7 | 4.3 | 3 | 6.4 | 4.1 | 8 |
| 18 | 6.3 | 4.2 | 11 | 6.8 | 4.4 | 1 | 6.4 | 4.2 | 12 |
| 19 | 6.3 | 4.0 | 5 | ... | ... | 0 | 6.3 | 4.0 | 5 |
| 20 | 6.4 | 4.2 | 9 | 7.2 | 4.5 | 1 | 6.5 | 4.2 | 10 |
| 21 | 6.4 | 4.0 | 5 | | ... | 0 | 6.4 | 4.0 | 5 |
| 22 | 6.5 | 4.2 | 4 | | | 0 | 6.5 | 4.2 | 4 |
| 23 | 6.5 | 4.2 | 2 | | | 0 | 6.5 | 4.2 | 2 |
| 24 | 6.7 | 4.2 | 3 | | | 0 | 6.7 | 4.2 | 3 |
| 25 | 6.7 | 4.3 | 2 | ... | | 0 | 6.7 | 4.3 | 2 |
| 26 | | | 0 | 6.6 | 4.0 | 1 | 6.6 | 4.0 | 1 |
| Total | | | 183 | | | 24 | | | 207 |

Table A-12.-Height frequency distribution of three-ridges **(Amblema plicata)** taken from the Illinois River by crowfoot bar, dredge, and wading in the 1966 survey.

| Height in Inches | Crowfoot Bar | | Dredge | | Wading | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Number Caught | Percent of Catch | Number Caught | Percent of Catch | Number Caught | Percent of Catch | Number Caught | Percent of Catch |
| 1.1 | 0 | 0.0 | 2 | 0.4 | 0 | 0.0 | 2 | 0.1 |
| 1.2 | 1 | 0.1 | 1 | 0.2 | 1 | 0.1 | 3 | 0.1 |
| 1.3 | 1 | 0.1 | 6 | 1.1 | 1 | 0.1 | 8 | 0.3 |
| 1.4 | 4 | 0.3 | 2 | 0.4 | 3 | 0.4 | 9 | 0.3 |
| 1.5 | 5 | 0.4 | 3 | 0.5 | 3 | 0.4 | 11 | 0.4 |
| 1.6 | 6 | 0.5 | 2 | 0.4 | 9 | 1.2 | 17 | 0.7 |
| 1.7 | 26 | 1.9 | 11 | 2.0 | 14 | 1.9 | 51 | 1.9 |
| 1.8 | 42 | 3.1 | 10 | 1.8 | 22 | 3.0 | 74 | 2.8 |
| 1.9 | 54 | 4.0 | 22 | 4.0 | 23 | 3.1 | 99 | 3.7 |
| 2.0 | 72 | 5.3 | 27 | 4.9 | 49 | 6.6 | 148 | 5.6 |
| 2.1 | 86 | 6.3 | 36 | 6.6 | 48 | 6.5 | 170 | 6.4 |
| 2.2 | 117 | 8.6 | 43 | 7.8 | 68 | 9.1 | 228 | 8.6 |
| 2.3 | 153 | 11.3 | 50 | 9.1 | 43 | 5.8 | 246 | 9.3 |
| 2.4 | 140 | 10.3 | 48 | 8.7 | 55 | 7.4 | 243 | 9.2 |
| 2.5 | 145 | 10.7 | 58 | 10.6 | 52 | 7.0 | 255 | 9.6 |
| 2.6 | 142 | 10.5 | 61 | 11.1 | 79 | 10.6 | 282 | 10.7 |
| 2.7 | 111 | 8.2 | 58 | 10.5 | 70 | 9.4 | 239 | 9.0 |
| 2.8 | 105 | 7.7 | 38 | 6.9 | 65 | 8.7 | 208 | 7.9 |
| 2.9 | 68 | 5.0 | 31 | 5.6 | 51 | 6.8 | 150 | 5.7 |
| 3.0 | 33 | 2.4 | 21 | 3.8 | 47 | 6.3 | 101 | 3.8 |
| 3.1 | 26 | 1.9 | 12 | 2.2 | 26 | 3.5 | 64 | 2.4 |
| 3.2 | 8 | 0.6 | 3 | 0.5 | 11 | 1.5 | 22 | 0.8 |
| 3.3 | 7 | 0.5 | 5 | 0.9 | 4 | 0.5 | 16 | 0.6 |
| 3.4 | 1 | 0.1 | 0 | 0.0 | 1 | 0.1 | 2 | 0.1 |
| 3.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3.6 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3.7 | 1 | 0.1 | 0 | 0.0 | 0 | 0.0 | 1 | • |
| 3.8 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3.9 | 1 | 0.1 | 0 | 0.0 | 0 | 0.0 | 1 | |
| Total | *1,355* | *100.0* | *550* | *100.0* | *745* | *100.0* | *2,650* | *100.0* |

• Less than 0.1 percent.

