A Partial Biological Survey of the Spring River Drainage in Kansas, Oklahoma and Missouri. Part I, Collecting Sites, Basic Limnological Data, and Mollusks

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Although Spring River, fed by numerous smaller streams, is the most important tributary in the Neosho (=Grand) System, no comprehensive study directed toward an understanding of its fauna has yet appeared in print. This report does not aspire to a position of ultimate knowledge in this interesting drainage, but it does contribute considerable data toward that end. Herein included are data on the ecological conditions present at the various collecting stations (see Neel, unpublished, for an analysis of bottom conditions in Shoal Creek), and an annotated list of the pelecypod and gastropod mollusks secured at each. The crayfish and vertebrates will be discussed in future contributions.

The author wishes to thank the several persons who contributed their time and energies during 1961 through 1964 to further the study. In field assistance I have had the company of Robert Hartman, Kansas Fish and Wildlife Service, J. B. Campbell, W. C. Jones, Jr., F. E. Calovich, C. F. Eaglesfield, E. S. Gibson, C. W. Beasley, R. E. Austin, C. C. Childress, G. W. Clothier, G. R. Dove, G. Ulrickson, R. A. Jewell, J. Triplett, and R. R. Sargert, all students at Kansas State College of Pittsburg. For cooperation in interstate efforts, Larry Gale, Chief, and John Goddard, Missouri Conservation Commission, are thanked. The following men contributed collecting data and species lists from their respective institutions: George A. Moore, Oklahoma State University, F. B. Cross, University of Kansas, Waymon C. Gibson, Northeastern Oklahoma A. and M. College, and Arthur Witt, University of Missouri. Special gratitude is extended to Dr. Joe K. Neel, Chief, Water Quality Section, U. S. Public Health Service, Kansas City, Missouri, for making his extensive data on Shoal Creek and its tributaries available.

Materials and Methods

Abbreviations for museum collections are as follows: KU, University of Kansas; M, University of Missouri; OSU, Oklahoma State University; NO, Northeastern Oklahoma A. and M. College.

Each collecting site has been assigned an arbitrary number for the purpose of mapping. In the annotated list of collecting sites, the original

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field numbers appear in parentheses following
those stations attended by the author appear

Specimens, other than those collected
secured by means of gill and tramble nets, s
SCUBA gear, and unless otherwise designa
heterotherm museum at Kansas State College

Plankton samples were secured by means
bucket, the netting possessing 6,000 meshes pe

Determinations of water quality followe
the American Public Health Standard Metho
was measured either by means of a Beckman
man Zeromatic meter. Carbonates were
standard HCl to successive bicarbonate and
indicated by phenolphthalein and methyl oran
calculations and relationships were determin
carbon dioxide was determined by titration w
solved oxygen was determined by the Alst
Winkler (sodium azide) method. Specific
a measure of water's ability to convey an elec
able to the total concentration of ionized sub
accomplished by means of a modified Wheatsto
The total bacteria per ml of water sample
appropriate dilutions and counting the numbe
an agar pour-plate following 24 hours incubati
total number of coliform bacteria was determi
dilutions and counting the number of colonies
using eosin-methylene blue agar as a differenti
24-hour incubation period. The presence of c
by lactose-fermentation tests, the production o
as positive confirmation of pollution by war
man.

Spring River, separated by a moderate e
River Drainage in the east, arises from num
Lawrence County, Missouri, and flows south
older geological formations (Pennsylvanian, P
confluence with the Neosho about six miles n
County, Oklahoma. Stream elevation declin
sea level at the headwaters to about 780 feet at
the main stream, tortuous and often much-br
well-defined and stable in the lower reache
and farm lands situated in gently rolling Ozar

Annotated List of Mollusks

A. Sphaeriidae

Following Herrington (1962), the genus *Musculium* is here relegated to *Sphaerium*. Hence, only two genera are represented in our collections, *Sphaerium* and *Pisidium*, and four species. All of the species seem to prefer relatively shallow, running water, although a few specimens were also secured from pooled backwaters. In the list that follows, the number of specimens obtained at each collecting site is enclosed in parentheses.

Sphaerium partumeium (Say)

Because of its habitat preference, i. e., muddy bottoms in sluggish water, this species is much more common in Cow Creek than in the other two streams, becoming progressively less abundant downstream. The shell is of the thin variety.

