

## Identification of Host Fishes for Four Species of Freshwater Mussels (*Bivalvia:Unionidae*)

**ABSTRACT:** The glochidial host fishes for four species of freshwater mussels (*Unionidae: Uniomerus tetralasmus*, *Anodonta imbecilis*, *Carunculina texasensis* and *Ligumia subrostrata*) are identified. The glochidia of *U. tetralasmus* parasitize *Notemigonus crysoleucas* while the other species of unionids studied use several species of the sunfish genus *Lepomis*, and *A. imbecilis* additionally parasitizes *Gambusia affinis*.

### INTRODUCTION

Leydig (1866; cited by Lefevre and Curtis, 1910) was the first to recognize that glochidial larvae of freshwater mussels (Family Unionidae), after leaving the adult, complete their development as parasites on the gills or fins of various species of fishes before assuming free-living, benthic existence. However, in the ensuing 100 years, the host fish(es) for only about 1/5 of the Nearctic species of unionids have been identified. Most of what is known about the glochidial hosts dates from early 1900s when freshwater mussels were of sufficient commercial importance to warrant artificial propagation studies (Lefevre and Curtis, 1910; Surber, 1913; Coker *et al.*, 1921). Fuller (1974) presents the most recent survey of glochidial hosts, as well as an extensive bibliography on the subject. The present study adds more information to this poorly known aspect of unionid biology for the following four species: *Uniomerus tetralasmus* (Say), *Anodonta imbecilis* Say, *Carunculina texasensis* (Lea) and *Ligumia subrostrata* (Say).

Fish and mussels were collected from two small ponds, from February through May 1974 at the following localities in East Baton Rouge Parish, Louisiana: Locality 1—Louisiana State University campus, Locality 2—U.S. Hwy. 61, Briarwood Golf Club. Because the glochidia have been figured for only two of the four species of unionids investigated (Surber, 1913), gravid mussels of each species were collected to facilitate identifications. A summary of the results is presented in Table 1.

### RESULTS AND DISCUSSION

Gravid *Uniomerus tetralasmus* were collected during February and March 1974 from Locality 1. Of the five species of fishes collected (Table 1), only *Notemigonus crysoleucas* was parasitized. Encysted glochidia were observed on the gill filaments and gill rakers (Fig. 1A), with an average infection of 12 glochidia per host fish. Previous observations of the bi-

TABLE 1.—Species of freshwater mussel glochidia and fishes collected at each site with appropriate host-parasite relationships indicated. Localities are identified in the text

Fish species	Species of mussel glochidia			
	Unionidae			
Locality 1:	Ambleminiæ <i>Uniomerus tetralasmus</i>			
<i>Dorosoma cepedianum</i>	....	....	....	....
<i>Notemigonus crysoleucas</i>	....	X	....	....
<i>Gambusia affinis</i>	....	....	....	....
<i>Lepomis cyanellus</i>	....	....	....	....
<i>L. macrochirus</i>	....	....	....	....
Locality 2:	Anodontinae	Lampsilinae		
	<i>Anodonta imbecilis</i>	<i>Carunculina texasensis</i>	<i>Ligumia subrostrata</i>	
<i>Dorosoma cepedianum</i>	....	....	....	....
<i>Notemigonus crysoleucas</i>	....	....	....	....
<i>Gambusia affinis</i>	X	....	....	....
<i>Labidesthes sicculus</i>	....	....	....	....
<i>Lepomis cyanellus</i>	....	....	....	X
<i>L. gulosus</i>	X	X	....	X
<i>L. macrochirus</i>	X	X	....	X
<i>L. marginatus</i>	X	....	....	....
<i>Pomoxis annularis</i>	....	....	....	....

ogy of this mussel and the host fish have shown they use somewhat similar habitats. *Unio mer tetralasmus* is possibly the unionid most resistant to desiccation and is a common inhabitant habitats with low oxygen and highly turbid water such as ponds and bayous (Stern, 1976). Such habitats are also inhabited by *N. crysoleucas*. Douglas (1974) described the distribution of *N. crysoleucas* in Louisiana as statewide, with perhaps the only waters lacking the species being those unfit for supporting any fishes.