Table A-13.-Average observed lengths and heights of three-ridges (**Amblema plicata**) of various ages from the 1966 Illinois River collections.

| *Age in Years* | *Alton Pool* | | | *La Grange Pool* | | | *Peoria Pool* | | | *Entire River* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels |
| 4 | 1.7 | 1.3 | 4 | 1.9 | 1.4 | 2 | 1.9 | 1.4 | 1 | 1.8 | 1.3 | 7 |
| 5 | 2.2 | 1.6 | 9 | 2.4 | 1.7 | 2 | 2.5 | 1.7 | 8 | 2.3 | 1.6 | 19 |
| 6 | 2.4 | 1.7 | 45 | 2.4 | 1.7 | 8 | 2.8 | 2.0 | 31 | 2.6 | 1.8 | 84 |
| 7 | 2.7 | 1.9 | 126 | 3.0 | 2.0 | 22 | 3.1 | 2.2 | 68 | 2.8 | 2.0 | 216 |
| 8 | 3.0 | 2.1 | 166 | 3.0 | 2.1 | 27 | 3.3 | 2.3 | 94 | 3.1 | 2.2 | 287 |
| 9 | 3.1 | 2.2 | 180 | 3.4 | 2.4 | 21 | 3.5 | 2.4 | 84 | 3.2 | 2.3 | 285 |
| 10 | 3.2 | 2.3 | 270 | 3.6 | 2.6 | 27 | 3.6 | 2.5 | 77 | 3.3 | 2.4 | 374 |
| 11 | 3.4 | 2.4 | 247 | 3.7 | 2.6 | 38 | 3.8 | 2.7 | 67 | 3.5 | 2.5 | 352 |
| 12 | 3.5 | 2.5 | 215 | 3.8 | 2.6 | 43 | 4.0 | 2.8 | 60 | 3.6 | 2.6 | 318 |
| 13 | 3.7 | 2.6 | 135 | 3.9 | 2.7 | 44 | 3.9 | 2.8 | 48 | 3.8 | 2.6 | 227 |
| 14 | 3.9 | 2.7 | 85 | 4.1 | 2.9 | 38 | 4.0 | 2.8 | 35 | 4.0 | 2.8 | 158 |
| 15 | 4.0 | 2.8 | 46 | 4.2 | 2.8 | 27 | 4.2 | 2.9 | 28 | 4.1 | 2.8 | 101 |
| 16 | 4.2 | 2.9 | 35 | 4.4 | 3.0 | 23 | 4.1 | 2.9 | 23 | 4.2 | 2.9 | 81 |
| 17 | 4.2 | 2.9 | 19 | 4.3 | 2.9 | 15 | 4.2 | 2.9 | 13 | 4.2 | 2.9 | 47 |
| 18 | 4.2 | 2.9 | 6 | 4.4 | 3.0 | 14 | 4.3 | 2.9 | 21 | 4.3 | 3.0 | 41 |
| 19 | 4.3 | 2.9 | 3 | 4.9 | 3.4 | 2 | 4.4 | 3.0 | 12 | 4.4 | 3.0 | 17 |
| 20 | 4.3 | 3.0 | 4 | 4.3 | 3.1 | 6 | 4.3 | 3.0 | 15 | 4.3 | 3.0 | 25 |
| 21 | 4.4 | 3.0 | 2 | 4.7 | 3.1 | 2 | 4.5 | 3.2 | 1 | 4.5 | 3.0 | 5 |
| 22 | ... | ... | 0 | 4.8 | 3.2 | 2 | 4.8 | 3.2 | 1 | 4.8 | 3.2 | 3 |
| 23 | 4.0 | 2.9 | 1 | ... | ... | 0 | 4.9 | 3.2 | 1 | 4.5 | 3.1 | 2 |
| 24 | | | 0 | | | 0 | ... | | 0 | ... | ... | 0 |
| 25 | | | 0 | | | 0 | 4.4 | 3.1 | 1 | 4.4 | 3.1 | 1 |
| *Total* | | | *1,598* | | | *363* | | | *689* | | | *2,650* |

Table A-14.-Average observed lengths and heights of maple-leafs (**Quadrula quadrula**) of various ages from the 1966 Illinois River collections.

| Age in Years | Alton Pool | | | La Grange Pool | | | Peoria Pool | | | Entire River | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels | Average Length in Inches | Average Height in Inches | Number of Mussels |
| 4 | 1.6 | 1.3 | 6 | | | 0 | 2.0 | 1.6 | 1 | 1.7 | 1.3 | 7 |
| 5 | 1.8 | 1.4 | 3 | ... | ... | 0 | ... | ... | 0 | 1.8 | 1.4 | 3 |
| 6 | 2.0 | 1.6 | 12 | 1.9 | 1.5 | 1 | 2.9 | 2.1 | 2 | 2.1 | 1.6 | 15 |
| 7 | 2.1 | 1.7 | 17 | 2.7 | 2.1 | 1 | 2.8 | 2.1 | 7 | 2.3 | 1.8 | 25 |
| 8 | 2.2 | 1.8 | 33 | 2.5 | 2.0 | 7 | 3.0 | 2.2 | 4 | 2.3 | 1.9 | 44 |
| 9 | 2.3 | 1.9 | 42 | 2.6 | 2.1 | 13 | 3.2 | 2.4 | 6 | 2.5 | 2.0 | 61 |
| 10 | 2.5 | 2.0 | 43 | 2.8 | 2.2 | 13 | 3.2 | 2.4 | 6 | 2.6 | 2.1 | 62 |
| 11 | 2.5 | 2.0 | 42 | 2.9 | 2.2 | 14 | 3.2 | 2.5 | 6 | 2.7 | 2.1 | 62 |
| 12 | 2.6 | 2.1 | 35 | 2.9 | 2.3 | 15 | 3.4 | 2.5 | 4 | 2.8 | 2.2 | 54 |
| 13 | 2.8 | 2.2 | 20 | 3.1 | 2.4 | 11 | . | ... | 0 | 2.9 | 2.3 | 31 |
| 14 | 2.9 | 2.3 | 10 | 3.1 | 2.4 | 5 | 3.0 | 2.4 | 1 | 2.9 | 2.4 | 16 |
| 15 | 2.8 | 2.4 | 2 | 3.6 | 2.5 | 3 | | ... | 0 | 3.3 | 2.5 | 5 |
| 16 | 3.1 | 2.5 | 1 | 3.7 | 2.8 | 2 | | | 0 | 3.5 | 2.7 | 3 |
| 17 | 3.2 | 2.5 | 1 | 3.4 | 2.6 | 1 | | | 0 | 3.3 | 2.6 | 2 |
| Total | | | *267* | | | *86* | | | *37* | | | *390* |

