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ABSTRACT — The study on which this paper is based was a preliminary effort to determine three factors: (1) the nature of the snail and trematode fauna of a small lake, (2) the incidence of trematode infection in the snail population, and (3) possible changes in the incidence of trematode infection in snails at various periods in a single summer.

West Twin Lake is located between Lake Mary and Lake Deming on the west side of Lakes Drive, Itasca State Park, Hubbard County, Minnesota. The lake is roughly circular (Fig. 1) with a diameter of about 350 feet. The north, west, and south shores are ringed with tamarack and floating sedge mat supporting some cattail and alder. The east shore is open, composed of road-fill, with a short, steep grassy bank between lakeshore and a road. West Twin Lake is connected to East Twin Lake by a culvert passing under Lakes Drive, and it is connected to Mary Lake to the north by a shallow, marshy creek. Because of the nature of the floating sedge mat, there are many shallow "lagoon" areas along the shore. These are muck-bottomed, surrounded with vegetation, and appear to provide favorable habitat for snails.

The water is very dark brown, allowing for little light penetration. The maximum depth is 5.5 meters. The pH ranges from 7.6 at the surface to 6.1 at 4 meters (unpublished data). Oxygen, as determined by the Winkler method, became depleted below four meters by the middle of July. The lake bottom is highly irregular (Fig. 1). At depths of less than four meters, much of the bottom is made up of fibrous plant remains having a dark brown color. At depths greater than four meters the bottom is a mixture of black and light-gray ooze with very little plant material and no stones.

Sampling procedure in lake and ashore

Five transects were set up across the lake forming a grid of sampling stations (Fig. 1) which were spaced approximately 18 meters apart. A total of 26 lake stations and 16 shore stations were used. The lake stations were marked by wooden floats.

Single dredge samples (Ekman dredge, 6 inches square) from each station were sifted through a 2.5mm mesh screen, and the snails were placed in plastic bags tagged with the station number and brought back to the lab. The lake stations were sampled three times: the first sampling was done on June 24 and July 1, the second sampling on July 26, 27, and 28, and the third on August 16 and 18.

The shore stations were indicated by a 6 inch strip of orange plastic tape attached to upright vegetation at the sampling point. Each station was sampled by two persons working simultaneously for a period of 10 minutes, collecting all snails encountered within a six-foot radius of the marked sampling point. The shore stations were sampled 4 times: July 2, July 11, July 30 and 31, and August 9 and 11.

Sorting and checking

Samples from each collecting point were sorted according to species, and the individual snails were placed in distilled water in Syracuse dishes and set under lights. They were checked 24 and 48 hours later for the emergence of cercariae. At the end of 48 hours, the smaller snails were crushed between two glass slides to determine whether they were carrying immature infections. In tabulating the results, a snail was considered infected if it was shedding cercariae or if it was crushed and contained developing cercariae.

Incidence of infection

Among 1,389 snails which were examined, 176 (12.7%) were infected with trematodes. Table 1 shows the incidence of infection by species of snail. The entry under *Helisoma* sp. refers to immature snails. Because the very young specimens of *Planorbula* and *Gyraulus* could not always be separated with certainty, these genera were entered, for the purpose of statistical analysis, as the *Planorbula-Gyraulus* group. The incidence of infection in the *Planorbula-Gyraulus* group was 15.6%. A chi-square test ($P < .005$) indicated that the incidence of infection was not evenly distributed among the species of snails. Inspection of the data shows that *Helisoma campanulata*, the *Planorbula-Gyraulus* group, and *Amnicola* sp. are considerably more heavily infected than most of the other species, and that *Bulimnea megasoma* has an extremely low level of infection.

Table 2 shows the incidence of infection by type of cercaria. Most of the unidentified cercariae were from immature infections observed when the snail was crushed. Other unidentified cercariae were mature but had begun disintegrating when observed. No multiple infections were seen. A chi-square test ($P < .005$) indicated that the contribution of each type of cercaria (other than the unidentified ones) to the overall incidence of infection

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was not equal. This is true if the calculation is done on the five morphological types after combining the infections of furcocercous cercariae and it is also true if the calculation is done before combining furcocercous types.

