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Unionid Mussels of the Wabash, White, and East Fork White Rivers, Indiana

Abstract—Distributions and abundances of unionid mussels (Mollusca: Pelecypoda) in the Wabash, White, and East Fork White rivers, Indiana, are presented as based on collections made at 49 stations during 1966–67. Only 30 of 64 species reported from the study area by previous workers were encountered. Comparisons of these findings with the results of earlier investigations indicate that reductions in the ranges and abundances of many species, and apparent extirpation of several kinds, have occurred within the last three decades.

Introduction

In 1900 Call (1) listed about 70 kinds of mussels, or freshwater clams of the family Unionidae (Mollusca: Pelecypoda), as inhabitants of Indiana. Four decades later Goodrich and van der Schalie (2) catalogued 75 different unionids from that state, 64 of which reportedly lived in the Wabash and White rivers. This paper documents the recent distributions and abundances of unionid clams in the Wabash, White, and East Fork White rivers of Indiana, and is based on data accumulated during a survey of the commercially valuable mussels of the rivers in consideration as reported by Krumholz, Bingham, and Meyer (3). Comparisons of the results presented here with those of the earlier investigations (1, 2) indicate that a dramatic modification of this fauna has occurred within the last 25–30 years, consisting principally of reductions in the ranges and abundances of many species and apparent local extinctions of others. The purpose of this paper is to record those changes and to relate them to Stansbery's (4) recent compilation of rare, endangered, and recently extinct mussels of the region east of the Mississippi River. The findings presented here are only one example of the gross modifications that continue to appear in the benthic faunas of North American waters.

Methods

Unionid mussels were collected at 49 stations on the Wabash, White, and East Fork White rivers (Fig. 1) during 1966 and 1967. The stations were located approximately 16 km apart on the Wabash River from Delphi, Indiana, to its confluence with the Ohio River (ca. 533 river km), and on the mainstream

and East Fork of the White River from Tunnelton, Ind., to junction of the former with the Wabash at Mt. Carmel, Illinois (ca. 259 river km). Living mussels were collected with a crowfoot bar over a distance of at least 1.6 km at each station. The crowfoot bar is a specialized type of mussel dredge used by many commercial mussel harvesters operating on the Mississippi River and its larger tributaries, and has been described in detail by Coker (5) and Carlander (6). Living animals and valves of dead specimens were also collected by hand at most stations in conjunction with the crowfoot bar collections, and shells were gathered and examined along river banks throughout the study area. Most living mussels that were captured were returned to the rivers, but individuals were retained for identification purposes when necessary.

Species Accounts

The following accounts are arranged alphabetically by genus. Entries are included for each of the 64 species reported from the Wabash and White rivers by Goodrich and van der Schalie (2), even though living specimens of only 30 kinds appeared during 1966–67, to emphasize the substantial degree of modification this fauna has undergone in recent years.

Living specimens of a species deemed abundant (A) within a given river segment were present in quantity at all or most stations in the area, and were the predominant members of the unionid fauna in that segment. Shells of each abundant form were present on the river bottoms and banks throughout the area(s) of abundance. Presence of a species indicated as common (C) within a river section was indicated by at least one but usually several living specimens at most stations in the area. Valves of dead individuals of common species were usually present throughout the section(s) inhabited by their living counterparts. Species defined as rare (R) were represented by four or fewer living animals in a given river segment.

