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PREVALENCE OF METACERCARIAE OF CRASSIPHIALA BULBOGLOSSA (TREMATODA, STRIGEOIDEA) IN FISHES OF THE HEADWATERS OF THE EMBARRAS RIVER, ILLINOIS

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ABSTRACT. Five of the twenty-three species of fishes collected from the Embarras River in Champaign Co., Illinois, were infected with metacercariae of the digenetic trematode Crassiphiala bulboglossa. Intensity of infection varied with respect to downstream location, species of hosts, specific body area of the host, and age of the host.

INTRODUCTION

Metacercariae of many digenetic trematodes encyst in the skin and flesh of various species of fishes where they are externally visible as small black spots. The metacercariae remain within the skin until the fish is eaten by a predatory bird, such as a kingfisher, which serves as the definitive host (Allison, 1950; Hoffman, 1956, 1967).

Examination of external cysts on infected fishes collected from the headwaters region of the Embarras River in Champaign Co., Illinois, revealed one species of digenetic trematode parasite identified as Crassiphiala bulboglossa Van Haitsma following Hoffman's (1967) synopsis. Dr. G. L. Hoffman (pers. comm.) confirmed the identification of this species from sketches of the parasite.

There have been no previous studies of fish parasites of the Embarras River. This paper describes the prevalence of C. bulboglossa on certain species of Embarras River headwater fishes, the prevalence of infection at various downstream locations, and the location of C. bulboglossa in specific body areas of the host. The relationship of parasite population density to fish host age will be discussed.

MATERIALS AND METHODS

Fishes were collected during October, 1973, with a small mesh minnow seine at stations along the Embarras River in Champaign Co.,

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designated by Menzel (1952) in his study of successional patterns of fishes. To evaluate parasite density shifts in time with regard to fish host age and infection of specific body areas, metacercarial counts from fishes collected at station 8 in 1971 and 1973 were compared. Approximately forty pigmented cysts were dissected from the integument and scales of specimens of each parasitized species found in the 1971 and 1973 collections. The metacercarial cysts were stained with borax carmine and, in some cases, counterstained with fast green, mounted, and microscopically examined.

For a comparison of the relative densities of parasites among specific body areas in the creek chub, *Semotilus atromaculatus*, the following conversion was used. The body surface was divided into the following areas: head, dorsal to lateral line, ventral to lateral line, dorsal fin, caudal fin, and ventral fins (anal, pelvics, and pectorals). The fins or sections of skin were dissected from the body and traced on paper which was analytically weighed. A specific body area ("ventral to lateral line") was chosen as a standard to which other areas were compared. The formula used to determine body area densities as compared to the ventral surface is as follows; Let N_{BA}= average number of cysts recorded for a specific body area, N_R= relative number of cysts with respect to the standard ventral surface area, W_{BA}= surface area "weight" for a specific body area, W_V= surface area "weight" for the ventral area. From $N_{BA}/W_{BA} = N_R/W_V$ comes $N_R = (W_{BA}/W_V)$. N_R is the relative density employed in this study.

Semotilus atromaculatus specimens from the 1971 and 1973 station 8 collections were divided into three total length classes as follows: 4.0-8.9 cm (small), 9.0-11.9 cm (medium), 12.0-16.0 cm (large). Parasite densities in the various length classes were computed by averaging the number of cysts from the total number of individuals of each class and weighting whis average relative to a standard total surface area (that of the medium sized fish).

Scientific names of fishes used in this study are those listed by Bailey et al. (1970).

RESULTS

Of the twenty-three species of fishes collected, only five species; *Campostoma anomalum*, *Notropis spilopterus*, *Notropis stramineus*, *Pimephales notatus*, and *Semotilus atromaculatus*, contained *C. bulboglossa* metacercarial cysts. The degree to which each of these species was infected is shown in Table I. The distribution of headwaters fishes usually follows a definite physiographic successional pattern (Shelford, 1911; Burton and Odum, 1945; Sheldon, 1968). This pattern in the Embarras River, with the notation of infected fishes, is illustrated in Table I. The prevalence of *C. bulboglossa* in the four major host species from each collecting station is shown in Figure I.

A comparison of *S. atromaculatus* specimens from the station 8 collections (1971 and 1973) shows similar relative parasite densities of designated body areas (Table 2). The body areas listed in increasing order as to their parasite densities are: dorsal fin, ventral fins, head, ventral surface, dorsal surface, and caudal fin. The 1971 and 1973 station 8 data also indicate parallel trends of increasing parasite density in relation to increasing host (*S. atromaculatus*) length (Figure 2).

