Studies on the Population Biology of Two Larval Trematodes in the Amphipod, Hyalella azteca

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ABSTRACT: The age frequency and density of a population of amphipods, *Hyalella azteca,* were compared with the occurrence and densities of two trematode parasites, *Crepidostomum cooperi* and *Plagioporus* sp. The overall seasonal density of the host and both parasites was greatest at 1 m depth, next at 3 m and least at 2 m. Prior to sexual maturity, amphipods were not infected. Following sexual maturation of the amphipod, the percentage of infected individuals increased with each succeeding age class. *H. azteca* and both trematode populations were independently heterogeneous in their spatial distributions. Recruitment rates and densities of *Plagioporus* sp. were lower than for *C. cooperi.* Infection percentages by both parasites, number of concurrent infections and neotenic forms of *C. cooperi* increased with increasing water temperatures.

INTRODUCTION

The freshwater amphipod, *Hyalella azteca,* is a widely distributed benthic omnivore. Eggleton (1931) found a high degree of association between *H. azteca* and the aquatic macrophytes *Chara* sp., *Elodea* sp., *Myriophyllum* sp. and *Potamogeton* sp.; Hargrave (1969, 1970a, 1970b, 1970c) suggested this association was due to the presence of certain epiphytes and bacteria on these plants.

Amphipods may become prey for several species of centrarchid and percid fishes (Brazo, 1973; Gerking, 1962; Ewers and Boesel, 1935; Langford and Martin, 1941) and thereby assume a prominent position in the food web of most North American lakes and streams. Though the population biology of *Hyalella azteca* has been well studied (Cooper, 1965), parasites of this species have attracted relatively little attention.

Hyalella azteca in Gull Lake, Kalamazoo Co., Mich, serves as the second intermediate host for two digenetic trematodes, *Plagioporus* sp. (the specific identity of *Plagioporus* is not known but appears to be at least similar to *P. lepomis,* Dobrovolny, 1939) and *Crepidostomum cooperi* (Hopkins, 1933; Ameel, 1937). The definitive host of these two parasites is generally either a centrarchid or percid fish.

While the life cycles and several other biological features of each of these two trematode species have been well-documented, there is little known of their population biology and even less known about these characteristics in relation to the population biology of the intermediate host, *Hyalella azteca.* A primary objective of the present study was to ascertain if densities of amphipod populations are related to densities of parasites and also to determine if other factors such as host age and water temperature are related to density, concurrent infection and recruitment of parasites.

STUDY AREA

Gull Lake is a spring-fed, mesotrophic lake, tending towards eutrophication (Moss, 1972a, 1972b). The lake is 9.7 km × 1.6 km, with 822 ha of surface area, reaching a depth of 31 m (Moss, 1972a). During 1974, the average thermocline depth was 9.1 m, the average Secchi disc depth was 4.2 m and

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the rate of hypolimnetic oxygen loss was 74.6 mg O_2/m^3/day. The bottom is predominantly marl, even though much of the lake is over 15 m in depth (Moss, 1972a). Dominant aquatic macrophytes include *Chara* spp., *Najas flexilis, Myriophyllum heterophyllum, Potamogeton* spp., *Utricularia* sp., *Eleodea canadensis* and *Vallisneria americana* (Moss, 1972a). The parasite fauna for Gull Lake centrarchids was described by Esch (1971).

Three sites along the NE shore of the lake were sampled. Site one (1 m in depth) possessed a sandy substrate and was 99% covered with *Chara* sp.; *Vallisneria americana* covered 1% or less of the surface. The second site, at 2 m depth, consisted of marl substrate; the only vegetation present was *V. americana* and it covered about 1% of the surface area. Site three was 3 m in depth, with a sandy substrate. *Chara* sp. and *Potamogeton* sp. covered about 10% of the surface with organic debris over another 20% of the surface area.

METHODS

A rope grid 12 m × 2 m was staked out parallel to the shore at each site; the grid was divided into 12 1 × 2 m plots. Each plot of all three sites was sampled at regular intervals for 8 consecutive weeks (additional sampling was conducted over a 4-month period, beginning in May and continuing through August). A 6-inch Eckman dredge was employed to remove all the substrate within an open box (½ m × ½ m × ¼ m) to a depth of 3 cm. Sampling was not repeated within the surface area covered by the box. Dredgings were washed through a #60 Tyler sieve and the amphipods recovered using the flotation technique of Anderson (1959). The recovered *Hyallela azteca* were washed in water, dehydrated with alcohol and cleared with xylene. Several *H. azteca* at a time were then pressed onto a slide under a cover slip and examined using a light microscope (430×). All amphipods were aged by counting the number of antennal segments, as described by Cooper (1965). *Crepidostomum cooperi* metacercaria were distinguished from those of *Plagioporus* sp. by size and the presence of occeli, pigment and eggs.