Table A-15.-Height frequency distribution of maple-leafs (Quadrula quadrula) taken from the Illinois River by crowfoot bar, dredge, and wading in the 1966 survey.

| Height in Inches | Crowfoot Bar | | Dredge | | Wading | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Number Caught | Percent of Catch | Number Caught | Percent of Catch | Number Caught | Percent of Catch | Number Caught | Percent of Catch |
| 0.9 | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 |
| 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 1.1 | 1 | 0.4 | 1 | 0.9 | 0 | 0.0 | 2 | 0.5 |
| 1.2 | 2 | 0.9 | 1 | 0.9 | 0 | 0.0 | 3 | 0.8 |
| 1.3 | 2 | 0.9 | 1 | 0.9 | 0 | 0.0 | 3 | 0.8 |
| 1.4 | 4 | 1.7 | 1 | 0.9 | 0 | 0.0 | 5 | 1.3 |
| 1.5 | 5 | 2.1 | 4 | 3.8 | 2 | 4.1 | 11 | 2.8 |
| 1.6 | 12 | 5.1 | 4 | 3.8 | 3 | 6.1 | 19 | 4.9 |
| 1.7 | 12 | 5.1 | 7 | 6.5 | 4 | 8.2 | 23 | 5.9 |
| 1.8 | 17 | 7.3 | 5 | 4.7 | 1 | 2.1 | 23 | 5.9 |
| 1.9 | 26 | 11.1 | 11 | 10.3 | 6 | 12.2 | 43 | 11.0 |
| 2.0 | 29 | 12.4 | 12 | 11.2 | 6 | 12.2 | 47 | 12.1 |
| 2.1 | 37 | 15.8 | 21 | 19.6 | 8 | 16.3 | 66 | 16.9 |
| 2.2 | 32 | 13.7 | 11 | 10.3 | 4 | 8.2 | 47 | 12.1 |
| 2.3 | 18 | 7.7 | 9 | 8.4 | 7 | 14.3 | 34 | 8.7 |
| 2.4 | 16 | 6.8 | 8 | 7.5 | 5 | 10.2 | 29 | 7.4 |
| 2.5 | 13 | 5.6 | 4 | 3.7 | 3 | 6.1 | 20 | 5.1 |
| 2.6 | 5 | 2.1 | 3 | 2.8 | 0 | 0.0 | 8 | 2.1 |
| 2.7 | 0 | 0.0 | 2 | 1.9 | 0 | 0.0 | 2 | 0.5 |
| 2.8 | 2 | 0.9 | 2 | 1.9 | 0 | 0.0 | 4 | 1.0 |
| Total | 234 | 100.0 | 107 | 100.0 | 49 | 100.0 | 390 | 100.0 |

Table A-16.-Height frequency distribution of pimple-backs (Quadrula pustulosa) taken from the Illinois River by crowfoot bar, dredge, and wading in the 1966 survey.

| Height in Inches | Crowfoot Bar | | Dredge | | Wading | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Number Caught | Percent of Catch | Number Caught | Percent of Catch | Number Caught | Percent of Catch | Number Caught | Percent of Catch |
| 1.0 | 7 | 2.4 | 3 | 4.3 | 0 | 0.0 | 10 | 2.3 |
| 1.1 | 5 | 1.7 | 0 | 0.0 | 0 | 0.0 | 5 | 1.2 |
| 1.2 | 5 | 1.7 | 0 | 0.0 | 0 | 0.0 | 5 | 1.2 |
| 1.3 | 15 | 5.1 | 5 | 7.1 | 1 | 1.6 | 21 | 4.9 |
| 1.4 | 14 | 4.8 | 0 | 0.0 | 2 | 3.2 | 16 | 3.8 |
| 1.5 | 13 | 4.4 | 2 | 2.9 | 2 | 3.2 | 17 | 4.0 |
| 1.6 | 41 | 13.9 | 8 | 11.4 | 9 | 14.5 | 58 | 13.6 |
| 1.7 | 50 | 17.0 | 19 | 27.1 | 11 | 17.8 | 80 | 18.8 |
| 1.8 | 60 | 20.4 | 7 | 10.0 | 14 | 22.6 | 81 | 19.0 |
| 1.9 | 25 | 8.5 | 17 | 24.3 | 6 | 9.7 | 48 | 11.3 |
| 2.0 | 24 | 8.2 | 6 | 8.6 | 8 | 12.9 | 38 | 8.9 |
| 2.1 | 15 | 5.1 | 2 | 2.9 | 2 | 3.2 | 19 | 4.5 |
| 2.2 | 12 | 4.1 | 1 | 1.4 | 5 | 8.1 | 18 | 4.2 |
| 2.3 | 2 | 0.7 | 0 | 0.0 | 1 | 1.6 | 3 | 0.7 |
| 2.4 | 6 | 2.0 | 0 | 0.0 | 1 | 1.6 | 7 | 1.6 |
| Total | 294 | 100.0 | 70 | 100.0 | 62 | 100.0 | 426 | 100.0 |

Table A-17.-Average observed lengths and heights of pimple-backs **(Quadrula pustulosa)** of various ages from the 1966 Illinois River collections.

