Delta Marsh
Field Station
Annual Report
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The University
of Manitoba

University of Manitoba Field Station
(Delta Marsh)

SEVENTH ANNUAL REPORT
1972

Division of Biological Sciences
The University of Manitoba
Winnipeg, Manitoba R3T 2N2

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THE UNIVERSITY OF MANITOBA

UNIVERSITY FIELD STATION (DELTA MARSH)

Director's Report for 1972

During the past year the University Field Station was used actively for research and teaching. To meet increased demands in both these areas, facilities were improved for greater accommodation. Mr. Barry Wallis joined the staff in summer as Executive Assistant to the Director and his presence has increased the efficiency of the operation of the Station.

Research

The long-term objective of our research program is to provide a better understanding of the dynamics of the marsh ecosystem. Ten research projects were carried out; of these six were continued from last year and four new studies were initiated. Dr. Emil Kucera completed his study on the population ecology of white-tailed deer and a report has been prepared providing much-needed information necessary for the management of deer in a marshland environment. Don Bernard and Marty Quaye were awarded M.Sc. degrees for their respective studies on shiners in Lake Manitoba and nematode parasites in frogs and toads. Both Sandy Macaulay and Floyd Phillips, working on Ph.D. programs, have finished their field studies at the Station and expect to complete their projects in 1973. Research projects received support from the Department of Mines, Resources and Environmental Management (Research Branch), National Research Council of Canada, Ducks Unlimited, Canadian Industries Limited and the University of Manitoba.

Staff and Utilization of Facilities

The Station was used for 409 resident weeks and 3,747 meals were served. The following staff, students and summer assistants were present for all or part of the year:

Faculty

Dr. J. M. Shay, Director (to July)
Dr. J. H. Gee, Acting Director (from July)
Dr. K. W. Stewart, Department of Zoology
Dr. E. Kucera, University Field Station (January-May)

Faculty (continued)

Dr. L. Mottus, University Field Station (June-October)

Graduate Students

S. Bates, Department of Zoology
A. J. Macaulay, Department of Botany
E. E. Mowbray, Department of Botany
E. Pip, Department of Botany
F. Phillips, Department of Botany
M. Quaye, Department of Zoology
J. Pearn, Department of Botany

Research and Summer Assistants

J. Evans, Research Assistant
L. Bond, Research Assistant
T. Jichuk, Research Assistant
B. Foley, Summer Assistant
G. Connor, Summer Assistant

Permanent Staff

B. Wallis, Executive Assistant
B. A. Huyghe, Secretary
N. Mulder, Manager
G. Mulder, Housekeeper
I. Garnham, Cook

Informal seminars were given by staff and graduate students throughout the summer. The Field Station is now available for year-round use and I feel it has a great potential for research and teaching in winter. In January and February 1973 Dr. E. E. Moodie from the University of Winnipeg brought out his ecology class for a two-day field course and I took the third year ecology class out over a three-day period. In addition, there was an Extension Division course on Human Survival given over three days. During these two months alone, the Station was used for 57 resident weeks. There is a strong demand for education in winter ecology and much-needed research at this time of year can be carried out from the Field Station. Its use in these areas should be actively promoted.

November Seminar

The Sixth Annual Seminar, held on November 18, attracted a large audience from several departments within the University, the Delta Waterfowl Research Station and Provincial and Federal Government staff. Six papers were presented by individuals who had worked at the Field Station during the summer and by Dr. L. J. Shapiro and Miss Anne Storey from the Department of Psychology who had been studying the behaviour patterns of mallard ducks at Charleswood Sewage Lagoon.

Teaching

(a). Summer School -- two Summer Session half courses were held at the Station during July. Introductory Ecology (1.336/22.229) was given by Dr. J. M. Shay and Mr. A. J. Macaulay. Nine students were enrolled and they studied sampling techniques in the field, attended lectures and participated in individual projects. Animal Ecology (22.334) was given by Dr. R. W. Nero, assisted by Mr. E. E. Mowbray. Seven students were enrolled and they examined effects of environmental factors on distribution and abundance of animal populations, attended lectures and completed individual projects. This year four courses have been planned and have been given as much publicity as possible.

(b). Fall Field Course -- this course, held prior to the start of classes, was provided for students enrolled in Introductory Ecology (1.336/22.229) in Winter Session. The 99 students were accommodated at the Station in four groups. Field work was intensive, starting at dawn and lasting until after dark in the evening. Instruction was provided by Drs. J. H. Gee, R. Longton and J. M. Stewart who were assisted by F. Phillips, G. Newsome, H. Balesic, R. Weslowsky and E. E. Mowbray. At the Field Station students completed analyses of the distribution and abundance of different species of vegetation, described line intercepts and belt transects through vegetation, measured a variety of environmental variables, completed a mark-recapture program to estimate number of fish in a paricular area, described and analysed marsh organisms and their feeding relationships, live trapped and released mammals to determine their distribution and abundance and learned to identify birds. These exercises provide valuable experience and a basis for a strong understanding of ecological concepts.

(c). Extension Division Courses -- in May a pilot weekend course on Bird Populations was given by Dr. R. Jones, Delta Waterfowl Research Station. This course attracted 20 participants from the public and was very well received. On the strength of their reception, a full program of courses was planned by Miss M. E. Hay of the Extension Division in cooperation with the Field Station. The first course, given in December on Adaptations of Mammals to Winter by Dr. R. R. Riewe, was overbooked and very popular. Through such courses, the Station can make a great contribution in the area of public education.

Visitors

In May a large group from the Department of Environmental Studies came for a weekend. In October a three-day workshop, sponsored by Environment Canada, was held on Alternate Life Styles.

Facilities

Murray's Cotage was completely renovated during the summer and was converted into a magnificent dining hall with a well-equipped kitchen. Up to 50 people can now be served at one time. A third building was purchased from the MacDonald Air Base and moved to the Station. Its renovation will be completed this summer, along with minor renovations to Criddle and Agassiz. On completion, the Station will provide dormitory accommodation for 45 and married accommodation for five families. The rip-rap wall was extended further west and now provides protection to all buildings that were endangered by shore erosion in summer storms last year.

General

The Summer School courses had smaller enrollments than expected and I think that they should receive more publicity. This is being done at the present time to ensure that facilities receive full potential use. Winter Session students attending the Fall Field course thoroughly enjoyed their stay at the Station and most wished for a longer course. This may be possible over the next two years due to changes in the time-tabling of ecology courses. The Extension Division courses this winter were very popular and I expect the Station to increase its role in the area of public education. With expansion of facilities, the Station can make a much greater contribution in the area of education without hindering its research effort. Indeed, research and education go hand-in-hand. The Station has a primary objective to obtain as much information as possible about the ecology of Delta Marsh and its surrounding environments. At the same time, this information must be communicated to others through teaching services. In this way, continued research and education will result in obtaining the maximum benefits possible from this valuable natural resource and will promote a greater appreciation for the human environment.

I would like to express my appreciation to all the staff, graduate students and others who made 1972 a successful year. Dr. Jennifer Shay left a very smooth-running Station in July and most of the success of last year is due to her efforts.

John Gee

J. H. Gee
Acting Director

Production and Population Densities of Tadpoles

in Under-Yearling Leopard Frogs at Delta Marsh

S. Bates

Department of Zoology

Introduction

Southern Manitoba is inhabited by extremely dense, localized leopard frog populations. That of the Delta Marsh is not only dense but also relatively isolated, with little competition from other Anuran species. Almost no work has been done on leopard frog populations, either production, growth rates, age distribution, mortality, density and distribution. The density of the Delta Marsh population combined with its isolation give an excellent opportunity for studying these parameters.

The density of this population is also attractive to the biological supply companies. The population of the northern midwestern United States has declined and the suppliers are looking to Manitoba to provide most of the frogs needed in North America. In order to determine what, if any, restrictions should be placed on the collection of a projected 50 million frogs from southern Manitoba, an attempt must be made to estimate the population parameters.

Methods and Results

Work this summer included investigations of egg production and development, tadpole density and development, and size classes of the transformed frogs and adults. One problem in estimating production arose from the localization of breeding. The density of eggs in a given area does not reflect the density in the whole marsh as breeding was confined to a few areas of open water of various depth. Two of these areas were investigated for egg production, one quite thoroughly.

The first area was an arbitrarily chosen 90 x 190-m plot staked out about 500 m southeast of the Field Station. The water was very shallow, bordered by and scattered with clumps of *Typha* and *Scirpus*. It was possible to find and measure all the egg masses, to take small subsamples to estimate the total number of eggs in each mass, and to observe which egg masses survived to hatching. Of a total of 38,000 eggs in the area, 20% failed to develop, 30% of the masses were displaced, and 19,000 or 50% survived to hatch.

The second area studied, the eastern 150 m of the Blind Channel, was too deep and too densely bordered by *Scirpus* and *Typha* to permit any count of the eggs. Egg deposition was dense in localized areas but seemed to stop abruptly as the water deepened.

Egg deposition took place in the first area between the 6th and 18th of May and between the 9th and 21st of May in the second. A period of cold weather between the 5th and 8th of May interrupted all breeding activity in the marsh and due to colder water temperature, breeding in the Blind Channel probably did not start until after the cold weather.

When the eggs hatched young tadpoles remained close to the egg masses for two days and disappeared for about four days. Meanwhile water levels were receding and the tadpoles in the first area were moving south into deeper channels choked with emergent vegetation, and it was difficult to obtain sufficient numbers of tadpoles for growth or density data. At this point, sampling was alternated between the Blind Channel and a ditch immediately south of the Field Station.

In order to estimate densities of tadpoles the ditch was isolated from the rest of the marsh with a 1/4" mesh seine net blocking the connecting culvert. The seine prevented immigration and emigration so that a mark and recapture enumeration of the tadpoles could be attempted. A solution of methylene blue, the longest lasting non-lethal stain of several tried, was injected into the medial fin as a mark. Sampling was done every two days and about 200 tadpoles added to the marked pool after each sample. A total of 1013 tadpoles were marked in the 12 days before transformation began. Estimates indicated between 16,000 and 27,000 tadpoles in the ditch, but no estimate could be made of the rate of predation or death from other causes.

Tadpole development was studied in both areas. Growth was slower in the Channel than in the ditch (Fig. 1) as well as being delayed. In each area body length increased rapidly for the first four weeks after hatching, declined in the fifth week as hind limbs developed, and halted in the sixth week as forelimbs appeared. Transformation finished by the end of the seventh week, the first week in July in the ditch and the second week in July in the Channel.

Large collections of transformed frogs were made throughout the summer to determine age classes, size and frequency distribution. About a thousand frogs each were collected in the first two weeks of May and September (Fig. 2). The September sample was biased; much time was spent collecting adult frogs only in order to have a large enough sample to indicate the adult size classes. One hundred frogs each month were collected at the beginning of June, July and August over a 24-hour period. All frogs were measured for snout-vent length, sexed when possible, marked with a toe clip specific for each month and released.

The May collection consisted of mainly females and juveniles, as the males disappeared from the breeding area shortly after breeding and did not return until July. The June sample contained very few males.

Sixty-five mm was an arbitrary division between mature and juvenile frogs, based on our finding no nuptual pads on frogs smaller than this size. Internal examination of a small sample of frogs of around 65 mm backed up this estimate, but a larger sample is needed to confirm it. The May sample suggests that frogs are not ready for breeding until their third summer. This breeding group virtually disappears after July. Many very large frogs returned to the ditch during transformation of the tadpoles, apparently to prey on the transforming frogs. These may, in an overfed and sluggist condition, have in turn been easy prey for the predatory birds in the area.

From the data of the May and September collections, cumulative frequency was plotted on probability paper in order to separate age classes (Figs. 3-6). Means for each age class are given by the length at 50%. The mean lengths in May were for females, 43 mm, 65 mm and 78 mm. Because the breeding males disappeared immediately after breeding the third male size class for May was represented by smaller males and showed a lower mean length than the females. Comparison of the means for each size class shows that there is no growth over the winter, and that there is a mean increase in size of 23.5 mm in the first year frogs and 17.0 mm in the second year frogs over the summer.