RESULTS AND DISCUSSION

Over a period of 8 weeks, beginning in late June and continuing through early August, densities of *Hyalella azteca* were determined at all sites (Fig. 1). After the 2nd week, amphipod densities increased sharply at 1 m, while there was little change at site two throughout the sampling period. The 2-m samples had lower amphipod densities presumably because the site lacked aquatic macrophytes with which *H. azteca* is usually associated. The aquatic macrophyte diversity at 3 m was similar to that at 1 m; but the density of these plants was much reduced, probably because there was reduced light penetration. The density of *H. azteca* was also low and changed little throughout the sampling period. The decrease in density of *H. azteca* with increasing depth has been previously reported (Efford, 1971; Hargrave, 1970b).

The percentage of *Hyalella azteca* infected with *Crepidostomum cooperi* in March and April was identical to that seen in May (Fig. 2). Recruitment apparently began in June at all three sites and continued at site one through August when it peaked. There was decline in infection at sites two and three after a June peak. The 1974 recruitment of *Plagioporus* sp. by *H. azteca* began in May, since prior to that time no infections were found (Fig. 3). The decrease in infection percentage in August probably indicates that the recruitment rate of new *Plagioporus* sp. was exceeded by the recruitment rate of new amphipods. The infection percentage of *C. cooperi* increased sharply in each size class beyond 17 antennal segments (Fig. 4). *Hyalella azteca* with more than 17

antennal segments are sexually mature (Cooper, 1965). The same pattern of infection has been observed for the burrowing mayfly *(Hexagenia limbata) i.e.,* the nymphs do not become infected with *C. cooperi* until there is apparent

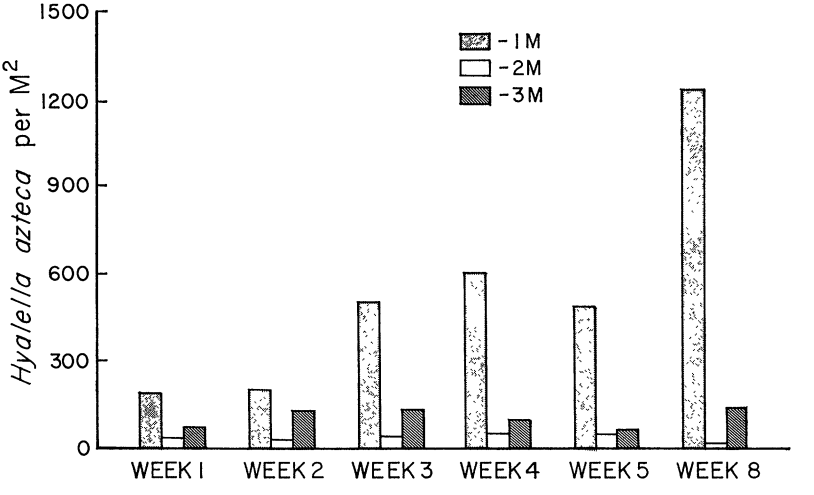

Fig. 1.—Density of *H. azteca* at 1, 2 and 3-m depths during the 1st, 2nd, 3rd, 4th, 5th and 8th weeks of sampling

