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FISH HOSTS FOR GLOCHIDIA OF THE PHEASANTSHELL,
ACTINONAIAS PECTOROSA

James B. Layzer¹ and Jason R. Khym¹

ABSTRACT

In the laboratory, we artificially infested 19 species of fish with glochidia of *Actinonaias pectorosa*; metamorphosis occurred on seven species (*Ambloplites rupestris*, *Cottus carolinae*, *Micropterus dolomieu*, *Micropterus punctulatus*, *Micropterus salmoides* and *Sander canadense*). The percentage of glochidia that metamorphosed on six species ranged from 15 % on sauger (*S. canadense*) to 43 % on largemouth bass (*M. salmoides*). Rock bass (*A. rupestris*) are considered to be a marginal host because less than 0.1 % of the glochidia transformed, and metamorphosis occurred on only two of 11 individuals tested. Since banded sculpin (*C. carolinae*) and *Micropterus* spp. are common in streams of the Cumberlandian region, it is unlikely that the lack of host fishes has been responsible for the loss of pheasantshell populations.

Key words: *Actinonaias pectorosa*, pheasantshell, glochidia, fish hosts, Clinch River, Tennessee.

INTRODUCTION

Freshwater mussels are one of the most endangered faunal groups in North America; 61 of the nearly 300 recognized taxa are federally listed as endangered. Moreover, populations of many non-listed species have declined or have been extirpated. Despite this degree of imperilment, basic life history information is lacking for many species. The larvae (glochidia) of most freshwater mussel species are parasitic, and require a suitable fish host to complete metamorphosis into juveniles. Although glochidia of some species can complete metamorphosis on the gills or fins of a wide range of fish species, others are very host-specific and can metamorphose only on a single fish species (see Watters, 1994). Hosts have been identified for only about one-third of the species occurring in North America (O'Dee & Watters, 2000). Many populations of mussels are functionally extinct, in that they consist entirely of old individuals with no evidence of recent recruitment. Altered thermal and flow regimes of regulated streams have been implicated as the causative factors for the lack of recruitment in some populations (Layzer *et al.*, 1993; Heinricher & Layzer, 1999; Hardison & Layzer, 2001); however, the lack of recruitment in some populations seems

¹U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, P.O. Box 5114, Cookeville, TN 38505.

related to a decrease or absence of host fish populations (Smith, 1985; Watters, 1996; Khym & Layzer, 2000).

The pheasantshell, *Actinonaias pectorosa* (Conrad 1834), is a Cumberlandian species endemic to the Cumberland and Tennessee river systems (Ortmann, 1924). It once occurred in most of the major tributaries of these rivers (Cicerello *et al.*, 1991; Parmalee & Bogan, 1998); however, many of these populations have either disappeared or exist only as remnants (Ahlstedt, 1991; Anderson *et al.*, 1991; Fraley & Ahlstedt, 2000; Layzer *et al.*, 1993; Schmidt *et al.*, 1989). Little is known about the life history of the pheasantshell other than it is considered a riffle-inhabiting species (Gordon & Layzer, 1989), and is gravid from September through May (Ortmann, 1921), but the glochidial host is unknown. Our ongoing efforts to reestablish populations of listed and non-listed species in the upper Tennessee River system requires either identifying a source population of sufficient size to allow translocating a large number of individuals, or artificially propagating and culturing the mussels needed. The objective of the present study was to identify host species of the pheasantshell to facilitate propagation of this species and to determine if potential recipient streams contained hosts.

METHODS

Because previous exposure to glochidia may induce immunological resistance to subsequent infestations (Reuling, 1919; Arey, 1923), all fish used were collected by electro fishing in streams or reservoirs that contained few or no mussels. Fish were acclimated to laboratory conditions for about 1 week before being infested with glochidia. In September 1997, pheasantshells were collected from the Clinch River, Tennessee, and examined in the field; gravid individuals were transported in insulated coolers to the laboratory, and placed into a living stream maintained at 10°C. To obtain glochidia, we anaesthetized mussels in 250 mg/l of MS-222; when the mussels relaxed and gaped, we removed them from the solution, and used a hypodermic syringe (Waller *et al.*, 1985) to flush glochidia from the marsupia. Fish in water-filled coolers were exposed to glochidia for 10-15 minutes to allow for attachment. During our initial screening tests to identify hosts, infested fish were separated by species and, depending upon size, were placed into either 38 l or 95 l aquaria. At 2-3 day intervals, the bottoms of the aquaria were siphoned, and the siphonate was collected on a 100 µm mesh screen. Filtered material was then washed into a gridded petri dish and examined with cross-polarized microscopy. We considered individuals to be fully developed juveniles if they possessed two adductor muscles, and exhibited movement within 24 h.