Two hypotheses are available to explain the high density of frogs at Delta. The first is a high starting crop and low turnover with low fecundity, a slow growth and development rate, and a large number of age classes. The second is a high turnover with a fast growth and development and a small number of age classes. Our data seem to fit more closely the second hypothesis, in contrast to many northern species. If such is the case, with proper regulation, southern Manitoba could probably sustain a substantial harvest of leopard frogs with no danger to the population.

FIGURE 1

TADPOLE GROWTH RATES

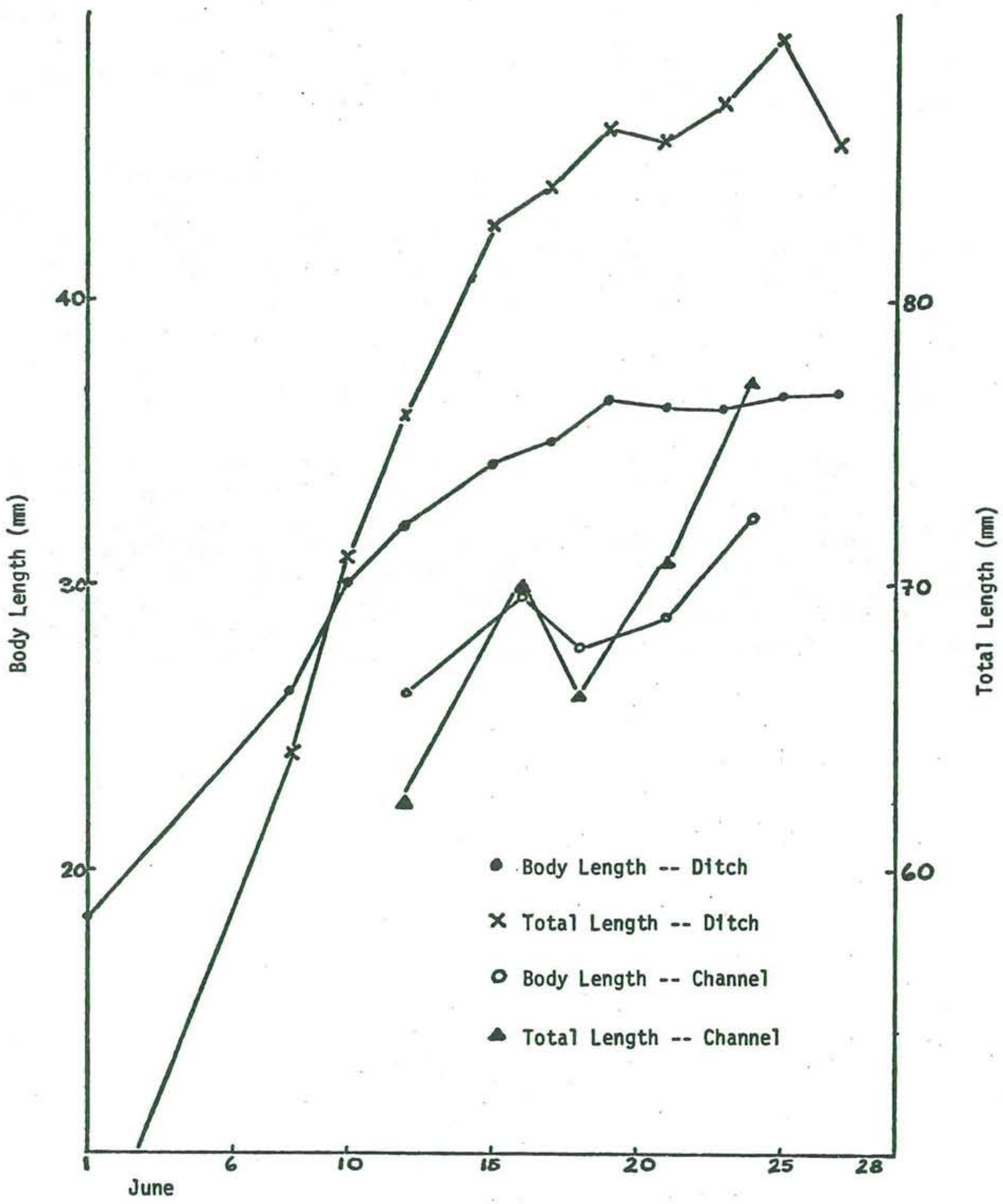


FIGURE 2

SIZE FREQUENCY -- SPRING AND FALL

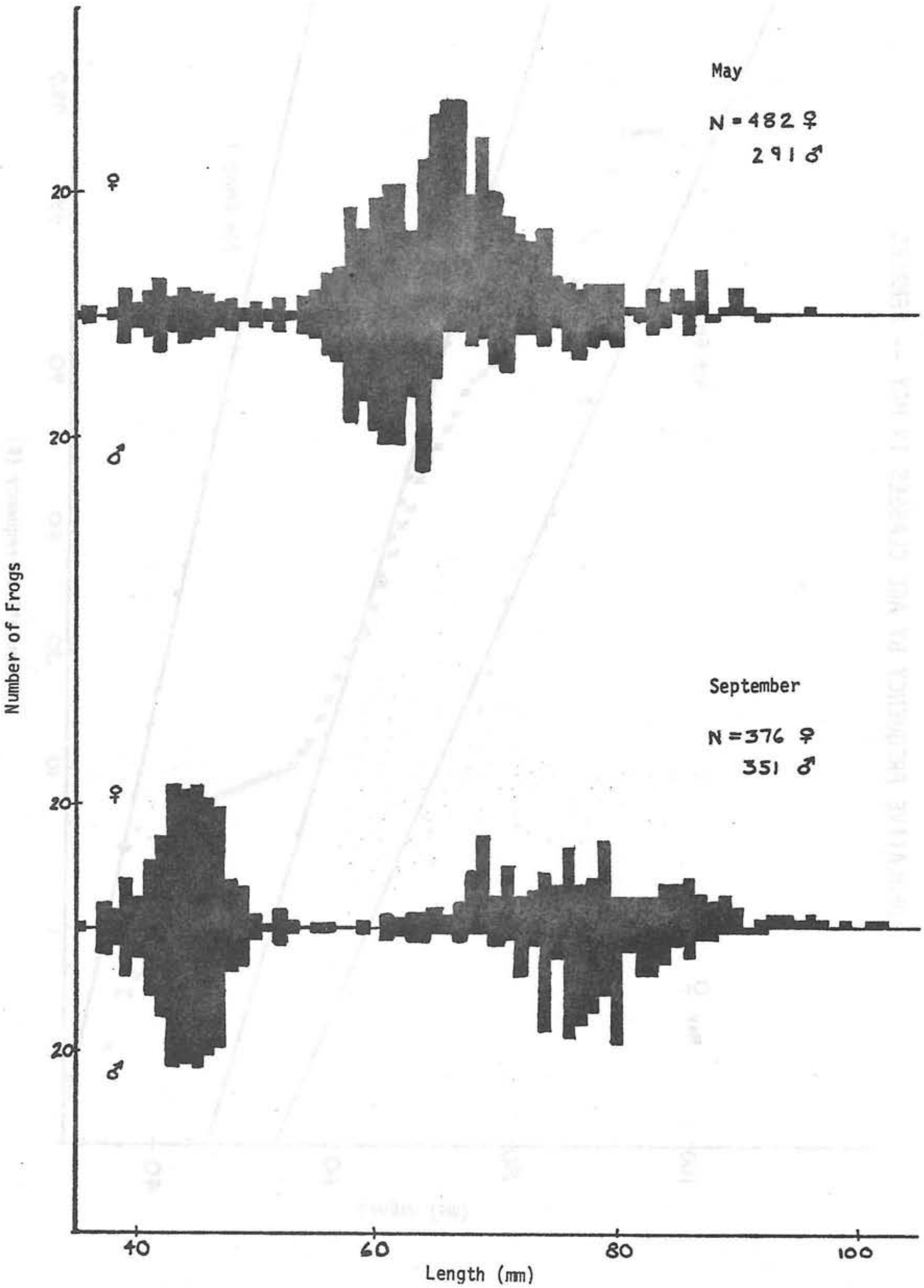


FIGURE 3

CUMULATIVE FREQUENCY BY AGE CLASSES IN MAY -- FEMALES

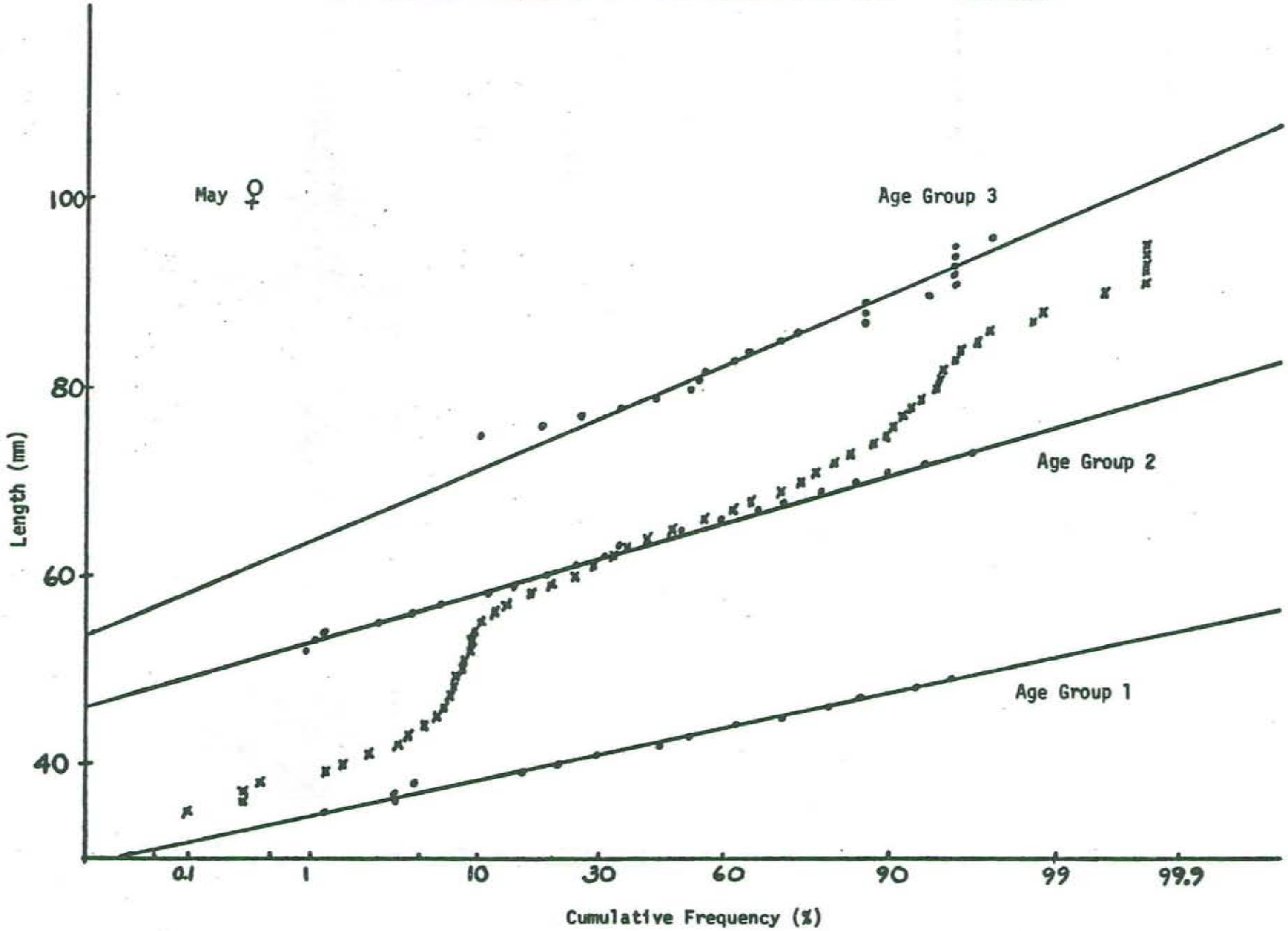


FIGURE 4

CUMULATIVE FREQUENCY BY AGE CLASSES IN MAY-- MALES

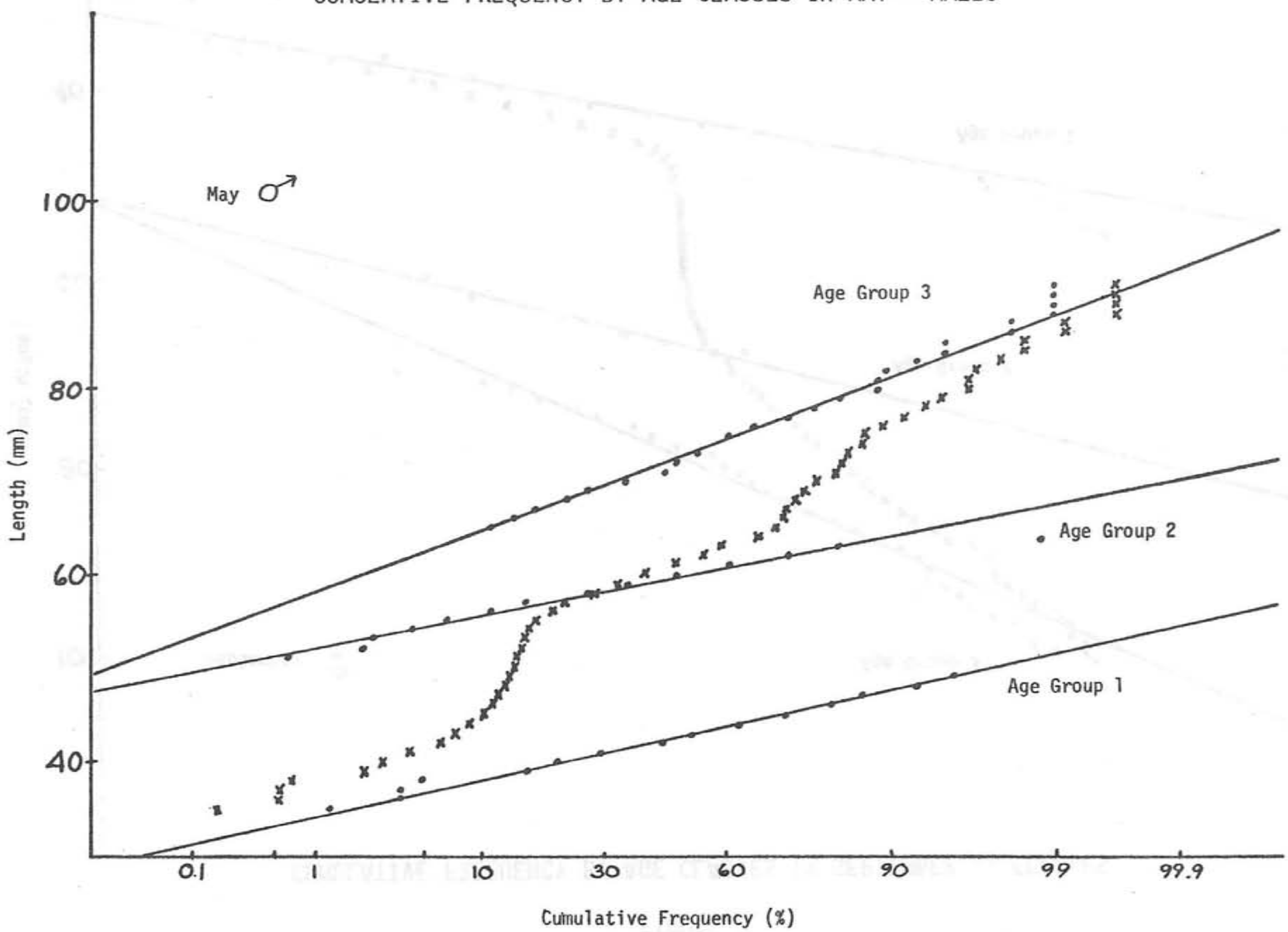


FIGURE 5

