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James J. Daly
University of Arkansas for Medical Sciences

Bruce DeYoung
University of Arkansas for Medical Sciences

Terryl L. Hostetler
University of Arkansas for Medical Sciences

Randal J. Keller
Murray State University

Distribution of *Clinostomum marginatum* (Yellow Grub) Metacercaria in Smallmouth Bass Populations from Crooked Creek in North Central Arkansas

James J. Daly*, Bruce DeYoung, and Terry Hostetler
Department of Microbiology and Immunology
University of Arkansas for Medical Sciences
Little Rock, AR 72205

Randal J. Keller
Department of Occupational Safety and Health
P.O. Box 9
Murray State University
Murray, KY 42071

*Corresponding Author

Abstract

Four hundred thirty-three smallmouth bass (*Micropterus dolomieui*) were collected from ten sites on Crooked Creek in North Central Arkansas from just below the city of Harrison to the White River in the summers of 1988-90. Necropsy of these hosts for yellow grub (*Clinostomum marginatum*) metacercariae showed a range of mean abundance (average/fish) from 1.4 ± 1.9 (SD) at a far up stream site to 105 ± 368 at the White River juncture. An increasing mean abundance of *C. marginatum* was seen from the uppermost sites of the creek downstream to the White River. Relating stream mileage with mean abundance gave a correlation coefficient (r) of 0.78, with $P = <0.01$. Maximum abundance (maximum number of parasites in a single host from a site) ranged from 7 to 2500 and also showed a positive correlation with stream mileage ($r = 0.77$, $P = <0.01$). Prevalence (% fish infected) at the different sites ranged from 61 to 91% but showed no significant correlation with stream distance. The increasingly heavier infections seen in the downstream sites are not due to poor water quality but probably to the combination of the greater presence of the definitive host, the great blue heron, and large intermediate host (smallmouth) populations.

Introduction

Crooked Creek is located in the Ozark Plateau of North Central Arkansas. It begins above the city of Harrison and ends at the White River. It has a continuing series of riffles and pools, which makes it excellent habitat for smallmouth bass (*Micropterus dolomieui*). The stream dries up in the summer at Yellville, approximately 25 miles from the White River but emerges again just east of Highway 101, approximately 10 miles from the White River. Crooked Creek has an excellent smallmouth fishery, but the bass harbor some of the highest population densities reported for the metacercarial stage of *Clinostomum marginatum*, or yellow grub. This study was done to survey the distribution of the parasite population along the length of the stream in order to gain information regarding the ecology of the host-parasite relationship in a stream environment. Such information would be useful if control programs against yellow grub become feasible.

Clinostomum marginatum is a trematode that has a fish-eating bird as its definitive host and a snail and a fish as intermediate hosts (Olson, 1967). Fifty-six freshwater fish have been found to harbor the metacercarial form of this parasite (Hoffman, 1967). These larvae can be up to 0.5 cm in length and are called yellow grub because of their coloration. The presence of a large number of these worms in the flesh of the fish can make it undesirable as a food item. In Arkansas, yellow grubs are found in noticeable numbers in the tissues of stream bass, particularly the smallmouth (*Micropterus dolomieui*). Smallmouth previously taken from Crooked Creek have been shown to have high mean abundances (average number of parasites/fish) of 23 and 32.7 ((Daly et al., 1987, Daly et al.1991) and the highest recorded abundances (number of parasites/individual fish) of 2500, 852, and 627 (Daly et al., 1991). During the course of an earlier study (Daly et al., 1987) it was noted that fish collected from upstream sites on the Creek were less infected than those collected from downstream sites. The aim of this study was to determine if a pattern of heavy infection exists from upstream to downstream sites.

