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Abstract

Seventy-two bass (Micropterus-spp.), mostly smallmouth, were collected from three areas of the Caddo River in west Arkansas and examined for the presence of *Clinostomum marginatum* metacercariae. Prevalence, mean abundance, and abundance for all fish were 68%, and 4.2 ±6.5, and 30, respectively. Fish from the upstream area near the headwaters were more heavily infested than those from further downstream. A gill/total body larval ratio of seven, was found for bass from another Arkansas stream, was examined as a predictor for total *Clinostomum* populations in stream bass. Using the formula gill parasites X seven divided by N (72), a value of 3.3 was found for mean abundance. The gill/total body ratio for Caddo bass was found to be higher at 8.9 but the ratio of 7 gives a reasonable estimate of *Clinostomum* burdens in a stream bass population. Use of this ratio allows bass hosts to be examined without necropsy thus preserving the host population in its environment.

Introduction

Clinostomum marginatum a trematode that has a fish-eating bird as its definitive host, a snail and fish as intermediate hosts. The metacercarial form has been found in 56 freshwater species of fish (Hoffman, 1967). In Arkansas, it is found in noticeable numbers in the tissues of stream bass, particularly the smallmouth (*Micropterus dolomieui*). Smallmouth taken from Crooked Creek, a stream in north central Arkansas, have been shown to have high *mean* abundances, (average number of parasites/fish) of 23 (Daly et al., 1987) and 32.7 (Daly et al., 1991); and record-setting abundances (number of parasites/individual fish) of 2500, 852, and 627 (Daly et al., 1991). These larvae can be up to 0.5 cm in length and are called yellow grub because of their pigmentation. Such large and obvious parasites can make the fish flesh unpalatable and may even effect the hosts' survival.

Also found in Crooked Creek bass was an arithmetic relationship between the easily visible grubs found in the gill area (gills, mucosal and membrane surface of the gill cavity, and the mouth) and the total body grub burden (including the number in the gills). Regression analysis showed a high correlation between the two variables with a ratio of approximately seven (Daly et al., 1992). Use of such a ratio to estimate total number of yellow grubs in bass without tissue invasion would allow large populations of hosts to be surveyed with little mortality thus preserving a valuable sport fishing resource.

Methods

During the summer of 1996, 72 smallmouth and largemouth bass (*Micropterus salmoides*) were collected from three areas on the Caddo River (Montgomery and Pike counties) by rod and reel using live or artificial bait. The areas were (1) upstream at Black Springs near the headwaters of the Caddo, (2) further south from Caddo Gap to confluence of the South Fork of the Caddo, and (3) and from the confluence of the South Fork of the Caddo to the Caddo at Glenwood. Fish were placed on ice and later necropsied with all of the soft tissue of the host being examined. Some host measurement data were lost. Records were available, regarding standard length and girth (cm), for only 49 fish from Caddo Gap to Glenwood. These fish measured (mean ±standard deviation) 24.7 ±4.1 cm in length and 7.5 ±1.7 cm in girth. A ratio of 3.3±0.3 was found between length and girth. Regression analysis showed an r-value of 0.92 with a P of <0.001. Of 72 hosts, 66 were smallmouth and six were largemouth bass. Parasite ecology terminology follows that of Bush et al. (1997).

Results and Discussion

Bass from the sampled areas showed much lower mean abundance and abundance of yellow grub than fish taken from Crooked Creek (Table 1). Prevalence, abundance, and mean abundance were higher upstream at Black Springs than downstream between Caddo Gap and Glenwood. Data from Crooked Creek showed much higher yellow grub loads downstream than upstream (Daly, J. J., unpubl. data). It is difficult to speculate the reasons for these differences in yellow grub populations for either a comparison between Crooked Creek and the Caddo or within the Caddo itself. The population densities of the different hosts regulate parasite populations and such data for birds, snails, and host fish are not available for these streams. However, it has been noted from casual examination and years of collecting that smallmouth populations are much greater in Crooked Creek than in the Caddo (crowding effect?). Another factor may be human activity. The downstream area in this study is the most utilized portion of the Caddo for recreation and agriculture as well as having the highest human population density. This may reduce the presence of the definitive host, most usually the great blue heron. Also, pollution contaminants may play a role. House et al. (1993) have shown that total coliforms and other bacterial markers for fecal contamination are highest in the downstream area of the present study. On Crooked Creek the upstream areas have the most chemical and physical contamination (Drope, 1997). These are also the sections with the fewest yellow grubs in bass (Daly, J. J., unpubl. data). Reasons for differences in grub loads in fish are presently speculative and, unfortunately, there are no other similar stream profile studies available for comparison. A peculiar aspect of helminth parasite populations can be seen in Table 1. The standard deviations of the mean abundances are as large or larger than the means themselves. This usually indicates a negative binomial distribution because of the uneven dispersion of the parasites within the host population, i.e. with some hosts having large numbers of a parasite while many hosts have none at all (Esch et al., 1990). For example, prevalence (Table 1) for hosts from all sites show 32% of bass to have no detectable yellow grubs.