CUMULATIVE FREQUENCY BY AGE CLASSES IN SEPTEMBER -- FEMALES

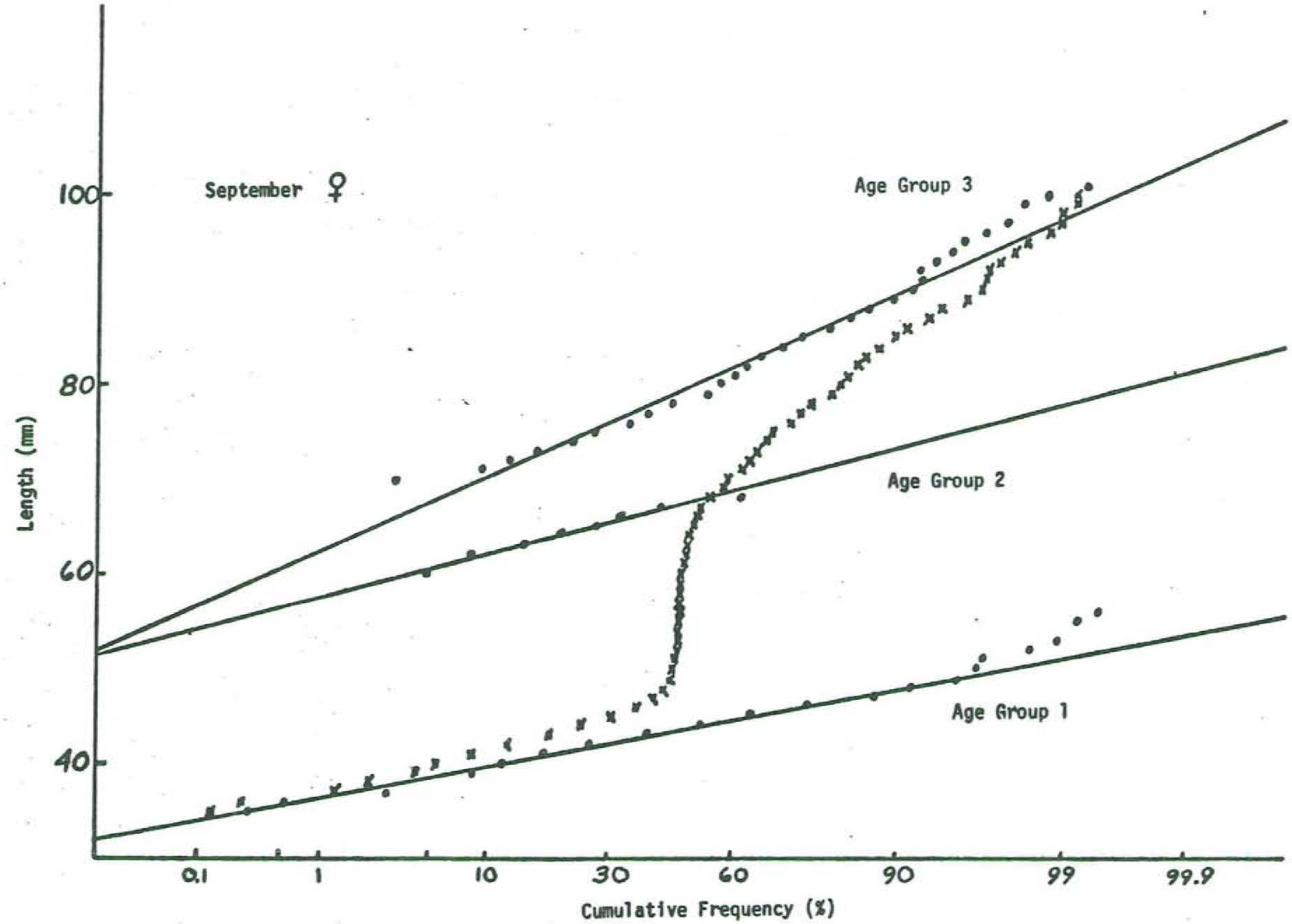
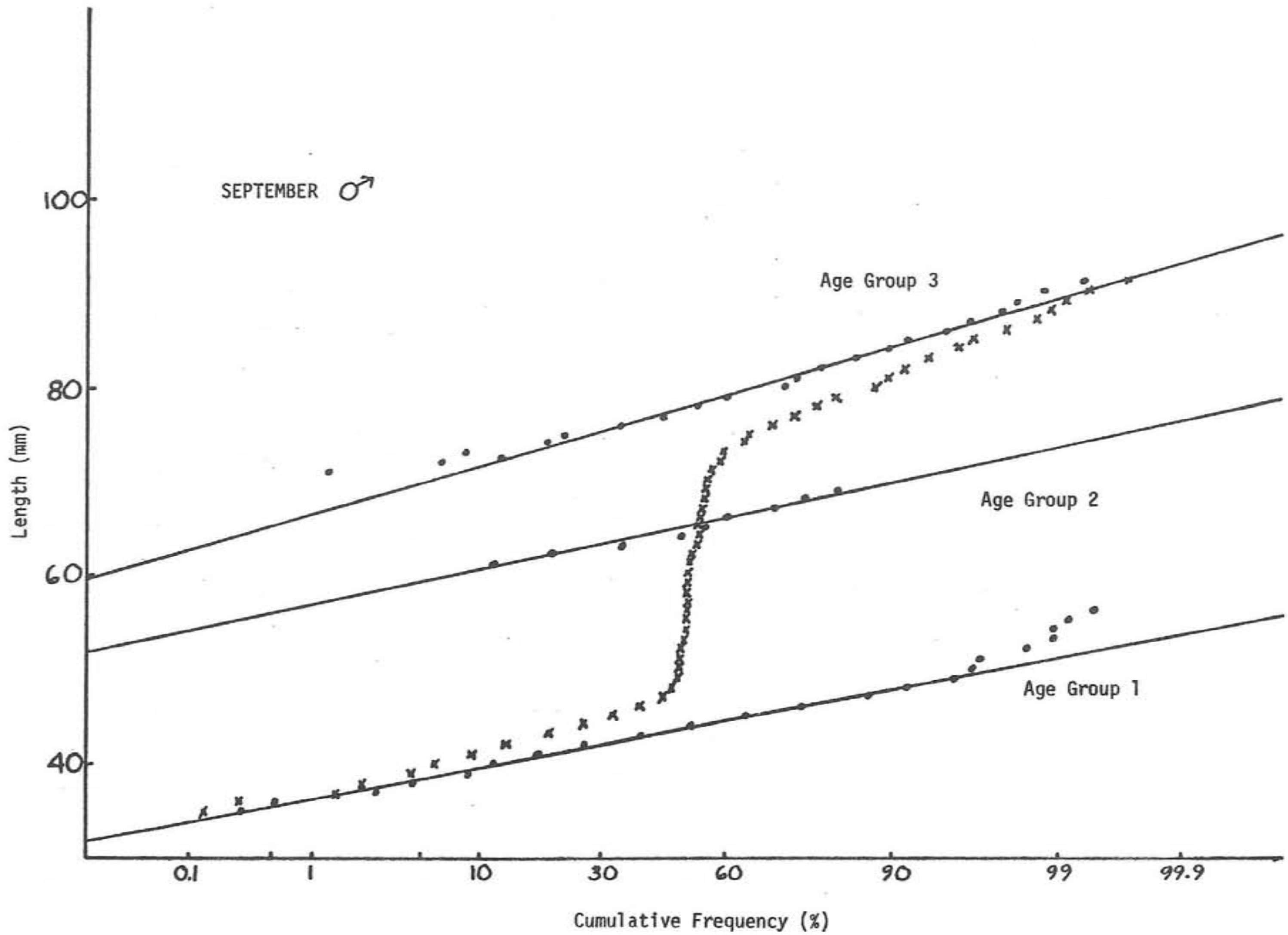


FIGURE 6

CUMULATIVE FREQUENCY BY AGE CLASSES IN SEPTEMBER -- MALES



Ecology of *Scirpus acutus* and *Scirpus validus* in the Delta Marsh

A. J. Macaulay

Department of Botany

Introduction

Bulrushes belong to the genus *Scirpus* of the Sedge family (which includes the familiar *Carex*, spikerush and cotton grass). *S. acutus* and *S. validus* are the largest and most prominent members of the genus in Manitoba. They are often the dominant vegetation of emergent zones in marshes and serve several important functions in wetland ecosystems:

1. Collect debris and speed the filling-in process.

2. Stabilize shorelines and prevent erosion by wave and wind action.

3. Provide nesting habitat for a large number of marsh birds: canvasback, redhead, coot, ruddy, western, pied billed and eared grebes, blackbirds and marshwrens.