In a subsequent test designed to compare the percent transformation among identified host species, we isolated individual fish following infestation in January 1998. Methods used for siphoning of aquaria and examination of the siphonate were the same as described above; however, for this test, we also counted the number of glochidia sloughed by individual fish. The sum of the glochidia and transformed juveniles collected from an individual tank was considered to be the initial infestation intensity (Khym & Layzer, 2000).

RESULTS

In all, 19 fish species were artificially infested with glochidia. Cyprinids and the northern hog sucker sloughed all glochidia within two days; most other non-host species sloughed all glochidia within 15 days of infestation (Table 1). Glochidia metamorphosed on seven species belonging to three families; however, metamorphosis occurred on only one of six rock bass infested. In contrast, metamorphosis occurred on all individuals of the other six species. The period of juvenile excystment was prolonged; the first juveniles were collected 21 days post-infestation, and the last juvenile excysted 70 days later. The mean number of juveniles recovered per fish ranged from 0.5 to 238. To determine if the variation in the number of juveniles recovered from each species was a function of initial infestation intensity or was a reflection of host suitability, we infested six of the seven identified host species (walleye were unavailable for this trial). Juveniles began excysting from all species, except rock bass, within 18 days of infestation. Juveniles metamorphosed on only one of five rock bass infested. The mean percent of glochidia that metamorphosed on other species varied from 15 to 43 and did not seem to be related to infestation intensity (Table 2).

DISCUSSION

Pheasantshell glochidia metamorphosed on seven species during our initial screening test; however, only one juvenile was recovered from six rock bass infested with glochidia. In contrast, the average number of glochidia completing metamorphosis on the other six species ranged from 121 to 238 per fish. Infestation intensity was not measured during the initial screening test; consequently, variation in the average number of juveniles obtained from individual fish may not reflect the suitability of a species as a host. Khym & Layzer (2000) found that infestation rates of black sandshell *Ligumia recta* (Lamarck 1819) glochidia varied greatly among individuals and species of fish that were simultaneously exposed to glochidia. They recommended determining

TABLE 1. Fish species artificially-infested with glochidia of *Actinonotus pectorosa* in the laboratory, maximum periods of attachment, and periods of metamorphosis at a mean (\pm SD) water temperature of $18.4 \pm 1.3^\circ\text{C}$.

Scientific name	Common name	N	Period of Attachment (days)	Period of metamorphosis (days)
<i>Ambloplites rupestris</i> (Rafinesque 1817)	rock bass	6	—	23-24
<i>Campostoma anomalum</i> (Rafinesque 1820)	central stoneroller	5	2	—
<i>Cottus carolinæ</i> (Gill 1861)	banded sculpin	6	—	21-46
<i>Etheostoma blennioides</i> Rafinesque 1819	greenside darter	5	7	—
<i>Etheostoma caeruleum</i> Storer 1845	rainbow darter	8	13	—
<i>Etheostoma flabellare</i> Rafinesque 1819	fantail darter	9	11	—
<i>Etheostoma ruffinectum</i> (Cope 1870)	redline darter	4	25	—
<i>Etheostoma simoetrum</i> (Cope 1868)	snubnose darter	2	7	—
<i>Hypentelium nigricans</i> (Lesueur 1817)	northern hog sucker	1	2	—
<i>Lepomis macrochirus</i> Rafinesque 1819	bluegill	2	15	—
<i>Lepomis megalotis</i> (Rafinesque 1820)	longear sunfish	2	11	—
<i>Lythruus ardens</i> (Cope 1868)	rosefin shiner	3	2	—
<i>Micropterus dolomieu</i> (Lacépède 1802)	smallmouth bass	2	—	21-55
<i>Micropterus punctulatus</i> (Rafinesque 1819)	spotted bass	3	—	23-55
<i>Micropterus salmoides</i> (Lacépède 1802)	largemouth bass	3	—	27-91
<i>Percina caprodes</i> (Rafinesque 1818)	logperch	1	7	—
<i>Percina notatus</i> (Rafinesque 1820)	bluntnose minnow	4	2	—
<i>Sander canadense</i> (Smith 1834)	sauger	2	—	21-40
<i>Sander vitreum</i> (Mitchill 1818)	walleye	1	—	21-56

TABLE 2. Comparison of infestation intensities and % juvenile transformation among host fish species infested with glochidia of *Actinonaias pectorosa* at a mean (\pm SD) water temperature of $19 \pm 1.7^\circ\text{C}$.