*Anodonta imbecilis*, *Carunculina texasensis*, and *Ligumia subrostrata* were collected from Locality 2. Howard (1914) believed that the glochidia of *A. imbecilis* displayed direct development by bypassing the parasitic stage and metamorphosing into juvenile mussels while still in the marsupial demibranches of the adult mussel. Several investigators, most recently Heald (1975), have disproven this. Ventral hooks are characteristic of anodontine glochidia, facilitating their attachment to fish fins. Glochidia of *A. imbecilis* parasitized four species of fish (Table 1) with the glochidia occurring in nearly equal numbers on the dorsal, caudal and anal fins (Fig. 1B). Because all these infections were light, with a total of only five glochidia

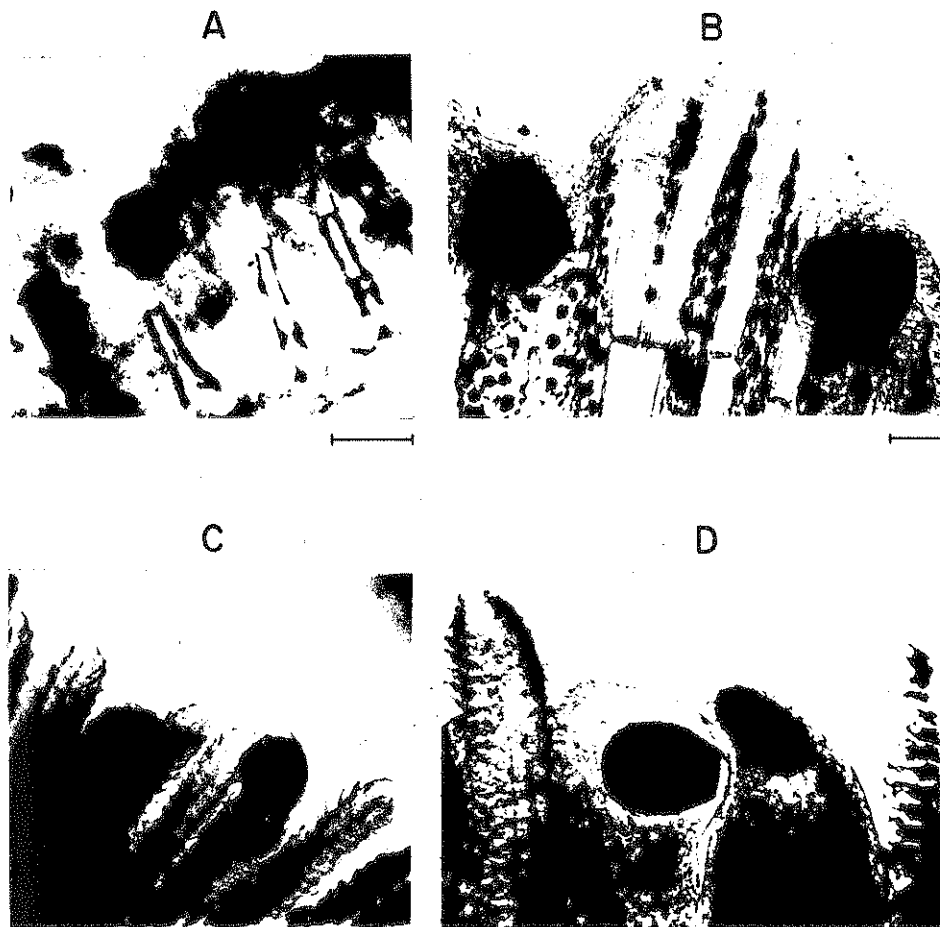


Fig. 1.—Freshwater mussel glochidia. A. *Unio mer tetralasmus* glochidium on the gill raker of *Notemigonus crysoleucas*. B. *Anodonta imbecilis* glochidia attached to the anal fin of *Lepomis macrochirus*. C. Encysted *Carunculina texasensis* glochidia on the gill filaments of *Lepomis macrochirus*. D. Encysted *Ligumia subrostrata* glochidia on the gill filaments of *Lepomis glauus*. Scale lines = 0.2 mm