Station records: 1(63), 2(37), 3(11), 4(23), 6(5), 7(43), 8(22), 9(1), 34(4), 36(13), 38(6), 82(6), 83(6).

Sphaerium transversum (Say)

Like *S. partumeium*, this species has a strong preference for relatively sluggish waters. It is much more abundant in Cow Creek, being found only in backwaters in the other two streams and their tributaries. Murray (1961) found *S. transversum* in similar habitats, to those observed by us, in the nearby Neosho River.

Station records: 1(54), 2(4), 3(37), 4(19), 5(1), 6(8), 8(4), 15(8), 33(3), 34(8), 35(1), 36(5), 38(2), 71(2), 74(1), 75(3), 79(1).

Sphaerium striatinum (Lamarck)

All specimens are of the long type, characteristic of the central United States (Herrington, 1962), and all are rather densely striate with thick, heavy shells. In each instance, the specimens were removed from running water over sand and gravel, or in coarse-grained mud. This type of habitat is scarce in Cow Creek and, to a large degree, also in Spring River. This is reflected in the distribution pattern as listed below.

Station Records: 1(2), 30(4), 39(1), 32(160), 33(568), 34(85), 35(227), 36(16), 38(8), 39(53), 41(13), 66(3), 67(5), 68(6), 71(16), 72(3), 81(2).

Pisidium compressum Prime

A small species with a preference for sandy bottoms.

Station records: 1(4).

Although these four specimens were the only representatives of *Pisidium* secured by us, *P. casertanum* should be sought. It is the most common member of the genus in the region of the Great Plains.

B. Unionidae

The entire molluscan fauna here under discussion lies in the Ozarkian mussel assemblage (van der Schalie, 1950), *i. e.*, occupies a land mass which probably protruded above embayments of the sea. The fauna, although more or less distinct, is most closely related to that of the Cumberland region, and both are occupied by advanced species. Since Murray and Leonard (1962) have discussed the origin of the Kansas mussel fauna in some detail, there is no point in laboring that problem here. The author agrees with their conclusions that the primary affinities are eastern, most likely Mississippian and/or Missourian. I should point out, however, that the occurrence of *Alasmidonta* and *Lasmigona* in Spring River correlates very well with some other findings, indicating possible capture of the Spring River Drainage from that of the White System in Arkansas. This report is based on 878 specimens, representing 22 genera and 31 kinds (species and subspecies) of unionid mollusks collected during this survey.

Fusconaia flava (Rafinesque)

A species primarily of small streams, preferring rock, hard sand or gravel bottoms in clear water. Not seen in Cow Creek, doubtless because of the high degree of pollution found there. In Shoal Creek it was most often secured from rocky bottoms in the gravel and sand beneath *Dianthera* roots, or from fissures in bedrock, in swiftly flowing water of 1 to 2½ feet in depth.

Station records: 34(3), 35(9), 36(3), 39(1), 68(3), 72(6), 77(9), 79(15), 81(3), 82(12).

Crenodonta (=*Amblema*) *costata* (Rafinesque)

Found primarily in backwater areas. We did not find the species abundant.

Station records: 6(6), 72(1), 82(6).

Crenodonta (=*Amblema*) *peruviana* (Lamarck)

Found only in samples taken at two stations in running water of more than 18 inches in depth.

Station records: 72(3), 81(6).

Quadrula quadrula Rafinesque

Although a common species in Kansas and Missouri, our sampling techniques produced few specimens, all from muddy-gravel at one side of the main channel. Primarily in water from 1 to 2 feet in depth.

Station records: 6(2), 81(4), 82(11).

Quadrula pustulosa (Lea)

In water from 2 or 3 inches to 2½ feet. Our specimens varied from strongly pustulose to smooth, there being about a 1:1 ratio between the two types.

Station records: 65(1), 81(4), 82(27).

Quadrula nodulata Rafinesque

A rare species in the Spring River Drainage, and uncommon in associated systems. Apparently restricted to clean gravel and rock bottoms in large streams.

Station records: 82(4).

Tritogonia verrucosa (Rafinesque)

Habitat variable, but muddy sand seems to be preferred.

Station records: 65(1), 73(1), 77(1), 79(3), 81(1), 82(13).