The arbitrary limits of the upper, middle, and lower sections of the Wabash River used for this report are given in Fig. 1, and my evaluations of

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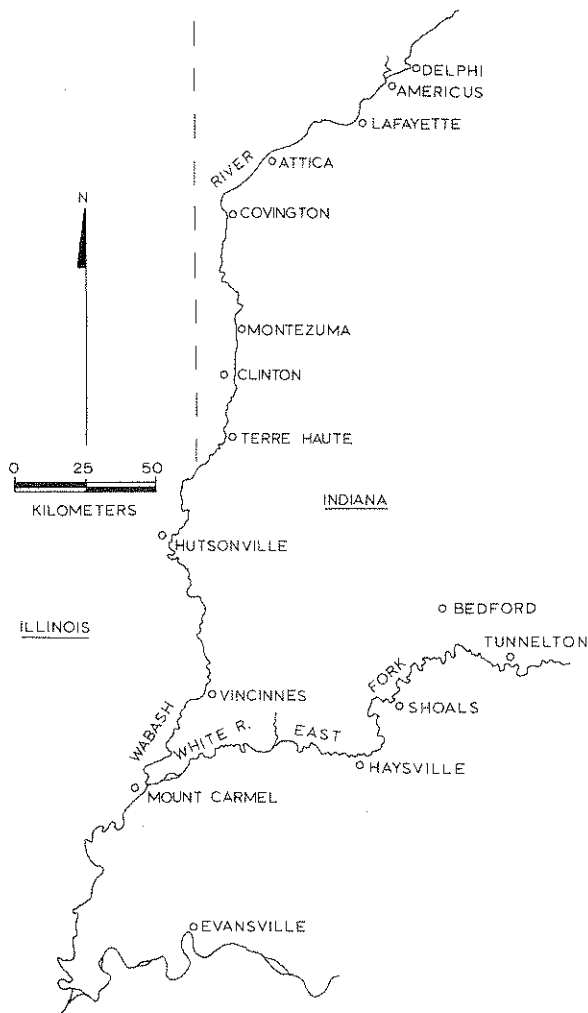


FIG. 1—Sections of the Wabash, White, and East Fork White rivers included in the study area. Upper Wabash; Delphi, Ind. to Terre Haute, Ind.; middle Wabash; Terre Haute to Mt. Carmel, Ill.; lower Wabash; Mt. Carmel to the Ohio River.

the distributions and abundances of the species present in the study area at the time of this investigation are summarized in Table 1.

Actinonaias carinata (Barnes). Call (1) and Goodrich and van der Schalie (2) reported this mussel to be common in larger Indiana rivers. At the time of this investigation it was common in the White River system and in the lower Wabash, and abundant in all sections of the Wabash upstream from Mt. Carmel, Ill.

Alasmidonta marginata (Say). Call (1) reported this clam as present in every river basin in Indiana, but did not comment on its abundance. Goodrich and van der Schalie (2) described it as present in head-water situations throughout the state. One small living specimen was collected during this project, in the upper Wabash a few km downstream from Americus, Ind. There was no evidence of its presence elsewhere in the study area.

Amblema costata Rafinesque. Goodrich and van

der Schalie (2) described this mussel as widely distributed in Indiana. I found it common throughout the Wabash and mainstream White rivers, and abundant in all areas of the East Fork upstream from Haysville, Ind.

Amblema peruviana (Lamarck). Goodrich and van der Schalie (2) reported this form to be present in the Wabash and White rivers, but did not comment on its abundance. The only evidence I found of it were several old eroded valves on a bank of the East Fork between Shoals, Ind. and Haysville, Ind.

Anodonta grandis Say. Call (1) recorded this species as abundant in sluggish streams, backwaters, and oxbow lakes along the Wabash and Ohio rivers. Goodrich and van der Schalie (2) considered it common in Indiana, and noted several collection localities for it on the Wabash. One living specimen

TABLE 1

Distribution and abundance of unionids in the Wabash, White, and East Fork White rivers, Indiana. R = rare, C = common, A = abundant. A dash indicates absence of a species from a river segment.