4. Food source for ducks which eat the achenes or seeds and for muskrats which eat the succulent bases.

5. Building material for muskrat houses.

These two species are morphologically very similar, showing a range of variation between the two extreme types. This has led to considerable dispute as to whether there are in fact two distinct species. As an added complication, they are often found in the same marsh, occasionally side by side and sometimes intermingling.

Objectives

I have hypothesized that, if the two are in fact different species, some degree of ecological separation should be demonstrable.

Methods

From the infinite number of ecological parameters available, I chose to analyze water chemistry factors (including T.D.S., Ca, Mg, SO_4, pH, Fe, NO_3), water depth and water level regime, and soil organic content and particle size distribution.

In order to avoid subjectively labelling each stand, I scored stands for 11 characters in order to summarize numerically each stand's similarity to one form or another. An assessment of stand performance has also been measured using density and fertility rates.

Results

The hybrid index analysis is not complete, but an example of its application, using one character, is given.

Fig. 1 represents a cross-section of the culm of *S. validus*-type. A measure of the cross-section diameter and the number of aerenchymal lacunae gives a mean lacunar diameter. A scatter diagram (Fig. 2) of these for each stand examined shows two distinct groups with some intermediates on the line of unity. I interpret this as two distinct expressions of the character, one *acutus*-like (1) and the other *validus*-like (1). The intermediates are either morphologically intermediate or mixed stands.

Using mean lacunar diameter, each stand can be plotted against sulfate concentrations (Fig. 3). It is apparent that the *acutus*-type 0.5-1.0 displays a wider range of tolerance than the *validus*-type. Similar correlations exist with Ca and Mg, all of which when combined explain the restrictions of *S. validus* to non-calcareous soils which I showed last year at this time.

Employing the same technique, it is apparent that the *acutus* form will tolerate a much wider range of water depths (Fig. 4). This is also related to the observation made at last year's seminar that *S. validus* is characteristic of sites with temporary water that is dry by freeze up. In fact, *S. validus* will invariably be the form to volunteer on exposed mud, but will not persist should water depths in excess of 50 cm be maintained for two years.

FIGURE 1

SCIRPUS VALIDUS CULM CROSS-SECTION

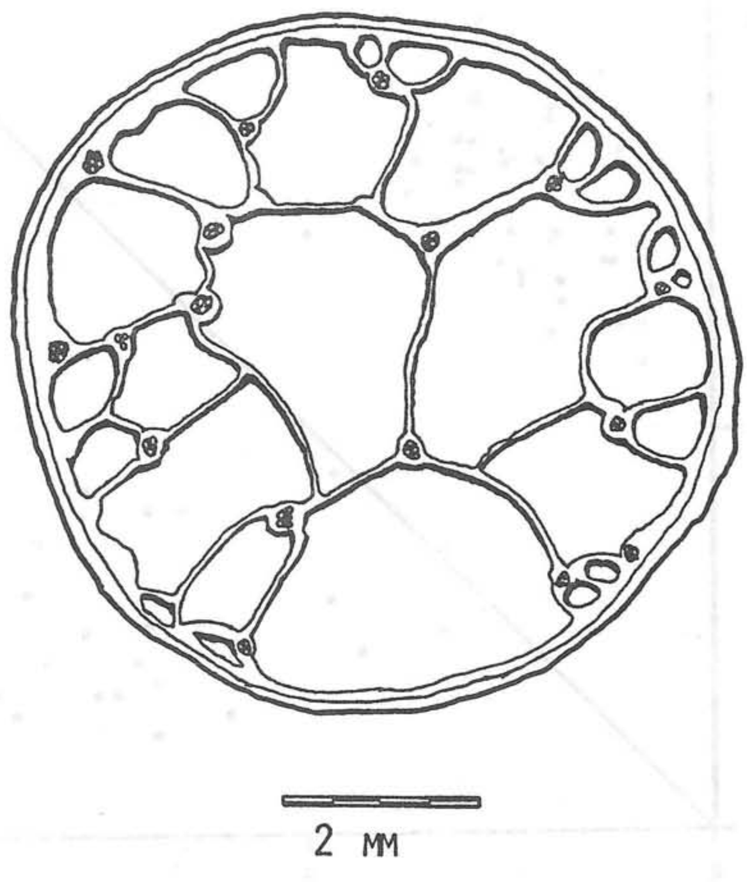


FIGURE 2

RELATIONSHIP BETWEEN CULM DIAMETER AND NUMBER OF AERENCHYMAL LACUNAE
Measurements taken midway along the length of the culm.

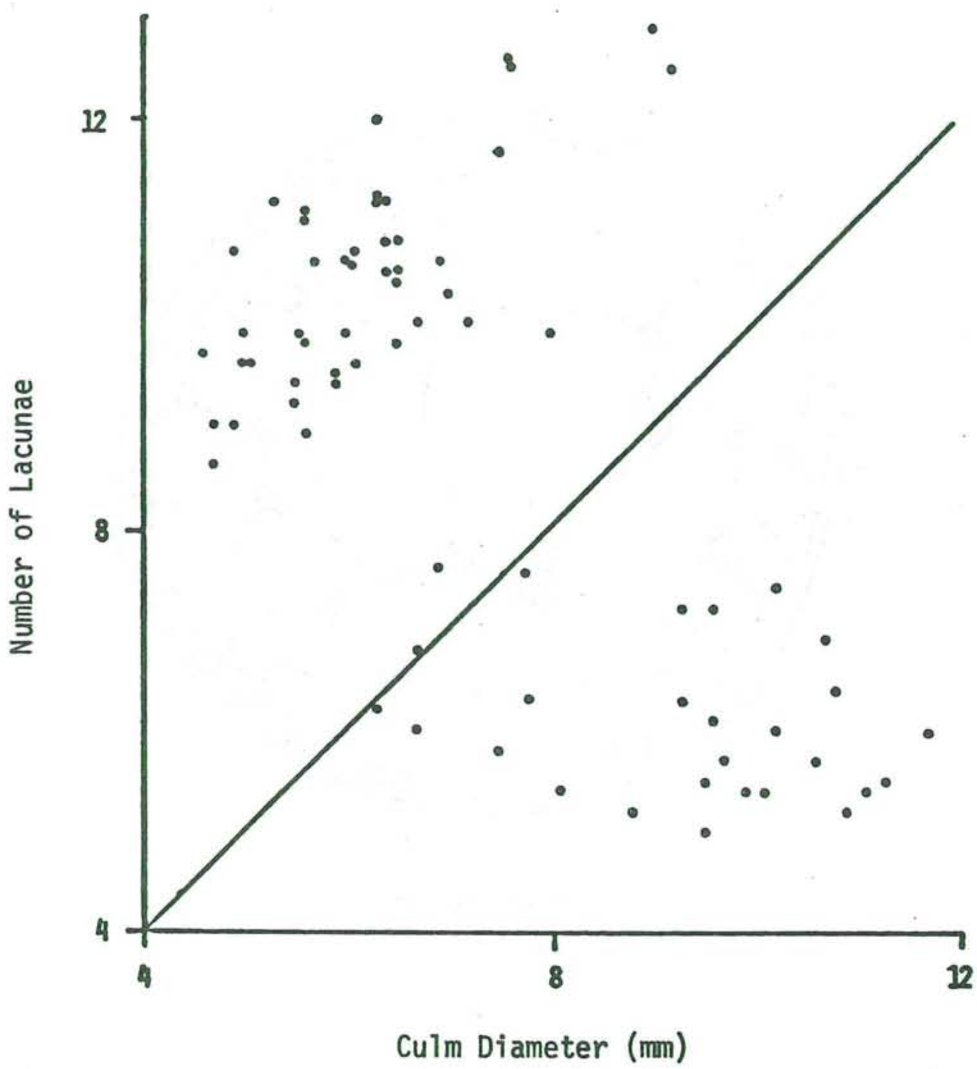
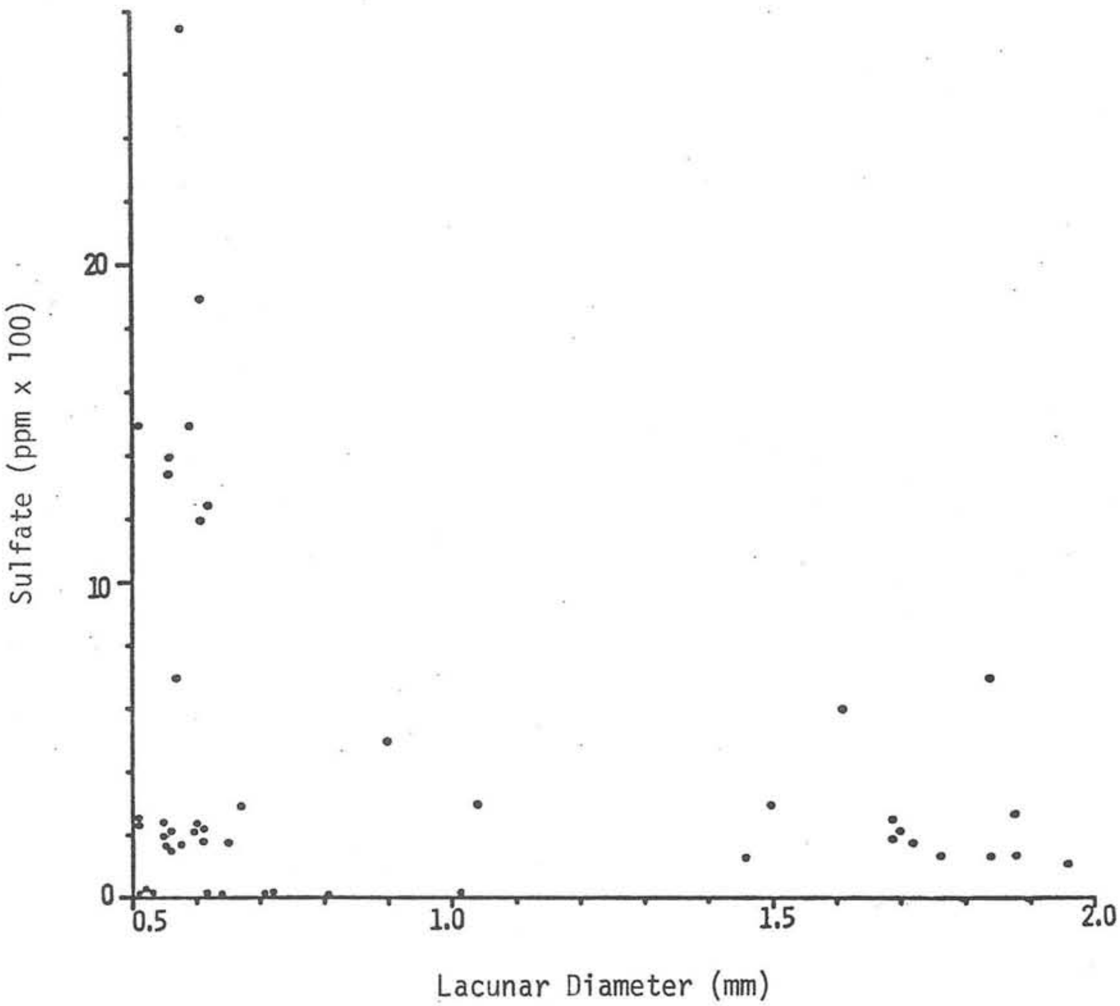


FIGURE 3

RELATIONSHIP BETWEEN LACUNAR DIAMETER
(CULM DIAMETER DIVIDED BY NUMBER OF AERENCHYMAL LACUNAE)
AND SULFATE CONCENTRATION OF SURFACE WATERS



Some of the Ecological Effects of Marsh Burning at Delta Marsh, Manitoba, with Emphasis on *Phragmites communis*-Dominated Communities

E. E. Mowbray

University Field Station

Introduction

Phragmites communis (giant reed grass), is not considered a beneficial plant in terms of waterfowl or marsh management. It appears very few animals utilize it as food, nesting habitat, or for other uses.