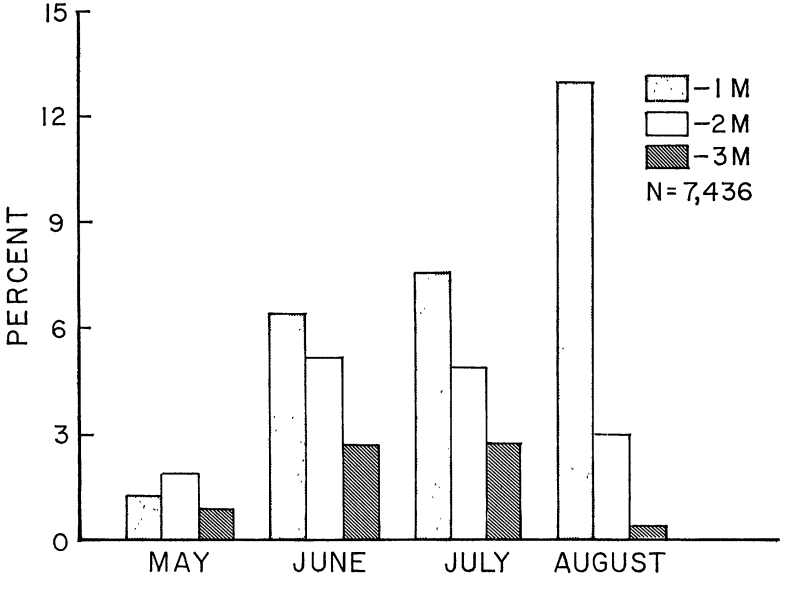

Fig. 2.—Percent of *H. azteca* infected with *C. cooperi* at 1, 2 and 3-m depths during May, June, July and August

sexual dimorphism (Hunt, 1953). It thus appears that as the intermediate hosts increase in size, there is a concomitant increase in infection by both species of parasite. This would be an excellent strategy for these parasites, since there is size selection for prey by the fish definitive host (Werner and Hall, 1974).

The parasite loads for both species increased significantly during the season (Fig. 5). Prior to the middle of July, no concurrent infections or neotenic *Crepidostomum cooperi* metacercaria were observed. During the next 3-week period, 60% of the *C. cooperi* metacercaria had become neotenic, while the number of concurrent infections quadrupled.

During May and June, *Hyalella azteca* exhibited considerable spatial heterogeneity (Table 1). The two trematodes showed even greater spatial heterogeneity than the host population during the same months. However, as the summer progressed, spatial heterogeneity of both host and parasites became less (Table 1). Anova regression analysis indicated that there was no correlation between parasite and host densities ($R^2 = 0.19$ and 0.02 where $P > 0.24$ and 0.99), nor was there a correlation between densities of *Plagioporus* sp. and *Crepidostomum cooperi* ($R^2 = 0.08$ with $P > 0.77$).

Previous unpublished studies indicated that the first intermediate host for *Plagioporus* sp., *Goniobasis livescens,* is found in very low densities in the area studied, *i.e.,* between one and two per m^2. The first intermediate hosts for *Crepidostomum cooperi, Sphaerium* spp. and *Pisidium* spp., were quite abundant, however, with several hundred found per m^2. The infection percentage

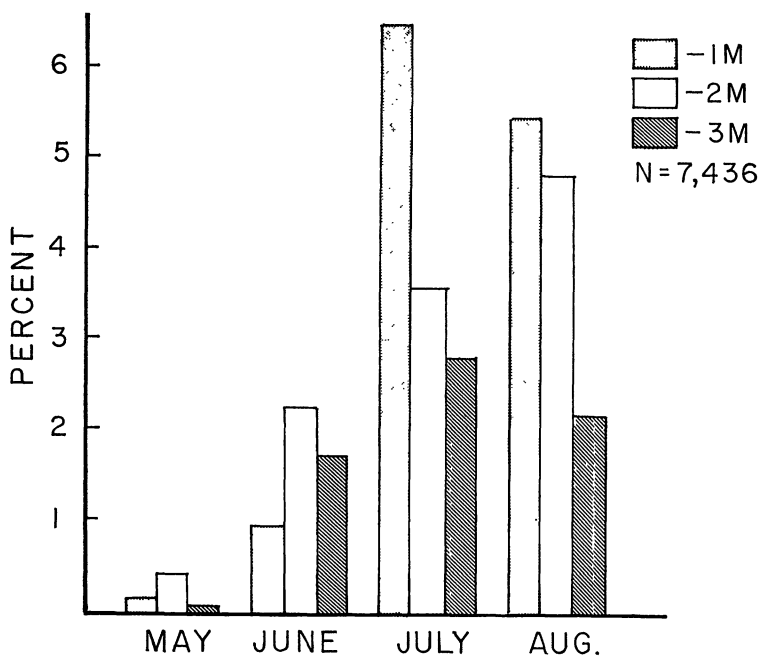

Fig. 3.—Percent of *H. azteca* infected with *Plagioporus* sp. at 1, 2 and 3-m depths during May, June, July and August