DISCUSSION

C. anomalum, *N. spilopterus*, *P. notatus*, and *S. atromaculatus* were determined to be the "suitable fish hosts" (Allison, 1950) of *Crassiphiala bulboglossa* in the Embarras River headwaters. The single cyst located in one *N. stramineus* specimen was not considered to be significant. *C. bulboglossa* metacercarial cysts have been previously reported from *S. atromaculatus* (Hoffman, 1967; DuBois, 1970) and *C. anomalum* (Cloutman, 1976) but have not been reported from *N. spilopterus*, *N. stramineus*, or *P. notatus*. *Crassiphiala bulboglossa* cysts have been reported from several fish hosts including *Esox americanus*, *Esox lucius*, *Notemigonus crysoleucas*, *Etheostoma nigrum*, and *Ericymba buccata* (Hoffman, 1956, 1960; DuBois, 1970). These fishes were captured in the Embarras River headwaters but were not found to be parasitized by *C. bulboglossa*. The first four of the previously listed species were found in quantities too small to expect infection given the degree of parasitism of the other major fish hosts. However, *E. buccata*, a common cyprinid species in the Embarras River headwaters, remained free of *C. bulboglossa* cysts for unknown reasons.

An analysis of the geographic distribution of parasitized fishes must consider the distribution of other intermediate hosts which may in turn be influenced by environmental conditions. *C. bulboglossa* are known to pass through a snail intermediate host (genus *Helisoma*) which has been identified from the Embarras River headwaters as *H. trivolvis* (J. Suloway, pers. comm.). This snail species is known to prefer quiet, shallow, stagnant or semi-stagnated waters (Branson, 1961; Harman and Berg, 1971). The upper Embarras River should provide acceptable habitat for this species, however quantitative and local distributional data are lacking. Snails produce infectious cercariae which may then encyst in the fish host. Infection probably takes place in restricted areas as it is unlikely that cercariae swept downstream would be effective due to dilution effects and the short cercarial life expectancy. Thus, the distribution of the snail host may play a key role in determining which fishes become infected.

It appears that a successional pattern exists relative to *C. bulboglossa* infection with individual data for *C. anomalum*, *P. notatus*, and *S. atromaculatus* indicating an increase in degree of infection from station 1 to station 8 (Figure 1). These three species maintain relatively stable populations in this drainage in terms of relative abundance (Buth, 1974) possibly restricting their movements relative to the rather arbitrarily chosen collecting stations, although evidence for seasonal fluctuations in other *P. notatus* populations have been reported (Smith, 1963). Thus, the apparent pattern of increasing degree of infection in these species may reflect some successively distributed parameter, possibly an increase in availability of infectious cercariae from the snail intermediate hosts. The infection of _N. spilopterus_ did not exhibit a successionally oriented distribution (Figure 1) as previously described for the other host species. However, the population of this species varies seasonally (Buth, 1974) and the "mixing" of individuals during migration would effectively dilute any successional effects of parasitic infection.

Allison (1950) stated that the encysted metacercariae remain burrowed in the fish host until the fish is preyed upon by a bird or otherwise dies. This study supports that hypothesis by showing a steady increase in the relative densities of parasites as the fish size and age increases (Figure 2). Assuming the average rate of _C. bulboglossa_ attack to be fairly constant and knowing that the fish surface area increases at a slower rate than the volume, the relative _C. bulboglossa_ densities would increase with fish size.

Data for relative body area densities indicate agreement in infection patterns for the 1971 and 1973 _S. atromaculatus_ collections (Table 2). The relative trematode density was found to be greatest for the caudal fin. The dorsal side was also highly parasitized and showed consistantly higher parasite densities than was found on the ventral surface. The relative parasite densities of the head and ventral fins tended to be similar and somewhat greater than the lowest density area, the dorsal fin. A general picture of the behavior of _S. atromaculatus_ could prove valuable in a partial account for the densities observed. The frictional forces involved with substrate contact might explain reduced ventral surface densities as compared to higher dorsal surface densities. Possibly the acetabulum of the cercaria cannot remain fixed long enough to allow trematode encystment on the ventral surface.

Various factors affecting regional surface densities of _C. bulboglossa_ deserve further study. Additional information concerning the local distribution, abundance, and degree of _C. bulboglossa_ infection of the snail intermediate host may help to explain the patterns of infection observed in this study.

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Table I. Distribution of fishes and prevalence of *Crassiphiala bulboglossa* infection in the Embarras River headwaters. Numbers of infected fishes are indicated in parentheses.