Methods

Four hundred and thirty-three smallmouth bass (*Micropterus dolomieui*) were collected from ten sites on Crooked Creek in North Central Arkansas from below Harrison to the White River in the summers of 1988-90. The ten collection sites are as follows: Huzzah Creek (HU); Harmon 1, 2, and 3 (H1, H2, H3), which were 2 low water bridges on Crooked Creek Drive East and the main bridge on Harmon Road North; The city of Pyatt (P), at the juncture of Little Sugar Orchard Creek; Clear Creek (CC); Turkey (T), between Comal and Georges Creek; Georges Creek (G); The city of Yellville (Y), at Kelly's Slab; and the

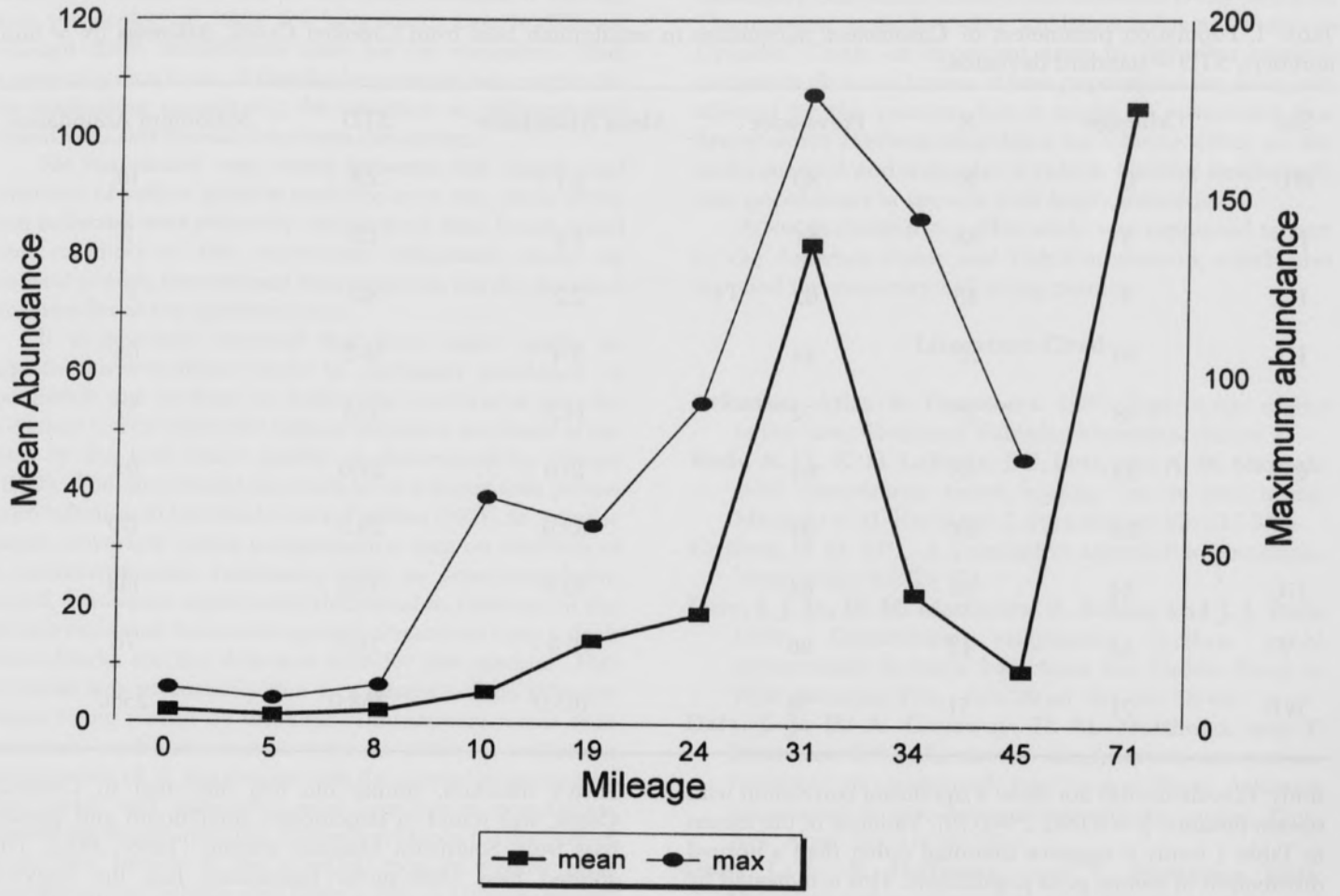

Fig. 1. Mean and maximum abundances of *Clinostomum marginatum* in smallmouth bass from ten sites on Crooked Creek. The light line is maximum abundance (heaviest infected fish) and solid line mean abundance (avg./fish). The maximum abundance of 2500 for the White River site is not included because it greatly exceeds the limits of the graph.

