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Preliminary Survey of pulmonate Snails of Central Minnesota

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Abstract

Aquatic snails were collected at 148 sites from various wetland habitats in central Minnesota between May and September, 1988. These data were used to determine the distribution, environmental preference and parasite-intermediate host relationships of lymnaeid snails found within the study area.

Lymnaeids generally preferred still water of near neutral pH with a small particle size substrate. However, individual lymnaeid species appeared to have more specific requirements. Lymnaea megasoma and L. exilis seemed to prefer slightly acid water. Lymnaea catascopium appeared to prefer deeper open water of lakes and slow moving rivers. Lymnaea caperata and L. (Fossaria) spp. preferred temporary wetlands and mud flats. Due to the drought of 1988, habitat destruction may have strongly influenced distribution of these amphibious species. Species which occur in shallow temporary wetlands may therefore have a wider distribution than this study indicates.

The distribution of all lymnaeid species collected was compared to the approximate distribution of Fascioloides magna. This is a common trematode parasite of white-tailed deer in the Northeastern portion of Minnesota. Its life cycle includes lymnaeid snails as intermediate hosts. No strong correlation was found between the range of any snail species and that of the fluke. We were able to infect L. palustris, L. caperata, and L. catascopium (a new host record) in the laboratory. This suggests that more complex factors than intermediate host distribution govern the distribution of F. magna in the state.

INTRODUCTION

Snails are an important part of the wetland ecosystem. They serve as decomposers of vegetation and food for wildlife. They are also intermediate hosts for some nematode (roundworm) and almost all trematode (fluke) parasites that infect wildlife, domestic animals and man.

This study had two objectives. First, to determine the range of various snail species within a given area of Minnesota. Previous surveys of snails in Minnesota are outdated in view of present land management practices (Baker, F.C., 1911: Daniels, L.E., 1909; Sargent, H.E., 1895-6), limited in scope to a few snail species (Baker, F.C., 1936) or limited to few or unspecified sampling sites (Baker, F.C., 1929; Baker, F.C.,1935; Dawley, C., 1947). We statistically evaluated the incidence of Lymnaea spp. collection with environmental parameters such as water pH, substrate, and wetland type.

Second, to determine whether the distribution of a specific intermediate snail host could limit a parasite's distribution. The relationship between the trematode Fascioloides magna, (the Large American Deer Liver Fluke), and snails in the genus Lymnaea which serve as its intermediate hosts in Minnesota and throughout the country was of special interest.

Several species of Lymnaeids can serve as intermediate hosts for Fascioloides magna. The snails become infected when penetrated by the ciliated, free-living miracidium stage of the fluke which hatches from ova passed in the feces of infected deer. The miracidia develop into the sporocyst stage, followed by at least one or two redial stages. Cercaria are formed inside the redia and are shed from the snail. The cercaria swim to vegetation, where they encyst forming metacercaria. These encysted metacercariae are then infective to the vertebrate host. There is much asexual reproduction in the snail host.

In this study, infection with three to six miracidia commonly gave rise to over 150 cercariae, and there was the potential for much greater multiplication. The redial stage actively fed on snail tissue and caused much tissue destruction. In heavy infections the entire digestive gland was destroyed, and the snail was killed. Some species of Lymnaeids seemed better able to withstand the infection then others.

In Minnesota F. magna is endemic to the Northeastern half of Minnesota but is missing or very rare south and west of a line approximated by Highway 10. Since there are enough deer to maintain an infection in Southwestern Minnesota we postulated that the range of the appropriate snail intermediate host(s) might explain the fluke range.

MATERIALS and METHODS

Sixteen general collection areas, eight on each side of the approximate endemic Fascioloides magna range border line, were selected (Table 2, Map 1) . These were chosen to include major water drainages and obvious geological and limnological variations such as prairie biome, large lakes, and the driftless area water systems. At each general area we collected from 4 to 14,(mean = 9), specific sites based on wetland diversity in the area for a total of 148 individual sites. Data records of water pH, substrate, primary vegetation, and *surrounding land* use were kept for each specific site. Samples of each snail species found at individual sites were taken. Live snails and dry shells were collected individually by hand and/or by sieving of the substrate or vegetation. Collection was restricted to about 3 feet or less of water in large lakes and included shoreline mud at all sites. Due to the drought many of the shallow water sites were dry so only shells were collected. Shells and live snails were brought to the laboratory. Live snails were fixed in 70% ethanol/10% glycerine. Representative samples of dry shells and fixed snails were labeled as to site. Snail identification was based on shell morphology and radular formulas when necessary using available keys (Clarke, A.H., 1973; Burch, J.B., and T.J. Tottenham, 1980: Burch, J.B., 1982; Eddy, S. and Hodsen, 1982). We restricted our identification of Lymnaea (Fossaria) Slab. to two species with tricuspid lateral radular teeth [L.(F). parva , and L.(F). modicella] and two with bicuspid teeth [L.(F). bulimoides and L.(F). dalli] as practiced by Clarke 1973. There is widespread disagreement concerning the taxonomy of the Fossaria spp. The snails we identified as L.(F). modicella are considered by some as a synonym for a group of closely related species (the Fossaria obrussa group). We did not feel the taxonomy of the Fossaria spp. was distinct enough at this time to warrant any further speciation.

Wetland classification was based on the 1956 U.S. Fish and Wildlife Service Circular #39 definitions, and the US Army Corps of Engineers publication: Wetland Plants and. Plant Communities of Minnesota and Wisconsin. Distribution maps were made of all Lymnaeid species collected within the collection area. A total list of species collected was made.

Some of the live Lymnaea spp. collected were used to develop laboratory populations. Trematode-free snails hatched in aquaria were infected with F. magna to determine their ability to serve as intermediate hosts. Eggs recovered from white-tailed deer were hatched in the laboratory. An average of 6 miracidia per snail were used to infect snails in tissue culture plates. Snails were either allowed to shed cercariae naturally or were crushed two to three months after infection to collect the cercariae.

Statistical Analysis

Data were subjected to Chi square analysis in an attempt to determine correlations between snail species distributions and environmental factors of water pH, substrate, and wetland type. Significance was set at a P value of .05. Data were grouped to facilitate analysis. Substrate was defined as organic, mud, sand, and gravel-rock. Wetland types were grouped into categories of open water, marsh, slow flowing water, and fast flowing water. Water pH was listed in groups of .5 pH units. Actual site descriptions were recorded in Table 2.

RESULTS

Aquatic snails from 17 genera (Table 1) were collected at 148 individual sites from 16 general collection areas in central Minnesota (Table 2, Map 1). Individual site maps were included (Maps 2 -37). These sites represented a variety of wetland habitats. Ten species of snails in the genus Lymnaea were collected (see photo) from 120 of the 148 sites (81%). All of the Lymnaea MR. except L. megasoma were found both north and south of Highway 10.

Lymnaea stagnalis was collected from 27/148, 18% of the sites (Table 1, Map 38). This species was collected from water ranging in pH from 5.2 to 6.5. There were no significant differences in the number of ice. L. stagnalis positive sites with respect to pH or substrate type (Tables 3 and 5). There were significantly more L. stagnalis positive sites found in the open water habitats (Table 4) .

Lymnaea palustris was collected from 45/148, 30% of the sites (Table 1, Map 39). It was collected from water ranging in pH from 5.2 to 7. There were significantly more L. palustris positive sites from pH 6.5-6.9 (Table 3). There was no significant difference in the number of positive sites with any substrate (Table 5), or habitat type (Table 4).

Lymnaea exilis was collected from 23/148, 16% of the sites (Table 1, Map 40). This species was collected over a pH range of 5.0 to 6.5 with significantly more positive sites within pH range 5.05.4 (Table 3). There were significantly more L. exiles positive sites found on organic substrate (Table 5), and in marsh habitats (Table 4).

Lymnaea caperata was collected from 18/148, 12% of the sites (Table 1, Map 41). It was collected from water ranging in pH from 6.0 to 6.5. There were no significant differences seen between the number of L. caperata positive sites within the pH ranges (Table 3), or on any substrate type (Table 5). There were significantly more positive sites found in marsh habitats (Table 4), virtually all of which were shallow marshes, drainage ditches or temporary water.