| *Age in Years* | *Average Length in Inches* | *Average Height in Inches* | *Number of Mussels* |
|---|---|---|---|
| 4 | 1.3 | 1.1 | 4 |
| 5 | 1.4 | 1.2 | 8 |
| 6 | 1.6 | 1.3 | 24 |
| 7 | 1.8 | 1.6 | 53 |
| 8 | 1.9 | 1.7 | 83 |
| 9 | 2.0 | 1.8 | 97 |
| 10 | 2.1 | 1.8 | 63 |
| 11 | 2.2 | 1.9 | 45 |
| 12 | 2.3 | 2.0 | 22 |
| 13 | 2.5 | 2.2 | 12 |
| 14 | 2.4 | 1.9 | 7 |
| 15 | 2.5 | 2.1 | 5 |
| 16 | 2.5 | 2.1 | 3 |
| *Total* | | | *426* |

Table A-18.-Average observed lengths and heights of warty-backs **(Quadrula nodulata)** of various ages from the 1966 Illinois River collections.a

| *Age in rears* | *Average Length in Inches* | *Average Height in Inches* | *Number of Mussels* |
|---|---|---|---|
| 5 | 1.7 | 1.4 | 3 |
| 6 | 1.8 | 1.4 | 5 |
| 7 | 1.9 | 1.5 | 8 |
| 8 | 2.0 | 1.7 | 7 |
| 9 | 2.1 | 1.7 | 18 |
| 10 | 2.2 | 1.8 | 9 |
| 11 | 2.2 | 1.8 | 6 |
| 12 | 2.3 | 1.8 | 6 |
| 13 | 2.4 | 1.9 | 2 |
| 14 | 2.2 | 1.8 | 1 |
| *Total* | | | *65* |

**Three specimens collected were not aged.**

Table A-19.-Average observed lengths and heights of rock pocketbooks (**Arcidens confragosus**) of various ages from the 1966 Illinois River collections.

| *Age in Years* | *Average Length in Inches* | *Average Height in Inches* | *Number of Mussels* |
|---|---|---|---|
| 5 | 2.6 | 1.8 | 2 |
| 6 | 2.5 | 1.7 | 5 |
| 7 | 3.0 | 2.0 | 10 |
| 8 | 3.1 | 2.1 | 18 |
| 9 | 3.3 | 2.3 | 19 |
| 10 | 3.8 | 2.6 | 4 |
| 11 | 3.9 | 2.6 | 7 |
| 12 | 4.0 | 2.6 | 4 |
| 13 | 4.5 | 2.8 | 4 |
| 14 | 3.7 | 2.7 | 1 |
| 15 | 4.1 | 2.7 | 1 |
| *Total* | | | *75* |

Table A-20.-Average observed lengths and heights of three-horned warty-backs (**Obliquaria reflexa**) of various ages from the 1966 Illinois River collections.

| *Age in Years* | *Average Length in Inches* | *Average Height in Inches* | *Number of Mussels* |
|---|---|---|---|
| 4 | 1.8 | 1.2 | 2 |
| 5 | 1.2 | 0.9 | 1 |
| 6 | 1.7 | 1.2 | 5 |
| 7 | 1.7 | 1.3 | 13 |
| 8 | 1.6 | 1.2 | 7 |
| 9 | 1.9 | 1.4 | 10 |
| 10 | 2.0 | 1.5 | 4 |
| 11 | 1.8 | 1.4 | 4 |
| 12 | .. | .. | 0 |
| 13 | 2.1 | 1.6 | 2 |
| 14 | .. | .. | 0 |
| 15 | 2.1 | 1.6 | 1 |
| *Total* | | | *49* |

Table A-21.—Distribution of mussels in the mainstream of the Illinois River since 1870.

| *Kind of Mussel* | *Upper River*[a] | *Peoria Pool* | *La Grange Pool* | *Alton Pool* |
|---|---|---|---|---|
| *Cumberlandia monodonta* | *At* | A | P | P |
| *Fusconaia ebena* | P | P | P | P |
| *Fusconaia flava* f. *flava* | P | P | P | A |
| *Fusconaia flava f. undata* | P | P | P | P |
| *Megalonaias gigantea* | A | P | P | P |
| *Amblema plicata* | P | P | P | P |
| *Quadrula quadrula* | P | P | P | P |
| *Quadrula pustulosa* | P | P | P | P |
| *Quadrula nodulata* | P | P | P | P |
| *Quadrula metanevra* | P | P | P | P |
| *Tritogonia verrucosa* | P | P | P | P |
| *Cyclonaias tuberculata* | P | P | P | P |
| *Plethobasus cyphyus* | P | P | P | P |
| *Pleurobema coccineum f. solida* | P(?) | P | P | P |
| *Pleurobema pyramidatum* | P(?) | P(?) | P(?) | P(?) |
| *Elliptio crassidens* | P | P | P | P |
| *Eiliptio dilatatus* | P | P | P | P |
| *Arcidens confragosus* | A | P | P | P |
| *Lasmigona costata* | P | A | P | A |
| *Lasmigona complanata* | P | P | P | P |
| *Anodonta grandis grandis* | P(?) | P | P | P(?) |
| *Anodonta grandis corpulenta* | P | P | P | P |
| *Anodonta imbecillis* | P | P | P | P |
| *Anodonta suborbiculata* | A | P | P | P |
| *Alasmidonta calceolus* | P | A | A | A |
| *Alasmidonta marginata* | P | P | A | A |
| *Strophitus undulatus* | A(?) | P | P | P |
| *Anodontoides ferussacianus* | A | P | A | A |
| *Obliquaria reflexa* | P | P | P | P |
| *Obovaria olivaria* | P | P | P | P |
| *Actinonaias ligamentina* | P | P | P | P |
| *Plagiola lineolata* | P | P | P | P |
| *Truncilla truncata* | P | P | P | P |
| *Truncilla donaciformis* | P | P | P | P |
| *Leptodea fragilis* | P | P | P | P |
| *Proptera alata* | A | P | P | P |
| *Proptera capax* | P | A | P | P |
| *Proptera laevissima* | A | P | P | P |
| *Carunculina parva* | A | P | P | P |
| *Ligumia recta* | P | P | P | P |
| *Villosa iris iris* | P | A | A | A |
| *Lampsilis anodontoides* f. *anodontoides* | P | P | P | P |
| *Lampsilis anodontoides* f. *fallaciosa* | P | P | P | P |
| *Lampsilis radiata luteola* | P | P | P | P |
| *Lampsilis ventricosa* | P | P | P | P |
| *Lampsilis orbiculata* f. *orbiculata* | A | A | A | P |
| *Lampsilis orbiculata* f. *higginsii* | P | P | P | P |
| *Dysnomia triquetra* | P | A | P | A |
| *Total Recorded Kinds of Mussels Since 1870* | *38* | *41* | *43* | *41* |
| *Total Recorded Kinds of Mussels Taken Alive in 1966-1969* | *0* | *16* | *18* | *20* |