Plethobasis cyphyus (Rafinesque)

An uncommon species in the Spring River Drainage. In Kansas, the species has heretofore been known only from one site in the Verdigris River (Murray and Leonard, 1962). Habitat muddy sand.

Station records: 69(1 valve), 79(1 valve), 82(1).

Pleurobema cordatum coccineum (Conrad)

The pig-toed mussell is a small-stream and headwaters species, as demonstrated by our records, few as they are. Downstream, it is replaced by the next two forms.

Station records: 65(5), 68(5), 72(12).

Pleurobema cordatum catillus (Conrad)

Prefers muddy sand or gravel in streams of moderate gradient. May only be (as is perhaps the next form) an ecological variant of *P. c. coccineum*. Young moderately to strongly rayed.

Station records: 30(1), 72(1), 79(3), 81(1), 82(4).

Pleurobema cordatum pyramidatum (Lea)

In Kansas, this form has been known only from the Neosho River (Murray and Leonard, 1962). It is not surprising, then, to find the mussel in Spring River.

Station records: 82(1).

Elliptio dilatatus (Rafinesque)

The lady-finger mussell was secured in a variety of habitats, sluggish backwaters to mid-channel torrents, and from mud, sand, cleft rocks and

gravel bottoms. In water from 6 inches to 3 feet. Not known from Cow Creek, but is one of the most abundant species in Spring River proper. The specimens from Shoal Creek all possessed white nacre, whereas those from stations downstream from 68 varied from white to pinkish-salmon and mauve.

Station records: 34(1), 35(3), 68(31), 72(18), 77(5), 79(3), 81(5), 82(27).

Uniomerus tetralasmus (Say)

Our specimens invariably were secured from mud-bottomed backwater embayments at depths of 1 to 3 feet. Very scarce in the main streams, although common in Cow Creek. The form is apparently resistent to pollutants.

Station records: 1(4), 4(3), 5(9), 6(1), 8(2), 32(1), 35(1), 40(3).

Lasmigona costata (Rafinesque)

Extremely rare in Kansas, and heretofore known only from the Neosho River (Murray and Leonard, 1962). The fluted mussel is little resistant to pollution, and also to high turbidity. *Lasmigona* is very abundant in the clear tributaries of the White River in Arkansas, especially so on gravel riffles, situations similar to those prevailing at the single station listed below. The species probably entered the Neosho system through the auspices of stream capture.

Station records: 82(2).

Lasmigona complanata (Barnes)

A mud-lover, and common in streams with such bottoms, where unpolluted. Abundant in the upper end of Grand Lake.

Station records: 6(2, dead); 90(16).

Anodonta grandis Say

A widespread, hermaphroditic species (Thomas, 1959) in backwater areas to depths of 3 feet, but appears to avoid the highlands. *A. grandis* is an important item in the diet of racoons. The two specimens from station 6 were heavily laden with glochidia, and when placed in an aquarium discharged them. Many larvae were later observed attached to the fins and gills of *Lepomis cyanellus* and to the fins and gills of a large larval *Necturus maculosus*, both of which being kept in the aquarium. The glochidia began dropping off after two weeks. No additional observations were made on them.

Station records: 5(1), 6(2), 7(6), 8(1), 11(1), 33(3), 34(4), 35(9), 36(1), 38(2), 39(1), 77(4), 82(1), 90(6).

Anodonta imbecilis Say

This small hermaphrodite (Thomas, 1959) is widely distributed in the United States, but in Missouri, Kansas and Oklahoma it is restricted primarily to lowland, mud-bottomed swamps, marshes, ponds, and sluggish backwaters. Our specimens were all secured from shallow water, in Cow Creek only, again reflecting the ecological differences between the three major streams in the system.

Station records: 3(5), 5(2), 6(3).

Alasmidonta marginata Say (Figures 6, A and B)

Three of the specimens from station 82 were utilized by the author (Branson, in press) in reporting this species from Kansas. Since that time, four additional specimens have been found in our collections. All living specimens were located in mid-stream in gravel.

Interestingly enough, our specimens are more like those from southern Illinois, *A. m. truncata* (Wright), than those seen from the Illinois River in Oklahoma. They are very similar to specimens secured from Kings River, a tributary of the White in Arkansas.