In Manitoba the stands die back to ground level each winter leaving standing canes and combustible litter to accumulate from year to year. Burning seems to be a possible method for managing *Phragmites*, *i.e.*, opening up dense stands.

Objectives

1. To determine the effect of prescribed burning on *Phragmites* and associated flora in terms of an increase or decrease of faunal populations or change in plant species composition.

2. To investigate if the density of *Phragmites* can be reduced by burning and under what conditions or intervals.

3. To monitor microclimate on burned and control areas to assess differences.

4. To find out if fall burning results in reduced snow accumulation.

Methods

In this study a controlled burning program has been carried out for 1-1/2 years to determine the effects of fire on *Phragmites* and the associated flora and fauna. The study is to continue for another 1-1/2 years. Data are being collected before burning, on the succession and composition of vegetation following burning, and also on areas selected as controls. The use of the areas by deer and small mammals is being determined. Records are being kept of bird nests found on the areas as well as observations on bird use. Any abnormal increase or decrease in invertebrate populations on the areas is being noted.

If burning proves to be a favorable means of managing *Phragmites*, guidelines will be forthcoming as to the most suitable conditions and intervals for burning.

Results

1. (a) Effect on *Phragmites*

New shoots appear on burned areas 7-10 days after fire. The growth rates recorded exceeded 2.5 cm per day not only during the peak growing season in early summer, but also following burning in July and August.

Biomass increases following burning. Table 1 shows the dried weights for material clipped on control and burned areas. All these clippings were taken in August at peak growth prior to the onset of senescence.

TABLE 1

PRODUCTIVITY OF CONTROL VERSUS BURNED AREAS

Area	Average dried weight of clippings	
	Live material	Dead material
Control areas (average of 50 1-m^2 quadrats)	46.0 gm	32.0 gm
Fall 1971 and spring 1972 burned areas (average of 50 1-m^2 quadrats)	66.4 gm	---

Initial growth in spring on burned areas commenced 10-15 days earlier and these areas remained green 14-20 days longer in autumn than in the respective control areas.

Burning does not appear to affect the height of the *Phragmites*; however, it was noted that shoots leaf out lower on burned areas.

There is no increase in inflorescence on *Phragmites* following burning. Percentage *Phragmites* with inflorescence: control area = 57% and burned area = 56%.

(b) Effect on Associated Flora

To date there has not been any significant change in species composition of the vegetation due to burning. Table 2 compares the frequency of species on three sites with the respective control sites. *Sonchus* (sow thistle) is stimulated to flower by burning, there being 25% more *Sonchus* in bloom on burned areas than on the respective control areas.

2. Effects on Fauna

(a) Small Mammals

Phragmites dominated communities are not productive for small mammals. During 5,902 trap nights, 204 small mammals were live trapped, many of these being recaptures. A few *Microtus* (meadow vole) captured and tagged on a site before burning were recaptured on the same site after burning. They have also been seen burrowing on burned areas which is uncharacteristic of this species. From the data so far collected, it appears that the population of shrews (*Blarina, Sorex cinereus* and *Sorex arcticus*) is reduced after burning while that of deer mice (*Peromyscus*) is increased.

The trapping program was severely affected by skunks which attacked the traps to get at the bait. Thirty-nine skunks were trapped, aged, sexed and tagged. These were released 2-5 miles from the trap sites; one returned to the original site from 5 miles away and four others from 2-4 miles away. Ten skunks were taken from one den, indicating an extraordinarily high population. Skunk activity has now ceased with the onset of sub-zero weather.

(b) Deer

The white-tailed deer (*Odocoileus virginianus*) population appears to find the burned areas attractive. They are not only attracted to the new growth following burning, but are also seen on the areas immediately after the fire. Deer came onto 13 out of the 19 fires monitored (68%) while the areas were still smoking.

(c) Birds

Several species of birds not normally seen around *Phragmites* stands have been noted on the burned areas; these include snipe, killdeer, yellow legs, mourning dove, flickers, Hungarian partridge and sharptail grouse. Marsh hawks, short-eared and great horned owls also appear to be attracted to the burned areas.

3. The density of *Phragmites* is reduced by burning, but burned areas have a higher density of live stems per m^2 than the respective control areas. Table 3 shows the density of *Phragmites* live and dead stems on Sites I, II and III, plus Site IV which was burned on May 5, 1972.

TABLE 3

DENSITY OF *PHRAGMITES* ON CONTROL VERSUS BURNED AREAS

	Site I		Site II		Site III		Site IV	
	Control	Burn	Control	Burn	Control	Burn	Control	Burn
Average live stems/m^2	55.3	69.6	64.4	73	77.4	86.6	59.8	78.8
Average dead stems/m^2	46	0	48.8	0	31.4	0	69.2	0

This increase in live density is strictly from rhizome growth as no seed germination was found on burned areas.

4. Microclimate data are still being processed.

5. Snow accumulation data are being gathered this winter.

Summary

1. Fire increases the density of live *Phragmites* shoots and biomass.

2. Species composition of vegetation does not change because of burning.

3. There is earlier spring growth on areas burned. *Phragmites* growth can exceed 2.5 cm/day.

4. Population of shrews is adversely affected by fire, whereas deer mice increase following fire and meadow voles survive fire well.

5. Deer are attracted to burned areas.

6. Many birds are seen on burned areas that are not normally associated with *Phragmites* habitat.

TABLE 2

FREQUENCY OF SPECIES EXPRESSED AS A PERCENTAGE OF OCCURRENCE OVER QUADRATS SAMPLED

Species	Site I[1]				Site II[2]				Site III[3]			
	Burn[4]		Control		Burn		Control		Burn		Control	
	1971	1972	1972	1971	1971	1972	1972	1971	1971	1972	1972	1971
Phragmites	70	72.5	81.2	80	100	100	100	100	100	100	100	100
Cirsium	80	98	95	90	63	75	75	60			10	
Mentha	55	42.5	45	45	30	35	22	28	5		15	5
Stachys	45	70	61.6	37								
Sonchus	85	100	91.8	91.8	90	95	90	90	30	10	5	10
Urtica	5		10	5	32	35	38.5	40				
Lycopus	15	26.6	31.6	20	29	31	20	20				
Teucrium	7.5	13.3	5	10	10	12	7.5	5	10		35	20
Aster	22.5	28.3	31.6	17.5								
Typha	25	23.7	21.2	21.2								
Melilotus		5										
Scolochloa	25	20	25	25								
Cicuta	1.2		3.7	3.7								
Scirpus acutus	3.7	2.5	16.2	13.7								
Carex	3.7	3.7	2.5	2	34	40	40	39				

[1]Site I is a marginal stand with the lowest density of stems ($55/m^2$) and was burned May 15, 1972. Each column based on 80 permanent quadrats.

[2]Site II is an intermediate stand burned on October 10, 1971. Each column based on 120 randomly thrown quadrats.

[3]Site III is a *Phragmites* island with very few other species present and was burned on September 15,1971. Each column based on 60 randomly thrown quadrats.

[4]Burn 1971 data are before the sites were burned.

A Preliminary Investigation into the Fungal Flora of Delta Marsh Soils

J. W. Pearn

Department of Botany

Abstract

As a part of the research program at the University Field Station, Delta, Manitoba, a study of soil inhabiting fungi is being undertaken. The various components of soil fungal populations are isolated from the soil of selected habitats using soil washing and replicate plating techniques. These techniques are designed to permit identification and an estimate of numbers of individual organisms present. Preliminary results indicate a large number of organisms are present, and the species composition is different from that initially anticipated.

Introduction

The University Field Station, Delta, Manitoba, has, over the past six or seven years, carried out a research program on various aspects of a marsh ecosystem. As a part of this program, it is desirable to have a general index of the fungal flora, because the role of fungi as decomposers in any ecosystem is extremely important, and most biomass, regardless of its nature, is eventually affected by this decomposer group. More specifically, in a marsh ecosystem where productivity is large, fungal populations are likely to be large and diverse.

My research program concentrated on the study of the identity, distribution and abundance of soil fungi.

Methods

Two habitats were selected for sampling of soil fungi: the wooded ridge separating the lakeshore and the marsh, and a pure stand of *Phragmites communis* within the marsh (Fig. 1).

Soil fungi are obtained at each site by random sampling of soil from each of four 1-m^2 permanent quadrats. Using a soil core borer, soil samples are removed from the 0-10, 10-20 and 20-30 cm intervals. Four cores from each of these intervals are collected in each of the four permanent quadrats; the resulting 16 cores are then bulked. A sampling template ensures random and equal collection of soil (Fig. 2).

The fungal population of soil is heterogeneous, Phycomycetes, Ascomycetes and Fungi Imperfecti being routinely isolated from soil. However, not all of them are natural soil inhabitants. The *Penicillia* and *Aspergilli* are examples of two groups which are frequently isolated from soil, but both of these groups sporulate profusely on decaying vegetation and large numbers of spores are easily introduced into the soil. Some less-vigorous natural soil-inhabiting fungi may be predominantly mycelial with only sparse sporulation. Other fungi such as the members of the genus *Fusarium* can produce a resting stage or chlamydospore. If results from the isolation of soil fungi are to be meaningful, then isolation procedures must be designed in such a manner that separation of these various forms is possible. I use the following isolation scheme, shown in Fig. 3.

The techniques employed here have been designed to obtain as many different fungi as possible. Soil washing removes many soil-born spores; the separate plating of diluted wash water and diluted washed soil reduces subsequent competition in culture and permits slower-growing mycelial forms to become established. This procedure also aids in separating soil invaders such as some of the *Aspergilli* and *Penicillia*, which tend to sporulate freely; and soil inhabitants which are often predominantly mycelial. Since separate plating of wash water and washed soil cannot completely eliminate competition in culture, the growth inhibitors, oxgall and sodium propionate, are added to culture media. This not only prevents slower-growing colonies from being overgrown, but produces discrete colonies which are easily counted and isolated. Plating of samples onto different culture medias containing different nutrients and incubating replicate sets, each at 10, 15, 20 and 25° C, should assist in eliminating nutritional selectivity of the media to particular fungi. The procedures should also give an impression of the temperature regimes at which different fungi are active in the soil.

Results

Results from the dilution platings indicate that both sample sites have fungal populations which are not particularly large, but diverse. Estimates of population numbers based on the 0-10 cm soil interval suggest that the wooded ridge has 15,500 propagative units/gm dry weight of soil and the *Phragmites* stand 66,000 propagative units/gm dry weight of soil. At least 75 distinct species appear to be represented among the 6,000 pure isolates obtained from both sites. Some of the more-common genera from these isolates are *Penicillium*, *Fusarium*, *Chrysosporium*, *Cylindrocarpon*, and *Paecilomyces*. Several of the *Cylindricarpon* isolated are undescribed species.