Lymnaea catascopium was collected from 17/148, 11% of the sites (Table 1, Map 42). This species was found over a pH range of 5.1 to 7.0 with no significant difference between the number of L. catascopium positive sites (Table 3). There were *significantly* fewer positive sites found on mud substrate, (Table 5), and significantly more positive sites found in open water (Table 4).

Lymnaea megasoma was collected from 10/148, 7% of the sites (Table 1, Map 43). It was collected from water ranging in pH from 5.0 to 6.0. There were significantly more L. megasoma positive sites found within the pH range of 5.0-5.4 (Table 3). There were significantly more positive sites found with organic substrate (Table 5). There was no significant difference between the number of positive sites found in any wetland type (Table 4).

Lymnaea (Fossaria) parva was collected from 14/148, 9% of the sites (Table 1, Map 44). This species was collected from water ranging in pH from 5.2 - 6.5, with no significant differences between the number of positive sites found within any pH range (Table 3). There was no significant difference in the number of F. parva positive sites found with any wetland type (Table 4) or with any substrate type (Table 5).

Lymnaea (Fossaria) modicella was collected from 28/148, 20% of the sites (Table 1, Map 45). It was collected from water ranging in pH from 5.2 - 6.5, with no significant differences between the number of positive sites found within any pH range (Table 3). There was no significant difference between the number of positive sites found in any wetland type (Table 4).There was a significantly higher number of positive sites with a gravel-rock substrate and a significantly lower number with an organic substrate, (Table 5).

Lymnaea (Fossaria) bulimoides was collected from 2/148, 1% of the sites (Table 1, Map 46). It was found in the pH ranges of 6.06.4, and 6.5-6.9 (Table 3). Both positive sites were from marsh habitats (Table 5). One positive site had an organic substrate and the other was mud (Table 4).

Lymnaea (Fossaria) dalli was collected from 1/148, 1% of the sites (Table 1, Map 46). This was a slow moving water habitat with a pH of 6.3 and a mud substrate.

Specimens of L. caperata, L. palustris, and L. catascopium were infected in the laboratory with an average of six miracidia of Fascioloides magna per snail , and all three species produced viable metacercariae.

In experimental infections of L. caperata, cercariae were shed as early as 42 days after infection and could be shed for several months. A high percentage, approximately 90%, of the snails took the initial infection and many were capable of carrying the infection through to the release of metacercariae.

Approximately 70% of the *L. catascopium* which were exposed to miracidia became infected at least through the redial stage, and some snails shed cercariae by day 41. This is a new host record for *F. magna*. The infection did not produce as many metacercariae per snail as did *L. caperata*. There was also a greater death loss among the infected *L. catascopium* than *L. caperata*.

A smaller percentage, approximately 40%, of the *L. palustris* exposed to miracidia became infected through the redia stage but those that did were able to tolerate a large number of rediae and could produce over 400 cercariae per snail from an average infection of six miracidia.

In experimental infections cercariae were either allowed to shed naturally from the infected snail or were released by crushing the snail. At the time of crushing, two to three months after infection, many of the snails contained a large number of rediae as well as cercariae. Metacercariae from *L. caperata* and *L. palustris* were infective to mice, and remained viable for over six months when kept in water at four degrees celsius. Metacercariae from *L. catascopium* have not yet been tested for infectivity.

Due to the diversity of vegetation communities within each wetland habitat type we were not able to make any correlations between individual *Lymnaea* sp. distributions and specific plants. We felt the vegetation communities were adequately reflected in the wetland types.

Discussion

Lymnaeids in general appeared to prefer still water between pH 6-7 with a small sized particulate substrate. There appeared to be certain environmental preferences with particular species however. Based on field observations and the statistics we were able to do on a sometimes limited sample from a drought year the following generalizations were made.

Lymnaea stagnalis was the second most common lymnaeid found during this study. This species was collected throughout the study area except along the eastern border. It appeared to prefer permanent shallow open water, but did occur occasionally in marsh and slow water habitats. Substrate type and pH seemed to have little effect on its distribution. L. stagnalis was found most often associated with L. palustris and L. modicella.

Lymnaea palustris was the most commonly collected lymnaeid snail species in this study. Its distribution roughly paralleled that of L. stagnalis. Lymnaea palustris was commonly found in all habitats sampled except fast water. It was found most often in water of nearly neutral pH with mud substrate. It was most commonly found in association with L. stagnalis and L. modicella.

Lymnaea exilis was found in permanent or semi-permanent waters most commonly along the Northern and Eastern borders of the collection area. This species appeared to prefer marsh habitats, organic substrates, and slightly acid waters. It was found most commonly associated with L. megasoma. It was rarely found associated with L. palustris, although the latter was also commonly found in marsh habitats, giving the impression that the two species had very different distributions.

Lymnaea caperata was found in temporary shallow water habitats, often in drainage ditches and seeps. It occurred in widely separated locations throughout the collection area. Due to the very dry sample year and the associated loss of shallow water, it was hard to determine if this scattered distribution was due primarily to an inability to find the snail or to specific habitat requirements. We failed to find *L. caperata* in St. Croix State Park in 1988, a site where we had found it in abundance in previous years.

Lymnaea catascopium was found in permanent waters in the north-central portion of the collection area. Preferring the deeper open water of lakes with sandy substrates, it appeared to be the most aquatic lymnaeid collected. Because of this habit it was rarely associated with other lymnaeid species.

Lymnaea megasoma was found fairly rarely, in a wide variety of habitats. It appeared to favor organic substrates and a slightly acid pH. It was most often associated with *L. exilis*.

Lymnaea (*Fossaria*) *parva* and *L.*(*F.*) *modicella* were found very commonly throughout the study area in almost identical microhabitats. Both of these species are more amphibious than the rest of the lymnaeids. They were invariably found on the mud just above the water line or in very small puddles at the edge of larger bodies of water. Although the statistics indicated that *L.*(*F.*) *parva* was more commonly found in fast water and *L.*(*F.*) *modicella* on a gravel-rock substrate (and less commonly found on an organic substrate), we felt this was due to the poor fit of these species into the previously designated categories rather than any intrinsic effect of habitat on their distributions. It is possible that the parameters we monitored did not accurately reflect the differences that may have occurred in the microhabitats of the sites.

Lymnaea (Fossaria) bulimoides and Lymnaea (Fossaria) dalli were found in too few locations to do any valid statistical analysis.

Based on the ecology of these snail species, it seems probable that L. caperata and L. palustris could be important natural intermediate hosts for F. magna. Both are found in shallow marshes and drainage ditches which could be exposed to fluke eggs. Lymnaea caperata especially is often found in temporary water in wooded areas which would be frequented by deer. We have found naturally infected Lymnaea caperata from St. Croix State Park, an endemic fluke area, which shed cercariae in the laboratory. One of these infected snails shed over 800 cercariae.

Lymnaea catascopium was usually found in larger lakes and rivers. It would not be expected to be exposed to very high numbers of miracidia. Thus although L. catascopium can serve as an experimental host it is not likely to play a role in the natural system.

Collections were made at Carlos Avery in mid May 1989. The only live snails found were Lymnaea (Fossaria) spp. The year before L. megasoma, L. palustris, L. exilis, L. stagnalis and

L. (*F*.) *spp.* were found from the same collection sites. It is unclear whether this is due to the greater ability of the more amphibious *Fossaria* species to survive the previous dry year, the rather early collection-time or some other factor.

A similar pattern was seen at the sites sampled on May 24, 1989 within the general collection area of St. Cloud. *Lymnaea caperata* and *Fossaria* *spp*. were the only live lymnaeids collected, each of which was collected from five of ten collection sites. While this is not atypical of *Fossaria* numbers from 1988, we never found this high a percentage of sites with live *L*. *caperata* within any general collection area in 1988. *Lymnaea* *caperata* is also a more amphibious species. This high collection incidence could be explained by the wet spring of 1989 which provided more shallow water sites preferred by this species then the previous year.