An analysis of variance on the proportion of infected snails from each station (Tables 3 and 4) showed that overall incidence of infection did not vary with the sampling date. For the data from the lake stations (Table 3) it also indicates that the incidence of infection did not differ among the sampling points. For the shore stations (Table 4), however, the analysis of variance indicates that the proportion of infected snails at each sampling point was not equal. This would indicate a clumping of the trematode infections in particular areas along the shore. However, since the experimental error (component of variability associated with sampling stations) is so small compared with the sampling error (the ratio of experimental error to sampling error is 0.0325), the apparent clumping is relatively insignificant. The number of snails from shore stations, 1,333, is so large that very small differences in infection levels between sampling stations become statistically significant. The 95% confidence interval for the difference between the mean infection levels of shore *vs.* lake stations ($-0.0872 \leqslant \overline{s-l} \leqslant 0.0908$) indicates zero difference.

Comparison of various findings

The levels of infestation with larval trematodes reported in the literature vary widely, so comparisons are difficult. Cort, Hussey, and Ameel (1960) working with a single species of snail, *Stagnicola emarginata angulata*, reported 12.4% positives for snails collected during July, 1957. The figure of 12.4% is very close to the 12.7% reported here for overall incidence of infection for all species of snails. Bourns (1963) reported 48.3% infection for *Lymnea stagnalis*, whereas the present study showed a 4.4% incidence for this species. Cort, Mc-

