# Seasonal and Spatial Variation in Glochidial Infections of Fish in the Barren River, Kentucky

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**Abstract.** We collected 27 species of mussels and 46 species of fish from five 150-m-long sites on the Barren River. Of 2,510 fish examined, 4.1% were infected with glochidia. Infection rates were similar (range of 3.6% to 5.5%) among four of the five sites. Only 1.5% of fish examined from the fifth site were infected. Seasonality of glochidial infections by anodontines and lampsilines generally concurs with periods reported in the literature. Amblemine glochidia were present on fish from December through July largely due to an extended period of glochidia release by *Megalonaias nervosa*. Most infected fish were collected on sites with high fish species richness. Mussels were most abundant on sites with an abundant fish fauna.

## Introduction

The larval stage (glochidium) of most freshwater mussels is an obligate parasite of fish. Some mussel species are host-specific, utilizing a single fish species; others parasitize as many as 25 fish species (Gordon and Layzer 1989). Obviously, host fish play a vital role in the life cycle of most mussel species. However, hosts are known for just slightly more than 20% of the mussel species in North America (Fuller 1974).

Mussel subfamilies (Ambleminae, Anodontinae, and Lampsilinae) differ in length of brooding period and timing of glochidia release. Most amblemines are short-term brooders; they spawn in spring and release glochidia in summer. Lampsilines and anodontines are long-term brooders and spawn in late summer and hold glochidia in their marsupia over winter for release in the spring. However, there is variation in these reproductive periods within subfamilies. For instance, *Megalonaias nervosa* (an amblemine) reproduces and releases glochidia in the fall (Howard 1914). Lampsiline glochidia have been found in stream drift throughout the year (Neves and Widlak 1988).

The proportion of released glochidia that successfully attach to fish is very low. Of 4,800 fish examined by Neves and Widlak (1988) over one year, only 14% had encysted glochidia. Holland-Bartels and Kammer (1989) found glochidial infections on 4% of 2,000 fish examined from June through August. Although not all species examined may have been hosts, these low rates of infection suggest that host abundance may play an important role in determining mussel abundance.

In this study, we examined seasonal and spatial variation of glochidial infections of fish in a medium-sized river with diverse mussel and fish faunas.

## Study Area

The study was conducted on a 5-km reach of the Barren River downstream of Lock and Dam No. 1 in Warren County, Kentucky. Water levels in the study reach are affected by discharges from the dam at Barren River Lake located 40 km upstream.

The mussel fauna of the Green River drainage, which includes the Barren River, is among the most diverse in the United States. Isom (1974) reported 77 species from the drainage; 35 of these species have been collected from the Barren River (Clench and van der Schalie 1944). In the most recent study of the mussel fauna in the Green River drainage, 46 species were recorded from the Green River within the Mammoth Cave National Park boundary (Cicerello and Hannan 1990). Seven of these species (*Cumberlandia monodonta, Cyprogenia stegaria, Epioblasma rangiana, Obovaria retusa, Pleurobema clava, P. plenum,* and *Villosa ortmanni*) are federally endangered or candidates for listing (U.S. Fish and Wildlife Service 1990).

The ichthyofauna of the Barren River drainage is diverse. Burr and Warren (1986) report 122 fish

species from the drainage, including five endemics. The fish assemblage includes 31 cyprinids, 25 percids, 14 catostomids, and 9 ictalurids.

## Materials and Methods

Five 150-m-long sites were established in riffle, run, and pool habitats. Fish were sampled monthly from March through September and bimonthly from October through February at each of the five sites. A variety of gear was used depending upon water levels. Sampling gear included DC electrofishing equipment, gill nets, hoop nets, and seines.