This high incidence of the amphibious species early in the year brings up some interesting points. *Lymnaea* *caperata* especially may in fact be present in high numbers only in the spring of the year when shallow waters would be available and then aestivate during the heat of the summer. This could explain the scattered distribution and fairly rare collections of this species in 1988. Almost all *L*. *caperata* identifications were made from dried shells in 1988, as few live snails were found. It also implies that this species may be very capable of surviving prolonged dry periods. The distribution of *L*. *caperata* may in fact be much greater than we could determine in 1988. Continued surveillance of selected areas over a period of years may yield some interesting data regarding the seasonality of various snail species.

We would lake to thank Dr. Emile Malek for his gracious help in identifying the *Lymnaea* (*Fossaria*) species.

LITERATURE CITED

Baker, F.C., 1911. The Lymnaeidae of North and Middle America, recent and fossil. Chicago Acad. Sci. spec. pub. no. 3 piXVi+l-539.

Baker, F.C., 1929. Mollusca from Vermillion and Pelican Lakes, Minnesota, with the description of a new variety of Helisoma corpulenta. Nautilus 42(3):95-97, (4):131-136.

Baker, F.C., 1935. Land and Freshwater Mollusca from North Star lake and vicinity, Itasca county, Minnesota. American Midland Naturalist 16:256-274.

Baker, F.C., 1936. New Lymnaeidae from the United States and Canada. II. Michigan, Minnesota, and Montana. Nautilus 49(4):127-130.

Burch, J.B., and T.J. Tottenham, 1980. North American Freshwater Snails. Trans. Poets Soc. 1(3):81215.

Burch, J.B., 1982. North American Freshwater Snails. Trans. Poets Soc. 1(4):217-365.

Clarke, A.H., 1973. Canadian Freshwater Molluscs (Lymnaedae). Malacologia 13-14:1-5XX.

Daniels, L.E., 1909. Records of Minnesota Mollusks. Nautilus 22:119-121.

Dawley, C., 1947. Distribution of Aquatic Mollusks in Minnesota. Amer. Midland Nat. 38:671-697.

Eddy, S., and Hodson (eds), 1982. Taxonomic Keys to the common animals of the north central states. 4th edition. Revision by Underhill, Schmid and Gilbertson. Burgess Publishing Company, Minneapolis, Minnesota.

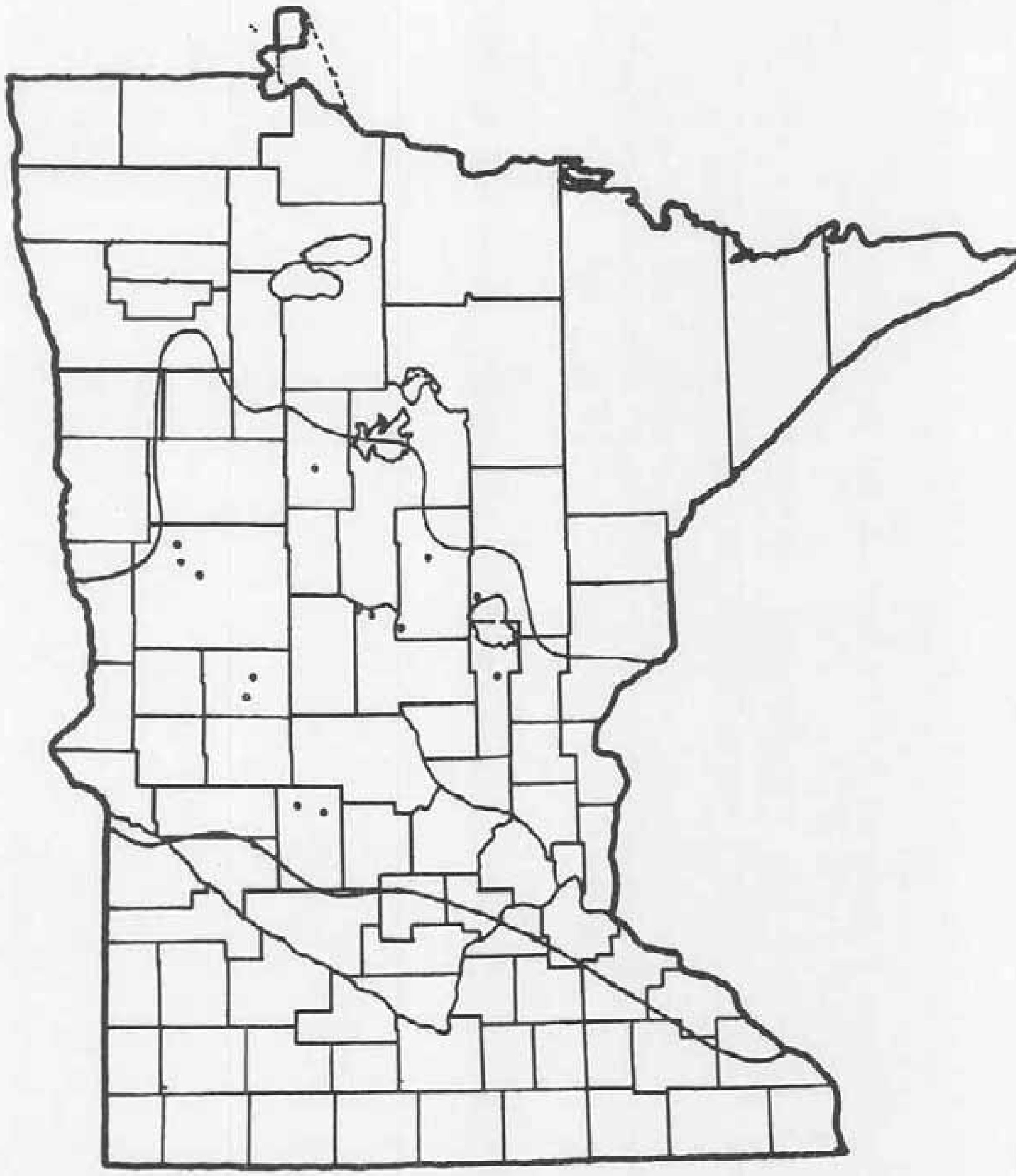
Sargent, H.E., 1895-6. Annotated list of Mollusca of Clearwater, Wright Co., Minnesota. Nautilus 9:8790 125-128.

Stromberg,B.E., etal., 1983. Current Status of *Fascioloides magna* in Minnesota. Minn. Veterinarian 23(1):8-13.