Species	Wabash River			White River	
	Upper	Middle	Lower	Main Stream	East Fork
<i>Actinonaias carinata</i>	A	A	C	C	C
<i>Alasmidonta marginata</i>	R	—	—	—	—
<i>Amblema costata</i>	C	C	C	C	A
<i>Anodonta grandis</i>	—	—	R	—	—
<i>Anodontooides ferussacianus</i>	R	—	—	—	—
<i>Cyclonaias tuberculata</i>	—	—	—	—	R
<i>Cyprogenia irrorata</i>	—	R	—	—	—
<i>Elliptio crassidens</i>	—	—	—	—	C
<i>Fusconaia ebeneus</i>	R	R	R	C	C
<i>F. undata</i>	R	R	—	R	C
<i>Lampsilis anodontooides</i>	C	C	C	—	—
<i>L. ventricosa</i>	C	C	C	C	C
<i>Lasmigona complanata</i>	C	C	C	R	C
<i>L. compressa</i>	R	—	—	—	—
<i>L. costata</i>	R	R	—	—	—
<i>Leptodea fragilis</i>	C	C	C	C	C
<i>L. laevissima</i>	—	—	R	—	—
<i>Megalonaias gigantea</i>	R	C	—	R	C
<i>Obliquaria reflexa</i>	R	R	R	R	C
<i>Obovaria olivaria</i>	A	A	C	C	C
<i>O. subrotunda</i>	R	—	—	—	R
<i>Plethobasus cyphus</i>	C	—	—	—	R
<i>Pleurobema cordatum</i>	—	—	R	—	—
<i>Proptera alata</i>	C	C	C	C	C
<i>Quadrula metanevra</i>	C	C	R	R	R
<i>Q. pustulosa</i>	A	A	A	A	A
<i>Q. quadrula</i>	A	A	A	A	A
<i>Strophitus rugosus</i>	R	—	—	—	—
<i>Tritogonia verrucosa</i>	C	C	—	—	—
<i>Truncilla truncata</i>	R	R	R	R	R

was taken during this investigation, from the lower Wabash. No further evidence of it appeared.

Anodonta imbecillis (Say). I found no evidence of this form. Goodrich and van der Schalie (2) described it as present in most Indiana drainages and noted several collection localities for the species on the upper Wabash.

Anodonta suborbiculata (Say). Goodrich and van der Schalie (2) reported this unionid as present in the lower Wabash and in the mainstream of the White River. I did not find it in the study area.

Anodontoides ferussacianus (Lea). Both previous monographs (1, 2) recorded this mussel as common in Indiana, and Goodrich and van der Schalie noted a collection site for it on the upper Wabash. Two living specimens were collected during this study, both from the upper Wabash. No further evidence of the species appeared.

Arcidens confragosus (Say). I did not find this unionid. Goodrich and van der Schalie reported it from the White River and from two locations on the middle and lower Wabash.

Carunculina glans (Lea). I found no evidence of this animal. Goodrich and van der Schalie (2) reported it from the White River system and from the lower Wabash. Stansbery (4) considers the species to be rare and endangered.

Carunculina parva (Barnes). I obtained no specimens. Goodrich and van der Schalie (2) considered the species to be widespread in Indiana rivers and mentioned three collection localities for it on the Wabash.

Cyclonaias tuberculata (Rafinesque). The earlier investigators (1, 2) considered this mussel to be common in large Indiana rivers. I found no evidence of it in the Wabash and mainstream White rivers. A few specimens appeared at stations on the East Fork upstream from Shoals, Ind., and the species was rare in that area.

Cyprogenia irrorata (Lea). Call (1) reported this unionid as common in the Wabash River. Goodrich and van der Schalie (2) reported it from the Wabash and White rivers and their larger tributaries, and provided collection localities for it from the middle and lower Wabash. I collected one living specimen and two shells of the species from stations on the middle Wabash. No further evidence of it appeared.

Dysnomia flexulosa (Rafinesque). Goodrich and van der Schalie (2) indicated this mussel to be a rare inhabitant of the White and lower Wabash rivers. Stansbery (4) considers it to be extinct, and I found no evidence of its persistence in the present study area.