All fish collected were retained. Large individuals were put on ice and then frozen within 48 h. Small individuals were fixed in 10% buffered formalin in the field and transferred to 70% ethanol in the laboratory. Fish were examined for glochidial infections using a dissecting microscope with 10-70× magnification. Glochidia were removed with a probe and preserved in 70% ETOH. Length, height, and hinge length of each glochidium were measured to the nearest 5 μm with a compound microscope (100×) fitted with an ocular micrometer. Dimensions of glochidia removed from fish were compared with those of glochidia obtained from gravid mussels and to measurements reported in the literature (Surber 1912, 1915; Matteson 1948; Yokley 1972; Hoggarth 1988; Waller et al. 1988; Jirka and Neves 1992).

A qualitative assessment of mussel species composition and abundance was made on each site by timed diving. Two divers, either snorkeling or using scuba gear, searched each site for 30 minutes. All mussels collected were identified to species.

## Results

Twenty-seven species of mussels were collected in the study area including the federally endangered *Pleurobema plenum* (Table 1). The mussel assemblage included 13 amblemines, 10 lampsilines, and 4 anodontines.

A total of 6,753 fish representing 46 species, 16 families, and 11 orders were collected. The fish fauna was dominated by catostomids (12 species), centrarchids (9 species), and cyprinids (7 species). The number of fish collected varied greatly among months. The steelcolor shiner (*Cyprinella whipplei*) was the most abundant species, followed by emerald shiners (*Notropis atherinoides*), spotfin shiners (*Cyprinella spiloptera*), gizzard shad (*Dorosoma cepedianum*), brook silversides (*Labidesthes sicculus*), and bluegills (*Lepomis macrochirus*).

We found glochidia attached to 4.1% of the 2,510 fish examined. Glochidial infection rates were similar among most sites (Table 2). Infection rates varied among months; the highest incidence of glochidia infections (41%) occurred in March (Figure 1). We found no glochidia on 729 fish examined in September and 176 in October. Because we collected only five fish in February, the absence of attached glochidia may not be representative.

Seasonality of glochidial infections was evident for each subfamily (Figure 2). Amblemine glochidia were found on fish from December through July, and anodontine glochidia were present on fish from March through May. Lampsiline infections were present for an extended period, March through August.

**Table 1.** Mussel species collected at five sites in the Barren River.

| | Site | | | | |
|---|---|---|---|---|---|
| Subfamily and species | 1 | 2 | 3 | 4 | 5 |
| Anodontinae | | | | | |
| *Arcidens confragosus* | | | | | X |
| *Pyganodon grandis* | | | | X | |
| *Lasmigona complanata* | X | | | X | X |
| *Lasmigona costata* | X | X | X | | X |
| Ambleminae | | | | | |
| *Amblema plicata* | X | X | X | X | X |
| *Cyclonaias tuberculata* | X | | | | |
| *Elliptio crassidens* | | X | X | X | X |
| *Fusconaia flava* | | X | | | |
| *Fusconaia subrotunda* | | | X | X | |
| *Megalonaias nervosa* | X | X | X | X | X |
| *Pleurobema cordatum* | X | X | X | X | X |
| *Pleurobema plenum* | X | X | X | X | |
| *Pleurobema pyramidatum* | | X | X | | |
| *Pleurobema coccineum* | | X | | X | |
| *Quadrula pustulosa* | X | X | X | | X |
| *Quadrula quadrula* | X | | X | | X |
| *Tritogonia verrucosa* | X | X | X | | X |
| Lampsilinae | | | | | |
| *Actinonaias ligamentina* | X | X | X | | X |
| *Ellipsaria lineolata* | X | X | X | X | |
| *Lampsilis cardium* | | | | | X |
| *Lampsilis ovata* | X | | X | | X |
| *Leptodea fragilis* | | | X | X | X |
| *Ligumia recta* | | | X | | |
| *Obliquaria reflexa* | | X | | X | |
| *Potamilus alatus* | X | | | X | X |
| *Ptychobranchus fasciolaris* | X | X | X | | X |
| *Truncilla truncata* | | | X | | |
| Total | 25 | 114 | 106 | 26 | 134 |

**Table 2.** Species composition and incidence of glochidial infections of fish collected from five sites on the Barren River.