Station records: 65(3), 81(1), 82(6).

Strophitus rugosus (Swainson)

According to Baker (1928) and Murray and Leonard (1962), this species is characteristic of large and medium-sized streams. However, we found it abundant in all types of stream situations, it being one of the most widespread species in the Spring River System. The usual habitat was sand and mud, although the specimens from Shoal Creek were removed from fissures in bedrock. The nacre ranged from white to a beautiful salmon in color, and one specimen from station 82 possessed a few green rays in the epidermis.

Station records: 6(7), 8(1), 25(1), 33(1), 34(1), 35(1), 36(1), 40(1), 65(2), 67(4), 69(2), 72(6), 78(2), 79(3), 81(2), 82(17).

Actinonaias carinata (Barnes)

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

Station records: 32(2, immature), 34(5), 35(4), 36(1), 39(2), 43(1), 68(4), 72(3), 77(6), 78(2), 79(20), 81(5), 82(15).

Truncilla truncata Rafinesque

Two specimens of this interesting little mussel were removed from broken rocks in water approximately 18 inches in depth. Murray and Leonard (1962) indicated soft or hard mud as the usual habitat, but the habitat in our Missouri station corresponds to that found by Isley (1925) in Oklahoma.

Station records: 68(2).

Truncilla donaciformis (Lea)

Generally regarded as a species inhabiting sandy bottoms, the faun's foot mussel is most usually found in relatively clean water. The Shoal

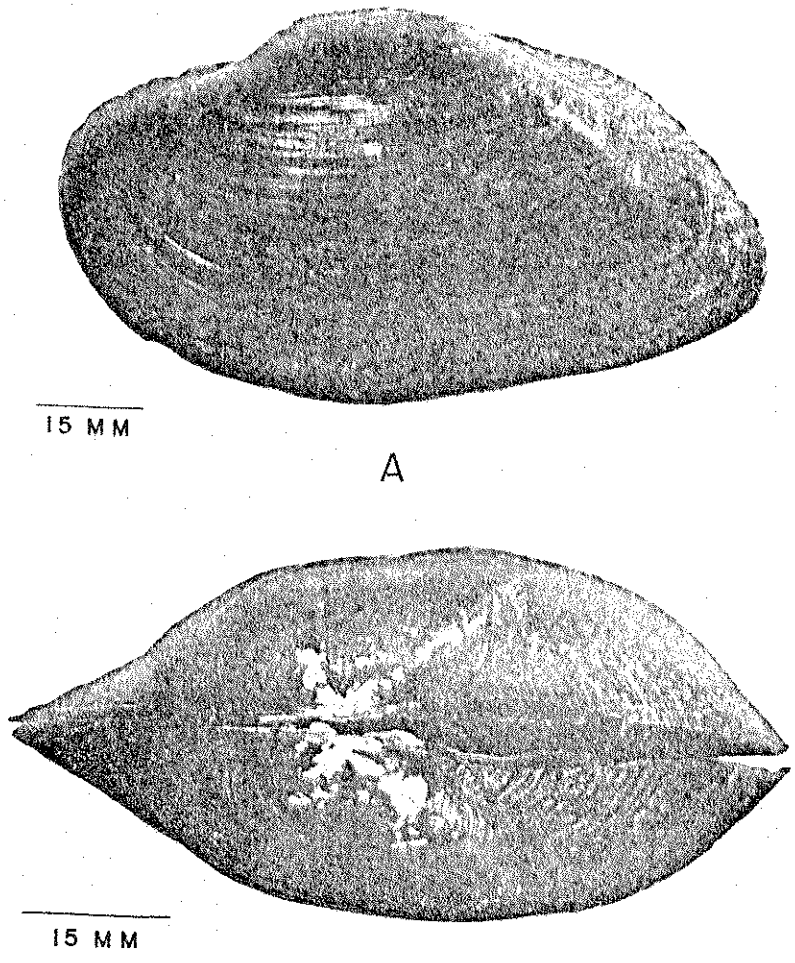


Figure 6. Alismadonta marginata Say. A, left valve; B, dorsal view. Spring River, below Kansas State Highway 96 bridge, Cherokee County, Kansas.

Creek specimens were collected from rock fissures in 2½ feet of water, those from Spring River from sand. In all four localities there was a moderate to swift current.