[a] From the confluence of the Kankakee and Des Plaines rivers to Starved Rock dam.
[b] P designates present and A designates no record of the occurrence of the species.

Table A-22.—Kinds of mussels taken alive from the mainstream of the Illinois River in the vicinities of Henry and Chillicothe in 1912a and 1966.

| Kind of Mussel | Henry | | Chillicothe | |
|---|---|---|---|---|
| | 1912 | 1966 | 1912 | 1966 |
| F. ebena (Ebony Shell) | P[b] | A | P | A |
| F. *f*. f. undata (Pig-Toe) | P | A | P | A |
| M. gigantea (Washboard) | P | P | P | A |
| A. plicata (Three-Ridge) | P | P | P | P |
| Q. quadrula (Maple-Leaf) | P | A | P | A |
| Q. *pustulosa* (Pimple-Back) | P | A | P | A |
| T. verrucosa (Buckhorn) | P | A | P | A |
| C. *tuberculata* (Purple Warty-Back) | A | A | P | A |
| E. crassidens (Elephant's Ear) | A | A | P | A |
| E. *dilatatus* (Lady-Finger) | P | A | P | A |
| A. confragosus (Rock Pocketbook) | P | A | P | A |
| L. complanata (White Heel-Splitter) | P | A | P | A |
| A. g. grandis (Floater) | P | P | P | A |
| A. g. corpulenta (Floater) | P | P | P | A |
| A. imbecillis (Paper Pond Shell) | P | P | P | A |
| S. undulatus (Squaw Foot) | P | A | P | A |
| O. *reflexa* (Three-Horned Warty-Back) | A | A | P | A |
| 4. ligamentina (Mucket) | P | A | P | A |
| P. lineolata (Butterfly) | P | A | P | A |
| T. truncata (Deer-Toe) | P | A | P | A |
| L. fragilis (Fragile Paper Shell) | P | P | P | A |
| P. *alata* (Pink Heel-Splitter) | P | P | P | A |
| P. laevissima (Fragile Heel-Splitter) | P | P | P | A |
| C. parva (Liliput Shell) | P | A | P | A |
| L. a. f. anodontoides (Yellow Sand-Shell) | P | A | P | A |
| L. a. f. fallaciosa (Slough Sand-Shell) | P | P | P | P |
| L. r. luteola (Fat Mucket) | P | A | P | A |
| L. o. f. higginsii (Higgin's Eye) | A | A | P | A |

[a] Forbes & Richardson (1913:633 & 536) and D (1914:37).
[b] P designates present and A designates absent.

Table A-23.—Kinds of mussels taken alive from Peoria Lake in 1912, and in the 1924-1925 and 1966-1969 periods.

| *Kind of Mussel* | *1912'* | *1924–1925[a]* | *1966-1969* |
|---|---|---|---|
| *F. ebena* (Ebony Shell) | P[b] | A | A |
| *F. flava f. flava* (Wabash Pig-Toe) | P | A | A |
| *F. flava f. undata* (Pig-Toe) | P | P | P |
| *M. gigantea* (Washboard) | P | A | P |
| *A. plicata* (Three-Ridge) | P | P | P |
| *Q. quadrula* (Maple-Leaf) | P | P | P |
| Q. *pustulosa* (Pimple-Back) | P | P | A' |
| *Q. metanevra* (Monkey-Face) | P | A | A |
| *T. verrucosa* (Buckhorn) | P | A | A' |
| *C. tuberculata* (Purple Warty-Back) | P | A | A |
| *P. coccineum* f. *solida* | P | A | A |
| *E. dilatatus* (Lady-Finger) | P | P | A |
| *A. confragosus* (Rock Pocketbook) | P | A | P |
| *L. complanata* (White Heel-Splitter) | P | P | P |
| *A. g. grandis* (Floater) | P | A | P |
| *A. g. corpulenta* (Floater) | P | P | P |
| *A. imbecillis* (Paper Pond Shell) | P | P | A |
| *A. suborbiculata* (Heel-Splitter) | P | P | A |
| *S. undulatus* (Squaw Foot) | P | A | A |
| *O. reflexa* (Three-Horned Warty-Back) | P | P | A |
| *0. olivaria* (Hickory-Nut) | P | A | A |
| *A. ligamentina* (Mucket) | P | A | A |
| *P. lineolata* (Butterfly) | P | A | A |
| *T. truncata* (Deer-Toe) | P | A | A |
| *T. donaciformis* (Fawn's Foot) | P | A | A |
| *L. fragilis* (Fragile Paper Shell) | P | P | P |
| *P. alata* (Pink Heel-Splitter) | P | P | A |
| *P. laevissima* (Fragile Heel-Splitter) | P | P | P |
| *C. parva* (Liliput Shell) | P | P | A |
| *L. recta* (Black Sand-Shell) | P | A | A |
| *L. a. f. anodontoides* (Yellow Sand-Shell) | P | A | A |
| *L.* a. f. *fallaciosa* (Slough Sand-Shell) | P | P | P |
| *L.* r. *luteola* (Fat Mucket) | P | P | P |
| *L. ventricosa* (Pocketbook) | P | A | A |
| *L. o.* f. *higginsii* (Higgin's Eye) | P | A | A |