Map38 *Lymnaea stagnalis* Distribution

Map 40 Lymnaea exilis Distribution

Map 41 Lymnaea caperata Distribution

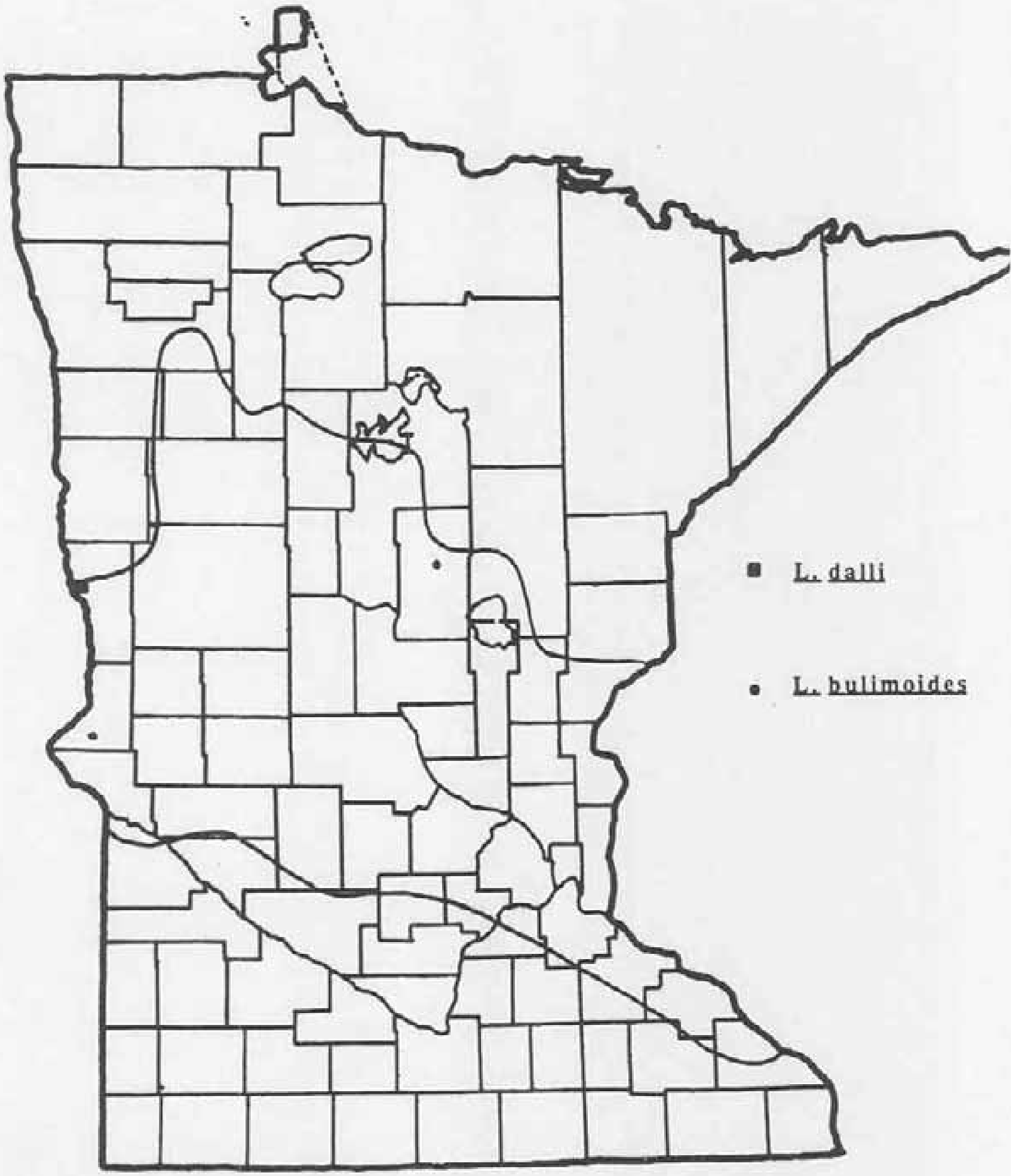


Map 42 Lymnaea catascopium Distribution

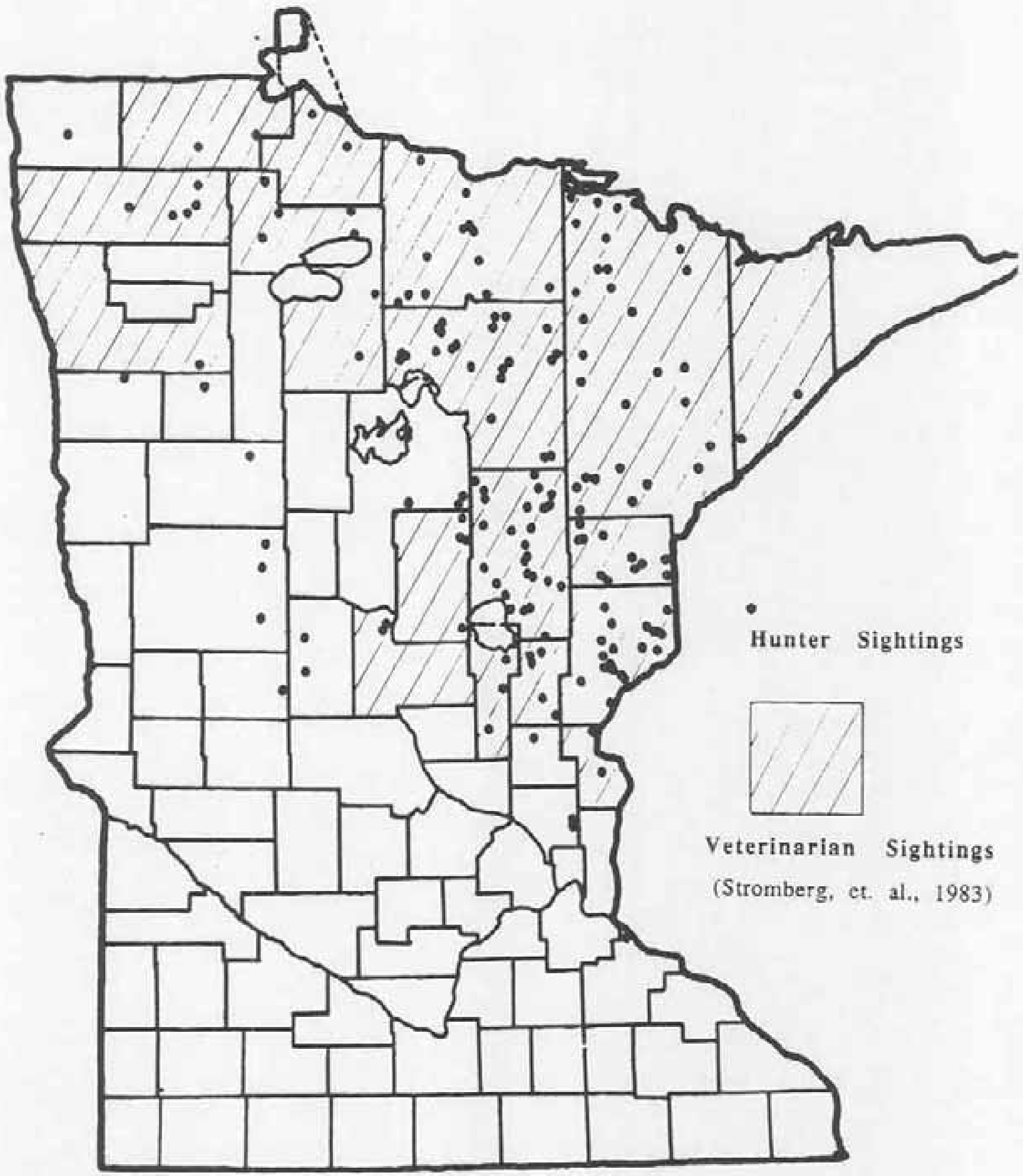
Map 43 Lymnaea megasoma Distribution

Map44 Lymnaea (Fossaria) parva Distribution

Map 45 Lymnaea (Fossaria) modicella Distribution



Map 46 Lymnaea (Fossaria) dalli and L.(F.) bulimoides
Distribution



Map 47 Endemic *Fascioloides magna* range

SNAIL SPECIES	SITES WHERE SNAILS WERE FOUND
	LYMNAEIDAE
Lymnaea palustris 45/148 (30%)	Alexandria 2,4,6,9,10,11 and 12; Breckenridge 2 and 4 ;Browns Valley 1,2,3,5,6,7,7a,8,10,11, and 13; Camp Ripley 2, and 7; Carlos Avery 2; Fosston 1a,1b,2,3,4,8 and 9; Mille Lacs 3 and 5; Park Rapids 4;Pelican Rapids 2,5,7, 10, and 11; Tamarack 8; Willmar 1,2,5,6,7 and 8.
L. stagnalis 27/148 (18%)	Alexandria 4,7 and 10; Browns Valley 8; Camp Ripley 1 and 3; Carlos Avery 2; Fosston 2,3,4,5,6,8,; Mille Lacs 3; Park Rapids 8; Pelican Rapids 4,6 and 8; Tamarack 1,5,7,8 and 10; Willmar 2,3a,3b and 4.
L. exilis 23/148 (15%)	Carlos Avery 1,2,3 and 4; Frontenac 4; Leech Lake 4,6 and 7; Mille Lacs 1,1a,4 and 11; Minnetonka 1; Park Rapids 2,4, and 7; William O'Brien 2,3 and 4; Tamarack 3 and 5; Weaver 2; Willmar 10.
L. caperata 18/148 (12%)	Alexandria 5,6 and 13; Browns Valley 1,3,5 and 7; Camp Ripley 7; Frontenac 3 and 4; Mille Lacs 6,8 and 11; Pelican Rapids 5 and 7; Willmar 1,3 and 9.
L. catascopium 17/148 (11%)	Alexandria 7,9; Camp Ripley 1,6,8,10; Mille Lacs 1,1a,12; Park Rapids 2,2a; Pelican Rapids 3,4,8; Willmar 3,3a,5.
L. megasoma 10/148 (7%)	Camp Ripley 9; Carlos Avery 1,2,4; Leach Lake 5; Mille Lacs 1,1a,2; Tamarack 1,7.