White River (WR). These sites were chosen for ease of access and well as their position on the stream. Bass hosts were all collected in Crooked Creek and none from the feeder streams. Mileage of each site, in respect to the White River as the terminus, can be found in Table 1. Mileage was determined by following the contours of Crooked Creek from maps in Streets and Trips 2001® from Microsoft and the Arkansas Atlas & Gazeteer. Mileage was determined by following the contours of the stream.

Bass were collected by rod and reel using live or artificial bait. Fish were placed on ice and later necropsied with all of the soft tissue of the host being examined. Metacercaiae were removed to petri dishes with saline and counted. Parasite ecology terminology follows that of Bush et al. (1997) with maximum abundance meaning the most heavily infected individual host; mean abundance is the average number of parasites/number of hosts examined, and prevalence is the percent of fish infected/number or hosts examined. The term site in this paper refers to the collection area rather than parasitized area of host. T Tests and regression analyses (for r and P values) were done using Microsoft Excel, 1997.

Results and Discussion

Abundance and mean abundance of *Clinostomum marginatum* metacercariae in smallmouth increased as downstream distance increased (Table 1, Fig. 1). Regression analysis of mean abundance and site position gave an r of 0.78 and $P = 0.008$ and for maximum abundance, r = 0.8 and P of 0.007. Prevalence ranged from 61 to 91% with an overall prevalence of 79% for all smallmouth bass in the

Table 1. Population parameters of *Clinostomum marginatum* in smallmouth bass from Crooked Creek, Arkansas (N = host numbers, STD = standard deviation).

Site	Mileage	N	Prevalance	Mean Abundance	STD	Maximum Abundance
HU	0	10	80	2.1	2.8	10
H1	5	38	61	1.4	1.9	7
H2	8	45	62	2.2	3.2	11
H3	10	37	84	5.4	10.9	64
P	18	27	72	14.3	17.5	57
CC	24	43	84	19.0	24.0	92
T	31	107	91	83.0	28.3	179
GC	34	31	84	22.5	32.5	144
Y	45	44	86	9.4	14.2	76
WR	71	51	70	105.0	368.0	2500

study. Prevalence did not show a significant correlation with stream distance ($r = 0.096$, $P = 0.79$). Variance of the means in Table 1 imply a negative binomial rather than a normal distribution of yellow grub populations. This is indicated by a large standard deviation relative to the mean and is produced by many hosts having few or no infection while some hosts have large numbers of parasites. This is the rule for most parasitic relationships (Esch et al., 1990). In order to statistically test if significant differences occur using parametric procedures, a log transformation was done on the individual data where $X = \log(N) + 1$ with zero infestations assigned a 0 value. With these transformations, whereby the variance became much less than the mean, the Student T Test showed that most heavily infested sites (WR, T, GC, CC) were significantly different from the least infested sites (HU, H1, and H2) with P values of less than 0.001.