Discussion

In comparison, Timonin (1935), using only the soil dilution plate technique, recorded fungal population numbers from 87,000 to 270,00/gm dry weight of soil for the A horizon of five different Manitoba soils. Bisby *et al.* (1933, 1935) recorded 177 species of fungi from a wide range of Manitoba soils.

It is possible that additional species will be identified as cultural examination and comparisons are completed. It is also possible that some entities presently thought to be distinct might merely be an expression of the normal range of variation within a single species such as is common in *Penicillium* species. If this were the case, the total number might be reduced.

In conclusion, it is hoped that the information from this project will aid in arriving at a more-complete understanding of the marsh ecosystem.

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FIGURE 1

SAMPLING SITES

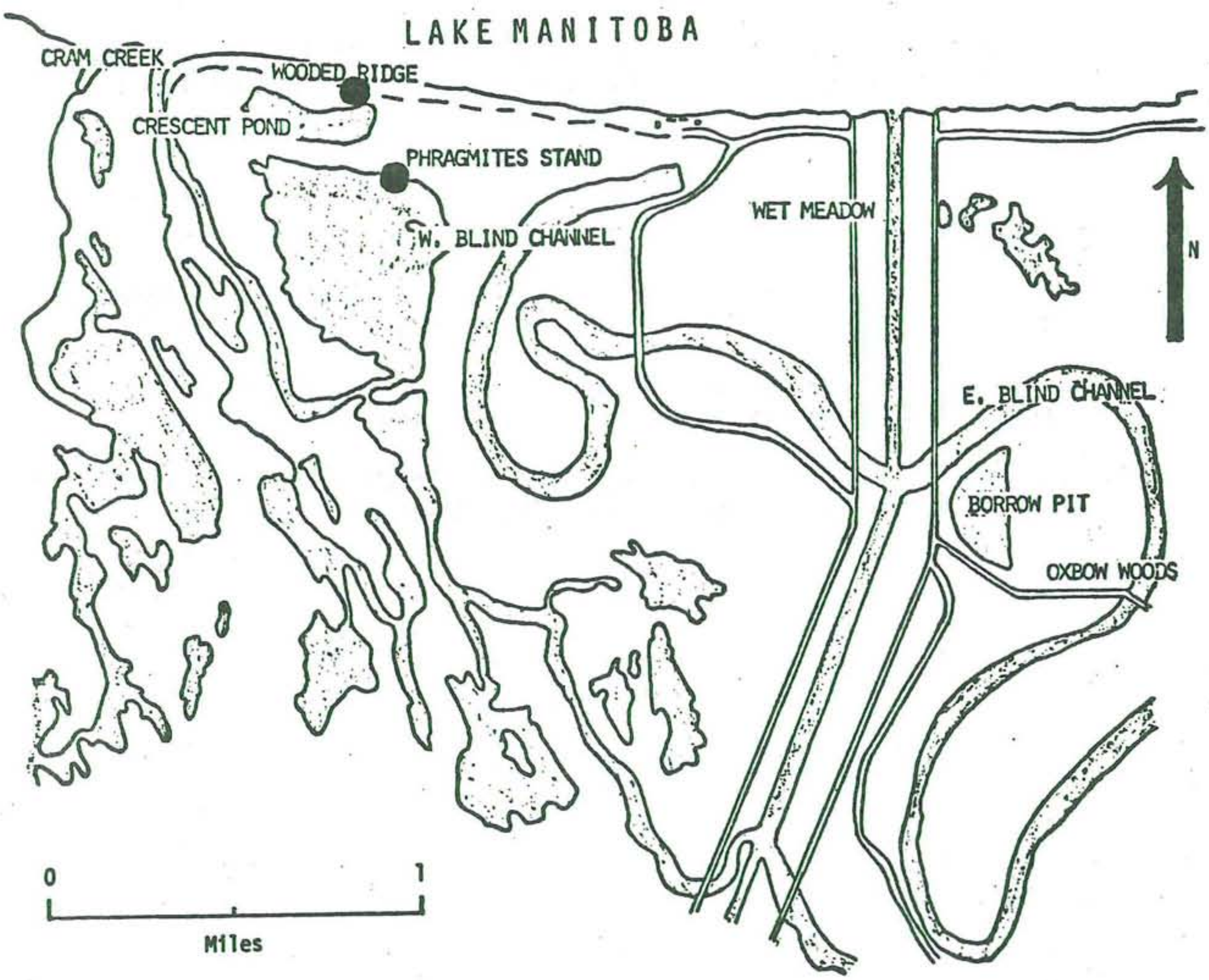

FIGURE 2

SOIL SAMPLING EQUIPMENT

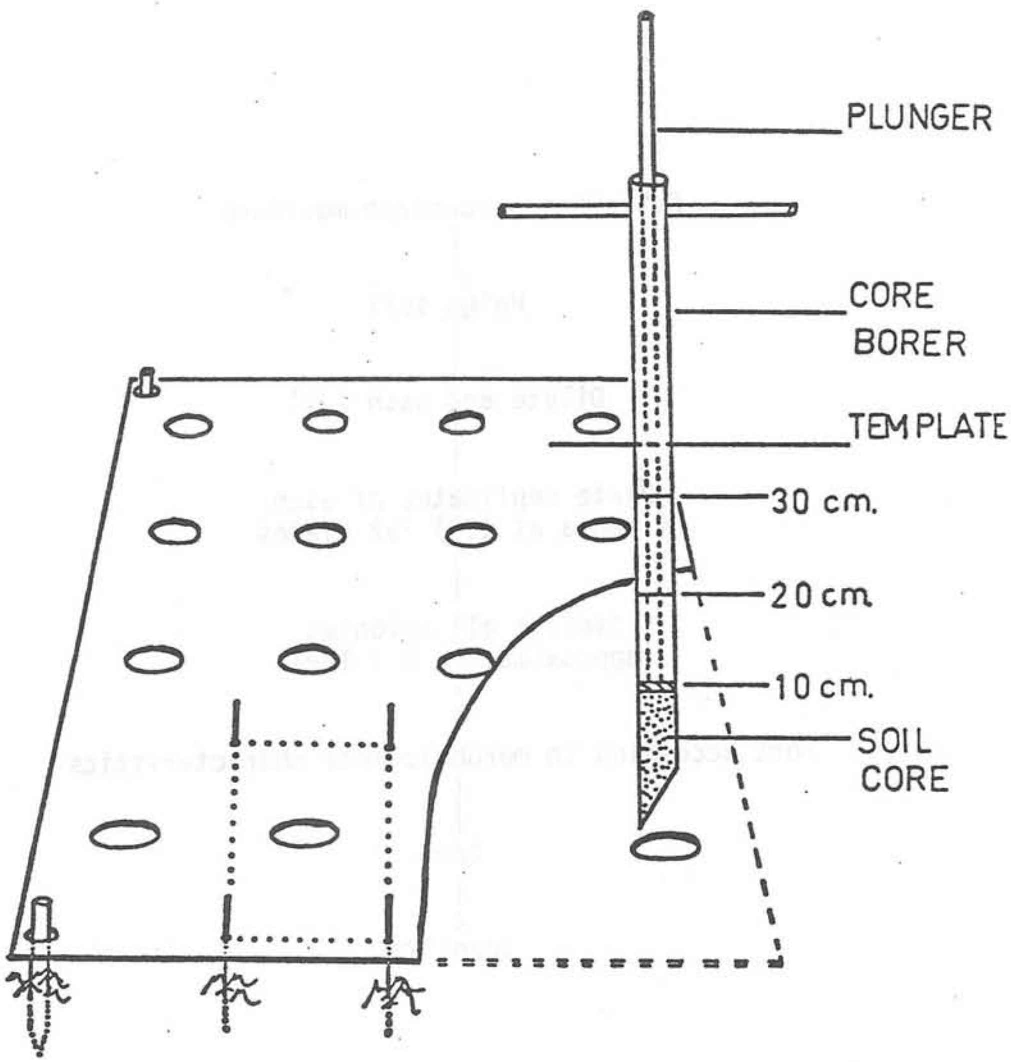

FIGURE 3

ISOLATION SCHEME

Determine percentage moisture

Weigh soil

Dilute and wash (3x)

Plate replicates of each
(4 media at 4T°) 192 plates

Isolate all colonies
(approximately 2 x 10^3)

Sort according to morphological characteristics

Store

Identify

The Dynamics of Plant-Snail Associations in the Delta Marsh

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Department of Botany

Introduction

The most conspicuous components of many small aquatic ecosystems in Manitoba are the large primary producers and the macroscopic primary consumers. Of the latter the gastropod molluscs make up the largest proportion in terms of both numbers and biomass. Almost no conclusive studies concerning plant-snail interrelationships in fresh waters have ever been carried out. The aim of this study was to determine whether gastropods are positively associated with submerged macrophytes, and if so, whether any species-specific correlations appear to exist.

Methods

Three sites in the Delta Marsh area were selected for this study. Two of the sampling sites, a 100-m x 100-m portion of open shoreline of Lake Manitoba with *Potamogeton pectinatus* as the dominant submerged macrophyte and a 30-m x 30-m portion of Crescent Pond dominated by *Myriophyllum exalbescens*, were well exposed to the wind. The third site, a sheltered roadside ditch south of the Field Station buildings in the west marsh, contained four plant species in substantial numbers and is the site further considered here.

The ditch could be divided into three discreet zones. The first two zones were almost completely sheltered from the wind; the first attained a maximum seasonal water depth of 0.75 m and consisted largely of pure stands of *Potamogeton pectinatus*. The second zone, with a maximum seasonal water depth of over 1 m, supported mixed stands of *Ceratophyllum demersum* and *P. pectinatus*. The third zone was subject to greater wind action and reached 0.75 m at its deepest point. It consisted of pure stands of *P. richardsonii* along the sides, together with isolated patches of *Myriophyllum exalbescens*. The deepest regions of this zone were devoid of macrophyte vegetation. Thermal stratification was very marked in the first two zones. Approximately 600 m^2 (7 m x 86 m) of the ditch was used for sampling, encompassing part of the first zone and all of the second and third zones.

Twenty substrate samples including the rooted vegetation were taken every two weeks using a 15 x 15-cm Ekman dredge. A 590-ml subsample consisting of 30% of the original Ekman sample area and volume was taken together with the corresponding vegetation. This subsample size contained all the mollusc species present in the original sample and yet was large enough to provide a reproducible estimate of the rooted shoot density. The subsample was filtered down through a nest of sieves, the smallest mesh being 1 mm. All molluscs were extracted from the plants, identified and measured and it was noted whether they were alive or dead. Wet and dry weights of the plants were determined; these were found to correlate with cover estimates at a significance level of less than 1%. Cover was estimated using a specially designed calibrated reflecting rule 0.5 mm long. A series of counts of live snails on each plant species was made independently of the sampling on the same day in addition to the Ekman samples.

Results

The results of the Ekman samples are shown in Fig. 1. The horizontal axis is the time axis; each interval represents a two-week period commencing with May 17 and ending on August 22. The vertical axis denotes the percentage ratio of the mean observed density of each species at a given time in a given series of samples over the mean maximum density observed for that species at any time in any series of samples. The perpendicular axis represents the 15 species or groups of species present in the ditch. Solid bars indicate the mean fraction of the total number of individuals of each species observed that were alive.

In Fig. 1a, Series A summarizes the data for the non-vegetated samples. It can be seen that no live snails occurred in these samples at any time. Series B represents the samples that contained *Potamogeton richardsonii*. Most conspicuous is the increase of *Lymnaea stagnalis*, species 1, in the latter part of the summer. In Fig. 1b, Series C deals with samples containing *P. pectinatus*. Here *Physa gyrina*, species 10, shows an increase during midsummer while lymnaeid species (1-4) show irregular fluctuations. Series D represents *Myriophyllum exalbescens* and, in Fig. 1c, Series E represents *Ceratophyllum demersum*. Insufficient numbers of shoots of the latter species were present in the samples of the first three sampling periods for representative means to be calculated.