Table 1a

SNAIL SPECIES	SITES WHERE SNAILS WERE FOUND
	LYMNAEIDAE
Lymnaea palustris 45/148 (30%)	Alexandria 2,4,6,9,10,11 and 12; Breckenridge 2 and 4 ;Browns Valley 1,2,3,5,6,7,7a,8,10,11, and 13; Camp Ripley 2, and 7; Carlos Avery 2; Fosston 1a,1b,2,3,4,8 and 9; Mille Lacs 3 and 5; Park Rapids 4;Pelican Rapids 2,5,7, 10, and 11; Tamarack 8; Willmar 1,2,5,6,7 and 8.
L. stagnalis 27/148 (18%)	Alexandria 4,7 and 10; Browns Valley 8; Camp Ripley 1 and 3; Carlos Avery 2; Fosston 2,3,4,5,6,8,; Mille Lacs 3; Park Rapids 8; Pelican Rapids 4,6 and 8; Tamarack 1,5,7,8 and 10; Willmar 2,3a,3b and 4..
L. exilis 23/148 (15%)	Carlos Avery 1,2,3 and 4; Frontenac 4; Leech Lake 4,6 and 7; Mille Lacs 1,1a,4 and 11; Minnetonka 1; Park Rapids 2,4, and 7; William O'Brien 2,3 and 4; Tamarack 3 and 5; Weaver 2; Willmar 10.
L. caperata 18/148 (12%)	Alexandria 5,6 and 13; Browns Valley 1,3,5 and 7; Camp Ripley 7; Frontenac 3 and 4; Mille Lacs 6,8 and 11; Pelican Rapids 5 and 7; Willmar 1,3 and 9.
L. catascopium 17/148 (11%)	Alexandria 7,9; Camp Ripley 1,6,8,10; Mille Lacs 1,1a,12; Park Rapids 2,2a; Pelican Rapids 3,4,8; Willmar 3,3a,5.
L. megasoma 10/148 (7%)	Camp Ripley 9; Carlos Avery 1,2,4; Leach Lake 5; Mille Lacs 1,1a,2; Tamarack 1,7.

Table 1a

Fossaria modicella 28/148 (20%)	Alexandria 4,9,10; Browns Valley 5; Camp Ripley 1,4,11; Fosston 6; Minnetonka 1,2,4; Leech Lake 1; Frontenac 1a,2,5,6,8,9; Tamarack 7,10; Willmar 2,3b,6,7; William O'Brien 1,2; Weaver 1,2.
F. parva 14/148 (9%)	Alexandria 10; Camp Ripley 5,9,12; Fosston 8; Mille Lacs 3,9; Leech Lake 2; Park Rapids 2,5,8; O'Brien 1; Weaver 1,4.
F. bulimoides 2/148 (1%)	Browns Valley 8;Camp Ripley 2.
F. dalli 1/148 (1%)	Breckenridge 1.
	PLANORBIDAE
Helisoma trivolvis 67/148 (45%)	Alexandria 1,2,4,6,10,11,12,13,14; Brown's Valley 2,3,5,6,7,8,10,11,13; Camp Ripley ,3,5,12. Carlos Avery 1,2,4; Fosston 2,3,4,5,6,7,8,9; Frontenac 5; Leech Lake 1,2,3,6; Mille Lacs 1,2,3,4,11; Minnetonka ,3; Park Rapids 1,2,3,4,5; Pelican Rapids 2,4,5,6,8; William O'Brien 2; Tamarack ,5,7,8,10; Weaver 2,5; Willmar 1,2,3,4,5,6.
H. anceps 33/148 (22%)	Alexandria 4,7,9,10,14; Brown's Valley 11; Camp Ripley 1,6,8,10; Fosston 5,6,7,8,9; Leech Lake 3;Mille Lacs 5,9,12; Park Rapids 2,2a,5,6,8; Pelican Rapids 1,3,4,8,9; Willmar 2,3a,5,6.
H. campanulatum 36/148 (24%)	Alexandria 1,3,4,7,9,10,11; Camp Ripley 1,3,5,8,9; Fosston 7; Leech Lake 3,9; Mille Lacs 5,7,9; Park Rapids 2,2a,6,8; Pelican Rapids 3,4,8,9; William O'Brien 6; Tamarack ,4,6,7,10; Weaver 2; Willmer 3a,3b,5.
H. p. infracarinatum 7/148 (5%)	Leech Lake 5; Park Rapids 8; William O'Brien 3,4,6; Tamarack 4,10.

Table 1b

Promenetus exacuous 24/148 (16%)	Alexandria 4,7,14; Brown's Valley 8,11; Camp Ripley 8; Carlos Avery 2; Fosston 2,4,7,8; Minnetonka 2,5; Park Rapids 2,7,8; Pelican Rapids 4; William O'Brien 2; Tamarack 4,5,8; Weaver 2,5; Willmer 4.
P. umbilicatellus 6/148 (4%)	Alexandria 12; Brown's Valley 3; Carlos Avery 2,5; Fosston 4; Minnetonka 1.
Planorbula armigera 20/148 (14%)	Alexandria 3,9,10,11,13; Brown's Valley 5,7; Camp Ripley 5; Fosston 2,8,9; Mille Lacs 4; Park Rapids 2,3; Pelican Rapids 4; William O'Brien 2; Tamarack 5,7,10; Weaver 2.
P. campestris 2/148 (1%)	Fosston 1a; Pelican Rapids 5.
Gyraulus parvus 8/148 (5%)	Alexandria 12; Frontenac 3; Leech Lake 2,5; Park Rapids 4,5; Pelican Rapids 4; Willmar 5.
G. deflectus 13/148 (9%)	Alexandria 4; Brown's Valley 11; Camp Ripley 5,8;Leech Lake 3,5; Mille Lacs 3,9; Park Rapids 8; Pelican Rapads 9; William O'Brien 3; Tamarack 4;Willmar 2.
G. circumstriatus 3/148 (2%)	Carlos Avery 2; Leech Lake 3; Park Rapids 7.
G. sp. 6/148 (4%)	Fosston 2,7; Park Rapids 1; Weaver 2,5; Willmar 1.
Armiger crista 1/148 (1%)	Alexandria 12.

Table 1c

	PHYSIDAE
Physa sp. 112/148 (76%)	Alexandria 2,4,6,7,9,10,11,12,13,14; Breckenridge 1,2,3,4; Brown's Valley 1,2,3,4,5,6,7,7b,8,9,10,11,12,13; Carlos Avery 2,3,4,5; Camp Ripley 1,3,5,6,8,9,10,11,12; Fosston1a,1b,2,3,4,5,6,7,8,9; Frontenac 1,1a,2,3,5,6,7,8,9; Leech Lake 1,2,3,9; Mille Lacs 1,1a,2,3,5,8,9,11,12; Minnetonka 1,2,3,5; Park Rapids 2,3,4,6; Pelican Rapids 2,4,6,8,9;William O'Brien 1a,3,5; Tamarack 1,2,4,5,6,7,8,10; Weaver1,2,3,4,5; Willmar 1,2,3a,3b,4,5,6,7,8,10.
Aplexa hypnorum 31/148 (21%)	Alexandria 5,8,12; Brown's Valley 1,3,5,7,13;Camp Ripley 2,4,7; Fosston 4,8,9; Frontenac 4; Leech Lake 4,6,7; Mille Lacs 4; Park Rapids 7;Pelican Rapids, 6,7,10; William O'Brien 4, Tamarack 2,3,8,9; Willmer 1,5,9.
	HYDROBIIDAE
Amnicola limosa 36/148 (24%)	Alexandria 2,7; Brown's Valley 7,11; Camp Ripley 1,6,8,10,11; Fosston 7,9; Frontenac 7; Leech Lake 3; Mille Lacs 2,3,5,9,12; Minnetonka 1,2; Park Rapids 2,2a,5,8; elican Rapids 3,8,9; William O'Brien 1a,1b; amarack 4,10; Weaver 5; Willmer 2,3a,3b,5.
A. walkeri 5/148 (3%)	Alexandria 4; Brown's Valley 11; Frontenac 7,8; Park Rapids 2.
Cincinnatia cincinnatiensis 1/148 (1%)	Brown's Valley 7.