Dysnomia perplexa (Lea). Goodrich and van der Schalie (2) described this species as "well represented" in the Wabash and White rivers. I found no evidence of it.

Dysnomia personata (Say). Goodrich and van der Schalie (2) recorded this animal as rare in the White and lower Wabash rivers. I obtained no specimens and Stansbery (4) considers it to be extinct. These same statements apply to the following two species, with the exception that Stansbery (4) considers *D. sulcata* to be rare and endangered rather than extinct.

Dysnomia sampsoni (Lea)

Dysnomia sulcata (Lea)

Dysnomia triquetra (Rafinesque). Goodrich and van der Schalie (2) considered this form to be the most common member of its genus in Indiana, and reported it to be rare in the Wabash and White rivers. No evidence of it appeared during this investigation.

Elliptio crassidens (Lamarck). Call (1) described this mussel as present in the Wabash River. Goodrich and van der Schalie (2) reported it to be an inhabitant of the larger rivers draining southern Indiana, and noted collection records for the species from the middle Wabash and the East Fork. It did not appear in the Wabash or mainstream White rivers during 1966-67, but was common throughout the East Fork upstream from Haysville, Ind.

Elliptio dilatatus (Rafinesque). Call (1) considered this species to be one of Indiana's most abundant mussels, and particularly so in the Wabash River. Goodrich and van der Schalie (2) concurred, noting a number of collection sites for it on the Wabash. The only evidence I found of it was several old and weathered valves on a bank of the East Fork at Shoals, Ind.

Fusconaia ebenus (Lea). Call (1) reported this mussel as common in larger Indiana rivers, and Goodrich and van der Schalie (2) described it as present in the Wabash and White rivers. At the time of this study it was rare in the Wabash, and common in the mainstream and East Fork of the White River.

Fusconaia subrotunda (Lea). Goodrich and van der Schalie (2) reported this clam from the Wabash, but made no statement concerning its abundance. I found no evidence of it.

Fusconaia undata (Barnes). Goodrich and van der Schalie (2) indicated this mussel to be present in the Wabash and White rivers. I collected a few living specimens in the upper and middle segments of the Wabash, and consider the species rare in those areas. Individuals appeared sporadically in collections from the mainstream and East Fork of the White River downstream from Shoals, Ind., and the species was common throughout the East Fork upstream from Shoals.

Call (1) noted that *F. undata* is quite variable in appearance, becoming larger and more laterally inflated with increasing distance downstream. Goodrich and van der Schalie (2) pointed out that some taxonomists assign the smaller upstream form to a separate species, *F. flava* (Lea). All specimens taken during the present study were referred to as *F. undata*.

Lampsilis anodontoides (Lea). Call (1) considered this clam to be common in Indiana rivers. Goodrich and van der Schalie (2) limited its distribution to tributaries of the Ohio River, and mentioned three collection localities for the species in the middle and lower Wabash. Specimens were common in all areas of the Wabash that I studied, but none appeared in the White river system.

Lampsilis fasciola Rafinesque. Goodrich and van der Schalie (2) described this animal as rare in Indiana and noted two collection sites for it on the

Wabash River. I found no evidence of its presence in the study area.

Lampsilis orbiculata (Hildreth). I did not find this species. Goodrich and van der Schalie (2) indicated it to be present in both the Wabash and White rivers.

Lampsilis siliquoidea (Barnes). Goodrich and van der Schalie (2) considered this mussel to be one of Indiana's most common unionids and gave four collection sites for it on the Wabash River. I obtained no specimens.

Lampsilis ventricosa (Barnes). Due to confusion surrounding the taxonomic status of the nominal forms *L. ovata* (Say), *L. ventricosa*, and *L. ovata ventricosa* (Barnes) (2), I am treating them collectively as a single species, *L. ventricosa*. Both earlier reports (1, 2) described this mussel as common in the Wabash and White rivers, and it remained so throughout the 1966-67 study area.