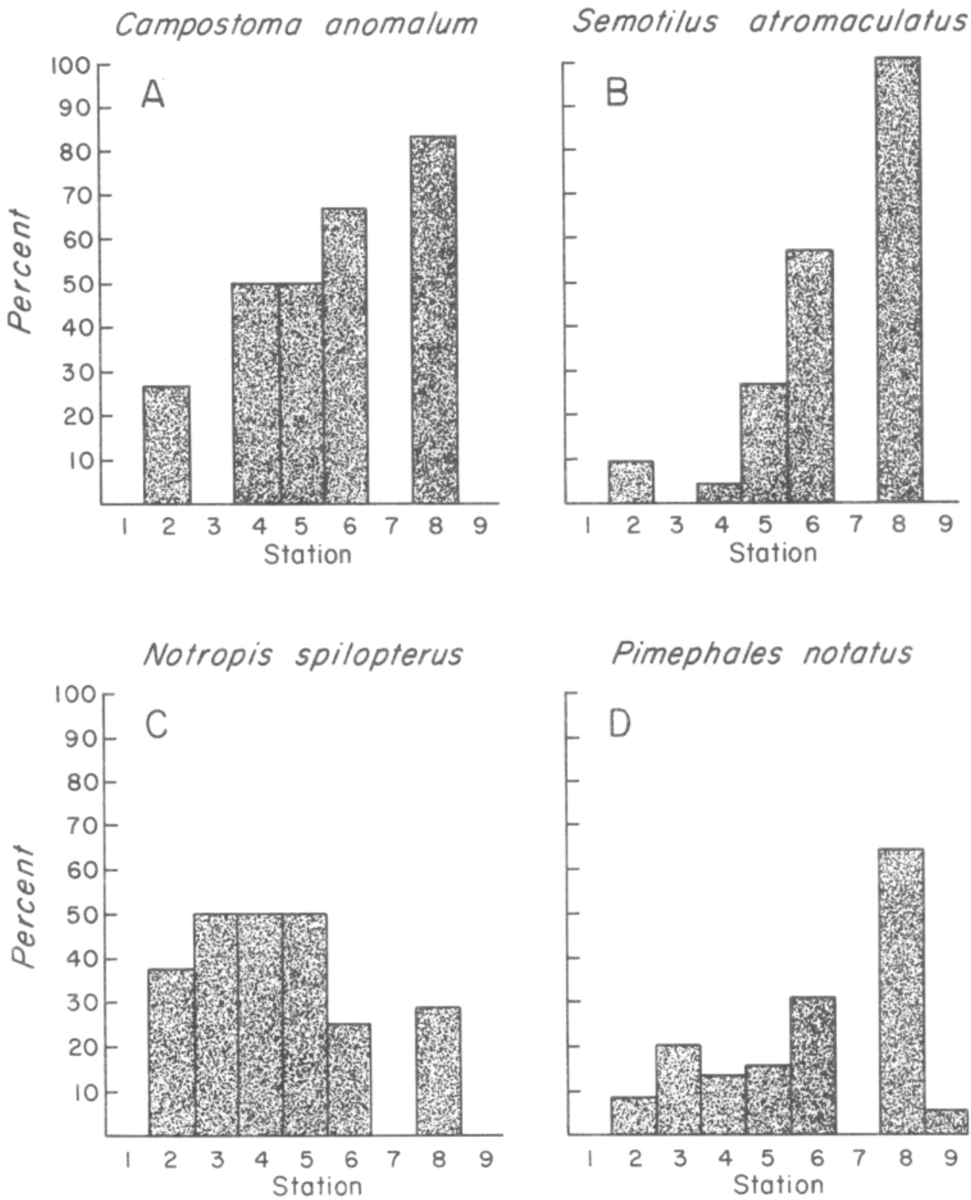
SPECIES	STATIONS 1	2	3	4	5	6	7	8	9	TOTAL	PERCENTAGE PARASITIZED
1. *Pimephales notatus**	10	127(11)	10(2)	15(2)	13(2)	13(4)	2	64(40)	19(1)	273(62)	22.7%
2. *Lepomis cyanellus*	2	7	6	4	8	9	5	1		42	0
3. *Notropis spilopterus**	1	24(8)	2(1)	2(1)	2(1)	4(2)		7(2)	1	43(15)	34.9
4. *Lepomis megalotis*		15	4	1	18	2	5	6	7	58	0
5. *Notropis stramineus**		21	3	16(1)	7	3		33		83(1)	1.2
6. *Notropis umbratilis*		21	1				33	13		68	0
7. *Campostoma anomalum**		15(4)		12(6)	2(1)	3(2)		12(10)		44(23)	52.2
8. *Semotilus atromaculatus**		75(6)		22(1)	18(4)	7(4)		43(43)		165(58)	35.2
9. *Fundulus notatus*		3		3	8	5			5	24	0
10. *Lepomis humilis*		35		2	2		4			43	0
11. *Ericymba buccata*		8			21	6		73		108	0
12. *Erimyzon oblongus*		3			2		6			11	0
13. *Lepomis macrochirus*		20					2			22	0
14. *Ictalurus natalis*		2					1			3	0
15. *Phenacobius mirabilis*					3			3		6	0
16. *Aphredoderus sayanus*					1					1	0
17. *Catostomus commersoni*							5	3		8	0
18. *Esox lucius*							1			1	0
19. *Notemigonus crysoleucas*							6			6	0
20. *Ictalurus melas*							1			1	0
21. *Etheostoma nigrum*							1			1	0
22. *Pomoxis annularis*							1			1	0
23. *Esox americanus*								1		1	0
Total number of species	3	14	6	9	13	9	14	12	4	23	
Total number of specimens	13	376	26	77	105	52	73	259	32	1013(159)	15.7

*Species found to carry *C. bulboglossa* metacercariae.