Table 1d

	VALVATIDAE	
Valvata tricarinata 24/148 (16%)	Alexandria 2,4,7; Browns Valley 4,6,7,9,11; Camp Ripley 1,8; Fosston 7; Frontenac 7; Mille Lacs ,8; Pelican Rapids 2,3,8,9; Tamarack 4,10; Willmar 2,3a,3b,5.
V. sincera 2/148 (1%)	Alexandria 4; Leech Lake 2.
	VIVIPARIDAE
Campeloma sp. 5/148 (3%)	Frontenac 8,9; Park Rapids 2,2a; Pelican Rapids1.
Viviparus georgianus 2/148 (1%)	Mille Lacs 7; Pelican Rapids 1.
Viviparus sp. 1/148 (1%)	Weaver 2.
	ANCYLIDAE
Laevapex fuscus 2/148 (1%)	Pelican Rapids 1; Tamarack 1.
Ferrisia rivularis 2/148 (1%)	Leech Lake 1,5.
F. parallela 1/148 (1%)	Leech Lake 3.
	PLEUROCERIDAE
Pleurocera acuta 3/148 (2%)	Frontenac 6,7,8.

Table 1e

LAND SNAILS

Triodopsis multilinata 2/148 (1%)	Frontenac 2,3.
Prometiopsis lapidaria 3/148 (2%)	Frontenac 3; Tamarac 4; Weaver 2.
Vertigo sp. 2/148 (1%)	Park Rapids 1,7.
Vallonia sp. 1/148 (1%)	Pelican Rapids 7.
Succinea ovalis 43/148 (29%)	Alexandria 2,3,5,9,12; Breckenridge 1,4; Browns Valley 4,5,7; Camp Ripley 7; Carlos Avery 2; Fosston 1a,3,4,6,7,8,9; Frontenac 2,3,4; Leech Lake 4,7; Mille Lacs 4; Minnetonka 3,4; Park Rapids 7; Pelican Rapids 5,7,10; William O'Brien 2; Tamarac 3,5,6,9; Weaver 2; Willmar 1,2,4,5,9,10.
S. avara 5/148 (3%)	Browns Valley 6,7; Fosston 7; Weaver 5; Willmar 8.
Zonitoides nitidus 16/148 (11%)	Alexandria 2,3,5,9,12; Browns Valley 7; Fosston 7,8,9; Frontenac 3; Mille Lacs 9; Minnetonka 5; William O'Brien 1a; Tamarack 7; Willmar 5,9.
Discus cronkhitei 3/148 (2%)	Alexandria 5; Browns Valley 9; Willmar 5.

Table 1f

Collection Site Descriptions

GENERAL AREA	#	COUNTY	DATE	SITE DESCRIPTION	H20 °C	pH	WET LAND TYPE	SUBSTRATE TYPE
Alexandria	1	Todd	9/10/88	Wildlife Area, Hgwy 11	13	6	Shallow Marsh	Organic
	2	Todd	9/10/88	Long Prairie River, Clotho	14	6.3	Slow Small River	Mud
	3	Todd	9/10/88	Long Prarie River, Hgwy 1	15	6.3	Slow Small River	Rock-Mud
	4	Douglas	9/10/88	Lake Osakis, Hgwy 10	18	6.5	Shallow Open Water	Sand
	5	Douglas	9/10/88	Ditch, Across from Lake Osakis	-	No pH	Shallow Marsh, Ditch	Mud
	6	Douglas	9/10/88	Wildlife Area, Hgwy 10	12	6	Fresh Meadow	Mud
	7	Douglas	9/10/88	Lake Carlos & La Homme Dieu	17	6.5	Shallow Open Water	Sand
	8	Douglas	9/10/88	Marsh, East of Lake Carlos	-	No pH	Shallow Marsh	Mud
	9	Douglas	9/10/88	Wildlife Area, Lake Carlos	14	6.3	Deep Marsh	Sand
	10	Douglas	9/10/88	Hgwy, 5 & 34	14	6.3	Shallow Marsh, Ditch	Mud
	11	Douglas	9/10/88	Hgwy 24	17	7	Deep Marsh	Mud
	12	Grant	9/10/88	Hgwy 55 &27	-	7	Shallow Marsh	Mud
	13	Grant	9/10/88	Chippewa River, Hgwy 13	-	No pH	Slow Small River	Sand
	14	Pope	9/10/88	Lake Minnewaska, Starbuck	24	7	Shallow Open Water	Sand
Breckenridge	1	Wilkin	9/13/88	Red River, Hgwy 18	13	6.3	Large Slow River	Mud
	2	Wilkin	9/13/88	Ditch, Hgwy 210	-	No pH	Shallow Marsh	Mud
	3	Wilkin	9/13/88	Ottertail River, Hgwy 210	14	6.3	Slow Small River	Mud-Gravel
	4	Ottertail	9/13/88	Orwell Wildlife Area, Hgwy 8	14	6.5	Deep Marsh	Sand-Gravel
Browns Valley	1	Traverse	9/12/88	Ditch, Hgwy 27	-	No pH	Shallow Marsh	Mud
	2	Traverse	9/12/88	West Branch Twelvemile River	13	6.5	Small Slow River	Mud
	3	Traverse	9/12/88	Ditch North of Mustinka River	-	No pH	Shallow Marsh Ditch	Organic
	4	Traverse	9/12/88	Access to Mustinka River	18	6.2	Slow Small River	Mud-Gravel
	5	Traverse	9/12/88	Dam, Mud Lake -Lake Traverse	15	6.5	Slow Small River	Mud
	6	Traverse	9/12/88	N.E. Landing on Lake Traverse	16	6.3	Shallow Open Water	Rock
	7	Traverse	9/12/88	Mid - Landing Lake Traverse	-	6.3	Shallow Open Water	Sand-Gravel
	7a	Traverse	9/12/88	Stream into Lake	-	6.3	Seep	Sand
	8	Traverse	9/12/88	Wildlife Area, Arthur Township	18	6.5	Deep Marsh	Organic
	9	Big Stone	9/12/88	Bigstone Lake, North Landing	17	7	Shallow Open Water	Sand-Rock
	10	Big Stone	9/12/88	Fish Creek, Hgwy 7	15	6.5	Slow Small River	Mud
	11	Big Stone	9/12/88	Big Stone Lake, Landing	19	6.5	Shallow Open Water	Sand-Rock
	12	Big Stone	9/12/88	Minnesota River, Hgwy 75	18	6.5	Large Slow River	Mud
	13	Big Stone	9/12/88	Ditch, Hgwy 7 Cornell	20	6.5	Shallow Marsh	Sand
Camp Ripley	1	Crow Wing	8/30/88	Upper Mission Lake, Landing	19	6.2	Shallow Open Water	Sand
	2	Crow Wing	8/30/88	Mission Lake, Hgwy 19	13	6.2	Shallow Marsh	Mud
	3	Crow Wing	8/30/88	Mississippi River, Landing	19	6	Large Slow River	Sand-Mud