Lasmigona complanata (Barnes). Call (1) and Goodrich and van der Schalie (2) described this animal as common to abundant in large Indiana rivers. Living specimens were common in all areas studied in 1966-67 except the mainstream of the White River. Presence of the species in that area was indicated by several fresh and intact valves of dead animals collected from sections of river bottom.

Lasmigona compressa (Lea). I collected only one specimen of this unionid, from a station on the upper Wabash at Americus, Ind. Goodrich and van der Schalie (2) described the species as common and wide-spread in the streams and rivers of Indiana.

Lasmigona costata (Rafinesque). Call (1) considered this clam to be common in all large rivers of Indiana. Goodrich and van der Schalie (2) mentioned collection locations for it on the upper and middle sections of the Wabash River. I found it to be rare in the Wabash as far downstream as Vincennes, Ind. The species did not appear elsewhere in the study area.

Lastena lata (Rafinesque). Goodrich and van der Schalie (2) described this unionid as a rare inhabitant of the Wabash and White rivers. No specimens were taken during this survey, and Stansbery (4) considers it to be a rare and endangered species.

Leptodea blatchleyi (Daniels). This form is known only from its type locality near the Grand Chains Islands in the lower Wabash (2). I found no evidence of it there or elsewhere in the study area.

Leptodea fragilis (Rafinesque). Both earlier works (1, 2) indicated this animal to be common in the Wabash and White rivers. It remained so at the time of this investigation, and was common throughout the study area.

Leptodea laevis (Lea). Goodrich and van der Schalie (2) described this species as rare in the lower portion of the Wabash River. I collected one living specimen from the lower Wabash. No further evidence of it appeared.

Leptodea leptodon (Rafinesque). Goodrich and van der Schalie (2) reported this animal as rare in the lower Wabash. I took no specimens and Stansbery (4) considers it to be a rare and endangered species.

Ligumia recta (Rafinesque). Goodrich and van der Schalie (2) considered this mussel to be an inhabitant of all major Indiana drainages. I found no evidence of its presence in the study area.

Megaloniais gigantea (Barnes). Call (1) reported this clam as present in larger Indiana rivers. Goodrich and van der Schalie (2) mentioned its presence in the Wabash and White rivers, but did not comment on its abundance. I collected a few living specimens from the upper and middle segments of the Wabash, but found no evidence of it in the lower section of that river. Several old and worn valves of the species appeared in the mainstream of the White River, but no living specimens were obtained in that area. The species was rare in the East Fork below Shoals, Ind., and common upstream from that point.

Obliquaria reflexa Rafinesque. Call (1) considered *O. reflexa* to be common in Indiana. Goodrich and van der Schalie (2) mentioned its presence in the Wabash and White rivers, and noted that it was rarely found in large numbers. I found living individuals throughout the study area. It was rare in the Wabash and mainstream White rivers, and common in the East Fork.

Obovaria olivaria (Rafinesque). Call (1) described this species as abundant in all Indiana rivers, and Goodrich and van der Schalie (2) considered it to be common in the Wabash and White rivers. I found it to be abundant in the upper and middle sections of the Wabash River, and common throughout the remainder of the study area.

Obovaria retusa (Lamarck). Goodrich and van der Schalie (2) indicated this animal to be rare in the Wabash and White rivers. No evidence of it appeared during this investigation and Stansbery (4) considers it to be a rare and endangered species.

Obovaria subrotunda (Rafinesque). Both earlier works (1, 2) reported this clam to be common in the Wabash and White rivers. I found it to be rare in the upper Wabash and in the East Fork. This species did not appear elsewhere in the study area.

Plagiola lineolata (Rafinesque). I did not obtain this species. Goodrich and van der Schalie (2) reported it from the Wabash and White rivers but did not comment on its abundance.

Plethobasus cicatricosus (Lea). Goodrich and van der Schalie (2) described *P. cicatricosus* as a rare inhabitant of the Wabash River. No specimens were taken during this survey, and Stansbery (4) considers the species to be rare and endangered.