Analysis of the significance of the difference between the means for each species at each time in the non-vegetated samples and each of the vegetated samples by means of unpaired t-tests revealed that *Lymnaea stagnalis* was highly significantly associated with *Potamogeton richardsonii*. Unpaired t-tests for the significance of the difference of the means between the *P. richardsonii* and the *P. pectinatus* samples showed that the above associations reached a peak prior to the end of June for *Physa gyrina* and prior to the beginning of August for *Lymnaea stagnalis*. These findings coincided with the results of the independent live counts of the snails (Fig. 2). Part A of Fig. 2 shows *Lymnaea stagnalis* occurrence as a percentage of the total number of snails of all species observed on each species of plant during each sampling period; part B represents the occurrence of *Physa gyrina*.

Analysis of snail size distribution classes is currently in progress to determine whether these preferences are due to some behavioural peculiarity dependent on the life cycle or whether, as now seems likely, the respective plants are producing certain metabolites at particular times of the year to which specific gastropod species are attracted. Subsequent study will be directed towards the examination of these two associations in detail.

FIGURE 1A

TIME AND SPACE-RELATIVE SPECIES-SPECIFIC DENSITY OF MOLLUSCS IN THE DITCH WITH RESPECT TO THE OCCURRENCE OF PLANT SPECIES

Each interval on the horizontal time axis denotes a two-week period commencing from May 17, 1972 and ending on August 22, 1972. The vertical axis represents the percentage ratio of the mean observed density for each species at a particular time in a given series of samples over the maximum observed density of that species at any time in any series of samples. The perpendicular axis represents the 15 species or groups of species present in the ditch (see Figure 1C).

Series A = non-vegetated Ekman samples
Series B = samples containing *Potamogeton richardsonii*

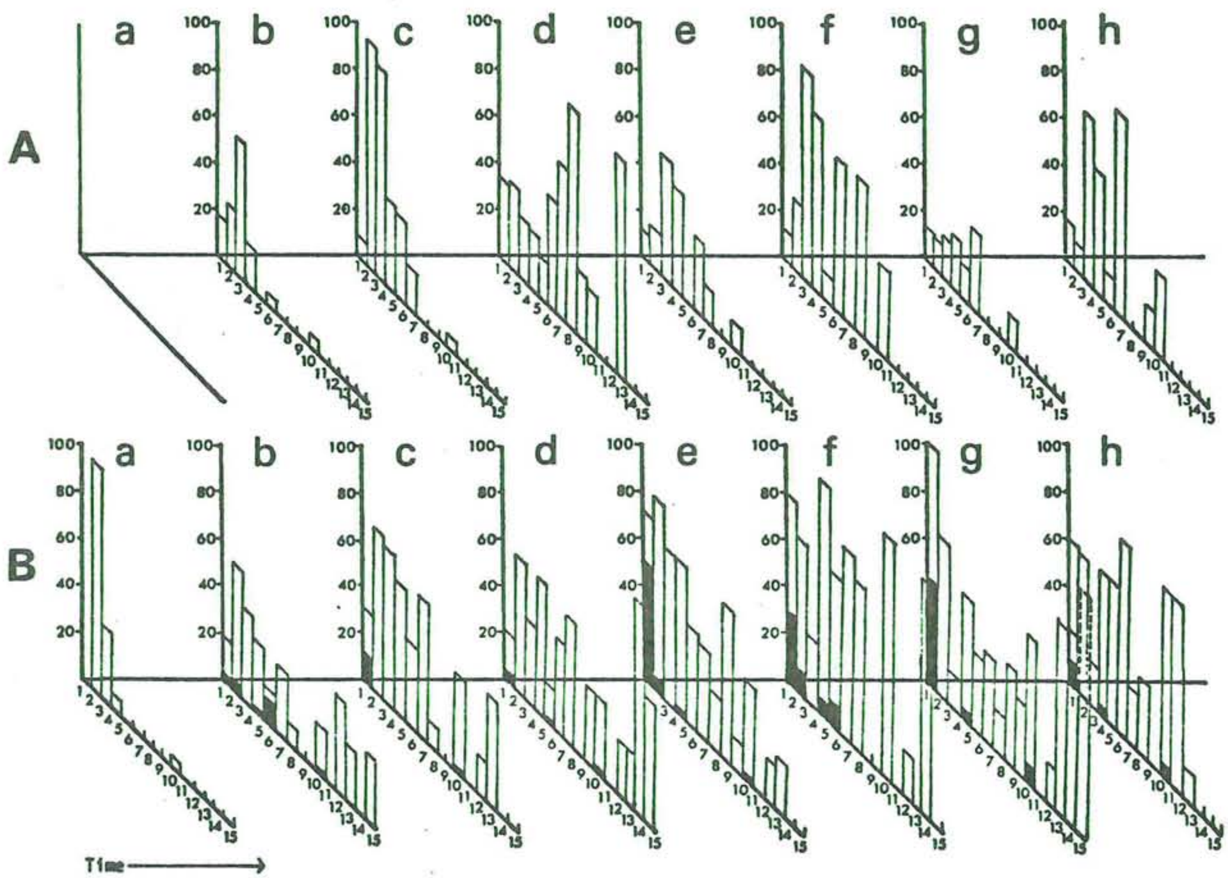


FIGURE 1B

TIME AND SPACE-RELATIVE SPECIES-SPECIFIC DENSITY OF MOLLUSCS IN THE DITCH WITH RESPECT TO THE OCCURRENCE OF PLANT SPECIES

Each interval on the horizontal time axis denotes a two-week period commencing from May 17, 1972 and ending on August 22, 1972. The vertical axis represents the percentage ratio of the mean observed density for each species at a particular time in a given series of samples over the maximum observed density of that species at any time in any series of samples. The perpendicular axis represents the 15 species or groups of species present in the ditch (see Figure 1C).

Series C = samples containing *P. pectinatus*
Series D = samples containing *Myriophyllum exalbescens*

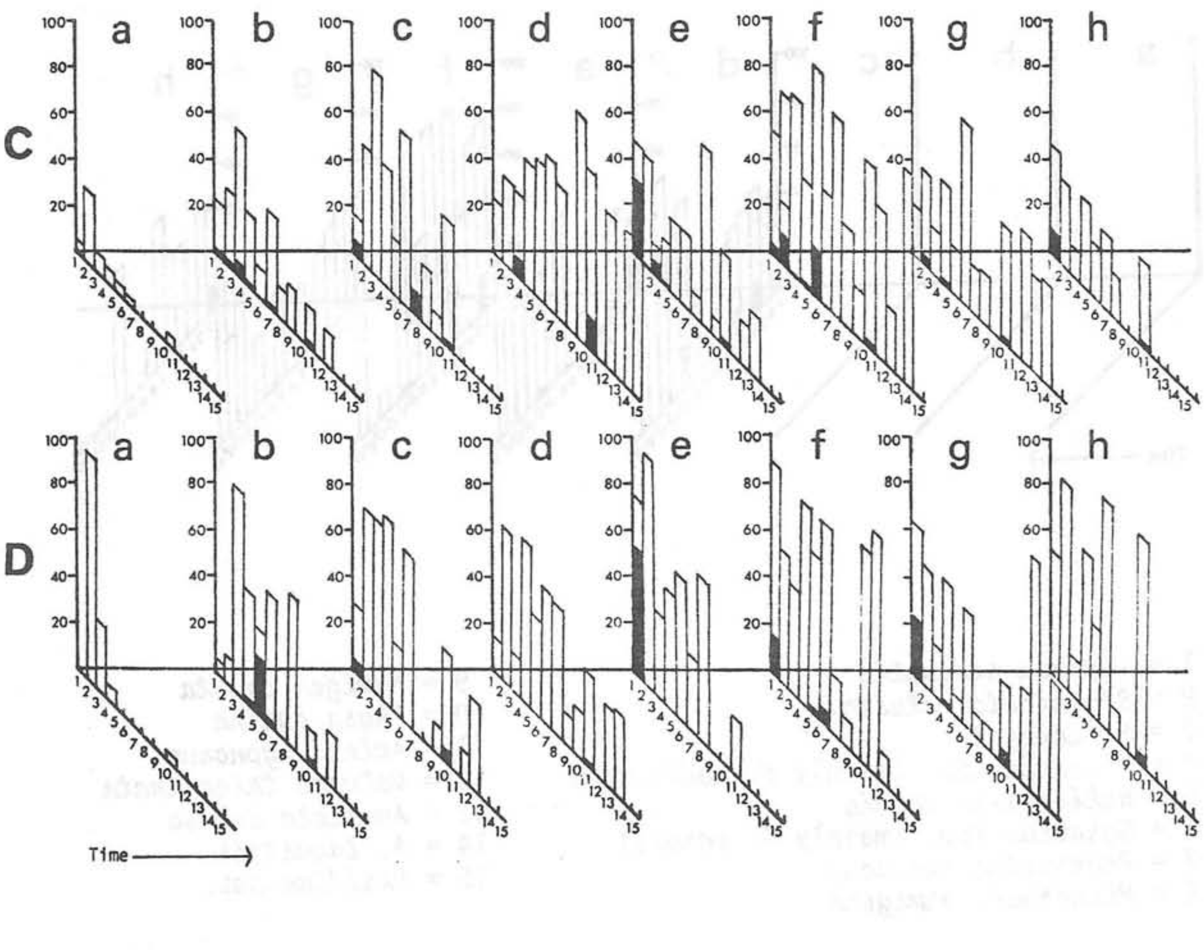
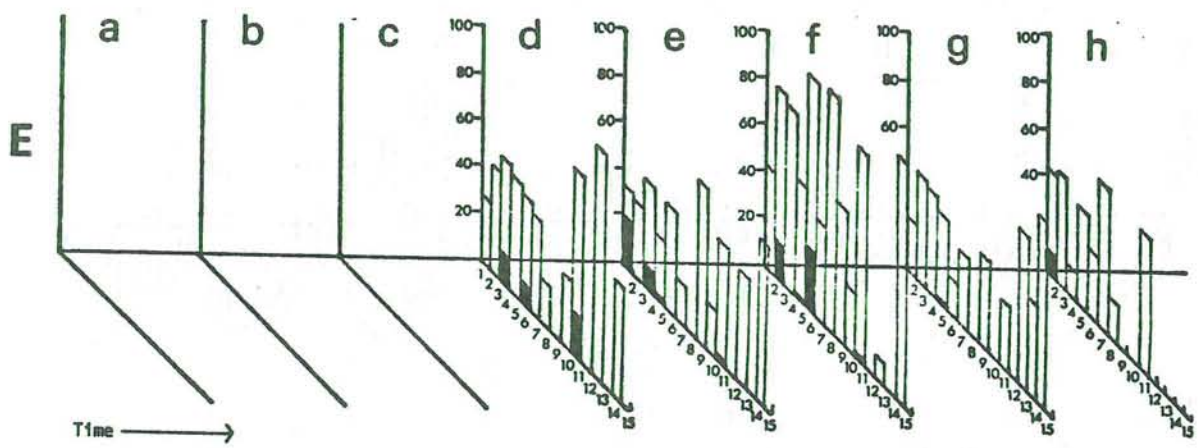


FIGURE 1C

TIME AND SPACE-RELATIVE SPECIES-SPECIFIC DENSITY OF MOLLUSCS IN THE DITCH WITH RESPECT TO THE OCCURRENCE OF PLANT SPECIES

Each interval on the horizontal time axis denotes a two-week period commencing from May 17, 1972 and ending on August 22, 1972. The vertical axis represents the percentage ratio of the mean observed density for each species at a particular time in a given series of samples over the maximum observed density of that species at any time in any series of samples. The perpendicular axis represents the 15 species or groups of species present in the ditch (see below).