Station records: 34(1), 35(1), 67(1), 68(1).

Leptodea Fragilis (Rafinesque)

The fragile-paper mussel is the dominant pelecypod in the pond-like backwaters located at the junction of Spring River with the Neosho. It is nearly three times as abundant as the next species. Although only five specimens were collected for the record, hundreds of dead and living specimens were observed.

Station records: 90(5).

Leptodea laevissima (Lea)

Baker (1928) indicated that *L. laevissima* was found only in streams with and in sand. Murray and Leonard (1962) found the species in quiet pools and in mud, and their findings agree with ours.

Station records: 90(2).

Proptera purpurata (Lamarck)

Although abundant in the master Stream (Neosho), this heavy-shelled species appears to be uncommon in the lower parts of the Spring River System. It is a species of deep water and mud bottoms; such conditions prevailed at the two localities listed below.

Station records: 34(2), 36(1).

Carunculina parva (Barnes)

All specimens were removed from mud bottoms in sluggish current. *C. parva* appears to be restricted to small streams. It is hermaphroditic (Tepe, 1943; Isley, 1925).

Station records: 1(1), 5(1), 6(1), 29(1), 33(6), 34(1), 35(10).

Ligumia recta latissima (Rafinesque)

The black sand mussel is typically a member of large stream faunas, primarily those inhabiting sandy botoms. However, we found it abundant in sandy mud at several of the Cow Creek stations, and less so in the other two streams.

Station records: 3(4), 4(4), 5(4), 6(4), 18(1), 20(1), 21(1), 30(1), 33(2), 67(1), 82(3).

Ligumia subrostrata (Say)

All specimens were found in sluggish waters over mud bottoms.

Station records: 1(1), 3(11), 5(8), 6(5), 25(3), 33(7), 34(2), 35(8), 40(2), 72(11), 78(2), 79(3), 82(7)

Lampsilis anodontoides anodontoides (Lea)

Except for a rather dark epidermis and the tendency to produce a few rays dorsally, our specimens are nearly typical for this race. We collected them from both shallow and deep water, in mud, sand and on rocky bottoms.

Station records: 1(1), 3(1), 4(9), 7(1), 8(2), 20(4), 33(1), 38(2), 69(1), 73(1), 82(1).

Lampsilies anodontoides fallaciosa Smith

The specimens here discussed, contrary to Baker's (1928) statement that the typical habitat is mud, were secured from a broken-rock bottom. The shell is covered by broad, dark-green rays separated by yellowish interspaces.

Station records: 77(5).

Lampsilis luteolus Simpson

Both in numbers and distribution, *L. luteolus* is the most common species encountered in the Spring River System. Our specimens were found in all types of ecological situations, including bedrock pockets in Shoal Creek. Such a distribution may reflect the species' own resistance to pollution and that of its fish hosts, especially *Lepomis macrochirus*, a very widespread species.

This is the species reported by Murray and Leonard (1962) as *L. radiata siliquoidea* (Barnes) from Kansas. Wheeler (1963) showed this name to be unavailable, and we follow him in this conclusion.

Station records: 3(13), 4(3), 5(7), 6(5), 8(5), 20(1), 30(1), 32(1), 33(3), 34(5), 35(5), 36(1), 39(1), 65(1), 67(1), 68(16), 72(52), 78(2), 82(9).

Lampsilis ovata (Say)

As indicated by the records listed below, this is another common species. Our specimens were secured primarily from gravel and sand bottoms. Murray and Leonard (1962) referred all Kansas specimens to the race *L. ovata ventricosa* (Barnes). In our samples, most of the specimens from Cow Creek appear to be intergrades with the form called *L. ovata satura* Lea, and those from Shoal Creek and from Spring River proper are nearly typical *satura*. The epidermis is very black, practically rayless. This area is doubtless a rather broad ecotonal cleavage, separating the plains from the Ozarkian uplift.

Station records: 32(1), 33(1), 35(1), 36(2), 38(2), 39(2), 65(5), 67(1), 72(1), 78(3), 79(4), 81(3), 82(28).