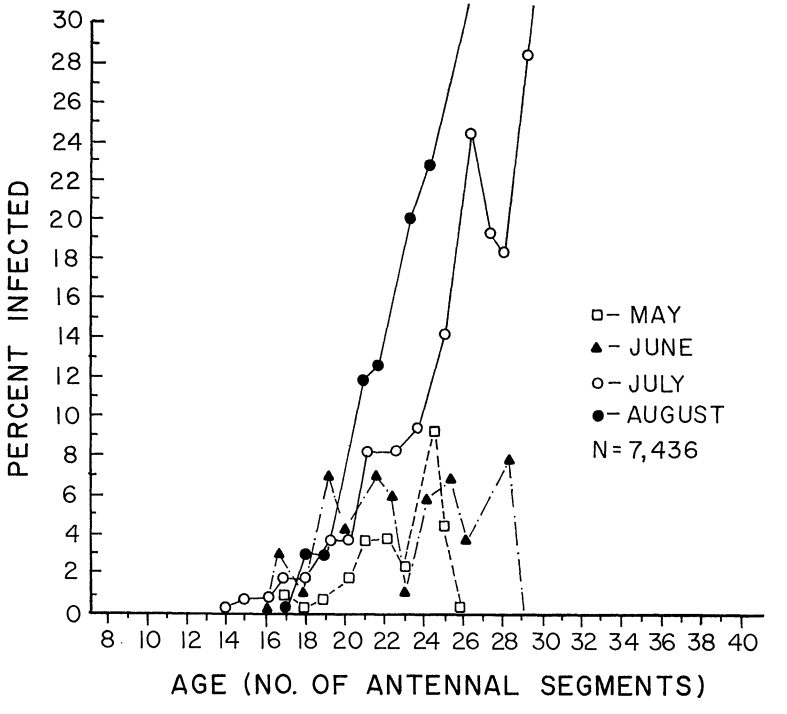

Fig. 4.—Percent of *H. azteca* infected within each age class during May, June, July and August

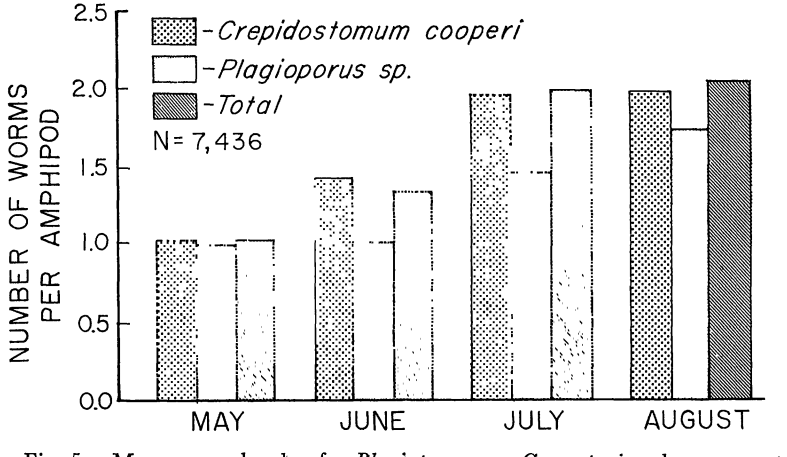

Fig. 5.—Mean worm burden for *Plagioporus* sp., *C. cooperi* and concurrent infections of *H. azteca* during May, June, July and August

of the fingernail clam (*Sphaerium* sp. and *Pisidium* sp.) was quite low, less than 1%. The net effect of such densities and infection percentages would be the same for both parasites, *i.e.*, very low numbers of infected molluscan hosts per unit area sampled. Considering local microhabitat variability (such as current, *p*H, nutrients), variability in mollusc population parameters, as well as variability in definitive host defecation patterns, it is understandable why spatial heterogeneity of *C. cooperi* and *Plagioporus* sp. metacercaria among amphipods should be clumped or contagious. The same kind of contagion was recently reported by Anderson (1974) for *Caryophyllaeus laticeps* larval stages among tubificid worms and was employed in explaining the frequency distribution of *C. laticeps* adults among the definitive host population. This type of contagious distribution is probably common among fish host-parasite systems and undoubtedly deserves attention in future studies.

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TABLE 1.—Variability in *H. azteca* densities and infection percentages by *C. cooperi* and *Plagioporus* sp. within site one during the 1st and 8th weeks of sampling

	Subplots within Site 1 (Week 1)					
Species	A	B	C	D	E	F
H. azteca/m²	96	512	520	16	52	64
Plagioporus sp.*	0	0	2	0	0	0
*C. cooperi**	5	5	12	0	0	15
	Subplots within Site 1 (Week 8)					
Species	A	B	C	D	E	F
H. azteca/m²	1325	1598	730	1291	1186	1325
Plagioporus sp.*	3	3	4	6	4	2
*C. cooperi**	5	9	9	9	12	11

*Infection percentage

LITERATURE CITED

AMEEL, D. J. 1937. The life history of *Crepidostomum cornutum*. *J. Parasitol.*, **23**:218-220.