per fish for *Lepomis marginatus* and *L. macrochirus*, it was not possible to demonstrate a preference. Although Tucker (1927, 1928) reported *L. cyanellus* as a host for *A. imbecilis* glochidia were found on the specimens examined in our study. The creek chub, *Semotilus atromaculatus* (Mitchell), has also been cited as a host for *A. imbecilis* by Clarke and I (1959).

The glochidia of *Carunculina texasensis* are hookless—as are the glochidia for most species in the subfamily Lampsilinae—and become attached to the gill filaments. Naturally occurring infections were found on two species of sunfishes (Table 1) with the total number of glochidia per fish ranging from 2-36. Encystment was primarily confined to the distal region of the filament (Fig. 1C).

Lefevre and Curtis (1910) reported the artificial infection of *Lepomis cyanellus* and *macrochirus* with *Ligumia subrostrata* glochidia. Examination of specimens of both sunfish species from Locality 2 confirmed that they are the natural hosts, along with the congener *Lepomis gulosus*. *Ligumia subrostrata*, the predominant species of mussel at Locality 2, extremely abundant with an average density of 200 individuals per m<sup>2</sup> and an estimated population of 15,000 individuals (T. Dietz, Department of Zoology, LSU, pers. comm.). Glochidial infections of *L. subrostrata* were also significantly higher on host fishes than for the other species of unionids. *Lepomis gulosus* was the host species most heavily infected, with the filaments containing in excess of 200 encysted larvae per fish (Fig. 1D). Excessive infection with glochidia (2000+ per host fish) have been shown to be lethal (Lefevre and Curtis, 1910) and optimum levels vary with size, age and species of the host fish. Glochidial infections undoubtedly affect respiration at the gill surfaces, although data are not available.

An analysis of the identified or implicated species of host fishes for all species of unionid mussels reveals that members of the Family Centrarchidae (sunfishes, basses and crappies) represent almost 50% of the total (Fuller, 1974). The same trend is reflected in our results where three of the four species of unionids studied parasitize centrarchids. Several authors (Reuling, 1919; Arey, 1923, 1932) believe glochidial infections produce an immune reaction in fishes. This immunity, which strengthens with repeated infections, becomes effective against reinfection by the same as well as other species. Such an immunity would act to prevent massive infections and increased mortality in the hosts.

Additional mechanisms exist which also serve to reduce competition for available hosts. Glochidia of *Anodonta imbecilis*, *Carunculina texasensis* and *Ligumia subrostrata* parasitize the same host fishes (Table 1), but there were spatial and temporal differences in encystment. The glochidia of *A. imbecilis* and *L. subrostrata* simultaneously parasitized the same hosts, but *A. imbecilis* glochidia used the fins while those of *L. subrostrata* were found on the gill filaments. *Ligumia subrostrata* and *C. texasensis* glochidia also parasitized the same host fishes (Table 1) but at the same site of encystment. However, the release of mature glochidia from gravid adult mussels of the latter two species was at different times, so that they were simultaneously parasitizing the same host. Fishes infected with *Ligumia* glochidia were released as early as the 1st week of February, while mature *Carunculina* glochidia were not released until the middle of May.