Table 1. Prevalence, maximum abundance and mean abundance of *Clinostomum marginatum* larvae in *Micropterus* species from the Caddo River and the total body/gill ratio as a predictor of total number of grubs in a population of bass hosts. Values in parentheses are the predicted average/fish derived from the number in the gills times the ratio of seven found for Crooked Creek bass.

Collection sites	N	Prevalence	Maximum Abundance	Number in Gills	Number in Body	Total Number	Ratio Total/Gills	Avg/Fish Mean± SD	(Avg/Fish)
All sites	72	68%	---	34	270	304	8.9	4.2± 6.5	(3.3)
Black Springs	20	85%	30	23	175	198	8.6	9.9± 9.0	(8.0)
Caddo Gap to South Fork	29	59%	7	6	36	42	7.0	1.5± 1.7	(1.5)
South Fork to Glenwood	23	65%	19	5	59	64	12.8	2.8± 4.1	(1.6)

Ratios of total body grubs to gill grubs can be found in Table 1. For all hosts this value was 8.9. Using the ratio of seven from Crooked Creek bass and multiplying this times the number of grubs found in the gill and mouth area divided by the number of hosts gives an estimate of mean abundances which can be compared to data derived from actual observations of total yellow grub loads. It can be seen from the last two columns of Table 1 that the number of gill parasites can be a reasonable predictor of yellow grub populations in bass populations. Regression analysis of host length and total number of grubs (df = 47) showed a weak ($r = 0.32$) but significant correlation ($P < 0.05$). Table 2 shows the regression analyses for total body vs gill numbers. One regression had a low correlation and no significance at the 0.5 level, which may be explained by the variation found in individual fish in this body/gill relationship. We have found the highest individual host variance primarily in populations of bass with low prevalences and mean abundance. Overall, the body/gill ratio works well as a predictor when host sample size is large enough to balance the individual variability and contains enough gill grubs to make an estimation. For practical purposes we have used this technique in culling fish for obtaining yellow grubs for physiology and biochemical studies thus returning to the stream bass that appear to be poorly infected.

Table 2. Regression analysis of the total of body yellow grubs per body to the number of grubs in the gill area.

Collecting sites	Degrees of Freedom	α	slope	r	*P*
All sites	70	0.02	0.11	0.71	<0.001
Black Springs	18	0.04	0.11	0.69	<0.001
Caddo Gap to South Fork	27	0.09	0.08	0.26	>0.05*
South Fork to Glenwood	21	0.01	0.08	0.61	<0.001

*Not significant

Use of the ratio of seven can be of economic value as well as for understanding yellow grub ecology. Daly and Singleton (1994) have shown a similar relationship in channel catfish (*Ictalurus punctatus*) taken from a farm pond in northwest Arkansas. Fifty-four catfish of similar size showed a prevalence of 100%, a mean abundance of 31.7, and a ratio of 5.56 ($r = 0.61$, $P<0.001$).

Yellow grub is becoming a problem for catfish farmers in Oklahoma, Arkansas, and Mississippi (Mitchell, pers. comm.). Fish infested with too many grubs are rejected at the processing plant. The presence of a wild fish population serving as a yellow grub reservoir for farm fish complicates the control of this parasite. Further studies on Ozark and Ouachita streams would be useful in determining the extent of this problem. The application of the ratio technique for population estimations described herein would allow large numbers of bass to be examined and returned to the environment as well as decreasing necropsy times.

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