Series E = samples containing *Ceratophyllum demersum*



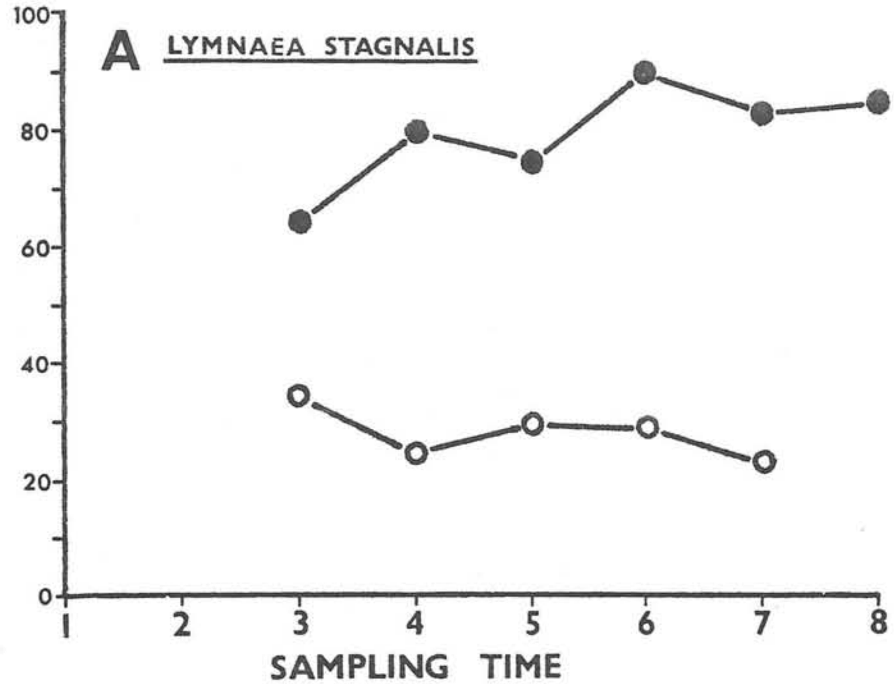
1 = *Lymnaea stagnalis*
2 = *Stagnicola palustris*
3 = *S. caperata*
4 = *Fossaria* spp. (mainly *F. modicella*)
5 = *Helisoma trivolvis*
6 = *Gyraulus* spp. (mainly *G. parvus*)
7 = *Promenetus exacuous*
8 = *Planorbula armigera*

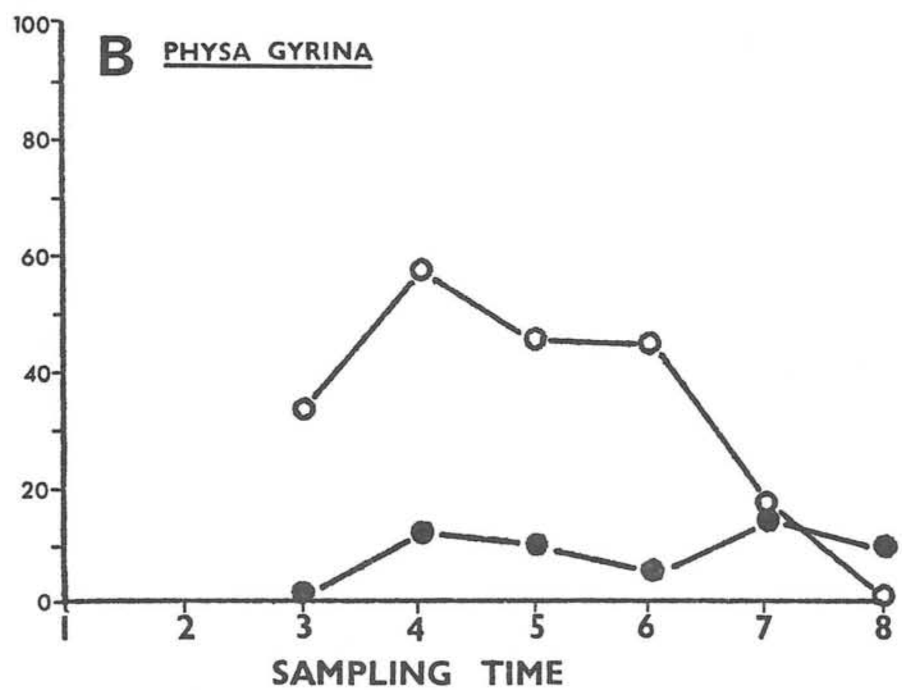
9 = *Armiger crista*
10 = *Physa gyrina*
11 = *Aplexa hypnorum*
12 = *Valvata tricarinata*
13 = *Amnicola limosa*
14 = *A. lacustris*
15 = *Pisidium* spp.

FIGURE 2

LYMNAEA STAGNALIS (PART A) AND *PHYSA GYRINA* (PART B) INDIVIDUALS AS A PERCENT OF THE TOTAL NUMBER OF SNAILS OF ALL SPECIES OBSERVED ON *POTAMOGETON PECTINATUS* (CLOSED CIRCLES) AND *P. RICHARDSONII* (OPEN CIRCLES) DURING EACH SAMPLING PERIOD

The sampling periods are two weeks apart and commence with May 17, 1972





The Effects of Municipal Sewage on the Behaviour Pattern of Ducks

Part I. A Preliminary Report

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Department of Psychology

Introduction

As prairie pot holes continue to dry up and disappear, concern mounts over the fate of the ducks that use these pot holes to reproduce and rear their young. A supplemental source of breeding habitat would benefit the ducks that normally use prairie pot holes.

One such possible source is the sewage lagoon or stabilization pond that frequently is associated with a large city. The sewage in these ponds consists mainly of human excreta with smaller contributions from food preparation, washing, laundry, surface drainage, etc. (Painter, 1971). The purpose of sewage treatment is to reduce the harmful and asthetically objectionable components of sewage (*i.e.*, colour, odour, floating solids) before these waters are discharged into receiving rivers and lakes.

Dornbush and Anderson (1964) have found that large numbers of ducks frequent stabilization ponds. Even larger numbers use the ponds during migration. McAnulty (1964) found that stabilization ponds are becoming more and more numerous in North America. He felt their attractiveness was due to the low costs involved in building a stabilization pond as compared with the costs of building a mechanical sewage treatment plant. As the number of sewage lagoons increases, it stands to reason that more and more ducks will make use of them, especially if the prairie pot holes continue to dry up. The purpose of this study was to determine if the use of such ponds effects the behaviour of ducks that reside on them.

Method

Subjects

The subjects used in this study were mallard ducks obtained from Whistling Wings in Hanover, Illinois. Upon their arrival the birds were banded and habituated to the general environment. This included day length, temperature, and each other. I do not know if any pair bonds existed among any of the birds that were shipped to us.

Apparatus and Procedure

Many different types of birds were observed to frequent the study site naturally. Among them were various shore birds, such as the avocet, Hudsonian godwit, Wilson's phalarope, and the black-bellied plover. Gulls, such as the glaucous gull and Franklin's gull, live at the study site. Eared grebes, western grebes, mallards, shovellers, blue-wing teal, pintails, coots, scaup, bufflehead, and redhead ducks, among others, were also frequent visitors and inhabitants of the area.

The study site consisted of five ponds, each of which differed in the degree to which it contained human excrement. Pond 1 contained raw sewage. Pond 5 was the cleanest and was fed back into the Assiniboine River. On each pond a smaller enclosure was erected into which the subjects were placed. Poles were pounded into the ground and snow fencing was laid beside it. The fencing was attached to the poles by means of wire and a special tool. Isolation pens were erected so that the subjects could be habituated to the site, so that spare subjects could be kept there, and so that injured birds could recuperate there. By means of a pontoon boat and our own boats we erected the snow fencing in the water as well as across the land. The resulting enclosure was triangular-shaped and fairly similar on all ponds. Within each pond we placed floating islands that were made of 1 x 12-inch planking, 2 x 4's, and styrofoam. In one corner of each island we erected a backdrop since incubating females seem to like a semi-enclosed structure with an open roof. The islands were anchored in place by means of wire and cinder blocks. The ducks accepted the floating islands readily and when nesting material was placed in them, they made nests with little difficulty. On each bank of each pond we placed a feeder capable of holding 50 pounds of a commercially prepared food.

When the birds had been habituated to the study site we randomly assigned two males and eight females to each pond. Observers stationed themselves outside of the study area and watched the birds from early in the morning to late in the evening. Maps of each pond enabled the observers to check the study site daily and on a predetermined schedule to record the number and location of eggs that were laid. Although eggs were laid in nests constructed on land, all of these clutches were destroyed by predators. Every other day the floating islands were checked for eggs. Very few eggs laid on the floating islands were lost to predators. After the young had hatched, their behaviour patterns were observed on the same schedule as the adults.

The ducks were observed during periods of time when they were most active. These periods of time were determined by observing the birds for 24 hours per day for five days.

The behaviour patterns which were of interest to us were feeding, drinking, shaking, stretching, cleaning movements, nibbling, oiling, bathing, swimming, sleeping and resting, and incubation. Each of the foregoing behaviour patterns was evaluated both in the morning and in the evening. Some of the behaviour patterns were divided into smaller, more meaningful components. For instance, feeding was divided into feeding from the water, feeding on land, and feeding from the feeder. In addition to the above measures, we also utilized the following ones concerning nesting success: total eggs laid, total eggs incubated, total number of rotten eggs, number of ducklings that hatched, number of ducklings alive after the first week, number of dead ducklings, number of missing ducklings, and number of abandoned nests.

With reference to each behaviour pattern, the null-hypothesis that was tested was that the proportion of birds emitting a particular behaviour pattern was unrelated to the level of pollution in each of the five ponds. A statistically significant finding would result in a failure to accept the null-hypothesis. That is, the proportion of birds emitting a particular behaviour pattern would be related to the degree of pollution on the five ponds. The Chi-square (2-tailed) test was used to evaluate the reliability of the previously mentioned relationship. The Chi-square goodness of fit test (2-tailed) was used in conjunction with the nesting success data.

Results

Of all of the behaviour patterns mentioned, the only ones that did not demonstrate a reliable relationship between their frequency of occurrence and the level of pollution on each pond were drinking in the morning, shaking in the morning, the combined effects of stretching in the morning and stretching in the afternoon, and oiling. With regard to nesting success, it was found that there were significant differences among the ponds with reference to the total number of eggs laid, the total number of eggs incubated, and the number of ducklings that were alive after one week.

Discussion and Summary

At this point an accurate interpretation of the data is hard to arrive at. It seems safe to say that the behaviour patterns of the ducks does differ as a function of the sewage lagoon in which they were placed. The exact nature of the cause of this difference is not known at this time, however. A chemical analysis of the water in each of the five ponds was made each week of the study. We hope to be able to correlate this information with the obtained differences among the five ponds.

In addition to affecting the frequency of occurrence of their behaviour patterns, the nature of the ponds seems to also influence some of the measures of nesting success.

One of the puzzling aspects of these results is that the birds on the various ponds seem to differ with respect to their reaction to the water in which they were placed but they don't seem to be adversely affected by the water itself. Whether this is because the ducks eat the organisms associated with domestic sewage or because we provided a supplementary source of food is not known. At any rate, it is not clear from these results as to whether the water in each of the five ponds is detrimental to the birds residing in them. Certainly their behaviour differs as a result of some aspect of them. Until we do further research on this problem, we won't be able to make any definite statements regarding the effects of municipal sewage on mallard ducks.

We are hopeful that subsequent studies will indicate that ducks can be reared in this environment. The natural presence of so many species of waterfowl makes us think that this may be the case. In addition, most of the ponds did support the adult ducks, eggs were laid, and young did hatch. If this site turns out to be an appropriate one at which one can rear birds, then we will be in a good position to provide a supplemental source of breeding habitat for our duck populations.

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APPENDIX I

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13. Allocated, but not fulfilled.

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