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#### LITERATURE CITED

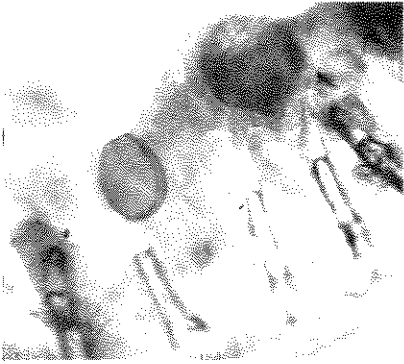
- AREY, L. B. 1923. Observations on an acquired immunity to a metazoan parasite. *J. Zool.*, **38**:377-381.
- . 1932. A microscopical study of glochidial immunity. *J. Morphol.*, **53**:367-379.
- CLARKE, A. H., JR. AND C. O. BERG. 1959. The freshwater mussels of central New York: an illustrated key to the species of northeastern North America. *N.Y. Agric. Exp. Sta. Mem.*, **367**:1-79.
- COKER, R. E., A. F. SHIRA, H. W. CLARK AND A. D. HOWARD. 1921. Natural history and propagation of fresh-water mussels. *Bull. Bur. Fish.*, **37**:75-181.
- DOUGLAS, N. H. 1974. Freshwater fishes of Louisiana. Claitor's Publishing Division, Baton Rouge. 443 p.
- FULLER, S. L. H. 1974. Clams and mussels (Mollusca: Bivalvia), p. 215-273. In: C. W. F. Jr. and S. L. H. Fuller (eds.). Pollution ecology of freshwater invertebrates. Academic Press, New York.

- HEARD, W. H. 1975. Sexuality and other aspects of reproduction in *Anodonta* (Pelecypoda: Unionidae). *Malacologia*, **15**:81-103.
- HOWARD, A. D. 1914. A second case of metamorphosis without parasitism in the Unionida *Science*, **40**:353-355.
- LEFEVRE, G. AND W. C. CURTIS. 1910. Studies on the reproduction and artificial propagation of fresh-water mussels. *Bull. Bur. Fish.*, **30**:105-201.
- LEYDIG, F. 1866. Mittheilung über den Parasitismus junger Unioniden an Fischen in No Tübingen, Inaugural-Dissertation. Frankfurt a. M. (Paper not seen).
- REULING, F. H. 1919. Acquired immunity to an animal parasite. *J. Infect. Dis.*, **24**:337-34
- STERN, E. M. 1976. The freshwater mussels (Unionidae) of the Lake Maurepas-Pontchartrai Borgne drainage system, Louisiana and Mississippi. Ph.D. Thesis, Louisiana State University, Baton Rouge. 206 p.
- SURBER, T. 1912. Identification of the glochidia of fresh-water mussels. *U. S. Bur. Fish. Do.* **771**:1-10.
- . 1913. Notes on the natural hosts of fresh-water mussels. *Bull. Bur. Fish.*, **32**:101-11
- TUCKER, M. E. 1927. Morphology of the glochidium and juvenile of the mussel *Anodonta imbecilis*. *Trans. Am. Microsc. Soc.*, **46**:286-293.
- . 1928. Studies on the life cycles of freshwater mussels belonging to the genus *Anodonta*. *Biol. Bull.*, **54**:117-127.

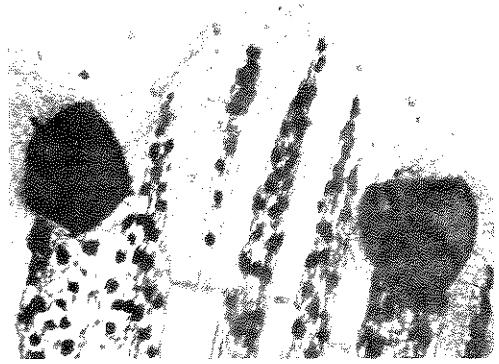
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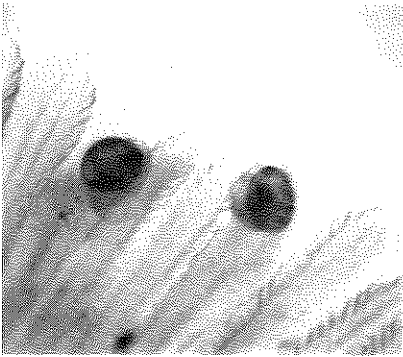
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