[a] Daniel lade (1914:37) and Richardson (1928:457).
[b] P designates present and A designates absent.
[c] Taken alive in 1969 immediately below Peoria Lake.

Table A-24.—Kinds of mussels taken alive from the mainstream of the Illinois River between the Peoria lock and dam and Havana in 1912 and 1966 and from Quiver Lake in 1966.a

| Kind of Mussel | Mainstream | | Quiver Lake |
|---|---|---|---|
| | 1912 | 1966 | 1966 |
| F. ebena (Ebony Shell) | Pb | A | A |
| F. f. undata (Pig-Toe) | P | P | A |
| M. gigantea (Washboard) | P | A | P |
| A. plicata (Three-Ridge) | P | P | P |
| Q. quadrula (Maple-Leaf) | P | P | P |
| Q. pustulosa (Pimple-Back) | P | A | P |
| Q. nodulata (Warty-Back) | P | A | A |
| T. verrucosa (Buckhorn) | P | A | A |
| C. tuberculata (Purple Warty-Back) | P | A | A |
| E. dilatatus (Lady-Finger) | P | A | A |
| A. confragosus (Rock Pocketbook) | P | P | A |
| L. complanata (White Heel-Splitter) | P | P | A |
| A. g. grandis (Floater) | P | A | P |
| A. g. corpulenta (Floater) | P | P | A |
| A. imbecillis (Paper Pond Shell) | P | P | A |
| A. suborbiculata (Heel-Splitter) | P | A | A |
| S. undulatus (Squaw Foot) | P | A | A |
| 0. rejlexa (Three-Horned Warty-Back) | P | A | P |
| A. ligamentina (Mucket) | P | A | A |
| P. lineolata (Butterfly) | P | A | A |
| T. truncata (Deer-Toe) | P | A | A |
| T. donaciformis (Fawn's Foot) | P | A | A |
| L. fragilis (Fragile Paper Shell) | P | P | A |
| P. alata (Pink Heel-Splitter) | P | P | A |
| P. capax (Fat Pocketbook) | P | A | A |
| P. laevissima (Fragile Heel-Splitter) | P | P | A |
| L. recta (Black Sand-Shell) | P | A | A |
| L. a. f. anodontoides (Yellow Sand-Shell) | P | A | A |
| L. a. f. fallaciosa (Slough Sand-Shell) | P | P | A |
| L. r. luteola (Fat Mucket) | P | A | P |
| L. ventricosa (Pocketbook) | P | A | A |
| L. o. f. higginsii (Higgin's Eye) | P | A | A |

a Data from Forbes and Richardson (1914:37) and 1966 survey.
b P designates present and A designates absent.

Table A-25.—Kinds of mussels taken alive from the mainstream of the Illinois River (including Bath Chute) from below Havana to the La Grange lock and dam in 1912 and 1966.[a]

| Kind of Mussel | 1912 | 1966 |
|---|---|---|
| F. ebena (Ebony Shell) | pb | A |
| F. f. f. undata (Pig-Toe) | P | A |
| M. gigantea (Washboard) | P | P |
| A. plicata (Three-Ridge) | P | P |
| Q. quadrula (Maple-Leaf) | P | P |
| Q. *pustulosa* (Pimple-Back) | P | P |
| Q. nodulata (Warty-Back) | P | P |
| Q metanevra (Monkey-Face) | P | A |
| T. verrucosa (Buckhorn) | P | A |
| C. tuberculata (Purple Warty-Back) | P | A |
| P. cyphyus (Bullhead) | P | A |
| P. coccineum f. *solida* | P | A |
| E. crass idens (Elephant's Ear) | P | A |
| E. dilatatus (Lady-Finger) | P | A |
| A. confragosus (Rock Pocketbook) | P | P |
| L. costata (Fluted Shell) | P | A |
| L. complanata (White Heel-Splitter) | P | P |
| A. g. grandis (Floater) | P | P |
| A. g. *corpulenta* (Floater) | P | P |
| A. imbecillis (Paper Pond Shell) | P | A |
| A. suborbiculata (Heel-Splitter) | P | A |
| S. undulatus (Squaw Foot) | P | A |
| 0. reflexa (Three-Horned Warty-Back) | P | A |
| A. ligamentina (Mucket) | P | A |
| P. lineolata (Butterfly) | P | A |
| T. *truncata* (Deer-Toe) | P | P |
| T. donaciformis (Fawn's Foot) | P | A |
| L. fragilis (Fragile Paper Shell) | P | P |
| P. alata (Pink Heel-Splitter) | P | A |
| P. capax (Fat Pocketbook) | P | A |
| P. laevissima (Fragile Heel-Splitter) | P | P |
| L. recta (Black Sand-Shell) | P | A |
| L. a. f. *anodontoides* (Yellow Sand-Shell) | P | A |
| L. a. f. fallaciosa (Slough Sand-Shell) | P | P |
| L. r. luteola (Fat Mucket) | P | P |
| L. ventricosa (Pocketbook) | P | A |
| L. o. f. higginsii (Higgin's Eye) | P | A |

.D (1914:37) and 1966 survey.
P designates present and A designates absent.
A single specimen of this species was collected in 1966 at Lake Matanzas, a bottomland lake adjacent to the river below Havana.

