Parasitism of Larval Fishes in a Riverine Overflow Habitat[1]

Steven A. Fischer, *School of Forestry, Wildlife, and Fisheries, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803*

William E. Kelso, *School of Forestry, Wildlife, and Fisheries, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803*

Abstract: Parasite loads of 4 larval fish species in a lower Mississippi River overflow pond were compared. Differences in parasite loads appeared to be related to adult spawning locations and larval fish habitat preferences. *Allacanthochasmus* sp. was the only parasite found in larval fishes, with maximum infestations of 1 metacercarial cyst in bluegill and 2 cysts in shad and inland silverside. No parasitism was observed in crappie. Total percent parasitism was highest in silverside (mean ± SE, 2.2 ± 0.5%), followed by bluegill (0.9 ± 0.2%) and shad (0.9 ± 0.3%). Results indicated that adult reproductive tactics, larval fish habitat preferences, and cercarial development of *Allacanthochasmus* sp. may influence rates of parasitism in larval fishes.

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A paucity of information exists concerning the chronology of parasites in young-of-the-year (YOY) fishes or parasitic impacts on production of fish early life history stages. Parasitic infestations could theoretically impact fish host mortality and regulate host population size (Anderson 1978, 1979, 1980; Anderson and May 1978; May and Anderson 1978). Mortality associated with parasitic infestation in larval fishes could thus directly impact productivity of natural fish populations and subsequently recreational and commercial fisheries.

An important objective of studies relating parasite fauna development to larval fish ontogeny is understanding the chronology of parasite infestations and the role of trophic position and habitat type in determining parasite levels. Information gained from such studies would greatly increase our understanding of fish early life histories, and would be an additional tool for evaluating the stability and importance

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of spawning and nursery habitats. No study published to date has examined parasite development in larvae of abbreviated iteroparous fishes throughout a spawning season. Goals of the present study were to compare parasite loads of larval fishes in a lower Mississippi River overflow pond and to relate differences in parasite loads to adult spawning locations and larval fish habitat preferences.

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Methods

Parasite infestation was examined in larval fishes from an overflow pond of the Mississippi River near Allendale, Louisiana, river mile (RM) 239. The overflow pond was located within 200 m of the river's natural levee and was excavated to provide fill for the flood control levee constructed by the U.S. Army Corps of Engineers. The study pond was typical of such habitats located along the lower Mississippi River. Flooding occurred in the study area when the Mississippi River stage reached 7.8 m at the Donaldsonville Gauge Station.

The study pond was approximately 11.0 ha in area (unflooded) and averaged approximately 1.8 m in depth with a maximum depth of 3.2 m. Riparian vegetation consisted of willows (*Salix* sp.), cockleburs (*Xanthium pennsylvanicum*), alligatorweed (*Alternanthera philoxeroides*), and grass (*Parthenium* sp.) with alligatorweed and *Parthenium* sp. also present in the pond. Pond substrate consisted of mud and silty-clay. Definitive hosts for several parasites found in freshwater fishes frequented the study site, including the great blue heron (*Ardea herodias*), belted kingfisher (*Megaceryle alcyon*), and great egret (*Casmerodius albus*) (Olsen 1974, Meyer and Olsen 1980).

Larval fishes were sampled from April through October 1986. On each sampling date, water temperature, dissolved oxygen, and water level within the overflow pond were recorded. In order to examine temporal changes in fish parasite loads, larval fishes were collected in the overflow habitat 3 times per week during April and May, twice weekly during June, and once per week from July through October. The single October sample was combined with September data for statistical analysis.

Larval fishes were collected with a 0.5-m diameter conical plankton net attached to a bow-mounted removable PVC frame attached to a 4.3-m jon boat (modified from Holland and Libbey 1981). Mesh size of the ichthyoplankton net was 505 um. An impeller-type flowmeter (General Oceanics, Model 2030R) positioned midway between the center of the mouth and net rim was used to estimate the volume of water sampled (Tranter and Smith 1968). During each sampling period, 2 larval fish tows were completed just below the surface for 5 minutes at a speed of approximately 1 m/sec (Jessop 1985). After each sampling run, the net was rinsed and the contents emptied into 1-liter glass jars containing 5% formalin.