Table 2a

Collection Site Descriptions

GENERAL AREA	#	COUNTY	DATE	SITE DESCRIPTION	H20 °C	pH	WET LAND TYPE	SUBSTRATE TYPE
Camp Ripley	4	Cass	8/30/88	Ditch, Hgwy 77	-	6.5	Shallow Marsh	Sand
	5	Cass	8/30/88	Rock Lake, Hgwy 1	21	6	Deep Marsh	Organic
	6	Morrison	8/30/88	Rest Area, Hgwy 210 and 3	-	6.3	Fast Large River	Sand
	7	Morrison	8/30/88	Ditch, Hgwy 28	-	No pH	Shallow Marsh, Ditch	Organic
	8	Morrison	8/30/88	Crow Wing River, Landing	20	6.2	Shallow Open Water	Sand-Rock
	9	Morrison	8/30/88	Bernhart Lake, Hgwy 3	23	5.6	Deep Marsh	Organic
	10	Crow Wing	8/30/88	Nokasippi River, Hgwy 2	19	6	Slow Small River	Sand
	11	Crow Wing	8/30/88	Crow Wing River, Landing	21	6	Large Slow River	Sand-Gravel
	12	Crow Wing	8/30/88	Mississippi River, Landing	-	6	Large Slow River	Sand-Gravel
Carlos Avery	1	Anoka	5/6/88	Marsh, Refuge	23	5	Shrub-Carr	Organic
	2	Anoka	5/6/88	Marsh, Refuge	24	5.2	Deep Marsh	Organic
	3	Anoka	5/6/88	Marsh, Refuge	19	5.3	Sedge Meadow	Organic
	4	Anoka	5/6/88	Ditch, Refuge	23	5.2	Deep Marsh	Organic
	5	Chisago	5/6/88	Sunrise River, Hgwy 19	21	5.5	Slow Small River	Organic
Fossion	1	Mahnomen	8/7/88	Pothole	24	6.5	Shallow Marsh	Organic
	1b	Mahnomen	8/7/88	Stock Pond	-	No pH	Deep Marsh	Sand-Mud
	2	Mahnomen	8/7/88	Lake	22.5	6	Deep Marsh	Organic
	3	Mahnomen	8/7/88	Pothole	23	6	Deep Marsh	Sand-Mud
	4	Polk	8/7/88	Pothole	21	6	Deep Marsh	Organic
	5	Mahnomen	8/7/88	Pothole	24	6.2	Deep Marsh	Mud
	6	Polk	8/7/88	Volden Lake	22	6	Deep Marsh	Sand-Organic
	7	Polk	8/7/88	Cross Lake	24	6.3	Shallow Open Water	Sand
	8	Polk	8/7/88	Poplar River	-	No pH	Slow Stream	Mud
	9	Polk	8/7/88	Poplar River	-	6.3	Slow Stream	Sand-Mud
Frontenac	1	Goodhue	9/2/88	Trout Stream, Hgwy 19	14	6	Trout Stream	Rock
	1a	Goodhue	9/2/88	Trout Stream	14	No pH	Trout Stream	Rock
	2	Goodhue	9/2/88	Trout Stream, Recreation Area	15	6.3	Trout Stream	Sand-Gravel
	3	Goodhue	9/2/88	State Forest Road off Hay Creek	21	6.3	Flood Plain Forest	Mud
	4	Goodhue	9/2/88	West of Hgwy 61	-	No pH	Shallow Marsh, Ditch	Organic
	5	Goodhue	9/2/88	Ditch	24	6.3	Shallow Open Water	Sand-Organic
	6	Goodhue	9/2/88	Mississippi, Wayside Park	25	6.3	Large Slow River	Rock
	7	Goodhue	9/2/88	Mississippi, City Park	-	6.3	Large Slow River	Rock
	8	Wabasha	9/2/88	Mississippi	-	6.3	Large Slow River	Sand
	9	Goodhue	9/2/88	Cannon River	-	6.3	Slow Small River	Mud
Leech Lake	1	Cass	7/11/88	Stream, Hgwy 83	20.5	5.7	Fast Stream	Rock

Table 2b

Collection Site Descriptions

GENERAL AREA	#	COUNTY	DATE	SITE DESCRIPTION	H20 °C	pH	WET LAND TYPE	SUBSTRATE TYPE
Leech Lake	2	Cass	7/11/88	Pond, Hgwy 34	22	5.2	Deep Marsh	Organic
	3	Cass	7/11/88	Leech Lake, Hgwy 200	20	5.5	Shallow Open Water	Sand-Gravel
	4	Cass	7/11/88	Pond, Hgwy 200	-	No pH	Shallow Marsh	Organic
	5	Cass	7/11/88	Ditch, Hgwy 200	30	4.5	Shallow Marsh, Ditch	Organic
	6	Cass	7/11/88	Pond, Hgwy 84	-	No pH	Fresh Meadow	Organic
	7	Cass	7/11/88	Temporary Pond S. of Whipholt	-	No pH	Shallow Marsh	Organic
	8	Cass	7/11/88	Tepee Lake, Landing	28	4.5	Shallow Open Water	Sand
	9	Cass	7/11/88	Lake, Rd. 377b	20	4.5	Shallow Open Water	Sand
Mille Lacs	1	Mille Lacs	8/29/88	Ditch, County Rd. 20	13	5.2	Deep Marsh	Organic
	1a	Mille Lacs	8/29/88			No pH	Deep Marsh	Organic
	2	Mille Lacs	8/29/88	Rum River, Hgwy 20	16	6	Fast Small River	Sand-Rock
	3	Mille Lacs	8/29/88	Lake Mille Lacs, Access Hwy 27	19	6.2	Shallow Open Water	Sand
	4	Mille Lacs	8/29/88	Lake Mille Lacs, Hgwy 27&155	16	6.3	Shallow Marsh	Organic
	5	Mille Lacs	8/29/88	Lake Mille Lacs, Landing	-	No pH	Shallow Open Water	Sand
	6	Aikin	8/29/88	Ditch, Hgwy 2	18	6	Shallow Marsh, Ditch	Sand Clay
	7	Aikin	8/29/88	Sugar Lake	20	6	Shallow Open Water	Sand-Rock
	8	Aikin	8/29/88	County Rd 17 & Hgwy 47	15	6	Deep Marsh	Organic
	9	Aikin	8/29/88	Pickeral Lake, Hgwy 210	21	6	Deep Marsh	Organic
	10	Aikin	8/29/88	Black Shadow Lake	21	6	Shallow Open Water	Sand
	11	Aikin	8/29/88	Ditch, Wildlife Area	20	6	Shallow Marsh	Mud
	12	Aikin	8/29/88	Lake Mille Lacs, Garrison Acces	22	6	Shallow Open Water	Sand-Rock
Minnetonka	1	Hennepin	6/8/88	Lake Minnetonka, Minnehaha Ck	20	6.4	Slow Stream	Gravel-Rock
	2	Hennepin	6/8/88	Lake Minnetonka, Landing	26	6	Deep Marsh	Mud
	3	Hennepin	6/8/88	Six Mile Creek and Halsted Bay	26	6	Deep Marsh	Mud
	4	Hennepin	6/8/88	Ditch	26	6.4	Deep Marsh	Organic
	5	Hennepin	6/8/88	Six Mile Creek & Hgwy 7	25	6	Slow Small River	Mud-Rock
Park Rapids	1	Hubbard	7/12/88	Pond, Hgwy 4	19	5.2	Shrub Carr	Sand
	2	Hubbard	7/12/88	Big Sand Lake	22	5.1	Shallow Open Water	Sand
	3	Hubbard	7/12/88	Stream, Hgwy 24	25	5.4	Slow Stream	Sand-Mud-Rock
	4	Hubbard	7/12/88	Pot Hole, W. of Lake George	25	5.2	Deep Marsh	Mud
	5	Clearwater	7/12/88	Mississippi River, Hgwy 200	22	5.4	Fast Small River	Sand-Mud
	6	Clearwater	7/12/88	Long Lake, County Park	24	6	Shallow Open Water	Rock Sand
	7	Clearwater	7/12/88	Pond, By Bohall Trail	-	No pH	Shallow Marsh	Mud
	8	Hubbard	7/12/88	Pond, Hgwy 71&41	25	6	Deep Marsh	Sand
Pelican Rapids	1	Otter Tail	9/11/88	Pelican River, Hgwy 59	16	6.5	Slow Small River	Mud