Ptychobranchus fasciolaris (Rafinesque) (Figures 7, A and B)

According to Murray and Leonard (1962), this species has not been collected in Kansas since 1890. Our single specimen (Branson, in Press), then, is of importance. The shell is 98.2 mm in length and 55.8 mm in greatest depth, strongly compressed and heavy. The nacre is glistening, pearly white, and the umbones are very low and compressed. The epidermis is greenish-horn posteriad, grading into dark horn anteriorly. There are 16 green, wavy pen-stripe lines radiating from the umbonal region on the posterior slope. Internally, the pseudocardinals are relatively small and serrate. The lateals are short, decurved and heavy. The interdentum is long and smooth. The retractor muscle scar is small, deeply placed beneath the lateral tooth, and the posterior adductor is small and directed posteriad. The anterior scars are also deeply placed, being located in front of the pseudocardinals. The pallial line is distinct and impressed for its entire length. The single specimen was found almost completely buried in a gravelly sand bar.

Station record: 82(1).

C. Gastropoda

Our collection of snails during the course of the survey, although not as intensive as that of pelecypods, turned up some intersting records and simulated a rather extensive study of *Mudaila potosiensis* (Lea), published elsewhere (Jones and Branson, 1964). Long (1964) pointed out an additional synonym overlooked by the authors of the last-cited paper, *M. plebejus* Anthony, 1850.

The following list included data for only seven genera, 11 species, and 5,450 specimens. There are doubtless several other species in the system, although the fauna is not a large one, if past experience can be trusted in this matter.

Mudalia potosiensis (Lea) (Pleuroceridae)

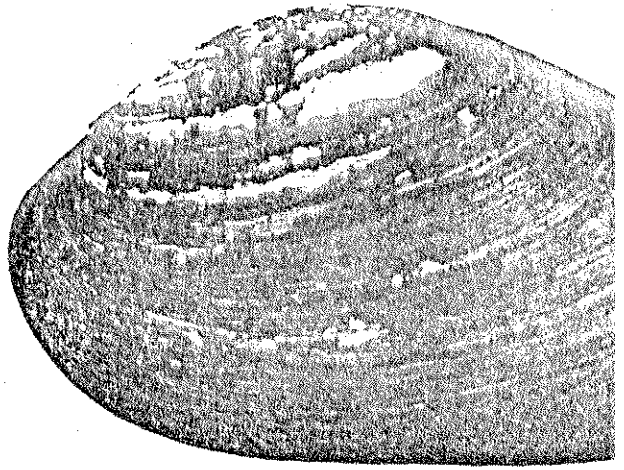
The specimens from stations 67 and 68 are banded, similar to those discussed by Jones and Branson (1964) from the small tributary at station 32 and from eastern Missouri and eastern Arkansas. This banded form was not seen in the main streams, and I have not collected it from any western-flowing large stream in Arkansas, nor from Oklahoma at all. It is apparently a headwaters modification.

Station records: 67(39), 68(6), 33(19), 32(332), 34(132), 35(3,155—all deposited in U. S. Nat. Mus.), 36(3), 38(2), 39(15), 40(6), 42(10), 44(241), OSU63(280), 67(39), 68(6).

Campeloma decisum (Say) (Viviparidae)

A mud-burrowing species which we invariably fou
or in the soil accumulated about the roots of *Dianthera a*
(1963) has hypothesized that this species' distributio
dependent on that of the aforementioned plant. Obser
made on the numbers of embryos produced per individu
sex ratios, all of the specimens for the study being
following sites:

Station records: 32(30), 33(32), 34(84), 35
38(24), 39(10), 40(55), 41(18), 43(21).



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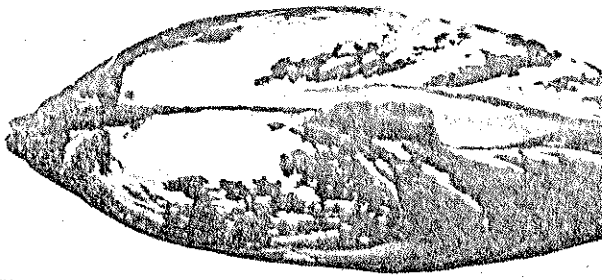
A



15 MM

B

Figure 7. Ptychobranchus fasciolare (Rafinesque). A, left valve
Spring River approximately 200 yards upstream from Kansas State H
Cherokee County, Kansas.