In the laboratory, larval fish tow samples were filtered through a 505-um mesh

screen and were identified to the lowest possible taxon (Meyer 1970, Hogue et al. 1976, Auer 1982, Hutton 1982). Individual larvae were subsequently examined for ectoparasites and endoparasites using a dissection microscope (1X–40X). Infected fishes were preserved in 5% formalin for subsequent parasite identification (Yamaguti 1958, Hoffman 1967). Mayer's acid carmine stain was used to aid in parasite identification (Pritchard and Kruse 1982).

Data was analyzed using the general linear model procedure of the Statistical Analysis System (SAS) (SAS Inst. Inc. 1985). Duncan's multiple-range test was used to analyze monthly differences in parasite frequencies in each fish species.

Results

From 2 April through 7 October 1986, 6,286 larval bluegill (*Lepomis macrochirus*), 7,161 shad (*Dorosoma* sp.), 1,295 inland silversides (*Menidia beryllina*), and 117 crappie (*Pomoxis* sp.) were examined for parasite infestation (Table 1). *Allacanthochasmus* sp. (Metacercariae: Heterophyidae) was the only parasite found in the larval fishes, with maximum infestations of 1 metacercarial cyst in bluegill and 2 cysts in shad and inland silverside. No parasitism was observed in larval crappie. High infection rate variability within and between samples was noted for all fishes which resulted in no statistically significant differences between months in which *Allachanthocahsmus* sp. was recorded.

Table 1. *Allacanthochasmus* sp. parasitism (mean ± S.E.) in larvae of 4 species from April through September 1986.

Month	Volume filtered (m^3)	Species	*N* samples	Density (larvae/m^3)	Percent parasitised
Apr	832.58	Bluegill	12	2.08	1.3 ± 0.4
		Shad	12	6.47	0.5 ± 0.2
		Silverside	12	0.73	1.5 ± 0.8
		Crappie	7	0.11	0.0
May	670.05	Bluegill	12	5.15	0.7 ± 0.4
		Shad	12	1.85	2.0 ± 0.8
		Silverside	12	0.95	4.1 ± 0.7
		Crappie	4	0.03	0.0
Jun	416.53	Bluegill	7	1.10	2.0 ± 1.1
		Shad	6	1.17	0.6 ± 0.4
		Silverside	6	0.21	1.1 ± 1.0
Jul	320.42	Bluegill	5	0.60	0.0
		Shad	4	0.19	0.0
		Silverside	6	0.02	0.0
Aug	260.32	Bluegill	4	1.10	0.0
		Shad	2	0.01	0.0
Sep	300.80	Bluegill	5	0.57	0.3 ± 0.3
Totals		Bluegill	45	6286	0.9 ± 0.2
		Shad	36	7174	0.9 ± 0.3
		Silverside	33	1331	2.2 ± 0.5
		Crappie	11	117	0.0

Total infection rate was highest for silverside (mean ± SE, 2.2 ± 0.5%; Table 1), followed by bluegill (0.9 ± 0.2%) and shad (0.9 ± 0.3%). Timing of peak infestation differed among species and was not consistently correlated with maximum abundance. Silverside abundance peaked in May (0.95 larvae/m^3), coinciding with the highest infection rate (4.1 ± 0.7%) exhibited by any species during any month. Bluegill abundance also peaked in May (5.15 larvae/m^3), while peak infection occurred in June (2.0 ± 1.1%), when bluegill densities had declined nearly 80%. Similarly, shad abundance peaked in April (6.47 larvae/m^3), while the peak infection rate of 2.0 ± 0.8% occurred in May when shad abundance had declined by 70%. *Allacanthochasmus* sp. cercariae exhibited an apparent decline in abundance after June, as almost no larval fishes collected after May were infected.