Species	N	Mean infestation intensity	Juvenile exystment period (days)	Mean number of juveniles/fish	% Juvenile transformation	
					mean	range
<i>Ambloplites rupestris</i>	5	1345	28	0.8	<0.1	0-0.25
<i>Cottus caroliniae</i>	25	578	18-39	122	21	NA
<i>Micropterus dolomieu</i>	1	1017	18-63	351	35	—
<i>Micropterus punctulatus</i>	3	1529	18-65	651	38	23-65
<i>Micropterus salmoides</i>	5	1975	18-72	878	43	18-65
<i>Salvelinus namaycush</i>	2	2939	18-44	409	15	9-21

NA = not determined because multiple individuals held in each aquarium.

infestation intensities and percent transformation to evaluate host suitability. The results of our suitability test clearly indicate that rock bass are a marginal host for pheasantshell glochidia; only four of 6,725 glochidia metamorphosed on rock bass. In contrast, 10,558 of 35,876 glochidia metamorphosed on the other five species tested. We could not determine if suitability as hosts varied significantly among these five species because of small sample sizes; however, mean transformation percentages on *Micropterus* spp. were similar (35-43 %) and tended to be higher than for other species. Although the pheasantshell is restricted to the upper Cumberland and Tennessee river systems, host fishes identified in our study have much larger geographic distributions. Most identified hosts of other Cumberlandian species are also widely distributed (Zale & Neves, 1982; Bruenderman & Neves, 1993; Gordon & Layzer, 1993; Gordon *et al.*, 1994; Yeager & Saylor, 1995). In addition to their wide distribution, banded sculpin and *Micropterus* spp. tend to be common or abundant throughout the Cumberlandian region. Thus, it is unlikely that the decline in most pheasantshell populations is related to the absence of host fishes.

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LITERATURE CITED

- AHLSTEDT, S.A. 1991. Cumberlandian mollusk conservation program. Activity I: mussel surveys in six Tennessee Valley streams. *Walkerana*, 5: 73-122.
- ANDERSON, RM., J.B. LAYZER & M.E. GORDON. 1991. Recent catastrophic decline of mussels (Bivalvia: Unionidae) in the Little South Fork Cumberland River, Kentucky. *Brimleyana* 17: 1-8.
- AREY, L.B. 1923. Observations on an acquired immunity to a metazoan parasite. *Journal of Experimental Zoology*, 38: 377-381.
- BRUENDERMAN & NEVES. 1993. Life history of the endangered fine-rayed pigtoe *Fusconaia cuneolus* (Bivalvia: Unionidae) in the Clinch River, Virginia. *American Malacological Bulletin*, 10: 83-91.
- CICERELLO, R.R., M.L. WARREN, Jr. & G.A. SCHUSTER. 1991. A distributional checklist of the freshwater mussels (Bivalvia: Unionoidea) of Kentucky. *American Malacological Bulletin*, 8: 113-129.
- FRALEY, S.J. & S.A. AHLSTEDT. 2000. The recent decline of the native mussels (Unionidae) of Copper Creek, Russell and Scott Counties, Virginia. Pp.189-195. *In* RA. Tankersley, D.I. Warmolts, G.T. Watters, B.J. Armitage, P.D. Johnson & R.S. Butler (eds.). *Freshwater Mollusk Symposia Proceedings*. Ohio Biological Survey, Columbus Ohio. 274 pp.
- GORDON, M.E. & J.B. LAYZER. 1989. Mussels (Bivalvia: Unionoidea) of the Cumberland