Plethobasus cooperianus (Rafinesque). All statements made for *P. cicatricosus* apply for this species.

Plethobasus cyphus (Say). Call (1) considered this to be one of Indiana's least abundant unionids, but reported it present in most rivers of the state. Goodrich and van der Schalie (2) described it as a rare inhabitant of the Wabash and White rivers. At the time of this investigation it was common in the upper Wabash and rare in the East Fork. There was no evidence of its presence elsewhere in the study area.

Pleurobema clava (Lamarck). Goodrich and van der Schalie (2) reported this mussel from the Wabash and White rivers but gave no information concern-

ing its abundance. I found no evidence of it, and Stansbery (4) considers the species to be rare and endangered.

Pleurobema cordatum (Rafinesque). Both earlier reports (1, 2) indicated this clam to present in larger Indiana rivers, but neither mentioned its abundance. At the time of this investigation it was a rare inhabitant of the lower Wabash. The species did not appear elsewhere in the study area.

Proptera alata (Say). This is another unionid described as common in large Indiana rivers by the earlier workers (1, 2). It remained common in all areas studied during 1966-67.

Proptera capex (Green). Goodrich and van der Schalie (2) listed this mussel as a rare inhabitant of the Wabash River. It did not appear during this study, and Stansbery (4) considers the species to be rare and endangered.

Ptychobranhus fasciolaris (Rafinesque). Goodrich and van der Schalie (2) considered this clam to be rare in the lower Wabash River. I found no evidence of it.

Quadrula cylindrica (Say). Call (1) considered this form to be common in the Wabash and White river systems, and Goodrich and van der Schalie (2) gave several collection localities for it on the Wabash. The only evidence of it to appear during the present investigation was a fragment of valve found on a bank of the Wabash near Hutsonville, Ill. Stansbery (4) considers the species to be rare and endangered, and it appears to have been extirpated from the Wabash and White rivers.

Quadrula metanevra (Rafinesque). Call (1) recorded this mussel as present in Indiana, and Goodrich and van der Schalie (2) described it as common in the Wabash and White rivers. At the time of this study the species was common in the upper and middle sections of the Wabash, and rare in the remainder of the investigated areas.

Quadrula nodulata (Rafinesque). Goodrich and van der Schalie (2) reported this mussel from the Wabash and White rivers, but did not comment on its abundance. I found no evidence of it.

Quadrula pustulosa (Lea). Both earlier monographs (1, 2) described this unionid as common in larger Indiana rivers. It was abundant throughout the 1966-67 study area.

Quadrula quadrula (Rafinesque). All statements made for *Q. pustulosa* apply to this species.

Simpsoniconcha ambigua (Say). Goodrich and van der Schalie (2) described this animal as rare in the Wabash and White drainages. No evidence of it appeared during this investigation, and Stansbery (4) considers the species to be rare and endangered.

Strophitus rugosus (Rafinesque). Call (1) reported this clam as present in all Indiana rivers. Goodrich and van der Schalie (2) considered it to be abundant in the headwaters of every drainage system in the state, and noted six widely-spaced collection localities for the species on the Wabash. I found the species to be rare in the upper Wabash. It did not appear elsewhere in the study area.

Tritogonia verrucosa (Barnes). Both earlier works (1, 2) indicated this species to be present in the Wa-

bash River and its larger tributaries. During this study it appeared only in the upper and middle sections of the Wabash, where it was common.

Truncilla donaciformis (Lea). Goodrich and van der Schalie (2) considered this species to be common in the Wabash and White rivers. I found no evidence of its presence in the study area.

Truncilla truncata (Rafinesque). Call (1) and Goodrich and van der Schalie (2) reported this unionid to be common in the Wabash and White river systems. It was rare throughout the areas investigated in 1966-67.