| | Site | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Number of fish collected | 2,106 | 1,447 | 1,490 | 163 | 1,530 |
| Number of fish species | 28 | 32 | 33 | 19 | 20 |
| Number of fish examined | 580 | 570 | 684 | 111 | 547 |
| Number of fish infected | 32 | 23 | 35 | 4 | 8 |
| Percent infected | 5.5 | 4.0 | 5.1 | 4.1 | 1.5 |

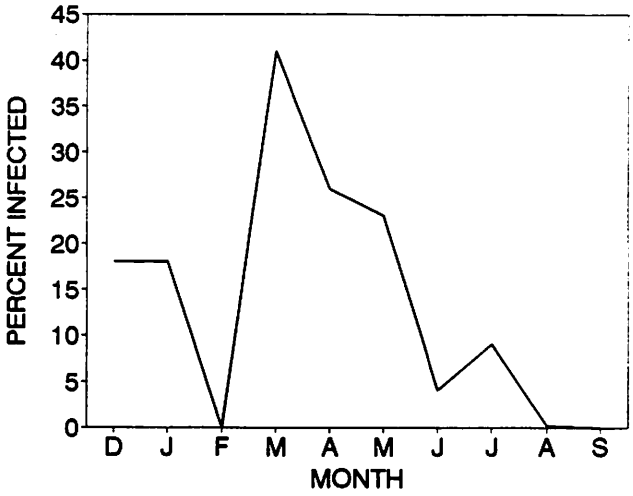


**Figure 1.** Overall monthly incidence of glochidial infections of fish collected from the Barren River.

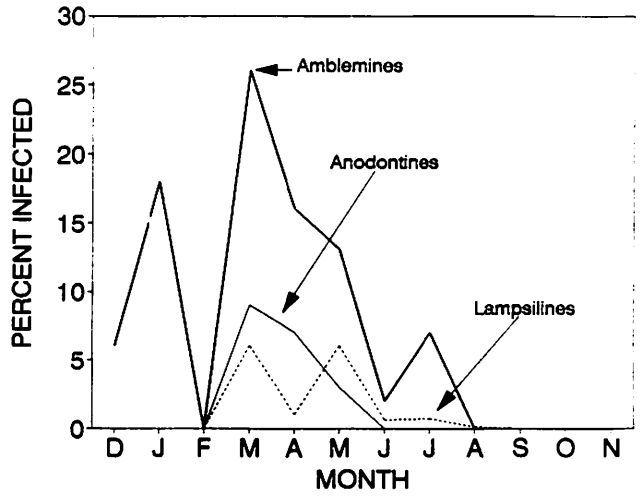


**Figure 2.** Overall monthly incidence of glochidial infections of fish by each mussel subfamily.

## Discussion

The low overall infection rate (4.1%) is nearly identical to that reported for the upper Mississippi River (Holland-Bartels and Kammer 1989). However, the Mississippi River investigators examined only young-of-year fishes and cyprinids collected by seining from June through August. Fourteen percent of fish examined from the upper North Fork Holston River were found infected over a one-year period (Neves and Widlak 1988).

Observed seasonality of glochidial infections by anodontines and lampsilines in the Barren River was similar to that in other streams (Coker et al. 1921, Yokley 1972, Wiles 1975, Zale and Neves 1982, Weaver et al. 1991). However, Neves and Widlak (1988) found lampsiline glochidia in stream drift and on fish throughout the year. The extended period of amblemine glochidia infections is a result of the long period (up to 6 months) of encystment of *M. nervosa* glochidia released in the fall (Howard 1914).

Even though spatial variation in overall infection rates was low, the number of fish carrying infections on each site was variable. The highest numbers of infected fish were collected on sites with the highest fish species richness. The lowest abundance of mussels and fish occurred on the same site. These findings suggest that incidence of infection may be affected by fish diversity and mussel abundance may be influenced by fish abundance. If so, the management and conservation of freshwater mussels may depend greatly on maintaining an abundant and diverse fish fauna.

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