- River: Review of life histories and ecological relationships. *U.S. Fish and Wildlife Service, Biological Report*, 89(15). 98 pp.
- GORDON, M.E. & J.B. LAYZER. 1993. Glochidial host of *Alasmidonta atropurpurea* (Bivalvia: Unionoidea, Unionidae). *Transactions of the American Microscopical Society*, 112: 145-150.
- GORDON, M.E., J.B. LAYZER & L.M. MADISON. 1994. Glochidial host of *Villosa taeniata* (Mollusca: Unionoidea). *Malacological Review*, 27: 113-114.
- HARDISON, B.S. & J.B. LAYZER. 2001. Relations between complex hydraulics and the localized distribution of mussels in three regulated rivers. *Regulated Rivers: Research & Management*, 17: 77-84.
- HEINRICH, J.R. & J.B. LAYZER. 1999. Reproduction by individuals of a non-reproducing population of *Megalonaias nervosa* (Mollusca: Unionidae) following translocation. *The American Midland Naturalist*, 141: 140-148.
- KHYM, J.R. & J.B. LAYZER. 2000. Host fish suitability for glochidia of *Ligumia recta*. *The American Midland Naturalist*, 143: 178-184.
- LAYZER, J.B., M.E. GORDON & R.M. ANDERSON. 1993. Mussels, the forgotten fauna of regulated rivers: a case study of the Caney Fork River. *Regulated Rivers: Research & Management*, 8: 63-71.
- O'DEE, S.H. & G.T. WATTERS. 2000. New or confirmed host identifications for ten freshwater mussels. Pp. 77-82. In R.A. Tankersley, D.I. Warmolts, G.T. Watters, B.J. ARMITAGE, P.D. JOHNSON & R.S. BUTLER (eds.). *Freshwater Mollusk Symposia Proceedings*, Ohio Biological Survey, Columbus, Ohio. 274 pp.
- ORTMANN, A.E. 1921. The anatomy of certain mussels from the Upper Tennessee. *The Nautilus*, 34: 81-91
- ORTMANN, A.E. 1924. The naiad-fauna of Duck River, in Tennessee. *American Midland Naturalist*, 9: 18-62.
- PARMALEE, P.W. & A.E. BOGAN. 1998. *The freshwater mussels of Tennessee*. The University of Tennessee Press, Knoxville, Tennessee. 328 pp.
- REULING, F.H. 1919. Acquired immunity to an animal parasite. *Journal of Infectious Diseases*, 24: 337-346
- SCHMIDT, J.E., R.D. ESTES & M.E. GORDON. 1989. Historical changes in the mussel fauna (Bivalvia: Unionoidea) of the Stones River, Tennessee. *Malacological Review*, 22: 55-60.
- SMITH, D.G. 1985. Recent range expansion of the freshwater mussel *Anodonta implicata* and its relationship to clupeid fish restoration in the Connecticut River System. *Freshwater Invertebrate Biology*, 4: 105-108.
- WALLER, D.L., L.E. HOLLAND, L.G. MITCHELL & T.W. KAMMER. 1985. Artificial infestation of largemouth bass and walleye with glochidia of *Lampsilis ventricosa* (Pelecypoda: Unionidae). *Freshwater Invertebrate Biology*, 4: 152-153.
- WATTERS, G.T. 1994. An annotated bibliography of the reproduction and propagation of the Unionoidea (primarily of North America). Ohio Biological Survey Miscellaneous Contributions No. 1, 158 pp
- WATTERS, G.T. 1996. Small dams as barriers to freshwater mussels (Bivalvia, Unionoidea) and their hosts. *Biological Conservation*, 75: 79-85.
- YEAGER, B.L. & R.J. NEVES. 1986. Reproductive cycle and fish hosts of the rabbit's foot mussel, *Quadrula cylindrica strigillata* (Mollusca: Unionidae) in the upper Tennessee River drainage. *The American Midland Naturalist*, 116: 329-340.
- YEAGER, B.L. & C.F. SAYLOR. 1995. Fish host for four species of freshwater mussels (Pelecypoda: Unionidae) from the upper Tennessee River drainage. *American Midland Naturalist*, 133(1): 1-6.
- ZALE, A.V. & R.J. NEVES. 1982. Fish hosts of four lampsiline mussels (Mollusca: Unionidae) in Big Moccasin Creek, Virginia. *Canadian Journal of Zoology*, 60: 2535-2542.