Unio merus tetralasmus (Say). Both Call (1) and Goodrich and van der Schalie (2) described this animal as present in the Wabash River, but neither commented on its abundance. I did not find it.

Villosa (= *Micromya*) *lienosa* (Conrad). Goodrich and van der Schalie (2) reported this form from the Wabash and White rivers, but gave no information concerning its abundance. I obtained no specimens.

Discussion

The 34 unionid species reported from the Wabash and White rivers by Goodrich and van der Schalie (2) that did not appear during 1966-67 are listed in Table 2. Stansbery (4) considers 11 of those species as being rare and endangered, and three of the six species of *Dynomia* as being extinct. *Elliptio dilatatus* and *Quadrula cylindrica*, mussels once common in the Wabash and White rivers, were represented in the study area only by isolated shells found on river banks and seem to have been extirpated within the last three decades. A number of the species included in Table 2 were rare during the 1940's, however, and their absence may be more apparent than real. They may live in unsampled habitats, or simply may be rare and very difficult to obtain. Most of the species that were present appeared to be less abundant than indicated by Call (1) and Goodrich

TABLE 2

Unionids reported from the Wabash and White rivers by Goodrich and van der Schalie (2) that did not appear during this investigation. Species considered rare and endangered by Stansbery (4) are indicated by one asterisk. Species considered extinct by Stansbery are indicated by two asterisks.

<i>Amblema peruviana</i>	<i>Leptodea blatchleyi</i>
<i>Anodonta imbecillis</i>	<i>L. leptodon</i> *
<i>A. suborbiculata</i>	<i>Ligumia recta</i>
<i>Arcidens confragosus</i>	<i>Obovaria retusa</i> *
<i>Carunculina glans</i> *	<i>Plagiola lineolata</i>
<i>C. parva</i>	<i>Plethobasus cicatricosus</i> *
<i>Dynomia flexuosa</i> **	<i>P. cooperianus</i> *
<i>D. perplexa</i>	<i>Pleurobema clava</i> *
<i>D. personata</i> **	<i>Proptera capex</i> *
<i>D. sampsoni</i> **	<i>Ptychobranhus fasciolaris</i>
<i>D. sulcata</i> *	<i>Quadrula cylindrica</i> *
<i>D. triquetra</i>	<i>Q. nodulata</i>
<i>Elliptio dilatatus</i>	<i>Simpsoniconcha ambigua</i> *
<i>Fusconaia subrotunda</i>	<i>Truncilla donaciformis</i>
<i>Lampsilis fasciola</i>	<i>Unio merus tetralasmus</i>
<i>L. orbiculata</i>	<i>Villosa</i> (= <i>Micromya</i>)
<i>L. siliquoidea</i>	<i>lienosa</i>
<i>Lastena lata</i> *	

and van der Schalie (2), and most exhibited more restricted ranges than were indicated by the earlier authors. Only a few kinds, most notably *Quadrula quadrula*, *Quadrula pustulosa*, *Lampsilis ventricosa*, *Actinonaias carinata*, and *Obovaria olivaria*, appeared to be as or possibly more abundant at the time of this investigation as in years past.

A trend towards restriction of ranges and declines in abundance of many members of the unionid fauna of the Wabash and White rivers is clearly indicated, as is extirpation of certain species. Starrett (7) recently documented similar trends for the unionid fauna of the Illinois River, including local extinctions of 25 species. A gradual demise during the twentieth century of the mussel faunas of other rivers and streams in North America has been noted by many biologists, and the pattern appears to be general in drainages east of the Mississippi River (4). Earlier authors have attributed this phenomenon to a number of factors, the more important of which seem to be deterioration of rivers as suitable habitats for unionids caused by ever-increasing burdens of organic and industrial pollutants (8, 9, 10, 11), and destruction of mussel beds by damming and siltation (8, 12).