Heavy infections of yellow grub of 2500, 852, and 627 grubs/host were found at the furthest downstream site, the White River, but heavy individual infestations of 179 and 144 were found at other sites as well (Table 1). It was not unusual to find smallmouth bass with 25 or more worms downstream from Pyatt to the White River, but such hosts were rare from the upstream sites at Huzzah and Harmon. Prior to this study the heaviest infection was found from a member of the catfish family (*Ictaluris nebulosus*) in Pennsylvania with 500 yellow grubs (Torres and Price, 1971). Heavy infection, similar but less than that in Crooked Creek, was found in largemouth, smallmouth and spotted bass from Southwest Missouri streams (Taber, 1972). The spotted bass (*Micropterus punctulatus*) had the heaviest infections; one fish had 230 metaceriae and the 25 fish examined averaged 32.76 metaceriae/fish. Of the 25 smallmouth bass examined the prevalence was 88 percent, but the mean abundance was only 7.7. Heavy infections have also been reported in yellow perch (*Perca flavescens*) from lakes in Minnesota with 325 and 199 maximum infections (Elliott and Russert, 1949). In contrast to these reports and the present study the heaviest maximum abundance from a Ouachita stream in Arkansas, the Caddo, was only 30 metacercariae from 66 hosts (Daly et al., 1999). Mean abundances from three sites on that river were only 4.2, 9.9, and 2.8, upstream to downstream respectively. Yellow grub infections have been reported in fish from various geographic locations, but the data from Crooked Creek and the Caddo are unique in showing the variation of parasitism along a single stream.

Largemouth bass (*Micropterus salmoides*) were also examined from Crooked Creek and found to be infected. However, Crooked Creek is primarily a smallmouth bass stream, and there were too few (and some not at all) largemouth bass from individual sites to properly assess the yellow grub population in these hosts. Data from these fish

were not included in the present study because it was felt that the ecological niche for largemouth bass is different enough from smallmouth bass for its exclusion. Also, combining data from all sites for largemouth bass might also be misleading considering the variation at different sites found with smallmouth bass from this stream.

No correlation was found between fish length and infection of yellow grubs at each site or *in toto*. Sizes of the fish collected were relatively similar at all sites. It was noted that numbers of fish were more abundant, based on collection time, downstream than upstream but the stream is also smaller at the upstream sites.

It is generally assumed that poor water quality in aquatic environments leads to increased incidence of parasitism due to stress on hosts. The converse is seen for Crooked Creek where the highest infections are found at the sites of the best water quality as determined by Drope (1997). Pollution would not seem to be a factor with yellow grub infection in Crooked Creek. Crofton (1971), in a classic paper, reworked earlier nonparametric data on infection of a microcrustacean, *Gammarus*, with an acanthocephalan worm. Parasitism significantly decreased as distance on the stream increased from drainage into the stream from a duck farm. Ducks are the definitive host for this parasite. This decrease was presumably due to a dilution of the infective stages being passed by the birds. Downstream rather than upstream conditions must be more favorable for maximum transmission of *C. marginatum* with the proper proportion of bass, snail, and especially, great blue heron populations needed for heavy infection. Indirect evidence for the role of great blue herons is the marked drop in yellow grub infection at the Yellville site (Table 1, Fig. 1). Human activity is greatest in this area and may deter herons from feeding there thus decreasing the amount of parasite eggs entering the water and therefore reducing infection of snail hosts.

The importance of heavy yellow grub infection in Crooked Creek is several fold. Yellow grub is becoming a problem for catfish farmers in Oklahoma, Arkansas, and Mississippi (Mitchell, personal comm.). Daly and Singleton (1994) found fifty-four catfish of similar size from a pond in Northwest Arkansas to have a prevalence of 100% and a mean abundance of 31.7, values greater than most of the sites on Crooked Creek. Fish infected 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. It can also be argued that the catfish might be a reservoir for infection of stream bass.

A use for heavy yellow grub infections would be as a source for experimental studies on this worm itself, and this has been done (Daly et al., 1987). The complexities of the life cycle of this and other trematodes make it difficult and economically unfeasible to obtain these parasites by laboratory cultivation. Finally, the Arkansas Game and Fish Commission considers the smallmouth bass fishery in Crooked Creek an important asset to Arkansas outdoor recreation. It is not known if bass populations are adversely affected by the parasite, but it might be speculated that heavy worm burdens must have an adverse effect on the host's survival and may play a role in limiting smallmouth bass populations in streams with heavy infections.

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