ANDERSON, R. M. 1974. Population dynamics of the Cestode *Caryophyllaeus laticeps* (Pallas, 1781) in the Bream (*Abramis brama* L.). *J. Anim. Ecol.*, **43**:305-321.

ANDERSON, R. O. 1959. A modified flotation technique for sorting bottom fauna samples. *Limnol. Oceanogr.*, **4**:223-225.

BRAZO, D. C. 1973. Fecundity, food habits, and certain allometric features of yellow perch, *Perca flavescens* (Mitchell), before operation of a pumped storage plant of Lake Michigan. Unpublished M.S. Thesis, Michigan State University, East Lansing. 50 p.

COOPER, W. E. 1965. Dynamics and production of a natural population of a fresh water amphipod *Hyalella azteca*. *Ecol. Monogr.*, **35**:377-394.

DOBROVOLNY, C. G. 1939. The life history of *Plagioporus lepomis*, a new trematode from fishes. *J. Parasitol.*, **25**:461-470.

EFFORD, I. E. 1971. An interim review of the Marion Lake project. P. 89-109. UNESCO IBP symposium on productivity problems in freshwaters, Poland, May, 1970.
EGGLETON, F. E. 1931. A limnological study of the profundal bottom fauna of certain freshwater lakes. *Ecol. Monogr.*, **11**:231-332.
ESCH, G. W. 1971. Impact of ecological sucession on the parasite fauna in centrarchids from oligotrophic and eutrophic ecosystems. *Am. Midl. Nat.*, **86**:160-168.
EWERS, L. A. AND M. W. BOESEL. 1935. The food of some Buckeye Lake fishes. *Trans. Am. Fish. Soc.*, **65**:57-69.
GERKING, S. D. 1962. Production and food utilization of Bluegill sunfish. *Ecol. Monogr.*, **32**:50-60.
HARGRAVE, B. T. 1969. Epibenthic algae production and community respiration in the sediments of Marion Lake. *J. Fish. Res. Board Can.*, **36**:2003-2026.
———. 1970a. The utilization of benthic microflora by *Hyalella azteca* (Amphipoda). *J. Anim. Ecol.*, **39**:427-439.
———. 1970b. The distribution, growth and seasonal abundance of *Hyalella azteca* (Amphipoda) in relation to sediment microflora. *J. Fish. Res. Board Can.*, **27**:685-699.
———. 1970c. The effect of a deposit-feeding amphipod on the metabolism of benthic microflora. *Limnol. Oceanogr.*, **15**:21-30.
HOPKINS, S. H. 1933. The morphology, life histories and relationships of the papillose Allocreadidae. *Zool. Anz.*, **103**:65-74.
HUNT, B. P. 1953. The life history and economic importance of a burrowing mayfly, *Hexagenia limbata* in southern Michigan lakes. State of Michigan. Dep. Conserv. 151 p.
LANGFORD, R. R. AND W. R. MARTIN. 1941. Seasonal variations in stomach contents and rate of growth in a population of yellow perch. *Trans. Am. Fish. Soc.*, **70**:436-440.
MOSS, B. 1972a. Studies on Gull Lake, Michigan I. Seasonal and depth distribution of Phytoplankton. *Freshwater Biol.*, **2**:289-307.
———. 1972b. Studies of Gull Lake, Michigan II. Eutrophication evidence and prognosis. *Ibid.*, **2**:309-320.
WERNER, E. E. AND D. J. HALL. 1974. Optimal foraging and the size selection of prey by the Bluegill sunfish *(Lepomis macrochirus)*. *Ecology*, **55**:1042-1052.

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Improbability of Dispersal of Adult Asiatic Clams, Corbicula manilensis, via the Intestinal Tract of Migratory Waterfowl

ABSTRACT: To determine the potentiality for dispersal of Asiatic clams *(Corbicula manilensis)* via the intestinal tract of waterfowl, live clam specimens were force-fed to adult male lesser scaup ducks *(Aythya affinis)*. Examination of duck excreta revealed no egestion of viable individuals. In a second experiment, a simulated waterfowl gizzard was utilized to determine the chemical and physical effects of avian digestion on live Asiatic clams. Mortality of test clams was 100% after 1 min exposure in a solution of synthetic gastric juice.