Table A-26.—Locations of Illinois River mussel beds fished by commercial mussel fishermen in 1966.[a]

| River Mile | River Bank | River Mile | River Bank |
|---|---|---|---|
| 0.3— 2.0 | Left | 48.0–48.9 | Right |
| 5.0— 5.5 | Right | 50.7–51.5 | Right |
| 10.3–10.5 | Right | 53.0–53.9 | Left |
| 13.2–13.5 | Right | 54.0–54.7 | Right |
| 14.5–14.7 | Left | 55.9–56.4 | Left |
| 14.9–15.1 | Right | 57.8–59.1 | Right |
| 19.0–19.5 | Right | 60.4–61.5 | Right |
| 23.2–23.5 | Right | 62.1–62.6 | Right |
| 24.2–24.4 | Left | 63.8–64.5 | Right |
| 27.7–27.9 | Left | 65.9–66.5 | Left |
| 28.1–29.5 | Right | 66.6–66.9 | Right |
| 30.5–31.3 | Right | 68.9–69.4 | Right |
| 33.0–33.5 | Right | 72.6–74.3 | Right |
| 37.3–37.6 | Right | 74.5–75.1 | Left |
| 39.1–39.3 | Right | 75.2–75.8 | Right |
| 40.1–40.8 | Right | 79.0–79.9 | Right |
| 41.2–42.4 | Left | 80.4–80.8 | Right |
| 44.0–44.9 | Right | 83.5–83.7 | Right |
| 45.2–45.4 | Left | 86.4–87.0 | Left |
| 46.8–47.7 | Left | | |

[a] Based on observations of mussel fishing by the Illinois Natural History Survey crew and on interviews with commercial mussel fishermen. In 1969 commercial mussel fishing was conducted on beds located immediately below Peoria Lake and in Middle and Lower Peoria lakes, as discussed in the text.

Table A-27.—Estimates of standing crops of mussels in some of the beds fished commercially and in two unfished beds in the Illinois River in 1966.

| River Mile | River Bank | Live Weights of All Species in Pounds Per Acre | Shell Weights[b] of Commercial Species in Pounds Per Acre | |
|---|---|---|---|---|
| | | | All Sizes | Height 2.5 Inches or More |
| 1.0 | Left | 1,480 | 939 | 493 |
| 5.5 | Right | 625 | 282 | 119 |
| 10.5 | Right | 246 | 130 | 51 |
| 15.0 | Right | 462 | 294 | 138 |
| 19.4 | Right | 767 | 512 | 297 |
| 29.0 | Right | 1,375 | 816 | 493 |
| 30.6 | Right | 885 | 541 | 374 |
| 42.3 | Left | 845 | 561 | 164 |
| 48.3 | Right | 669 | 444 | 227 |
| 51.2 | Right | 3,233 | 2,092 | 1,312 |
| 53.6 | Left | 476 | 324 | 183 |
| 54.3 | Right | 643 | 267 | 88 |
| 60.8 | Right | 672 | 427 | 288 |
| 66.9 | Right | 756 | 525 | 179 |
| 72.9 | Right | 2,443 | 1,591 | 651 |
| 86.8 | Left | 648 | 337 | 312 |
| 162.3[c] | Left | 6,040 | 3,762 | 2,030 |
| 168.2[c] | Right | 1,457 | 949 | 536 |

[a] Live mussels, including shells and bodies.
[b] Includes only the weights of the shells of mussels taken alive.
[c] Not fished commercially in 1966, but was fished in 1969.

Table A-28.-Number of mussels caught per 5 minutes of fishing with the exploratory crowfoot bar in the 1966 survey of the Illinois River.

| *Kind of Mussel* | *Mussels Caught Per 5 Minutes of Fishing* | | | | |
|---|---|---|---|---|---|
| | Alton Pool | LaGrange Pool | Peoria Pool | Alton, La Grange, and Peoria Pools | Entire River[a] |
| *Fusconaia ebena* | * | 0.0 | 0.0 | * | * |
| *Fusconaia f. f. undata* | 0.1 | | | * | * |
| *Megalonaias gigantea* | 0.6 | 0.1 | 0.0 | 0.2 | 0.2 |
| *Amblema plicata* | 4.8 | 0.7 | 0.6 | 1.7 | 1.6 |
| *Quadrula quadrula* | 0.8 | 0.3 | 0.1 | 0.3 | 0.3 |
| *Quadrula pustulosa* | 1.4 | | 0.0 | 0.4 | 0.4 |
| *Quadrula nodulata* | 0.1 | | 0.0 | * | * |
| *Arcidens confragosus* | 0.2 | | | 0.1 | 0.1 |
| *Lasmigona complanata* | * | | * | * | * |
| *Anodonta g. grandis* | 0.0 | | * | * | * |
| *Anodonta g. corpulenta* | 0.1 | * | * | 0.1 | * |
| *Anodonta imbecillis* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Anodonta suborbiculata* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Obliquaria reflexa* | 0.1 | 0.0 | 0.0 | * | * |
| *Obovaria olivaria* | | 0.0 | 0.0 | * | * |
| *Truncilla truncata* | | | 0.0 | * | * |
| *Truncilla donaciformis* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Leptodea fragilis* | 0.1 | 0.1 | | 0.1 | * |
| *Proptera alata* | | | | * | * |
| *Proptera laevissima* | * | | | * | * |
| *Carunculina parva* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Lampsilis a. f. fallaciosa* | * | * | * | * | * |
| *Lampsilis r. luteola* | 0.0 | | * | * | * |
| *Total* | 8.3 | 1.2 | 0.7 | 2.9 | 2.6 |

[a] Includes Starved Rock and Marseilles navigation pools. No live mussel was taken in these pools in the 1966 survey.