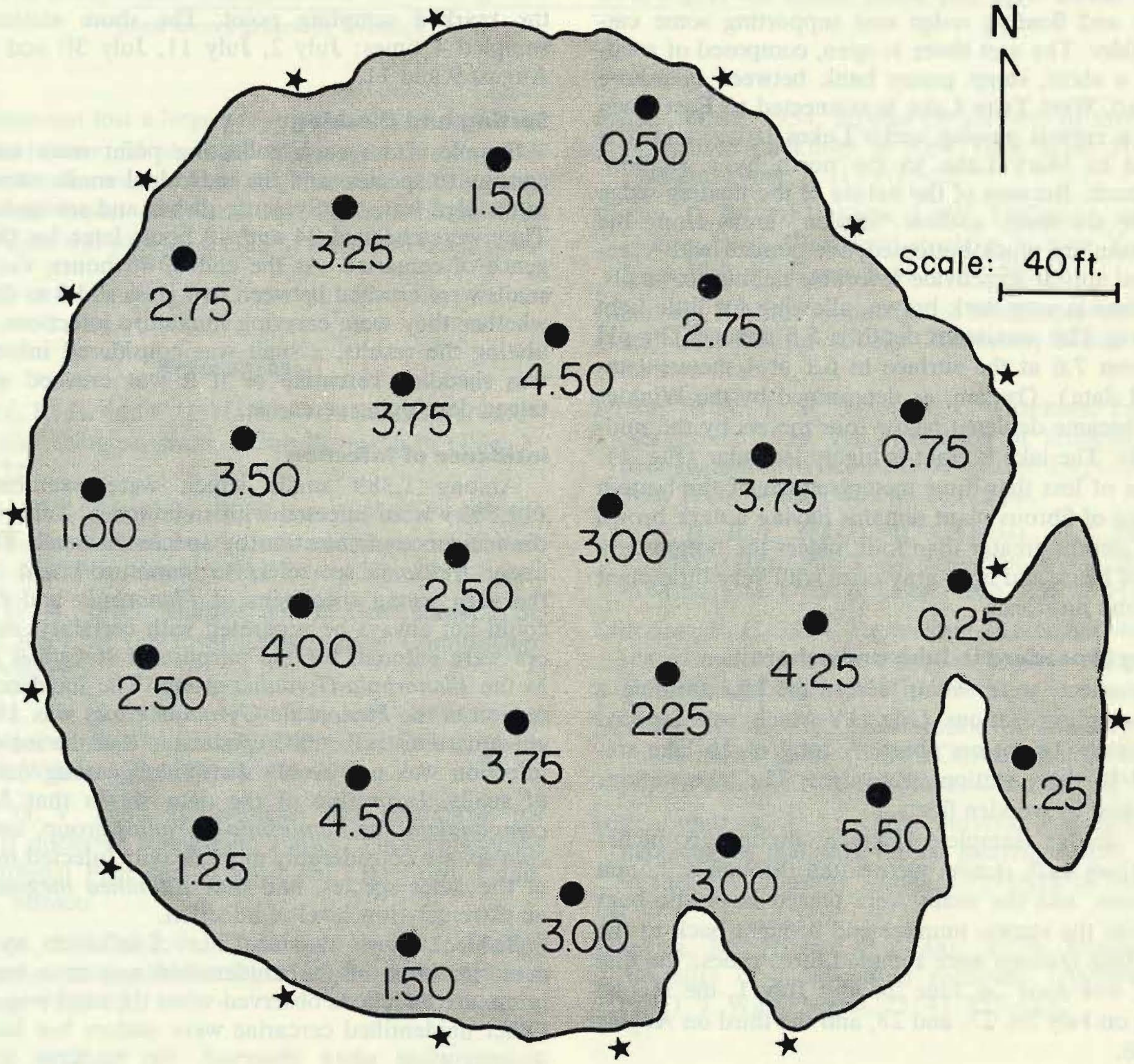

FIGURE 1. West Twin Lake, showing the location of the sampling stations.
● Lake station, depth in meters
★ Shore station

TABLE 1. Incidence of Infection by Species of Snail

	# Infected / # Collected	% Infected
AMNICOLA SP.	28/128	21.9
BULIMNEA MEGASOMA SAY	1/174	0.6
FERRISSIA SP.	0/2	0.0
GYRAULUS DEFLECTUS OBLIQUUS (DE KAY)	49/334	14.7
HELISOMA ANTROSA (CONRAD)	2/12	16.7
HELISOMA CAMPANULATA (SAY)	46/135	34.1
HELISOMA TRIVOLVIS (SAY)	17/242	7.0
HELISOMA SP.	3/68	4.4
LYMNEA STAGNALIS APPRESSA (SAY)	4/90	4.4
PHYSA GYRINA (SAY)	13/122	10.7
PLANORBULA ARMIGERA (SAY)	3/14	21.4
PROMENETUS EXACUOUS (SAY)	0/3	0.0
STAGNICOLA EXILIS LEA	0/8	0.0
IMMATURE PLANORBIDS	9/43	20.9
VALVATA TRICARINATA (SAY)	1/14	7.1
TOTAL	176/1389	12.7

TABLE 2. Incidence of Infection by Type of Cercaria.

	# Infections	Total # Infections: 176 % Infections	Total # Snails: 1389 % Snails Infected
AMPHISTOME	2	1.14	0.14
FURCOCERCOUS			
CLINOSTOMATIDAE	1	0.57	0.07
SCHISTOSOMATIDAE	1	0.57	0.07
SPIRORCHIDAE	3	1.70	0.22
STRIGEIDAE	14	7.95	1.01
UNIDENTIFIED	4	2.27	0.29
GYMNOCEPHALUS	13	7.39	0.94
MONOSTOME	14	7.95	1.01
XIPHIDIOCERCARIA	91	51.70	6.55
UNIDENTIFIED	33	17.75	2.37
TOTAL	176	100.00	12.67

Mullen, and Brackett (1939) found infection levels ranging from 57.6% to 98.8% in *Helisoma campanulata* from Michigan. Although *Helisoma campanulata* had the highest infection level in this study, it was only 34.1%.

Neither gulls, ducks, nor shorebirds were ever observed on West Twin Lake during this study, although they were present on other lakes in the area. The scarcity of these important definitive hosts may contribute to the low levels of infection in the snails. Possible hosts which were common at the lake include frogs, turtles, a variety of passerine birds, and porcupines. It is interesting to note that while schistosome dermatitis has been known in the area for a long time (Cort, 1950; Elliott, 1942) only one schistosome infection was found among the 1,389 snails.

Cort, McMullen, and Brackett (1937) and Cort, Hussey, and Ameel (1960) observed large changes in the incidence of different species of cercariae over a period of as little as 7 to 9 weeks. In particular, they found that collections made toward the end of August showed an incidence of positives about twice as large as in those from the same areas made in late June or early July. This was not observed in the present study either for the overall incidence of positives, or for the incidence of the individual types of cercariae. Cort, McMullen and Brackett (1937) did not analyze their data to test the significance of different levels of infestation in different areas of Douglas Lake. The fact that differences in infection levels between stations in the present study are so slight is probably due to the small size of the lake and the relative uniformity of the shoreline.

There is much information in the literature on the occurrence of multiple infections and the possibility that one infection might confer immunity against another (Cort, McMullen, and Brackett, 1937, 1939; Cort, Hussey, and Ameel, 1960; Bourns, 1963). The fact that no multiple infections were observed in this study can probably be explained simply by the low levels of infection with the individual types of cercariae, rather than by the operation of any form of immunity or antagonism. Cort, McMullen, and Brackett (1937) found that a considerable number of multiple infections were observed in collections of about 500 snails only when the incidence of positives was considerably above 50% and at least two species of cercariae had a rather high incidence. These criteria obviously were not met in the present work.