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A Taxonomic Survey of Freshwater Oligochaetes from the Richmond, Virginia Area With Reference to Commensal Ciliates¹

Abstract—In the first survey of smaller freshwater oligochaetes undertaken in Virginia, nineteen species were collected from four lakes of the Richmond area over a twelve-month period; two species belong to the family Aeolosomatidae, 15 to Naididae, 1 to Opistocystidae, and 1 to Lumbriculidae. The genus *Homochaeta* is identified for the first time from North America. Fifteen of the species have not been recorded previously from the state.

Two of the 19 species harbored commensal ciliates within the gut: *Radiophrya deronis* in *Dero digitata*; *Mesnilella clavata* and *Ptychostomum lumbriculi* in *Lumbriculus variegatus*. These ciliates are reported for the first time in North American oligochaetes. Attempts to maintain ciliates within cultured worms were unsuccessful.

Introduction

The distribution of North American aquatic oligochaetes and the occurrence of ciliates in their guts have received very limited attention. For this reason, the present study was initiated to survey freshwater oligochaetes of the families **Aeolosomatidae**, **Naididae**, **Opistocystidae**, and **Lumbriculidae** in four bodies of water of the Richmond, Virginia area and to determine the incidence of commensal ciliates within the gut.

The freshwater oligochaetes have been a notoriously troublesome group with which to work and appear not to have been a major point of interest to limnologists (1). Many species have been inadequately described, and taxonomy is in a constant state of revision.

The most recent comprehensive studies on North American oligochaetes have been conducted by Brinkhurst. His surveys include the families **Naididae** and **Opistocystidae** (2), **Tubificidae** (3), and **Lumbriculidae** and **Aeolosomatidae** (4). In 1971 Brinkhurst and Jamieson published a volume reviewing the aquatic oligochaetes of the world (5). Sperber's (6) comparative morphological studies of the **Naididae**, in which she attempts a phylogenetic revision of the family, are based almost exclusively on specimens from Sweden; forms from other continents are studied solely from the literature. Although Brinkhurst and Sperber remain the most reliable guides to North American freshwater oligochaetes, other helpful

sources include Goodnight's (7) revision of the freshwater oligochaetes of North America; Pennak's (8) guide to the oligochaetes which does, however, lack recent taxonomic revisions; and Stephenson's (9) descriptions of British specimens.

There have been no previous published surveys of the smaller oligochaetes of Virginia, but several recent studies have been conducted in other localized areas of the United States (Causey (1), in Arkansas; Harman (10), in Mississippi; Wurtz and Roback (11), in some Gulf Coast rivers; and Harman and Platt (12), in Louisiana).

Studies concerning the incidence of ciliates in oligochaetes have been carried out almost totally on European and Asian specimens. Rossolimo (13) published a survey of ciliates found in oligochaetes from Lake Baikal. Heidenreich (14) compiled a review of ciliates occurring in annelids from ponds, ditches, and pools near Breslau, Germany. Raabe (15) includes a complete history of the Hysterocestidae.

De Puytorac, who has contributed some of the most authoritative research on the Astomatida, completed a comprehensive study in 1954 of the cytology and taxonomy of the astomates of freshwater oligochaetes as well as an extensive review of the literature (16); and, in 1959 (17) and 1960 (18), he published papers describing a number of astomates found in *Oligochaeta* from Ochrida Lake in Yugoslavia. Meier (19) made an extensive survey in Germany of oligochaetes and ciliates found within the gut.

There are no published accounts of ciliates found within the gut of Naididae and Lumbriculidae in the United States.

Materials and Methods

Monthly collections were made from Westhampton Lake on the University of Richmond campus (February 1971 to February 1972); Maymont Park Ponds (February 1971 to August 1971); Swan Lake in Byrd Park (August 1971 to February 1972); and Twin Lakes, on River Road (February 1971 to February 1972).

Bottom debris and mud from shallow portions of the lakes were collected in wide-mouthed jars and examined within 24 hours under a stereoscopic binocular microscope. Tentative identifications were

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