* Denotes less than 0.1 mussel caught per 5 minutes of fishing.

Table A-29.-Number of mussels caught per 5 minutes of fishing with the dredge in the 1966 survey of the Illinois River.

| *Kind of Mussel* | *Mussels Caught Per 5 Minutes of Fishing* | | | |
|---|---|---|---|---|
| | Alton Pool | La Grange Pool | Peoria Pool | Alton, La Grange, and Peoria Pools[a] |
| *Fusconaia ebena* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Fusconaia f. f. undata* | 0.2 | 0.0 | 0.2 | 0.1 |
| *Megalonaias gigantea* | 2.8 | 0.3 | 0.0 | 0.6 |
| *Amblema plicata* | 26.1 | 3.0 | 5.1 | 8.5 |
| *Quadrula quadrula* | 6.1 | 0.9 | 0.6 | 1.7 |
| *Quadrula pustulosa* | 5.8 | 0.1 | 0.0 | 1. |
| *Quadrula nodulata* | 0.7 | 0.1 | 0.0 | 0.2 |
| *Arcidens confragosus* | 1.0 | 0.2 | 0.0 | 0.3 |
| *Lasmigona complanata* | 0.0 | 0.1 | [illegible] | * |
| *Anodonta g. grandis* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Anodonta g. corpulenta* | 0.4 | 0.2 | 0.2 | 0.2 |
| *Anodonta imbecillis* | 0.1 | 0.0 | * | * |
| *Anodonta suborbiculata* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Obliquaria reflexa* | 1.7 | 0.0 | 0.0 | 0.3 |
| *Obovaria olivaria* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Truncilla truncata* | 0.4 | 0.0 | 0.0 | 0.1 |
| *Truncilla donaciformis* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Leptodea fragilis* | 0.5 | 0.1 | * | 0.1 |
| *Proptera alata* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Proptera laevissima* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Carunculina parva* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Lampsilis a. f. fallaciosa* | 0.1 | 0.0 | 0.1 | * |
| *Lampsilis r. luteola* | 0.0 | 0.0 | 0.0 | 0.0 |
| *Total* | 45.9 | 5.0 | 6.2 | 13.2 |

[a] The dredge was not used in the Starved Rock and Marseilles navigation pools.
[b] Denotes less than 0.1 mussel caught per 5 minutes of fishing.

Table A-30.-Number of mussels caught per man-hour of fishing by wading in the 1966 survey of the Illinois River.

| Kind of Mussel | Mussels Caught Per Man-Hour of Fishing | | | | |
|---|---|---|---|---|---|
| | Alton Pool | LaGrange Pool | Peoria Pool | Alton, La Grange, and Peoria Pools | Entire River[a] |
| Fusconaia ebena | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fusconaia f. f. undata | 1.2 | 0.0 | 0.3 | 0.4 | 0.4 |
| Megalonaias gigantea | 1.7 | 0.3 | * | 0.6 | 0.6 |
| Amblema plicata | 25.8 | 10.3 | 14.1 | 16.1 | 15.5 |
| Quadrula quadrula | 3.3 | 0.7 | 0.0 | 1.1 | 1.0 |
| Quadrula pustulosa | 4.9 | 0.2 | 0.0 | 1.3 | 1.3 |
| Quadrula nodulata | 2.2 | 0.1 | 0.0 | 0.6 | 0.6 |
| Arcidens confragosus | 0.1 | 0.5 | 0.0 | 0.2 | 0.2 |
| Lasmigona complanata | 0.0 | 0.1 | 0.0 | * | |
| Anodonta g. grandis | 0.0 | 0.1 | 0.1 | * | * |
| Anodonta g. corpulenta | 1.6 | 1.1 | 1.6 | 1.4 | 1.4 |
| Anodonta *imbecillis* | 0.1 | 0.2 | 0.0 | 0.1 | 0.1 |
| Anodonta suborbiculata | 0.0 | 0.1 | 0.0 | * | |
| Obliquaria reflexa | 0.5 | 0.1 | 0.0 | 0.2 | 0.1 |
| Obovaria olivaria | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Truncilla truncata | 0.2 | 0.1 | 0.0 | 0.1 | 0.1 |
| Truncilla donacformis | 0.1 | 0.0 | 0.0 | * | |
| *Leptodea fragilis* | 1.1 | 0.3 | * | 0.4 | 0.4 |
| Proptera alata | 0.5 | 0.0 | 0.1 | 0.2 | 0.2 |
| Proptera *laevissima* | 1.6 | 0.7 | 0.2 | 0.7 | 0.7 |
| Carunculina parva | 0.1 | 0.0 | 0.0 | * | * |
| Lampsilis a. f. fallaciosa | 1.9 | 0.3 | 0.4 | 0.8 | 0.7 |
| *Lampsilis* r. luteola | 0.0 | 0.1 | 0.2 | 0.1 | 0.1 |
| Total | 46.9 | 15.3 | 17.0 | 24.3 | 23.4 |

[a] Includes Starved Rock and Marseilles navigation pools. No live mussel was taken in these pools in the 1966 survey.
[b] Denotes less than 0.1 mussel caught per man-hour of fishing.

## A