Table 2c

Collection Site Descriptions

GENERAL AREA	#	COUNTY	DATE	SITE DESCRIPTION	H20 °C	pH	WET LAND TYPE	SUBSTRATE TYPE
Pelican Rapids	2	Otter Tail	9/11/88	Pothole Hgwy 22	17	6.5	Deep Marsh	Mud-Sand
	3	Ottertail	9/11/88	Jewett Lake, Landing	18	7	Shallow Open Water	Sand-Gravel
	4	Otter Tail	9/11/88	Lake of Red River, Landing	18	6	Shallow Open Water	Organic
	5	Otter Tail	9/11/88	Pot Hole, Hgwy 1	-	No pH	Shallow Marsh	Mud
	6	Otter Tail	9/11/88	Pot Hole,Hgwy 43 &22	18	6.2	Shallow Open Water	Mud
	7	Otter Tail	9/11/88	Anderson Lake, Hgwy 3	-	No pH	Shallow Marsh, Ditch	Mud
	8	Otter Tail	9/11/88	Pelican River, Landing	19	6.2	Shallow Open Water	Sand
	9	Otter Tail	9/11/88	Lake Lida	21	7	Shallow Open Water	Sand-Mud
	10	Otter Tail	9/11/88	Ditch, Hgwy 11	-	No pH	Shallow Marsh	Mud
	11	Otter Tail	9/11/88	Wildlife Area, Hgwy 10	-	No pH	Shallow Marsh	Sand-Gravel
William O'Brien	1	Washington	8/22/88	St. Croix River, Landing	22	6	Fast Large River	Gravel
	1a	Washinton	8/22/88	St. Croix River, Landing		6.5	Fast Stream	Mud
	2	Chisago	8/22/88	Pleasant Valley Rd.	20	6.5	Deep Marsh	Sand-Mud
	3	Pine	8/22/88	Ditch County nRd. 19	20	5	Shallow Marsh	Mud
	4	Pine	8/22/88	Beaver Pond off Trail	-	No pH	Shrub-Carr	Sand
	5	Pine	8/22/88	Sand River	-	No pH	Fast Small River	Mud-Sand
	6	Pine	8/22/88	Pond, Across Rd. Park Entrance	-	5	Shallow Open Water	Sand
Tamarack	1	Becker	7/13/88	Missouri Lake, Hgwy 113	25	5.2	Shallow Open Water	Rock
	2	Becker	7/13/88	Bad Medicine Lake, Hgwy 113	24.5	5.5	Deep Marsh	Organic
	3	Becker	7/13/88	Marsh, Hgwy 35	-	No pH	Open Bog	Sand
	4	Becker	7/13/88	Waboose Lake	26	5.4	Shallow Open Water	Organic
	5	Becker	7/13/88	Flat Lake	27	5.3	Deep Marsh	Sand
	6	Becker	7/13/88	River, Rochert	26	5.5	Fast Small River	Organic
	7	Becker	7/13/88	Marsh, Hgwy 12	26	5.4	Deep Marsh	Sand
	8	Becker	7/13/88	Pelican River, Hgwy 34	20	5.5	Slow Small River	Mud
	9	Becker	7/13/88	Ditch, Hgwy 10	-	No pH	Shallow Marsh	Mud-Sand
	10	Becker	7/13/88	Ditch, Hgwy 10	25	6.2	Deep Marsh	Rock
Weaver'	1	Wabasha	6/27/88	Snake Creek	14	6.5	Trout Stream	Organic
	2	Winona	6/27/88	Dorer Pond #3	30	6.4	Deep Marsh	Mud
	3	Winona	6/27/88	White Water River	28	6.2	Slow Small River	Rock
	4	Winona	6/27/88	White Water River	22	6.2	Trout Stream	Mud
	5	Wabasha	6/27/88	Weaver Marsh, Access	28	6.2	Deep Marsh	Organic
Willmar	1	Kandiyohi	8/4/88	Game Refuge	-	No pH	Shallow Marsh	Mud
	2	Kandiyohi	8/4/88	Lake Ringo	25	6.5	Shallow Open Water	Gravel
	3	Kandiyohi	8/4/88	Green Lake	25	6	Shallow Open Water	Sand

Table 2d

Collection Site Descriptions

GENERAL AREA	#	COUNTY	DATE	SITE DESCRIPTION	H20 °C	pH	WET LAND TYPE	SUBSTRATE TYPE
Willmar	3a	Kandiyohi	8/4/88	Green Lake	28	6.3	Shallow Open Water	Sand
	4	Kandiyohi	8/4/88	Marsh, Hgwy 5	-	No pH	Shallow Marsh	Organic
	5	Kandiyohi	8/4/88	Middle Lake	29	6.7	Deep Marsh	Organic
	6	Kandiyohi	8/4/88	Sunberg Lakes, Hgwy 104	27	6.5	Shallow Open Water	Mud
	7	Kandiyohi	8/4/88	Big Kandyohi Lake	28	6.3	Shallow Open Water	Sand
	8	Kandiyohi	8/4/88	Ditch, Hgwy 81&3	-	6.2	Slow stream	Organic
	9	Meeker	8/4/88	Ditch	-	No pH	Shallow Marsh, Ditch	Sand
	10	Wright	8/4/88	Ditch, Hgwy 39	-	No pH	Shallow Marsh	Organic

Table 2e

SNAIL SPECIES	4.5-4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-6.9	7.0-7.4	TOTAL**
Lymnaea stagnalis	0/2,0%	4/18,22%	1/7,14%	15/65,23%	5/19,26%	0/6,0%	25
L. palustris	0/2,0%	2/18,11%	1/7,14%	15/65,23%	13/19,68%	2/6,33%	33
L. exilis	0/2,0%	9/18,50%	0/7,0%	3/65,5%	2/19,10%	0/6,0%	14
L. caperata	0/2,0%	0/18,0%	0/7,0%	6/65,9%	2/19,10%	0/6,0%	8
L. catascopium	0/2,0%	3/18,17%	0/7,0%	10/65,15%	2/19,10%	1/6,17%	16
L. megasoma	1/2,50%	6/18,33%	1/7,14%	1/65,2%	0/19,0%	0/6,0%	9
Fossaria parva	0/2,0%	3/18,17%	1/7,14%	8/65,12%	1/19,5%	0/6,0%	13
F. modicella	0/2,0%	1/18,6%	1/7,14%	19/65,29%	7/19,37%	0/6,0%	28
F.bulimoides	0/2,0%	0/18,0%	0/7,0%	1/65,2%	1/19,5%	0/6,0%	2
F. dalli	0/2,0%	0/18,0%	0/7,0%	1/65,2%	0/19,0%	0/6,0%	1

Table 3 pH *

** pH could not be recorded from dry sites resulting in discrepancies in the number of species positive sites listed under different parameters.

SNAIL SPECIES	OPEN WATER	MARSH	SLOW WATER	FAST WATER	TOTAL
Lymnaea stagnalis	11/34,32%	13/72,18%	3/29,10%	0/13,0%	27
L. palustris	9/34,26%	26/72,36%	10/29,34%	0/13,0%	45
L. exilis	1/34,3%	21/72,29%	1/29,3%	0/13,0%	23
L. caperata	1/34,3%	14/72,19%	3/29,10%	0/13,0%	18
L. catascopium	11/34,32%	4/72,6%	1/29,3%	1/13,8%	17
L. megasoma	1/34,3%	8/72,11%	0/29,0%	1/13,8%	10
Fossaria parva	2/34,6%	6/72,8%	2/29,7%	4/13,31%	14
F. modicella	7/34,20%	10/72,14%	6/29,21%	5/13,38%	28
F. bulimoides	0/34,0%	2/72,3%	0/29,0%	0/13,0%	2
F. dalli	0/34,0%	0/72,0%	1/29,3%	0/13,0%	1

Table 4 Wetland Type *

SNAIL SPECIES	ORGANIC	MUD	SAND	GRAVEL-ROCK	TOTAL
Lymnaea stagnalis	9/38,24%	8/52,15%	9/46,20%	1/12,8%	27
L. palustris	10/38,26%	21/52,40%	13/46,28%	1/12,8%	45
L. exilis	15/38,39%	6/52,12%	1/46,2%	1/12,8%	23
L. caperata	5/38,13%	8/52,15%	5/46,11%	0/12,0%	18
L. catascopium	4/38,11%	0/52,0%	12/46,26%	1/12,8%	17
L. megasoma	8/38,21%	0/52,0%	2/46,4%	0/12,0%	10
Fossaria parva	4/38,11%	2/52,4%	6/46,13%	2/12,17%	14
F. modicella	3/38,8%	8/52,15%	12/46,26%	5/12,42%	28
F.bulimoides	1/38,3%	1/52,2%	0/46,0%	0/12,0%	2
F. dalli	0/38,0%	1/52,2%	0/46,0%	0/12,0%	1

Table 5 Substrate *

= stat. signif.

*Data expressed as total number of species positive sites / total number of collection sites for each catagory of pH, Wetland type and Substrate. Also expressed as a percentage.