Discussion

The life cycle of *Allacanthochasmus* sp. is not completely known. However, being a digenetic trematode it probably requires a molluscan first intermediate host (although a microcrustacean is possible), with fish serving as the second intermediate host (Schell 1970). Adult *Allacanthochasmus* sp. have been reported in the intestines of fish (Yamaguti 1958). High rates of parasitism by digenetic trematodes relative to other parasitic taxa might be expected in larval fish hosts which inhabit shallow waters. Cercariae released from molluscan (or microcrustacean) intermediate hosts are probably more prevalent in shallow vegetated habitats compared to open water. Cercariae of digenetic trematodes also actively locate and penetrate the somatic tissue of available hosts. Other parasitic taxa (i.e., cestodes, nematodes) require that first intermediate hosts, such as copepods and ostracods, be consumed for infestation to occur. Substantial predation on these taxa typically begins after the larval period of fish development with increases in swimming capabilities and gape width (Zaret 1980).

Because the lifecycle of *Allacanthochasmus* sp. is unknown, it is impossible to conclusively determine the causes of the differences in infestation among the 4 fishes. Interspecific differences could have simply been due to seasonal density fluctuations of parasites and hosts or a physiological host specificity exhibited by *Allacanthochasmus* sp. However, no host specificity has been reported for *Allacanthochasmus* sp., and there were no apparent relationships between periods of peak parasitism and larval densities (Table 1). Infestation patterns could have been related to reproductive modes of adult fishes, cercarial development of *Allacanthochasmus* sp., and larval fish habitat preferences. Inland silversides spend the majority of their life in the littoral zone. Reproduction is by broadcast spawning in shallow, nearshore waters, and the eggs subsequently attach to algal matter and emergent vegetation by means of an adhesive filament (Becker 1983). Consequently, recently hatched larvae would likely be in close proximity to high densities of cercariae.

Bluegill are shallow water nest builders. Werner (1969) reported that larvae

migrate to the limnetic zone for a period of approximately 1.5 months following the swim-up stage which would reduce the chances of cercarial infestation. In our study, this could have been reflected in low percentages of parasitism during May, with larvae being parasitised initially in the nest (April peak) and again upon return to shoreline areas (June peak).

Shad are pelagic broadcast spawners. Early developing larvae drift in the pelagic zone until such time that they swim inshore to feed and develop. If *Allacanthochasmus* sp. parasitism is habitat-related, parasitism should have increased through time as developing shad moved to shoreline areas. The data support this hypothesis as percent parasitism increased from April to May although densities of larval shad had declined. Parasite prevalence decreased in June, but this may have been related more to seasonal flooding in the overflow pond than to parasite/host dynamics.

Larval crappie exhibited no sign of parasitism during the study period. Adult crappie generally build nests in deeper waters than do bluegill, with larvae usually found in open waters of considerable depth (Pflieger 1975). In addition to a smaller sample size, the fact that larval crappie are more pelagic may explain why no parasitism was observed. In addition, crappie spawned earlier than other species in the overflow pond, and spawning may have occurred prior to *Allacanthochasmus* sp. cercarial development.

There is probably no single explanation of the infestation patterns observed in the various larval fishes. Parasitism in age-0 fishes appears to be a function of many factors, including time in the system, season, and host size, trophic position, and habitat preferences (Fischer 1987). Overall, larval fishes may not be preferred by parasites that use the fish as intermediate hosts because the potential for mortality from sources other than predation by the final host is high. However, observed trends in *Allacanthochasmus* sp. infestation in the larval fishes are consistent with those expected on the basis of larval fish habitat changes and a nearshore distribution of *Allacanthochasmus* sp. cercariae. Future description of the life cycle of *Allacanthochasmus* sp. will be necessary to fully explore this hypothesis.

Finally, it should be noted that fish hosts undergo a period of great stress during cercarial penetration by digenetic trematodes (Krull 1934, Smitherman 1968). Once the cercaria has successfully penetrated the epidermis of the host, it actively migrates in the tissue before developing into the metacercarial stage. As a protection mechanism, the fish host produces a cyst encapsulating the larval parasite. Although not investigated in this study, analyses of parasite frequencies by larval fish length class could provide a method for assessing fish mortality due to parasite infestation. As metaceraria are not lost as the fishes develop, one would expect a continual increase in the percentage and intensity of infected larvae with increasing length, if infected larvae are not subjected to increased mortality. Conversely, a decrease in infection frequency with increasing length of larvae would suggest differential mortality with respect to parasite load.

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