TABLE 3. Variance on Proportion of Infected Snails — Lake Stations

Source	SS	DF	MS	F OBS	F .95
DATES	0.1361	2	0.0681	1.1885	3.89
STATIONS WITHIN DATES	0.6875	12	0.0573	0.4432	2.00
SNAILS WITHIN STATIONS	5.3014	41	0.1293		
TOTAL	6.1250	55			

TABLE 4. Variance on Proportion of Infected Snails — Shore Stations

Source	SS	DF	MS	F OBS	F .95
DATES	0.2833	3	0.0944	0.5253	2.76
STATIONS WITHIN DATES	10.5997	59	0.1797	1.6701	1.32
SNAILS WITHIN STATIONS	136.6909	1270	0.1076		
TOTAL	147.5739	1332			

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References

BOURNS, T. K. R. 1963. Larval trematodes parasitizing *Lymnea stagnalis appressa* Say in Ontario with emphasis on multiple infections. *Canad. J. Zool.* 41:937-941.

CORT, W. W. 1950. Studies on schistosome dermatitis. XI. Status of knowledge after more than twenty years. Amer. Jour. Hyg. 52(3):251-307.

CORT, W. W., AMEEL, D. J., and OLIVIER, LOUIS. 1944. An experimental study of the development of *Schistosomatium douthitti* (Cort, 1914) in its intermediate host. *Jour. Parasitol.* 30:1-17.

CORT, W. W., HUSSEY, KATHLEEN L., and AMEEL, DONALD J. 1960. Seasonal fluctuations in larval trematode infections in *Stagnicola emarginata angulata* from Phragmites Flats on Douglas Lake. *Proceedings of the Helminthological Society of Washington.* 27:11-13.

CORT, W. W., MCMULLEN, D. B., and BRACKETT, STERLING. 1937. Ecological studies on the cercariae in *Stagnicola emarginata angulata* (Sowerby) in the Douglas Lake region Michigan. *Jour. Parasitol.* 23: 504-532.

1939. A study of larval trematode infections in *Helisoma campanulato smithii* (Baker) in the Douglas Lake region, Michigan. *Jour. Parasitol.* 25:19-22.

CORT, W. W., and OLIVIER, LOUIS. 1943. The development of the sporocysts of a schistosome, *Cercaria stagnicolae* Talbot. *Jour. Parasitol.* 29:164-176.

ELLIOTT, A. M. 1942. The present status of "swimmer's itch" in northern Minnesota. *Proc. Minnesota Acad. Sci.* 10:15-16.

HOFFMAN, GLENN L. 1958. Experimental studies on the cercaria and metacercaria of a strigeoid trematode, *Posthodiplostomum minimum. Exper. Parasit.* 7:23-50.

Movement of Franklin's Ground Squirrel Into Northeastern Minnesota

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ABSTRACT — Specimens of Franklin's ground squirrel have been obtained in several localities in St. Louis County, Minnesota. The movement of this prairie-dwelling rodent into the montane coniferous forest region of northeastern Minnesota may be related to recent man-made changes in the habitat.

Franklin's ground squirrels (*Spermophilus franklinii*) inhabit the tall grass and mixed grass prairies of North America from Kansas and Missouri on the south, and Indiana on the east, north through Minnesota and the Dakotas to east-central Alberta, Canada (Howell, 1938; Hall and Kelson, 1959). In Minnesota (Gunderson and Beer, 1953) Franklin's ground squirrels are found primarily south and west of the montane coniferous forest. The southern and western half of Minnesota was grown to tall grass prairie prior to cultivation (Shelford, 1963: 330) and probably presented ideal conditions for Franklin's ground squirrels.

The northeastern portion of Minnesota is classified by Shelford (1963: 121) as originally having a southern arm of montane coniferous forest vegetation (pine-hemlock faciation). A zone of hardwood forest extending from the northwest to southeast corners of the state separated the coniferous and prairie elements (Upham, 1884). A similar distribution of Franklin's ground squirrel exists in Wisconsin (Jackson, 1961), where it appears to be limited to the southern and western part of the state below the "tension zone" of Curtis (1959: 20), which divides the state into prairie and boreal regions.

De Vos (1964) recently reviewed range changes of mammals in the Great Lakes region. He reported that the prairie dwelling thirteen-lined ground squirrel (*S. tridecemlineatus*) had expanded its range fairly rapidly

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