Table 2. Average relative densities of parasites on various body areas of *Semotilus atromaculatus* collected at station 8 in 1971 and 1973 (the absolute average number of parasites per body region as corrected relative to the standard ventral surface area).

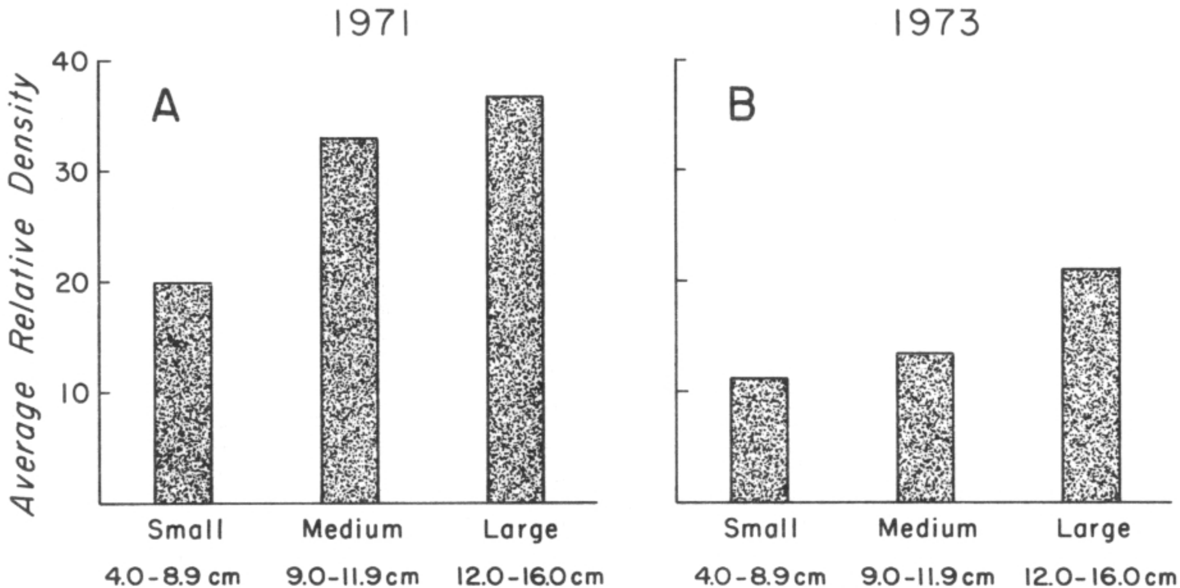
	Small		Medium		Large	
	1971	1973	1971	1973	1971	1973
Dorsal Fin	2.8	0	8.2	3.8	30.9	17.0
Ventral Fins	1.7	2.2	11.0	6.8	36.9	21.8
Head	2.5	2.0	12.5	6.5	37.3	19.0
Ventral Surface	4.3	2.3	16.2	7.5	34.9	25.9
Dorsal Surface	5.7	2.5	25.8	9.0	52.1	29.2
Caudal Fin	4.4	3.8	25.5	10.2	62.6	31.9
Total Fins	2.6	2.4	15.1	7.4	43.9	24.1

Figure 1. Percentage of parasitized individuals of: (A) *C. anomalum*, (B) *S. atromaculatus*, (C) *N. spilopterus*, and (D) *P. notatus*, at various collecting stations in the headwaters of the Embarras River.



Campostoma anomalum
A
Percent
100
90
80
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9
Station
Semotilus atromaculatus
B
1 2 3 4 5 6 7 8 9
Station
Notropis spilopterus
C
Percent
100
90
80
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9
Station
Pimephales notatus
D
1 2 3 4 5 6 7 8 9
Station

Figure 2. Average relative densities of parasites on three length classes of Semotilus atromaculatus collected at station 8 in (A) 1971 and (B) 1973 (the absolute average number of parasites per fish size as corrected relative to the standard medium sized fish).


1971
1973
A
B
Average Relative Density
40
30
20
10
Small
4.0-8.9 cm
Medium
9.0-11.9 cm
Large
12.0-16.0 cm
Small
4.0-8.9 cm
Medium
9.0-11.9 cm
Large
12.0-16.0 cm